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

In the Matter of	)	
	)	
International Comparison Requirements Pursuant to the Broadband Data Improvement Act	)	GN Docket No. 17-199
	)	
	)	
International Broadband Data Report	)	

SIXTH REPORT

Adopted: February 2, 2018 **Released: February 2, 2018**

By the Chief, International Bureau:

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I. INTRODUCTION

1. As required by Section 103(b) of the Broadband Data Improvement Act (BDIA), we issue this sixth International Broadband Data Report (Report), which provides comparative international information on broadband services and, where possible, a year-to-year measure of the extent of broadband service capability in the United States and select communities and countries abroad.[1] In this Report, we compare fixed and, for the first time, mobile broadband (LTE) speeds in the United States with the selected countries, to the extent data are available. We improve upon our pricing comparison from

[1] 47 U.S.C. § 1303(b). The Broadband Data Improvement Act, Pub. L. No. 110-385, 122 Stat. 4096 (2008), is codified in Title 47, Chapter 12 of the United States Code. 47 U.S.C. § 1301 *et seq.*

previous reports by providing a more comprehensive assessment of the competitiveness of broadband in each country and the value that broadband providers are delivering to consumers. We include a comparison of high-speed fixed and mobile broadband deployment in the United States and in Europe. Finally, we present demographic, market, and other regulatory information relating to broadband service capability. We include the highlights of our findings in this Report, and present the detailed data sources and additional discussion in the relevant appendices.

II. BACKGROUND

2. The BDIA requires the Commission to include as part of its assessment in the annual broadband deployment report "information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers."[2] The BDIA directs the Commission to choose international communities comparable to various communities in the United States with respect to population size, population density, topography, and demographic profile.[3] The Commission is required to include "a geographically diverse selection of countries" and "communities including the capital cities of such countries."[4] The Commission must "identify relevant similarities and differences in each community, including their market structures, the number of competitors, the number of facilities-based providers, the types of technologies deployed by such providers, the applications and services those technologies enable, the regulatory model under which broadband service capability is provided, the types of applications and services used, business and residential use of such services, and other media available to consumers."[5]

3. *Thirteenth Broadband Deployment Notice of Inquiry and Comments.* In the *Thirteenth Broadband Deployment Notice of Inquiry*, the Commission sought comment "on how to best interpret the statutory obligations" of the BDIA and how "to improve our next international assessment."[6] The Commission asked whether it should continue using the same overall approach to the international assessment as in past years[7] and whether it should select "at least 25 countries that have developed broadband markets, which have readily available data."[8] The Commission asked whether it should continue to present, for example, actual broadband speeds in different countries by using the publicly

[2] 47 U.S.C. § 1303(b)(1). Several terms that we use in this Report, such as "broadband," "advanced telecommunications capability," and "availability" may have specialized meanings in other contexts, and nothing in this Report should be read to suggest that our use of terminology here is intended to affect the meanings of other specialized terms in the context of the *2018 Broadband Deployment Report* or in other proceedings. *See, e.g., Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, GN Docket No. 17-199, Broadband Deployment Report, FCC 18-10, (Feb. 2, 2018) (*2018 Broadband Deployment Report*). The *2018 Broadband Deployment Report* incorporates by reference this Report to fulfill the requirements of Section 103(b) of the BDIA. 47 U.S.C. § 1303(b).

[3] 47 U.S.C. § 1303(b)(2).

[4] *Id.*

[5] *Id.* § 1303(b)(3).

[6] *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, GN Docket No. 17-199, Thirteenth Section 706 Report Notice of Inquiry, 32 FCC Rcd 7029, 7044, para. 51 (2017) (*Thirteenth Broadband Deployment Notice of Inquiry*).

[7] *Id.* at 7044-45, para. 52. Past international assessments have included comparisons of actual broadband download speeds, prices for fixed and mobile service plans, rural and non-rural broadband deployment (comparing the United States and Europe), demographic data (population, income, and education), and a summary of market and regulatory aspects of the countries included for comparison.

[8] *Id*. at 7045, para. 53.

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available speed test data provided by Ookla, proprietor of speedtest.net.[9] The Commission also sought comment on "how best to compare fixed and mobile broadband pricing in the United States with the selected countries," including whether to use a hedonic approach, and if so, whether previously captured price variables are adequate.[10] The Commission also sought comment on whether there are other sources of international broadband pricing data that could better improve the quality and usefulness of the comparisons.[11] The Commission also invited commenters to provide any relevant qualitative and quantitative data or suggest data sources that could improve our analysis.[12]

4. We received very few comments regarding how to best interpret the statutory obligations of the BDIA or ways to improve the international assessment. One commenter recognized the inherent difficulty in comparing the United States to other countries, but stated "it can still be instructive to compare similar locales in various countries."[13] Some commenters stated that international comparisons are of limited use, indicating, for example, that it is "doubtful that 25 comparable countries exist" due to the United States' large size, number of sparsely populated areas, and low density cities as compared to large foreign cities.[14] No commenter specifically offered or suggested alternate sources of broadband speed or price data.[15]

III. DISCUSSION

5. *Selection of Countries for Comparison*. The BDIA directs the Commission to report information comparing the extent of broadband service capability "in a total of 75 communities in at least 25 countries abroad."[16] To implement the statutory directive, we selected 28 foreign countries for comparison with the United States. To guide our selection of countries with comparable communities for this Report, we developed several criteria to meet the statutory directive of developing a geographically diverse and detailed set of data on international broadband service capability.[17] First, we attempted to select countries with comparable communities[18] by selecting countries that have more developed broadband markets. We focused on those Organization for Economic Cooperation and Development (OECD) Member countries that have the highest levels of broadband adoption under the assumption that

[9] *Id*. at 7045, para. 54.

[10] *Id*. at 7045-46, para. 55. A hedonic regression provides an empirical summary of how prices vary with the characteristics of a good. Our hedonic regression builds on the price index by allowing adjustment of prices for cost and demographic differences across countries and then predicting broadband prices for each country at the average U.S. values of these variables. *See infra* Appx. C at para. 2, note 5.

[11] *Thirteenth Broadband Deployment Notice of Inquiry*, 32 FCC Rcd at 7045-46, para. 55.

[12] *Id.* at 7045, para. 52.

[13] Judd Rodgers Comments at 1.

[14] Richard Bennett Comments at 8.

[15] Some commenters referenced various international broadband reports suggesting that the United States lags behind other countries for various broadband metrics, such as speed. *See, e.g.*, Thaddeus Ballantine Comments at 1 (citing Akamai data to state that "we [the United States] are not in the front in terms of bandwidth in fact we are 14th based on average download speed and 16th in terms of average peak speed"); David G. Mackay Comments at 1 (citing Speedtest.net/global-index to note that "the US ranks at number 9 for fixed broadband, and 46th for mobile").

[16] 47 U.S.C. § 1303(b)(1).

[17] *Id.* § 1303(b)(2).

[18] *Id.* ("The Commission shall choose communities for the comparison under this subsection in a manner that will offer, to the extent possible, communities of a population size, population density, topography, and demographic profile that are comparable to the population size, population density, topography, and demographic profile of various communities within the United States.").

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countries with higher levels of broadband adoption have more developed broadband markets.[19] Second, we included only countries for which substantial and relevant information is available.[20] The OECD also regularly compiles demographic and broadband data on all Member countries, and other broadband data such as speeds, prices, and deployment for these countries are readily available from other public sources.[21]

6. We combined the OECD fixed and mobile broadband subscription data for each country to assess which OECD countries have the highest broadband subscriptions.[22] Based on these data, the United States is included in the top 27 ranked OECD countries. For comparison with the United States, we selected the following top 26 OECD foreign countries (in alphabetical order): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Portugal, South Korea, Spain, Sweden, Switzerland, and United Kingdom. To increase geographic diversity and representation of the Americas region, we also included OECD Members Chile and Mexico although these countries are not among the top 27 foreign countries with the highest levels of broadband adoption. By including two additional countries, we compare up to 28 foreign countries to the United States (for a total of up to 29 countries), which exceed the statutory minimum of 25 comparison countries.[23] Our international comparisons reflect that the sources, definitions, and/or time periods of available data often differ by country and by dataset.[24]

[19] We note that the OECD's subscription metrics define transmission speeds of at least 256 kbps in one direction as "broadband service" for both fixed and mobile Internet access, which is slower than the 25 Mbps download/3 Mbps upload speeds which the Commission considers as "advanced telecommunications capability." *2018 Broadband Deployment Report* at para. 15. However, it is our view that the OECD's subscription metric, when applied across all countries, including the United States, provides a sufficiently reliable metric for selecting the countries to be discussed in this Report. In particular, the OECD Broadband Portal provides data on the number of broadband subscriptions (fixed and mobile) per 100 inhabitants. OECD, Broadband Portal, Fixed and Wireless Broadband Subscriptions per 100 Inhabitants, Table 1.2 (Dec. 2016) (*OECD Broadband Subscriptions Table 1.2*), http://www.oecd.org/sti/broadband/1.2-OECD-WiredWirelessBB-2016-12.xls. The OECD broadband subscription data include fixed broadband subscriptions with downloads speeds that are at least 256 kbps (DSL, satellite, terrestrial fixed wireless) or greater than 256 kbps (cable, fiber, broadband over power lines, leased lines), and mobile subscriptions which advertise data speeds of 256 kbps or greater. OECD, *Broadband Methodology: OECD Broadband Subscriptions Criteria (2015)* (*OECD Broadband Methodology*), http://www.oecd.org/sti/broadband/broadband-methodology.htm.

[20] *International Comparison Requirements Pursuant to the Broadband Data Improvement Act; International Broadband Data Report*, GN Docket No. 15-191, 31 FCC Rcd 2667, 2668-69, para. 3 (2016) (*Fifth International Broadband Data Report*).

[21] *See* OECD, *Members and Partners*, http://www.oecd.org/about/membersandpartners/ (last visited Jan. 16, 2018) (identifying OECD Member countries).

[22] *OECD Broadband Subscriptions Table 1.2*.

[23] 47 U.S.C. § 1303(b)(1); *see infra* Appx. A.

[24] The data relied upon in this Report come from a variety of sources, including contractual arrangements with TeleGeography, S&P Global (formerly SNL Kagan), and Ookla, staff research, and publicly available records.

IV. HIGHLIGHTS OF THE FINDINGS

7. In this section, we present highlights of our findings. The detailed presentation of the analysis and data is in the relevant appendices.

A. Broadband Speed Comparison

8. In Appendix B, we present information on "data transmission speeds" for broadband service capability as directed by the BDIA.[25] We present data on actual fixed and mobile broadband speeds based on data gathered by Ookla for the United States and 27 comparison countries for a ranking of fastest actual speed (1st) to slowest (28th).[26] Broadband speeds are often presented as either advertised speed or the actual speed.[27] We obtained actual speed data from Ookla[28] for our fixed and mobile international speed comparisons, which are collected primarily from software-based tests on an end user's device using speedtest.net.[29] The data are aggregated at the city level and include observations in 2014, 2015, and 2016 for both U.S. and international cities.

9. *Fixed Broadband Speed Results*. The United States ranked 10th out of 28 countries in 2016 in terms of actual download speeds (55.07 Mbps) weighted by the number of tests in each city—an improvement from a ranking of 11th in 2015 (40.38 Mbps) and 15th in 2014 (28.09 Mbps).[30] In 2016, the median weighted download speed for the United States increased to 55.44 Mbps from 40.17 Mbps in 2015 and 28.29 Mbps in 2014, and the U.S. ranking improved from 14th in 2014 and 13th in 2015 to 10th out of the 28 comparison countries.[31]

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[25] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers.").

[26] Due to data availability, the broadband speed comparison does not include Latvia. *See infra* Appx. B at para. 11.

[27] Actual speed is measured primarily by two methods: (i) by installing special hardware on an end user's device that enables the hardware to measure actual download and upload speeds and (ii) software-based tests. Steve Bauer, David Clark, William Lehr, Massachusetts Institute of Technology, *Understanding Broadband Speed Measurements* at 11-17 (2010) (*MIT Report*), https://www.measurementlab.net/publications/understanding-broadband-speed-measurements.pdf. In this Report, "actual speed" refers to mean actual speed unless otherwise specified. *See infra* Appx. B, para. 2, note 4.

[28] We obtained speed data through a contractual arrangement with Ookla. Ookla, *Ookla Speedtest* (*Ookla Speedtest*), http://www.speedtest.net (last visited Jan. 16, 2018). We note that generally, crowd-sourced data (such as Ookla's) can provide the benefit 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. Crowd-sourced data, however, are often not collected pursuant to statistical sampling techniques, and may require adjustments to construct a representative sample from the raw data. For instance, crowd-sourced mobile data come from a self-selected group of users, and there often is little control for most tests 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. *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 Mobile Wireless, Including Commercial Mobile Services*, WT Docket No. 13-135, Seventeenth Report, 29 FCC Rcd 15311, 15405-06, para. 191 (2014) (*Seventeenth Mobile Wireless Competition Report*).

[29] Ookla's mobile speed measurements are derived from customer tests run by Ookla Speedtest mobile apps that measure the performance of mobile connections. Ookla, *Ookla Speedtest Mobile Apps* (*Ookla Speedtest Mobile*), http://www.speedtest.net/mobile/ (last visited Jan. 16, 2018).

[30] *See infra* Appx. B, para. 14, Tbl. 2 and Fig. 1.

[31] *Id.* at para. 15, Tbl. 3. Our calculations are based on the median of the city-level averages reported by Ookla. Because the data are aggregated at the city level and we do not have access to individual speed test records, we

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10. *Mobile Broadband Speed Results.* With regard to actual mobile broadband speeds, the United States ranked 24th out of 28 countries in both 2016 (19.98 Mbps) and 2015 (15.58 Mbps), and 18th in 2014 (12.62 Mbps).[32] Actual mobile download speeds in the United States increased by approximately 58 percent from 2014 to 2016.[33] In 2016, the median weighted download speed for the United States increased to 19.36 Mbps from 12.62 Mbps in 2014, and its ranking decreased from 17th to 24th out of the 28 comparison countries.[34]

11. *Historical Overview of U.S. Fixed Broadband Speed*. Based on data from past International Broadband Data Reports, we present U.S. fixed download speeds and rankings from 2012 to 2016 to show some indication of how speeds and U.S. rankings have evolved over time. We note that due to differences in the Ookla data from 2012-2013 and the data from 2014-2016, the earlier data are not directly comparable to the later data.[35] Nevertheless, the data indicate that for the United States, both speeds and international rank have been on a rising trend since 2012.[36] Based on mean speed measurement, the United States ranked 25th fastest of 40 countries in 2012 (14.50 Mbps), and 26th fastest of 40 countries in 2013 (18.67 Mbps).[37] As noted above, the mean U.S. speed rank has since risen to 10th fastest of 28 countries in 2016 (55.07 Mbps).[38]

B. Broadband Price Comparison

12. In Appendix C, we present in detail our fixed and mobile broadband price analysis as directed by the BDIA.[39] We examine advertised broadband prices for both fixed and mobile service plans in the United States and up to 28 comparison countries depending on data availability (for a total of up to 29 countries). Between June and August of 2017, we collected a stratified random sample of the prices and terms for almost 3,000 fixed and mobile broadband plans from the websites of broadband providers in the United States and the selected countries.[40]

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cannot compute a true median. Here, the median refers to the median of the aggregated (average) annual city speed tests weighted by sample size, and average refers to the averages at the city level as provided by Ookla. *Id.* at para. 15, note 14.

[32] *Id.* at para. 20, Tbl. 7 and Fig. 2.

[33] *Id.* at para. 20.

[34] *Id*. at para. 21, Tbl. 8.

[35] The *Fourth International Broadband Data Report* and the *Fifth International Broadband Data Report* relied on Ookla speed data for 2012 to 2014 that consisted of daily speed test results for all cities. *See International Comparison Requirements Pursuant to the Broadband Data Improvement Act; International Broadband Data Report*, GN Docket 14-126, Fourth Report, 30 FCC Rcd 14994, 15225, 15248, Appx. F (2015) (*Fourth International Broadband Data Report*); *Fifth International Broadband Data Report*, 31 FCC Rcd at 2821,Appx. F (2016) (*Fifth International Broadband Data Report*). Ookla speed data for 2014 to 2016 used in this report consists of city speed test results averaged up to the yearly level, amounting to far fewer observations than the prior methodology. *See infra* Appx. B, paras. 10, 24-25.

[36] *See infra* Appx. B, para. 25.

[37] *Id.* at para. 25, Tbl. 11.

[38] *Id.* at para. 25, Tbl. 12.

[39] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers.").

[40] Fixed broadband price data include prices for both standalone broadband and bundles consisting of broadband and video service. Mobile broadband price data include primarily postpaid smartphone plans (both single and shared line) that allowed both unlimited voice calling and texting. Additionally, postpaid plans refer to plans that are paid

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13. We rank the countries by fixed and mobile price from the least expensive (1st) to most expensive (e.g., 29th) according to three different methodologies. As in previous reports, the first method compares countries according to unweighted average prices for standalone broadband plans within certain download speed ranges and mobile plans within bands of data usage allowances. To more closely match the characteristics of the comparison communities and their broadband offerings with those in the United States, we present country rankings by two additional methodologies: a broadband price index[41] and a hedonic price index.[42] Our additional assessments seek to better assess how the U.S. market is performing relative to other markets after accounting for quality differences as well as market-level cost and demographic differences that are known to affect pricing, such as population density, income, and education levels. The hedonic price index also allows an adjustment for observable differences in broadband quality across countries (e.g., speed and usage limits) and generates prices for a set of standardized broadband plans in every country to produce a price index that accounts for all of these factors and is comparable across countries.[43] For example, factors affecting rankings include income, where the United States has the 6th highest income of the 29 countries, and urban population density, where the United States is the 8th lowest.[44] As discussed below, the broadband and hedonic price index analysis demonstrate that accounting for country differences in cost, demographic, and quality factors give different assessments of the state of the U.S. broadband economy relative to other countries.

14. *Fixed Broadband Pricing*. For fixed broadband prices, under the first method comparing unweighted average prices, the United States ranks 18th out of 23 countries that offer fixed standalone broadband plans with download speeds of at least 25 Mbps and less than 100 Mbps, and 26th out of 28 countries that have fixed standalone plans with download speeds of 100 Mbps or greater.[45] When taking into account fixed broadband bundled with video service, the United States ranks 10th out of 20 countries with download speeds of at least 25 Mbps and less than 100 Mbps.[46] For the highest speed bundle plans with download speeds of 100 Mbps or greater, fixed broadband in the United States ranks 23rd out of 25 countries that offer such plans.[47] Using the second approach, the fixed broadband price index analysis, the United States ranks 21st out of 29 countries aggregating both standalone and bundled broadband products.[48] However, using the third approach, the fixed hedonic price index analysis that adjusts for

after usage (i.e., not prepaid or "pay-as-you-go" plans), and smartphone plans refer only to plans that have a data component. *See infra* Appx. C at paras. 14-15 and 40, note 84.

[41] The price index measures the dollar amount that U.S. broadband subscribers would need to have added or subtracted from their incomes to purchase the same basket of broadband services under the pricing structures in other countries. Quantity weights for our price index are the share of broadband subscribers in the United States that subscribe to each of the four broadband speed tiers we have chosen for analysis. *See id.* at paras. 23-28.

[42] A hedonic regression provides an empirical summary of how prices vary with the characteristics of a good. Our hedonic regression builds on the price index by allowing adjustment of prices for cost and demographic differences across countries and then predicting broadband prices for each country at the average U.S. values of these variables. *Id.* at paras. 29-32.

[43] The pricing analysis is designed to account for: (1) the different costs of deploying and operating broadband networks; (2) demographic differences that affect demand for broadband service; (3) multi-product bundling in broadband pricing; (4) different product offerings in each country; and (5) the availability and quality of complementary content and applications. *Id.* at para. 7.

[44] *See id.* at paras. 30, 70, Tbl. C1.

[45] *Id.* at para. 22, Tbl. 1b.

[46] *Id.* at para. 70, Tbl. C6.

[47] *Id.*

[48] *Id.* at paras. 4, 28, Tbl. 3.

(continued….)

cost, demographic, and quality differences across the countries, shows that the United States ranks 7th out of the 29 countries.[49]

15. *Mobile Broadband Pricing*. For mobile broadband prices, under the first method, the United States ranks 18th out of the 22 sampled countries based on unweighted average prices of individual plans with data usage allowances of 2 GB or less.[50] For the highest usage individual plans with data usage allowances greater than 10 GB, the United States ranks 21st out of the 28 countries that offer such plans.[51] According to the second method, the mobile broadband price index, the United States ranks 25th out of the 29 countries in individual plan pricing, and 18th out of the 29 countries in shared data plan pricing (i.e., "family plans" with multiple lines).[52] Combining individual and shared data plan pricing, the overall rank of the United States is 20th out of the 29 countries in the mobile broadband price index.[53] Relying on the third approach, the mobile hedonic price index that adjusts for country-level cost, demographic, and quality differences, the United States ranks 10th out of the 29 countries.[54]

C. High-Speed Broadband Deployment Comparison with Europe

16. In Appendix D, as directed by the BDIA, we compare "the extent of broadband service capability" by examining international fixed high-speed broadband deployment[55] in the United States and 21 European countries (EU21).[56] We rely on data gathered in June 2015 and June 2016 by the FCC and the European Commission (EC). For the first time, we also compare mobile high-speed broadband deployment in the EU21 and the United States by focusing exclusively on LTE, which is the baseline industry standard for the marketing of mobile broadband service.[57] We examine U.S. deployment of fixed

[49] *Id.* at paras. 4, 32, Tbl. 4.

[50] *Id.* at paras. 5, 47, Tbl. 5

[51] *Id.*

[52] *Id.* at paras. 5, 52, Tbl. 7.

[53] *Id.*

[54] *Id.* at paras. 5, 54, Tbl. 8.

[55] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers.").

[56] We refer to the set of countries that we compare here as the EU21 countries, as we selected 21 of the 31 European countries addressed in the *EC Broadband Report* as comparison countries for purposes of this Report. *See* European Commission, Broadband Coverage in Europe 2016: Mapping Progress Towards the Coverage Objectives of the Digital Agenda at 5 (2017) (*EC Broadband Report*), https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2016. The *EC Broadband Report* discusses the 28 member countries of the EU, as well as Iceland, Norway, and Switzerland. Our deployment comparison in this Report assesses the 21 countries that overlap with the European countries selected for the comparison overall. The 21 countries we include in our analysis are: Austria (AT), Belgium (BE), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (IT), Latvia (LV), Luxembourg (LU), Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), United Kingdom (UK), Iceland (IS), Norway (NO), and Switzerland (CH).

[57] *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. 17-69, Twentieth Report, 32 FCC Rcd 8968, 9018, para. 73 (2017) (*Twentieth Mobile Wireless Competition Report*). We note that the *2018 Broadband Deployment* analyzes mobile LTE coverage data associated with 5 Mbps/1 Mbps and higher minimum advertised speeds in the United States and supplements that data with actual on the ground 10 Mbps/3 Mbps and higher median speed data measurements. In Appendix D, we

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broadband with download speeds 30 Mbps or higher to match the European definition of high-speed broadband.[58] To match the fixed technologies used in the *EC Broadband Report*, we do not include satellite technology in the comparison of the United States and the EU21.

17. *Fixed High-Speed Broadband Deployment Results.* In the United States, fixed high-speed broadband reached 90 percent of all households and 62 percent of rural households by June 2016,[59] which is up from 89 percent of all households and 58 percent of rural households as of June 2015.[60] In the EU21, fixed high-speed broadband reached 76 percent of all households and 41 percent of rural households by June 2016,[61] which is up from 72 percent of all households and 30 percent of rural households as of June 2015.[62]

18. The U.S. deployment gap between non-rural and rural areas decreased from 39 percentage points as of June 2015 to 35 percentage points as of June 2016.[63] In the EU21, the gap between non-rural and rural areas decreased from 48 percentage points as of June 2015 to 42 percentage points as of June 2016.[64]

19. The United States ranked 11th out of the 22 countries in 2015 and 10th out of the 22 countries in 2016 with respect to fixed high-speed broadband deployment.[65] The United States ranked 10th out of the 22 countries in 2015 and 9th out of the 22 countries in 2016 in terms of its rural coverage of high-speed broadband.[66]

20. *Mobile High-Speed Broadband Deployment Results.* In the United States, mobile LTE coverage was widely deployed by the end of June 2016, reaching over 99 percent of all households and 98 percent of rural households.[67] In the EU21, during the same period, mobile LTE coverage reached 97 percent of all households and 83 percent of rural households.[68]

21. *Historical Overview*. Our historical overview for 2012 to 2016 shows that the United States had higher deployment rates than the EU21 countries as a whole during the period both generally,

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analyze mobile LTE coverage regardless of minimum advertised speeds or actual speeds to match the *EC Broadband Report*.

[58] *EC Broadband Report* at 11. This standard differs from that used for the fixed broadband deployment data for the United States in the *2018 Broadband Deployment Report.* That Report shows deployment of fixed broadband with 25 Mbps download and 3 Mbps upload speed. In addition, we assess deployment as of June 2016 and June 2015 to match the European data, while the *2018 Broadband Deployment Report* measures deployment as of December 2016 and December 2015.

[59] *See infra* Appx. D, paras. 12, 14, Figs. 2, 4.

[60] *Id.* at paras. 11, 13, Figs. 1, 3.

[61] *Id.* at, paras. 12, 14, Figs. 2, 4.

[62] *Id.* at paras. 11, 13, Figs. 1, 3.

[63] *See id*. at para. 16, Figs. 5, 6.

[64] *Id*.

[65] *See id*. at para. 17, Figs. 7, 8.

[66] *Id*. at para. 18, Figs. 9, 10.

[67] *See id*. at para. 21, Figs. 17, 18.

[68] *Id*.

(continued….)

and separately in rural and non-rural areas.[69] Deployment increased during the period, with the EU21 countries having a somewhat higher growth rate.[70]

D. Demographics Dataset

22. The BDIA directs the Commission to compare broadband development in international communities comparable to U.S. communities in terms of population size, density, topography, and demographic profile.[71] The dataset in Appendix E contains information for, in the aggregate, almost 300 province/county communities. We present updated demographics data for the United States and the 28 comparison countries on a sub-national basis, including the latest figures for such indicators as population size, population density, gross domestic product (GDP), and educational attainment.[72] Consistent with our approach in previous reports, we provide the most recent publicly available data for each variable in the community dataset in Appendix E. We present data available from the OECD for all countries in our sample, except for the United States and Canada, based on available data ranging from 2012 to 2016.[73] Data for the United States and Canada were obtained from other sources.[74] We also present topography information for the United States and the comparison countries based on information from the Central Intelligence Agency's The World Factbook.[75]

E. Market and Regulatory Developments

23. In Appendix F, as required by the BDIA, we identify the relevant similarities and differences between the United States and the 28 comparison countries with respect to multiple criteria.[76] First, we discuss the regulatory models for fixed broadband deployment. Second, we provide a list of regulators and, where relevant, the ministries responsible for regulating broadband. Third, we provide information concerning the major fixed and mobile broadband competitors and the types of technologies used to provide broadband. Finally, we present data on the types of activities that consumers in the United States and the comparison countries engage in while accessing the Internet. We rely on several

[69] *See id*. at para. 22, Figs. 19, 20.

[70] *Id*.

[71] 47 U.S.C. § 1303(b)(2).

[72] Using this sub-national data, one can draw comparisons across both international and domestic cities, states, and regions. As is the case in the United States, intra-country variations are greater than the inter-country differences. In particular, differences in population density, dispersion, and income may create significant variations. For example, the lower population density and greater size of the United States present unique challenges for broadband deployment.

[73] OECD, *OECD.Stats: Regions and Cities* (*OECD Regions and Cities*), http://stats.oecd.org/ (last visited Jan. 16, 2018).

[74] For the United States, we present 2016 data from the U.S. Census Bureau. For Canada, we present 2016 data from the Canadian Radio-television and Communications Commission. U.S. Census Bureau, *Percent Of Households With A Broadband Internet Subscription* (*U.S. Census Households With Broadband Subscription*), https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_1YR_GCT2801.US01PR&prodType=table (last visited Jan 16, 2018); Canadian Radio-television and Communications Commission, Communications Monitoring Report at 279 (2017) (*Canada Communications Monitoring Report*), https://crtc.gc.ca/eng/publications/reports/PolicyMonitoring/2017/cmr2017.pdf.

[75] Central Intelligence Agency, The World Factbook (last updated Jan. 3, 2018) (*CIA World Factbook*), https://www.cia.gov/library/publications/resources/the-world-factbook/.

[76] 47 U.S.C. § 1303(b)(3) ("The Commission shall identify relevant similarities and differences in each community, including their market structures, the number of competitors, the number of facilities-based providers, the types of technologies deployed by such providers, the applications and services those technologies enable, the regulatory model under which broadband service capability is provided, the types of applications and services used, business and residential use of such services, and other media available to consumers.").

(continued….)

sources, such as the TeleGeography GlobalComms Database[77] and the EC's Digital Economy and Society Index for this information.[78]

24. *Fixed Broadband Regulatory Models*. Based on our analysis, there are two basic fixed broadband regulatory models—a facilities-based competition model and an open access regulatory model—with some blending of the two models in most countries. There is also significant variation in regulatory approaches for implementing the same model. The facilities-based competition model relies on competition between the incumbent telecommunications operator and other operators (e.g., cable). The open access regulatory model features the use of mandated wholesale access to the incumbent's fixed network to create service-based competition by encouraging market entry at the retail level. Under either model, investment in fixed broadband networks may be primarily market- or state-aid-driven, depending on the extent to which governments subsidize network deployment.

25. *National Broadband Developments*. Many countries around the world recognize the fundamental role that broadband plays in helping to achieve social and economic development and continue to take steps to expand broadband access and use. According to the International Telecommunication Union (ITU), as of September 2017, 156 countries have introduced national broadband plans.[79] Many countries are developing comprehensive digital agendas[80] that go beyond conventional supply-side policies designed to expand broadband coverage and also include demand-side policies to promote affordability, Information and Communication Technology skills, and e-government, among other cross-cutting issues.[81]

26. Although approaches to national digital strategies vary significantly across countries, many governments continue to establish measurable targets to monitor broadband progress.[82] For example, the EU's Digital Single Market strategy calls on EU Member States to provide download speeds of 30 Mbps for all citizens and ensure that 50 percent of households have subscriptions of greater than 100 Mbps by 2020.[83] Moreover, by 2025, all schools, transport hubs, and main providers of public services should have access to Internet connections with download speeds of 1 Gbps, and all European households should have access to networks offering download speeds of at least 100 Mbps.[84] Finland, for its part, recently began the process of updating its national broadband strategy to redefine new speed and availability targets for 2025 and 2030.[85]

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[77] TeleGeography GlobalComms Database (*TeleGeography GlobalComms Database*), www.telegeography.com (last visited Jan. 16, 2018).

[78] European Commission, Digital Single Market: Digital Economy & Society Index (DESI) 2017 (2017), https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2017.

[79] Broadband Commission for Sustainable Development, The State of Broadband: Broadband Catalyzing Sustainable Development at 42 (2017) (*State of Broadband Report 2017*), http://www.broadbandcommission.org/publications/Pages/SOB-2017.aspx.

[80] *Id.* at 44; *see also* OECD, OECD Digital Economy Outlook 2017 at 34 (2017) (noting that "[national digital strategies] have become the norm across OECD countries") (*OECD Report 2017*), http://www.oecd.org/internet/oecd-digital-economy-outlook-2017-9789264276284-en.htm.

[81] *State of Broadband Report 2017* at 44.

[82] *OECD Report 2017* at 37.

[83] European Commission, *Digital Single Market: Broadband Strategy & Policy*, https://ec.europa.eu/digital-single-market/en/broadband-strategy-policy (last visited Jan. 16, 2018).

[84] *Id.*

[85] TeleGeography CommsUpdate, *Finnish Communications Ministry Begins Preparing New National Broadband Strategy* (July 13, 2017), https://www.telegeography.com/products/commsupdate/articles/2017/07/13/finnish-communications-ministry-begins-preparing-new-national-broadband-strategy/.

(continued….)

27. *5G Development.* Approaches to 5G development and the status of development efforts vary across countries. The United States has taken steps to make available low-, mid-, and high-band spectrum for next-generation wireless networks. For instance, in 2017, the Commission completed the auction for new 600 MHz licenses[86] and granted licenses for the 600 MHz Band (low-band).[87] On August 3, 2017, the Commission adopted a Notice of Inquiry seeking comment on ways to expand opportunities for next generation services—particularly wireless broadband services—in spectrum bands between 3.7 and 24 GHz (i.e., mid-band spectrum).[88] On November 16, 2017, the Commission adopted a Report and Order that, among other things, makes available 1,700 megahertz of millimeter wave (mmW) spectrum for terrestrial next generation wireless use, including 5G (high-band spectrum),[89] which was in addition to the nearly 11 gigahertz of spectrum opened up in July 2016 for wireless broadband operations in frequencies above 24 GHz (high-band spectrum).[90] Finally, we note that, in April 2016, the Commission created a new Citizens Broadband Radio Service, establishing an innovative three-tier framework to enable shared wireless broadband use of the 3550-3700 MHz band (3.5 GHz band);[91] the Commission is currently considering several rule changes that would further facilitate the implementation of 5G networks in this band.[92]

[86] *Incentive Auction Closing and Channel Reassignment Public Notice; The Broadcast Television Incentive Auction Closes; Reverse Auction and Forward Auction Results Announced; Final Television Band Channel Assignments Announced; Post-Auction Deadlines Announced*, AU Docket No. 14-252 et al, Public Notice, 32 FCC Rcd 2786 (2017). The Commission released a Public Notice on April 13, 2017, marking the completion of the incentive auction and the start of a 39-month post-auction transition period. *Id.*

[87] *Incentive Auction Task Force and Wireless Telecommunications Bureau Grant 600 MHz Licenses; Auction No. 1002*, Auction No. 1002, Public Notice, 32 FCC Rcd 4832 (2017).

[88] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, Notice of Inquiry, 32 FCC Rcd 6373 (2017).

[89] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, GN Docket No. 14-177, et al., Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, FCC 17-152 (rel. Nov. 22, 2017).

[90] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services et al.*, GN Docket No. 14-177 et al., Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016); Press Release, FCC, FCC Takes Steps to Facilitate Mobile Broadband and Next Generation Wireless Technologies in Spectrum Above 24 GHz (July 14, 2016), https://apps.fcc.gov/edocs_public/attachmatch/DOC-340301A1.pdf.

[91] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550- 3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, GN Docket No. 12-354, 30 FCC Rcd 3959 (2015); Press Release, FCC, FCC Puts Final Rules in Place for New Citizens Broadband Radio Service (Apr. 28, 2016), https://apps.fcc.gov/edocs_public/attachmatch/DOC-339104A1.pdf.

[92] *Promoting Investment in the 3550-3700 MHz Band; Petitions for Rulemaking Regarding the Citizens Broadband Radio Service*, GN Docket No. 17-258, Notice of Proposed Rulemaking and Order Terminating Petitions, FCC 17-134 (rel. Oct. 24, 2017); Press Release, FCC, FCC Seeks Comment on Promoting Investment in the 3.5 Ghz Band (Oct. 24, 2017), https://apps.fcc.gov/edocs_public/attachmatch/DOC-347378A1.pdf.

(continued….)

28. Other countries, including Austria,[93] Canada,[94] the Czech Republic,[95] and France,[96] among others, are in the midst of allocating additional spectrum across various bands to support 5G services. In Japan, with guidance from the Ministry of Internal Affairs & Communications (MIC), Japan's three wireless operators—NTT DOCOMO, KDDI, and SoftBank Mobile—are committed to launching commercial 5G services by the Tokyo Summer Olympics in 2020.[97] In partnership with industry, the South Korean government aims to introduce trial 5G services by the 2018 Winter Olympics in PyeongChang and to launch full commercial 5G services by December 2020. In January 2017, South Korea's Ministry of Science, ICT and Future Planning (MSIP) announced plans to allocate an additional 1,300 megahertz of spectrum for 5G services by 2018.[98]

29. In September 2016, the EC adopted a 5G Action Plan, which encouraged EU Member States to develop national 5G roadmaps by the end of 2017, and to identify at least one major city to be "5G-enabled" by the end of 2018, with the goal of expanding 5G coverage to all urban areas and major transportation hubs by 2025.[99] The plan also sought to identify "pioneer spectrum bands" to harmonize the initial launch of 5G services across Europe.[100]

30. Other countries are also in the process of developing policy and regulatory frameworks to facilitate the development of next-generation wireless technologies. For example, in March 2017, the United Kingdom (UK) issued a national 5G strategy focused on three main outcomes: accelerating the deployment of 5G networks; maximizing the productivity and efficiency benefits to the UK from 5G; and creating new opportunities for UK businesses at home and abroad, and encouraging inward investment.[101]

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[93] *See* Austrian Regulatory Authority for Broadband and Telecommunications (RTR), *Award Procedure 3.4-3.8 GHz (2018)*, https://www.rtr.at/en/tk/FRQ5G_2018 (last visited Jan 16, 2018).

[94] *See* Innovation, Science and Economic Development Canada, *Consultation on Releasing Millimetre Wave Spectrum to Support 5G* (June 2017), http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11298.html (last visited Jan. 16, 2018).

[95] *See* Czech Telecommunication Office (CTU), *End of Auction for Radio Frequencies in 3,7 GHz Band and Allocation of Frequency Ranges* (Aug. 30, 2017), https://www.ctu.eu/end-auction-radio-frequencies-37-ghz-band-and-allocation-frequency-ranges; *see also*, *e.g.*, Sarah McBride, *Czech Republic Auction Sees a Surge in Demand for 5G Spectrum* (Aug. 1, 2017), https://ovum.informa.com/resources/product-content/te0007-001171.

[96] *See* Arcep, Consultation Publique du 13 juillet 2017 au 7 septembre 2017: Attribution de fréquences de la bande 3410 - 3460 MHz pour le très haut débit radio en France métropolitaine (July 13, 2017), https://www.arcep.fr/uploads/tx_gspublication/consult-attribution-THD_radio-juil2017.pdf.

[97] *See*, *e.g.*, Yuki Nakamura, Ministry of Internal Affairs & Commc'ns, *Japan's 5G Policy Perspectives* (Nov. 9, 2016), https://5g-ppp.eu/wp-content/uploads/2016/11/Opening-1_Yuji-Nakamura.pdf.

[98] TeleGeography CommsUpdate, *Korean Ministry Looks to Boost 5G Bandwidth* (Jan. 19, 2017), https://www.telegeography.com/products/commsupdate/articles/2017/01/19/korean-ministry-looks-to-boost-5g-bandwidth/.

[99] European Commission, 5G for Europe: An Action Plan at 4 (2016), https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document.

[100] *Id.* at 5. Subsequently, in November 2016, the Radio Spectrum Policy Group (RSPG) considered various spectrum bands and identified the 3400-3800 MHz band as the primary band suitable for the introduction of 5G services in Europe. *See* Radio Spectrum Policy Group, Strategic Roadmap Towards 5G for Europe: Opinion of Spectrum-Related Aspects for Next-Generation Wireless Systems (5G) (2016), http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf.

[101] *See* Department for Culture, Media & Sport, Next Generation Mobile Technologies: A 5G Strategy for the UK (2017), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/597421/07.03.17_5G_strategy_-_for_publication.pdf.

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In July 2017, Spain launched a public consultation on the development of a national 5G plan.[102] In October 2017, Australia introduced a 5G strategy, outlining government actions to support the timely rollout of 5G services.[103]

31. At the international level, the ITU Radiocommunication Sector (ITU-R) and Regional Groups continue to focus on the harmonization of spectrum bands and their conditions of use in order to promote the timely implementation of technological changes and the benefits of economies of scale. The ITU-R has created an agenda item for the 2019 World Radiocommunication Conference (WRC-19) to consider spectrum for IMT-2020 (5G) in several frequency ranges above 24 GHz.[104] In addition, administrations and industry are participating in regional bodies committed to the advancement of 5G and building consensus towards standardization, spectrum, research and development, and cooperation with other strategic industry sectors. Some examples include the 5G Infrastructure Public Private Partnership (5G PPP),[105] the 5G Forum,[106] and 5G Americas,[107] which host meetings and summits to harmonize global efforts.

F. Other Relevant Information

1. Broadband Subscription (OECD Countries)

32. We report fixed and mobile broadband subscription in the United States and in OECD countries below. The OECD's subscription metrics define transmission speeds of at least 256 kbps in one direction as "broadband service" for both fixed and mobile Internet access.[108] This is considerably slower than the 25 Mbps download/3 Mbps upload speeds which the Commission considers as "advanced telecommunications capability."[109] In this section, we use the OECD's broadband definition to present comparable subscription statistics from OECD countries, including the United States. As the OECD notes, subscription is measured using different indicators and different reference dates across various countries and where a particular country falls in these rankings may be influenced by population density and dispersion, income, and other factors.[110] We provide an update on international efforts to improve data on broadband below.

33. As the most populous member of the OECD, the United States ranked first in 2016 in the sheer number of fixed broadband subscriptions with approximately 106,327,000 subscriptions.[111] In

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[102] Ministry of Energy, Tourism & the Digital Agenda (MINETAD), *Digital Agenda Opens a Public Consultation on the National Plan of 5G* (July 6, 2017), http://www.minetad.gob.es/en-US/GabinetePrensa/NotasPrensa/2017/Paginas/consulta-publica-5g20170706.aspx.

[103] *See* Australian Government Department of Communications and the Arts, 5G—Enabling the Future Economy (Oct. 2017), https://www.communications.gov.au/documents/5g-enabling-future-economy.

[104] *See State of Broadband Report 2017* at 21, 23.

[105] *See generally* 5G Infrastructure Public Private Partnership, *About the 5GPPP*, https://5g-ppp.eu/ (last visited Jan. 16, 2018).

[106] *See generally* 5G Forum, *5G Forum*, https://www.5gforum.org/english (last visited Jan. 16, 2018).

[107] *See generally* 5G Americas, *5G Americas*, http://www.5gamericas.org/en/ (last visited Jan. 16, 2018).

[108] *OECD Broadband Methodology*; *see also supra* note 19.

[109] *2018 Broadband Deployment Report* at para. 15.

[110] The United States has about one-quarter the population density of Europe, one-tenth that of Japan, and one-fifteenth that of South Korea.

[111] OECD, Broadband Portal, Total Fixed and Wireless Broadband Subscriptions by Country, Table 1.1 (Dec. 2016) (*OECD Broadband Subscriptions by Country Table 1.1*), http://www.oecd.org/sti/broadband/1.1-TotalBBSubs-bars-2016-12.xls. The OECD fixed broadband subscription data include fixed broadband subscriptions with downloads

(continued….)

2015, the number of fixed broadband subscriptions in the United States was approximately 100,865,000.[112] By comparison, Japan ranked second in 2016 with 38,743,212 fixed subscriptions.[113] In 2015, the number of fixed broadband subscriptions in Japan was 37,610,780.[114] With respect to penetration, measured by the number of subscriptions per 100 inhabitants, the United States ranked 16th out of 35[115] countries in 2016 for percentage of population with overall fixed broadband subscriptions, with 32.8 broadband subscriptions per 100 inhabitants.[116] Switzerland ranked first in 2016 in fixed broadband subscription penetration with 50.1 subscriptions per 100 inhabitants.[117] In 2015, the United States ranked 16th of 35 countries with 31.77 fixed broadband subscriptions per 100 inhabitants.[118]

34. In terms of sheer number of mobile broadband subscriptions,[119] the United States ranked first out of OECD's 35 countries with approximately 409,173,000 subscriptions with data plans as of December 2016[120] (compared to approximately 375,504,000 subscriptions as of December 2015 for the first place rank).[121] By comparison, Japan ranked second with 193,237,268 wireless broadband subscriptions in 2016 (also second with 176,010,204 in 2015).[122] The OECD's 2016 subscription data also rank countries according to the number of subscriptions per 100 inhabitants.[123] By this metric, the United States ranked fourth out of the 35 OECD countries in 2016 in mobile broadband subscriptions, with 126.3 mobile broadband subscriptions per 100 inhabitants[124] (by comparison, Japan ranked first in

speeds that are at least 256 kbps (DSL, satellite, terrestrial fixed wireless) or greater than 256 kbps (cable, fiber, broadband over power lines, leased lines); *OECD Broadband Methodology*.

[112] The 2015 data are no longer available on the OECD Broadband Portal. OECD, Broadband Portal, Table 1.1.1 (Dec. 2015).

[113] *OECD Broadband Subscriptions by Country Table 1.1*.

[114] The 2015 data are no longer available on the OECD Broadband Portal. OECD, Broadband Portal, Table 1.1.1 (Dec. 2015).

[115] Since the release of the *Fifth International Broadband Data Report*, the OECD added Latvia as a Member country, increasing the number of OECD countries to 35. OECD, *Latvia's Accession to the OECD*, https://www.oecd.org/latvia/latvia-accession-to-the-oecd.htm (last visited Jan. 16, 2018).

[116] *OECD Broadband Subscriptions Table 1.2*.

[117] *Id.*

[118] *See* OECD, Broadband Portal, Historical Time Series: Fixed and Wireless Broadband Penetration, Table 1.5 (Dec. 2016) (*OECD Historical Broadband Penetration Table 1.5*), http://www.oecd.org/sti/broadband/1.5-BBPenetrationHistorical-Data-2016-12.xls.

[119] The OECD mobile broadband subscription data include: (1) "data and voice subscriptions," including "mobile subscriptions which advertise data speeds of 256 kbit/s or greater and which have been used to make an Internet data connection via IP in the previous 3 months," and (2) "data-only subscriptions" which are defined as "subscriptions to dedicated data services over a mobile network which are purchased separately from voice services either as a stand-alone service (modem/dongle) or as an add-on data package to voice services which requires an additional subscription." *OECD Broadband Methodology*.

[120] *OECD Broadband Subscriptions by Country Table 1.1*.

[121] The 2015 data are no longer available on the OECD Broadband Portal. OECD, Broadband Portal, Table 1.1.2 (Dec. 2015).

[122] *Id.*

[123] *OECD Broadband Subscriptions Table 1.2*.

[124] *Id.*

(continued….)

2016 with 152.4 mobile broadband subscriptions per 100 inhabitants).[125] In 2015, the United States ranked sixth out of 35 countries with 116.7 mobile broadband subscriptions per 100 inhabitants.[126]

2. Efforts to Improve International Broadband Data

35. As we indicated in the previous reports, available data on international broadband are incomplete and generally challenging to compare because of significant gaps and variations in data collection methodologies across countries. In previous reports, we detailed the steps that the OECD and U.S. Government have taken to standardize broadband metrics.[127] Since then, the OECD and U.S. Government have continued to work to standardize broadband metrics, particularly in the area of hedonic price broadband pricing analysis.[128] OECD delegates published a final paper in July 2016 entitled, "Hedonic Prices for Fixed Broadband Services: Estimation Across OECD Countries," which refined the hedonic methodology using a more robust dataset.[129] The OECD also created a "beta-test" set of eight OECD members that will collect and apply the new methodology using pricing data for broadband bundles (including video services). The eight members are: Australia, Hungary, Israel, Mexico, Portugal, Spain, South Korea, and the United States. In November 2017, the initial results were previewed for OECD delegates; an initial draft paper, the finding of which OECD delegates will discuss and debate, is anticipated in May 2018. The OECD, with the support of the U.S. Government and other delegations, will continue to devote resources to the ongoing review and reform of its core broadband data collection efforts, among other initiatives, including refurbishment of the OECD's current "Broadband Portal"[130] in 2018.[131]

V. CONCLUSION

36. In conjunction with the Commission's adoption of the *2018 Broadband Deployment Report*, the release of this Report fulfills the obligation imposed by Section 103(b) of the BDIA.[132]

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[125] *Id.*

[126] *See OECD Historical Broadband Penetration Table 1.5.*

[127] *Fifth International Broadband Data Report*, 31 FCC Rcd at 2681, para. 45.

[128] The OECD has been using a "price basket" methodology for comparing communication prices across countries for over 20 years. As concluded by the OECD project (Towards a New OECD Metrics Checklist), hedonic price analysis could provide a new perspective. Hedonic models are based on the idea that products or services can be viewed as a bundle of characteristics that are valued by both buyers and sellers. Price represents the value of characteristics of the products or services. *See, e.g.*, Jack E. Triplett, Economic Interpretation of Hedonic Methods, Survey of Current Business, Bureau of Economic Analysis, Department of Commerce at 36-40 (Jan. 1986); *see also* OECD, *Glossary of Statistical Terms* (last updated Jul. 8, 2005), http://stats.oecd.org/glossary/detail.asp?ID=1225.

[129] In June 2015, the OECD, via a contract with Dr. Carol Corrado of Georgetown University in Washington, agreed to further refine the hedonic methodology using a more robust dataset. The initial findings were presented in a draft paper in June 2015 for initial review by OECD delegates, and a follow-up expert peer review of this work was conducted at the FCC in September 2015, with over 30 attendees from the FCC, U.S. Government, World Bank, and Canadian and Mexican regulatory officials collaborating on a set of final suggestions and observations for the authors to consider as they finalized the OECD analysis. The OECD published this paper in July 2016. Carol Corrado and Olga Ukhaneva, Hedonic Prices for Fixed Broadband Services: Estimation Across OECD Countries (2016), http://www.oecd-ilibrary.org/science-and-technology/hedonic-prices-for-fixed-broadband-services_5jlpl4sgc9hj-en?crawler=true.

[130] OECD, *Broadband Portal*, http://www.oecd.org/sti/broadband/oecdbroadbandportal.htm (last visited Jan. 16, 2018).

[131] OECD, *Going Digital: Making the Transformation Work for Growth and Well-Being*, http://www.oecd.org/going-digital/project (last visited Jan. 16, 2018).

[132] 47 U.S.C. § 1303(b).

VI. PROCEDURAL MATTERS

37. IT IS ORDERED that, pursuant to Section 103(b) of the Broadband Data Improvement Act, 47 U.S.C. § 1303(b), and pursuant to authority delegated to the International Bureau in Sections 0.51 and 0.261 of the Commission's rules, 47 CFR §§ 0.51, 0.261, this Report, with its associated Appendices A-F, is ADOPTED.

FEDERAL COMMUNICATIONS COMMISSION

Thomas Sullivan
Chief, International Bureau

APPENDIX A

Country List

1. In the Table below, we list the United States and the 28 foreign countries selected for purposes of this Report and identify the countries that are excluded in an Appendix with an "X".

Countries	Appendix B Broadband Speed Comparison	Appendix C Broadband Price Comparison	Appendix D High-Speed Broadband Deployment Comparison with Europe	Appendix E Demographics Dataset	Appendix F Market and Regulatory Developments
Australia			X		
Austria					
Belgium					
Canada			X		
Chile			X		
Czech Republic					
Denmark					
Estonia					
Finland					
France					
Germany					
Greece					
Iceland					
Ireland					
Italy					
Japan			X		
Latvia	X				
Luxembourg					
Mexico			X		
Netherlands					
New Zealand			X		
Norway					
Portugal					
South Korea			X		
Spain					
Sweden					
Switzerland					
United Kingdom					
United States			X		

APPENDIX B

Broadband Speed Comparison

1. As required by the BDIA, we present information on "data transmission speeds" for broadband service capability[1] for both fixed and mobile broadband. This information is based on actual speed data collected by Ookla.[2] The data include observations in 2014, 2015, and 2016 and include both U.S. and international cities.[3] As a historical overview, we also present available data on U.S. fixed download speeds and rankings from 2012 to 2016, which show how actual speeds have evolved over time.

I. DATA HIGHLIGHTS

2. *Fixed Broadband Speed Results*. With respect to fixed broadband speeds, the United States ranked 10th out of 28 countries in 2016 (55.07 Mbps) in terms of actual download speeds[4] weighted by the number of tests in each city—an improvement over 11th in 2015 (40.38 Mbps) and 15th in 2014 (28.09 Mbps). Actual fixed download speeds in the United States increased by approximately 96 percent from 2014 to 2016.

3. In all three years, Luxembourg had the highest mean fixed broadband speed, and Greece had the lowest. Luxembourg's mean fixed broadband speeds were 375.78 Mbps in 2016, 344.40 Mbps in 2015, and 222.13 Mbps in 2014. By contrast, Greece's mean fixed broadband speeds were 11.83 Mbps in 2016, 9.52 Mbps in 2015, and 8.90 Mbps in 2014. However, Luxembourg is an outlier—the mean fixed broadband speed in Luxembourg was more than three times the mean speed in the second-ranked country in 2016 (Japan at 102.34 Mbps), and more than four times the mean speed in the second-ranked countries in 2015 (Japan at 81.50 Mbps) and 2014 (South Korea at 53.15 Mbps).

4. In our historical overview, we find, based on the available data, that fixed speeds for the United States have been on a rising trend since 2012, and that its rank among the selected countries has been on a rising trend since 2012.

5. *Mobile Broadband Speed Results*. With regard to mobile broadband speeds, the United States ranked 24th out of 28 countries in both 2016 (19.98 Mbps) and 2015 (15.58 Mbps), and 18th in 2014 (12.62 Mbps), based on a comparison of mean download speeds. Actual mobile download speeds in the United States increased by approximately 58 percent from 2014 to 2016.

6. In 2016, mean mobile download speeds ranged from a high of 39.19 Mbps in South Korea to a low of 15.24 Mbps in Chile. The highest-ranked country in the previous two years was New

[1] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers).

[2] We obtained speed data through a contractual arrangement with Ookla. *Ookla Speedtest*.

[3] In this Appendix, due to data limitations, we are unable to replicate some of the analysis in the *Fifth International Broadband Data Report*, including jitter, packet loss comparisons, or compare the percent difference between advertised and actual speeds, as this year's Ookla dataset did not include the data. In addition, in contrast to past reports, we are unable to present hardware-based speed test measurements in the United States and the European Union (EU), as the European Commission (EC) has not released a Quality of Broadband Services in the EU covering either 2015 or 2016. *See Fifth International Broadband Data Report*, 31 FCC Rcd at 2801-48, Appx. F.

[4] In this Appendix, "actual speed" refers to mean actual speed unless otherwise specified. We chose mean speeds over median speeds due to the data limitations. The means are weighted by the number of tests performed in each city.

(continued….)

Zealand, with a mean mobile download speed of 27.85 Mbps in 2015 and 28.09 Mbps in 2014. Thus, the mean mobile download speed of the highest-ranked country rose significantly in 2016 after remaining roughly flat in the previous two years.

II. DATA SOURCES

7. Broadband speeds are often illustrated by either advertised speed or the actual speed.[5] For purposes of this Report, we obtained from Ookla actual speed data for our fixed and mobile international speed comparisons. The Ookla speed data are collected primarily from software-based tests on an end user's device using speedtest.net.

8. *Fixed Speed Testing*. To collect fixed speed data, Ookla measures maximum sustainable throughput between the user's computer and the nearest server by selecting a file size based on a bit test estimate of connection speed. This method measures the speed of the broadband connection when multiple computers or programs are using it.[6] Essentially, more data are used to test the faster connections than slower ones, ensuring the speed data reflect the actual speed experienced by the typical consumer.[7]

9. *Mobile Speed Testing*. Ookla's mobile speed measurements are derived from customer tests run over Ookla's Speedtest mobile app that measures the performance of mobile connections.[8] This app is available free of charge to smartphone users.[9] Once the app is downloaded, users can periodically measure the speed of their wireless connection, and these speed test observations are then used to produce Ookla's Net Index dataset.[10] Because the speed tests rely on the smartphone'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. Therefore, the Ookla data show significant variation in different geographies, as well as among service providers.

10. *Methodology and Time Period.* We obtained from Ookla a test speed for every city in this Report for the years 2014, 2015, and 2016. Prior to 2015, Ookla provided a test speed for every city on a daily basis.[11] Due to this change, we constructed a dataset, for every city in each country selected

[5] Actual speed is measured primarily by two methods: (i) by installing special hardware on an end user's device that enables the hardware to measure actual download and upload speeds and (ii) software-based tests. *See MIT Report* at 11-17; *see also Seventeenth Mobile Wireless Competition Report*, 29 FCC Rcd at 15405-06, para. 191 (2014) (discussing the characteristics of crowd-sourced data).

[6] This is done by using multiple threads (simultaneous transfers of data) and carefully sizing the transferred payload. Ookla Speedtest, *How Does the Test Itself Work? How is the Result Calculated?* (Jan. 13, 2012), https://support.speedtest.net/hc/en-us/articles/203845400-How-does-the-test-iitself-work-How-is-the-result-calculated.

[7] *MIT Report* at 3 ("[T]he Ookla/Speedtest approach – which typically results in greater measured data rates than the other approaches reviewed – was the best of the currently available data sources for assessing the speed of ISP's broadband access service. One of the key differences that accounts for this is that the Ookla/Speedtest tools utilize multiple TCP connections to collect the measurement data which is key to avoiding the receive window limitation. These tests are also much more likely to be connected to a server that is relatively close to the client running the test.").

[8] *Ookla Speedtest Mobile*; *Twentieth Mobile Wireless Competition Report*, 32 FCC Rcd at 9034-35, para. 90 (presenting Ookla speed data).

[9] Ookla gathers crowdsourced mobile speed data through the use of its Speedtest mobile app. The mobile data include tests over the carrier network and WiFi tests depending on the smartphone's connection.

[10] *See Twentieth Mobile Wireless Competition Report*, 32 FCC Rcd at 9034-35, para. 90.

[11] In the *Fifth International Broadband Data Report*, we used data for 2014 which included 6.3 million observations for 17,917 cities in 40 countries from January 1, 2014 to December 15, 2014. Mean download and upload speeds on a city-by-day level were aggregated to annual measures and weighted by the number of tests to draw comparisons

(continued….)

that appear in the data for all three years—2014, 2015, and 2016. Because the cities selected may change over time, not all the same cities appear every year. We then separately compared the changes in broadband speeds for all of the cities over time.

11. Because of the change in the fixed speed data, we rely on the newly acquired 2014, 2015, and 2016 Ookla data rather than the 2014 data relied upon in the *Fifth International Broadband Data Report*, which were based on daily city-level observations. We also note that the Ookla data omits Latvia in its fixed and mobile speed data, and therefore we compare the United States to 27 foreign countries for a total of 28 countries in our analysis. For fixed and mobile speed results, we present the download speed Mbps rankings for the United States and the selected 27 comparison countries based on weighted mean speed. For weighted mean speed, we take the mean across cities using the sample size in each city as weights.[12] In our historical overview, for the period 2012-2014 we also rely on Ookla speed data, but collected using a different methodology.

12. *Data Caveats*. The Ookla data can be useful in providing a high-level international comparison, but certain caveats should be noted. For instance, the physical distance of the end user to the server may influence the results of user-initiated, software-based speed measurement tests. Additionally, the actual speeds that are observed in each country reflect a combination of availability and usage. For example, a low mean download speed for a country could reflect either more people subscribing to low-speed broadband or poor performance and availability of high-speed broadband. Despite these shortcomings, the Ookla speed dataset helps in constructing international comparisons because of its large geographic scope and vast number of speed tests.[13]

III. INTERNATIONAL BROADBAND SPEED COMPARISON

A. Fixed Broadband Speed

13. Below, we present our fixed broadband speed test results. Table 1 shows our fixed broadband summary statistics for 2014 to 2016, which contained upload and download speeds for 61,920 cities in 2014; 94,894 cities in 2015; and 128,845 cities in 2016.

between capital cities and countries in previous IBDRs by using a stratified sampling approach. This approach divides the sample of cities into different non-overlapping bins according to their population level and then draws a sample from each bin. This allowed us to control for larger cities having inherently different broadband characteristics than smaller and more sparsely populated citied. *Fifth International Broadband Data Report*, 31 FCC Rcd at 2675, 2801-48, paras 28-29, Appx. F.

[12] For both fixed and mobile, we conducted an additional estimation check of the mean and median broadband speeds by creating a subsample of the full dataset called a panel, for the cities that appeared in the data for 2014, 2015, and 2016. We then compared the changes in broadband speeds for the same cities over time, holding fixed the sample universe. The mean and median broadband speeds for the subset sample of cities did not differ greatly from the full dataset we present in the Report.

[13] Since January 2008, Ookla has collected data on over 10.3 billion speed tests. Ookla, *Ookla SpeedTest Intelligence*, https://www.ookla.com/speedtest-intelligence (last visited Jan. 16, 2018).

Table 1
Fixed Broadband Summary Statistics (2014-2016)

All Available Data	Total Dataset	2014	2015	2016
Number of Countries	28	28	28	28
Number of Cities	186,127	61,920	94,894	128,845
Mean Tests Per City	2504.66	3251.49	2267.91	2320.11
Median Tests Per City	141	47	110	246
Download (Mbps)				
Minimum	0.26	0.26	0.26	0.27
Maximum	924.20	917.38	923.81	924.20
Mean	37.50	27.26	38.01	44.03
Median	33.36	26.61	37.65	42.49
Upload (Mbps)				
Minimum	0.00	0.01	0.00	0.01
Maximum	939.82	939.82	898.70	931.10
Mean	13.28	8.91	13.18	16.29
Median	8.71	7.16	9.34	10.26

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.
Note: The cities that make up the complete set of observations varies from year to year in the Ookla dataset, as does the number of tests for each city.

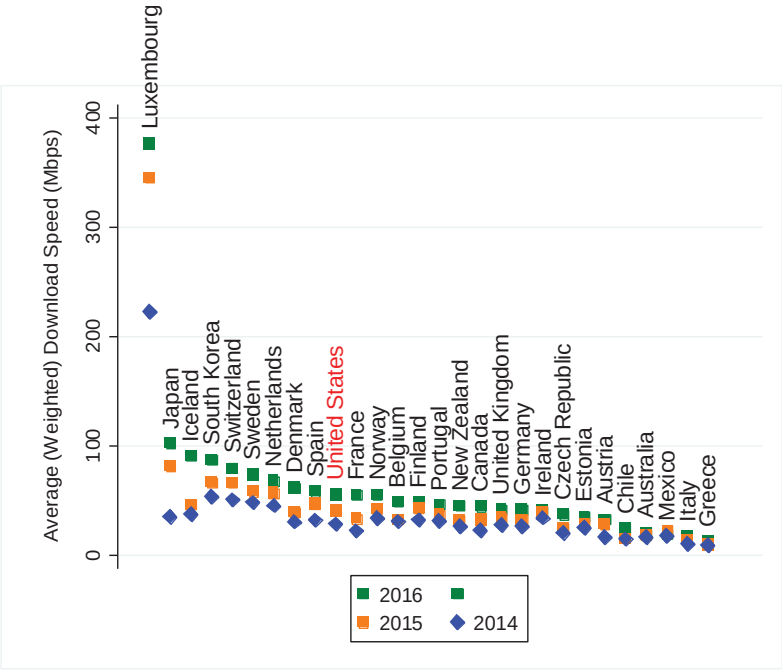
14. As shown in Table 2 and Figure 1 below, the United States ranked 10th out of 28 countries in 2016 in terms of mean download speeds (55.07 Mbps) weighted by sample size—an improvement over 11th in 2015 (40.38 Mbps) and 15th in 2014 (28.09 Mbps). Luxembourg, which as noted earlier is an outlier, is ranked first in 2014, 2015, and 2016, with mean download speeds of 375.78 Mbps, 344.40 Mbps, and 222.13 Mbps, respectively, in the full sample. In 2016, the bottom five countries remained the same, with Greece remaining last with a mean download speed of 11.83 Mbps (compared to 9.52 Mbps in 2015 and 8.90 Mbps in 2014).

Table 2
Mean (Weighted) Fixed Download Speed by Country (2014-2016)

Country	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Luxembourg	1	222.13	1	344.40	1	375.78
Japan	7	35.20	2	81.50	2	102.34
Iceland	6	37.32	8	45.96	3	90.36
South Korea	2	53.15	3	66.77	4	86.98
Switzerland	3	50.32	4	65.86	5	79.58
Sweden	4	47.77	5	58.14	6	73.81
Netherlands	5	45.20	6	56.54	7	67.54
Denmark	14	30.50	13	39.56	8	61.49
Spain	11	31.83	7	46.58	9	57.86
United States	**15**	**28.09**	**11**	**40.38**	**10**	**55.07**
France	21	22.02	16	33.59	11	54.80
Norway	9	33.85	10	42.12	12	54.71
Belgium	13	30.54	17	32.79	13	48.50
Finland	10	31.95	9	43.05	14	47.89
Portugal	12	30.97	14	36.70	15	46.14
New Zealand	18	26.40	19	32.07	16	44.99
Canada	20	22.85	20	31.88	17	44.29
United Kingdom	16	27.68	15	34.43	18	42.17
Germany	17	26.56	18	32.57	19	41.94
Ireland	8	34.16	12	40.09	20	40.28
Czech Republic	22	20.48	23	24.89	21	37.13
Estonia	19	24.86	21	28.71	22	35.05
Austria	24	16.63	22	28.48	23	32.58
Chile	26	14.50	26	15.16	24	24.38
Australia	25	16.13	25	18.49	25	20.12
Mexico	23	17.56	24	22.58	26	18.87
Italy	27	9.90	27	13.50	27	17.23
Greece	28	8.90	28	9.52	28	11.83

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.
Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Figure 1
Mean (Weighted) Fixed Download Speed by Country (2014-2016)



15. In Table 3 below, we present the median (weighted) fixed download speed by country for 2014-2016 for all available data. In 2016, the median weighted download speed for the United States increased to 55.44 Mbps from 40.17 Mbps in 2015 and 28.29 Mbps in 2014, and its ranking improved from 14th in 2014 and 13th in 2015 to 10th out of the 28 comparison countries.[14] Similar to the United States, most countries have mean and median speeds that are fairly constant from 2014 to 2016.[15] Luxembourg is ranked first in 2014 (224.77 Mbps), 2015 (295.68), and 2016 (358.66 Mbps) in median download speed.

16. In 2014, 2015, and 2016, the median download speeds increased for the majority of countries in the data, but fell in Ireland and Mexico. In Ireland, the median download speed dropped from 41.65 Mbps in 2014 to 36.98 Mbps in 2016. In Mexico, the median download speed dropped from 18.69 Mbps in 2014 to 15.99 Mbps in 2016.

[14] Because the data are aggregated at the city level and do not have individual speed test records, we cannot compute a true median. Here, the median refers to the median of the aggregated (mean) annual city speed tests weighted by sample size. By mean, we mean that the averages at the city level were provided by Ookla. Therefore, we took the median of the city level averages reported by Ookla.

[15] *See infra* paras. 16-17, Tbls. 3 and 4.

Table 3
Median (Weighted) Fixed Download Speed by Country (2014-2016)

Country	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Luxembourg	1	224.77	1	295.68	1	358.66
Iceland	6	37.92	7	50.78	2	96.92
Japan	8	35.62	2	74.67	3	95.58
South Korea	2	53.38	4	66.80	4	87.97
Switzerland	3	50.66	3	67.16	5	77.27
Sweden	7	36.41	5	61.53	6	74.67
Netherlands	4	45.15	6	54.01	7	65.03
Spain	9	34.75	9	46.62	8	58.78
Denmark	12	33.39	14	39.60	9	58.47
United States	**14**	**28.29**	**13**	**40.17**	**10**	**55.44**
Norway	10	34.71	11	41.43	11	55.35
Portugal	13	32.66	12	40.35	12	50.91
France	21	20.63	15	33.18	13	47.38
Belgium	16	26.65	20	27.13	14	46.95
New Zealand	17	26.64	17	31.17	15	44.63
Finland	11	34.53	10	45.01	16	43.06
Canada	20	23.73	16	31.29	17	42.93
Germany	18	26.45	18	30.47	18	40.88
United Kingdom	19	25.03	19	30.15	19	39.97
Estonia	15	27.37	23	21.50	20	37.63
Ireland	5	41.65	8	49.31	21	36.98
Czech Republic	23	15.69	24	19.93	22	35.73
Austria	26	13.79	22	23.79	23	35.50
Chile	24	15.67	26	16.37	24	23.07
Australia	25	14.70	25	17.68	25	19.08
Mexico	22	18.69	21	24.57	26	15.99
Italy	27	10.79	27	14.71	27	15.30
Greece	28	8.80	28	9.54	28	11.83

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.
Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

17. In Table 4 below, we present the mean download speeds by U.S. states and foreign countries for 2014, 2015, and 2016. Given the large population density and area of several U.S. states we compare U.S. states to foreign countries. In 2016, the highest ranked state is Kansas, which ranked 5th out of 77 states and countries with a mean speed of 80.49 Mbps. Kansas was also the highest ranked state in 2015 at 7th out of 77 U.S. states and countries, with a mean speed of 51.46 Mbps. In 2014, Delaware ranked the highest at 6th with a speed of 38.59 Mbps.

Table 4
Mean (Weighted) Fixed Download Speeds by U.S. States and Countries (2014-2016)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Luxembourg	1	222.13	1	344.40	1	375.78
Japan	10	35.20	2	81.50	2	102.34
Iceland	7	37.32	15	45.96	3	90.36
South Korea	2	53.15	3	66.77	4	86.98
Kansas	41	26.01	7	51.46	5	80.49
Switzerland	3	50.32	4	65.86	6	79.58
Hawaii	61	20.20	13	46.48	7	76.08
Sweden	4	47.77	5	58.14	8	73.81
Texas	33	28.41	10	47.36	9	69.02
Netherlands	5	45.20	6	56.54	10	67.54
Tennessee	24	30.97	33	39.60	11	64.82
Utah	29	29.60	14	46.00	12	64.28
California	21	31.15	12	46.57	13	62.46
North Carolina	63	19.20	37	38.28	14	62.41
Arizona	30	29.54	28	40.38	15	62.22
Missouri	22	31.10	8	50.16	16	62.20
Denmark	26	30.50	34	39.56	17	61.49
Nevada	27	30.35	29	40.36	18	60.46
Washington	19	31.85	9	49.09	19	59.70
Georgia	38	26.58	16	45.63	20	59.26
Delaware	6	38.59	20	44.11	21	58.22
Spain	20	31.83	11	46.58	22	57.86
New Jersey	8	37.12	17	45.23	23	57.73
Colorado	44	24.89	25	41.79	24	57.29
Massachusetts	11	34.91	18	45.08	25	56.89
Maryland	9	36.43	19	44.61	26	56.70
Alaska	66	17.56	48	34.04	27	56.16
France	55	22.02	49	33.59	28	54.80
Norway	14	33.85	24	42.12	29	54.71
Louisiana	51	23.16	39	37.63	30	53.44

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Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Table 4 (continued)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
North Dakota	48	23.79	35	39.53	31	53.32
New York	12	34.50	21	43.50	32	53.16
Florida	35	28.27	38	37.84	33	51.82
New Hampshire	28	30.01	32	39.85	34	51.51
Rhode Island	17	32.54	23	42.22	35	51.38
Oklahoma	47	24.15	45	34.91	36	51.23
Oregon	43	25.29	36	39.25	37	50.77
Connecticut	15	33.07	27	40.73	38	49.94
Virginia	16	32.64	31	40.08	39	49.12
Vermont	34	28.40	26	41.35	40	49.10
Belgium	25	30.54	51	32.79	41	48.50
Finland	18	31.95	22	43.05	42	47.89
Illinois	37	27.39	42	36.22	43	47.48
South Dakota	31	29.06	41	36.67	44	46.97
Portugal	23	30.97	40	36.70	45	46.14
Pennsylvania	32	28.59	43	34.97	46	46.07
New Mexico	57	20.92	55	31.21	47	45.79
West Virginia	64	19.08	47	34.24	48	45.47
Minnesota	46	24.44	44	34.94	49	45.16
New Zealand	40	26.40	53	32.07	50	44.99
Canada	53	22.85	54	31.88	51	44.29
Indiana	52	22.87	56	31.02	52	42.88
Kentucky	73	15.64	72	21.20	53	42.84
United Kingdom	36	27.68	46	34.43	54	42.17
Germany	39	26.56	52	32.57	55	41.94
Michigan	42	25.34	50	33.05	56	41.16
Mississippi	58	20.62	61	27.99	57	40.59
Ireland	13	34.16	30	40.09	58	40.28
Alabama	54	22.29	58	29.30	59	39.56
Arkansas	62	19.64	64	27.37	60	39.28
Nebraska	49	23.67	62	27.95	61	38.92
Idaho	67	17.17	67	25.35	62	38.09
Iowa	50	23.66	57	30.10	63	37.24

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Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Table 4 (continued)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Czech Republic	59	20.48	69	24.89	64	37.13
South Carolina	56	21.69	63	27.53	65	36.49
Estonia	45	24.86	59	28.71	66	35.05
Wyoming	71	16.43	65	26.78	67	33.30
Austria	70	16.63	60	28.48	68	32.58
Montana	68	16.88	66	26.01	69	30.62
Ohio	69	16.82	70	23.33	70	29.43
Wisconsin	60	20.34	68	25.14	71	28.69
Chile	75	14.50	75	15.16	72	24.38
Maine	74	14.97	73	18.91	73	21.35
Australia	72	16.13	74	18.49	74	20.12
Mexico	65	17.56	71	22.58	75	18.87
Italy	76	9.90	76	13.50	76	17.23
Greece	77	8.90	77	9.52	77	11.83

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Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

18. In Table 5, we compared mean fixed download speeds in the capital cities of U.S. states and the selected comparison countries. We present a comparison of U.S. state capitals with the capitals of the comparison countries, as directed by the BDIA that "[t]he Commission shall include in the comparison under this subsection . . . communities including the capital cities of such countries."[16] Austin, Texas is the highest ranked U.S. state capital with a rank of 2nd of 78 capitals in 2016 (110.96 Mbps).

[16] 47 U.S.C. § 1303(b)(2).

Table 5
Mean (Weighted) Fixed Download Speed
by Country Capital and U.S. State Capital Cities (2014-2016)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Luxembourg, Luxembourg	1	170.59	56,183	1	238.68	6,341	1	300.13	25,173
Austin, TX, U.S.	4	49.85	1,392,853	5	79.66	755,280	2	110.96	542,944
Reykjavik, Iceland	13	37.92	47,571	15	50.78	14,983	3	96.92	73,977
Paris, France	2	83.79	413	3	93.68	310	4	96.77	931,706
Stockholm, Sweden	7	42.26	34	4	88.35	57	5	89.34	145,213
Seoul, South Korea	3	53.38	486,932	8	66.80	424,781	6	87.97	360,565
Phoenix, AZ, U.S.	27	29.79	831,543	34	39.44	409,368	7	84.69	150,087
Jackson, MS, U.S.	52	23.93	36,284	42	34.54	28,654	8	81.03	9,728
Tokyo, Japan	17	35.62	1,051,715	7	71.21	722,467	9	80.24	838,054
Oslo, Norway	9	40.30	596,388	12	52.01	304,067	10	77.68	250,025
Salt Lake City, UT, U.S.	36	27.45	548,660	19	44.13	348,882	11	72.45	228,718
Nashville, TN, U.S.	28	29.71	213,631	36	37.74	139,669	12	69.67	99,940
Oklahoma City, OK, U.S.	29	29.63	302,669	24	41.64	157,788	13	67.35	75,466
Honolulu, HI, U.S.	59	20.47	278,913	23	41.79	254,978	14	65.14	162,823
Madrid, Spain	40	26.36	292	6	71.31	221	15	64.95	843,286
Salem, OR, U.S.	30	29.05	77,764	13	51.28	63,294	16	64.77	44,847
Atlanta, GA, U.S.	25	30.45	685,856	2	127.47	546,298	17	64.49	263,102
Olympia, WA, U.S.	24	30.54	80,179	14	51.05	56,739	18	63.87	34,271
Dover, DE, U.S.	6	44.16	29,250	11	52.32	22,005	19	63.46	16,963
Bern, Switzerland	26	30.10	5	30	40.62	6	20	61.17	38,788
Lansing, MI, U.S.	31	28.82	87,624	9	59.95	69,863	21	60.34	45,758
Amsterdam, Netherlands	60	20.39	213	73	18.14	536	22	59.60	275,193
Raleigh, NC, U.S.	62	19.82	319,470	30	40.62	326,968	23	58.42	138,758
Denver, CO, U.S.	50	24.18	999,544	33	40.13	657,396	24	57.75	406,555
Concord, NH, U.S.	21	32.64	24,537	29	40.69	21,694	25	57.61	13,741
Copenhagen, Denmark	15	36.05	163	27	40.96	60	26	57.60	137,735
Annapolis, MD, U.S.	8	40.35	35,926	17	46.51	30,999	27	56.94	18,602
Trenton, NJ, U.S.	12	38.90	77,050	18	44.36	57,904	28	56.65	39,850
Washington, DC, U.S.	22	32.52	374,696	20	43.14	319,088	29	55.97	225,414

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Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

Table 5 (continued)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Wellington, New Zealand	38	26.64	190,525	58	29.74	103,951	30	55.50	55,734
Boston, MA, U.S.	16	35.87	238,628	28	40.91	198,723	31	55.25	125,587
Bismarck, ND, U.S.	19	33.77	22,482	16	50.68	18,991	32	53.41	6,590
Boise, ID, U.S.	66	18.53	208,995	63	25.56	150,117	33	52.07	55,313
Lisbon, Portugal	14	36.10	710,256	21	42.89	404,664	34	51.96	321,952
Sacramento, CA, U.S.	35	27.51	456,600	26	41.07	336,064	35	51.69	226,513
Des Moines, IA, U.S.	55	23.18	165,510	54	31.31	92,922	36	51.36	43,534
Harrisburg, PA, U.S.	20	32.90	53,234	41	35.67	46,885	37	51.14	28,359
Indianapolis, IN, U.S.	49	24.34	400,721	48	32.93	207,688	38	50.73	144,284
Tallinn, Estonia	10	39.49	88	70	22.52	13	39	50.37	155,547
Providence, RI, U.S.	23	30.55	59,039	25	41.20	52,422	40	49.71	41,257
Saint Paul, MN, U.S.	47	24.75	345,834	55	31.29	197,739	41	48.73	53,777
Prague, Czech Republic	61	20.26	158	60	28.33	318	42	48.63	326,808
Santa Fe, NM, U.S.	56	22.73	48,269	39	36.39	43,234	43	48.16	35,323
Richmond, VA, U.S.	18	34.08	213,371	32	40.22	135,960	44	47.44	58,126
Springfield, IL, U.S.	46	25.00	60,565	35	38.00	43,286	45	47.24	30,066
Hartford, CT, U.S.	37	27.31	26,263	43	34.48	27,040	46	46.98	19,279
Baton Rouge, LA, U.S.	42	26.01	145,260	38	37.36	135,154	47	46.78	98,397
Little Rock, AK, U.S.	51	24.04	104,140	49	32.87	76,665	48	45.40	28,628
Montgomery, AL, U.S.	33	27.87	71,190	45	34.43	57,707	49	45.29	10,428
Dublin, Ireland	11	39.19	533	66	24.41	423	50	43.56	136,915
Ottawa, Canada	43	25.78	653,967	40	35.67	298,477	51	43.08	180,493
Helsinki, Finland	41	26.06	1,061	10	57.67	1,007	52	43.06	348,992
Columbus, OH, U.S.	69	17.54	461,117	59	29.58	323,834	53	41.75	231,898

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Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

Table 5 (continued)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Vienna, Austria	5	44.76	461	22	42.23	186	54	41.44	472,649
Tallahassee, FL, U.S.	53	23.60	144,559	52	32.26	131,740	55	41.23	78,334
Cheyenne, WY, U.S.	63	19.25	47,024	47	34.02	31,616	56	40.87	25,077
Madison, WI, U.S.	34	27.80	215,057	50	32.84	127,063	57	40.74	93,532
Charleston, WV, U.S.	72	15.49	76,161	37	37.65	53,811	58	39.59	7,196
Helena, MT, U.S.	68	18.16	35,778	56	30.41	25,671	59	39.10	17,819
Brussels, Belgium	44	25.76	224	71	19.33	88	60	39.04	172,244
Berlin, Germany	39	26.45	1,097,561	61	28.13	539,123	61	36.11	296,017
London, United Kingdom	45	25.03	4,236,152	57	30.15	1,414,159	62	34.98	674,685
Montpelier, VT, U.S.	71	15.57	12,315	67	24.37	8,243	63	34.95	5,057
Carson City, NV, U.S.	54	23.20	20,547	65	24.57	14,468	64	34.54	11,339
Lincoln, NE, U.S.	75	12.93	191,240	72	18.35	159,150	65	34.44	118,833
Jefferson City, MO, U.S.	64	19.12	45,576	53	31.70	40,953	66	33.92	25,982
Pierre, SD, U.S.	32	28.41	4,329	46	34.29	1,917	67	33.76	1,358
Topeka, KS, U.S.	57	22.14	79,929	51	32.38	52,739	68	32.19	13,069
Albany, NY, U.S.	58	21.31	82,087	62	26.86	52,239	69	31.38	37,918
Canberra, Australia	70	16.61	241,423	68	24.28	56,172	70	29.63	3,769
Juneau, AK, U.S.	48	24.36	6,296	44	34.47	5,056	71	28.50	1,033
Columbia, SC, U.S.	67	18.51	135,502	69	23.03	80,076	72	28.20	47,885
Santiago, Chile	77	9.41	2,546	78	8.69	1,514	73	22.83	913,652
Rome, Italy	76	10.79	2,503,159	76	14.71	1,025,307	74	20.83	601,526
Augusta, ME, U.S.	74	13.61	23,152	74	15.64	12,095	75	18.73	4,634
Frankfort, KY, U.S.	73	13.72	9,690	75	14.89	15,780	76	14.13	12,060
Athens, Greece	78	8.80	1,341	77	9.54	349	77	11.94	809,196
Mexico City, Mexico	65	18.69	4,770,066	64	24.57	1,907,816	78	8.79	129

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla. We note that we cannot draw statistical conclusions from cities with less than 300 tests per year.
Note: The yearly observation for Mexico, Federal District, Mexico and for Mexico City, Federal District, Mexico are averaged (weighted by total tests) for 2014 is 8.00 Mbps (88,347) and 18.89 Mbps (4,681,719). For 2015, it is 9.80 Mbps (29,043) and 24.80 Mbps (1,878,773).

B. Mobile Broadband Speeds

19. Table 6 below presents our mobile broadband summary statistics for all available data from 2014 to 2016. The data contain upload and download speeds for 96,350 cities in 2014; 98,538 cities in 2015; and 120,159 cities in 2016.

Table 6
Mobile Broadband Summary Statistics (2014-2016)

All Available Data	Total Dataset	2014	2015	2016
Number of Countries	28	27	28	28
Number of Cities	185,640	96,350	98,538	120,159
Mean Tests Per City	488.79	485.00	443.87	528.67
Median Tests Per City	30	25	20	47
Download (Mbps)				
Minimum	0.26	0.26	0.26	0.26
Maximum	190.41	96.91	129.20	190.41
Mean	18.02	12.85	16.68	22.73
Median	16.38	12.55	15.87	21.87
Upload (Mbps)				
Minimum	0	0	0	0
Maximum	72.88	45.19	72.88	72.54
Mean	7.37	5.31	7.04	9.10
Median	7.05	5.37	7.09	9.10

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.
Note: The cities that make up the complete set of observations varies from year to year in the Ookla dataset, as does the number of tests for each city. The data did not include any mobile speed observations for Latvia.

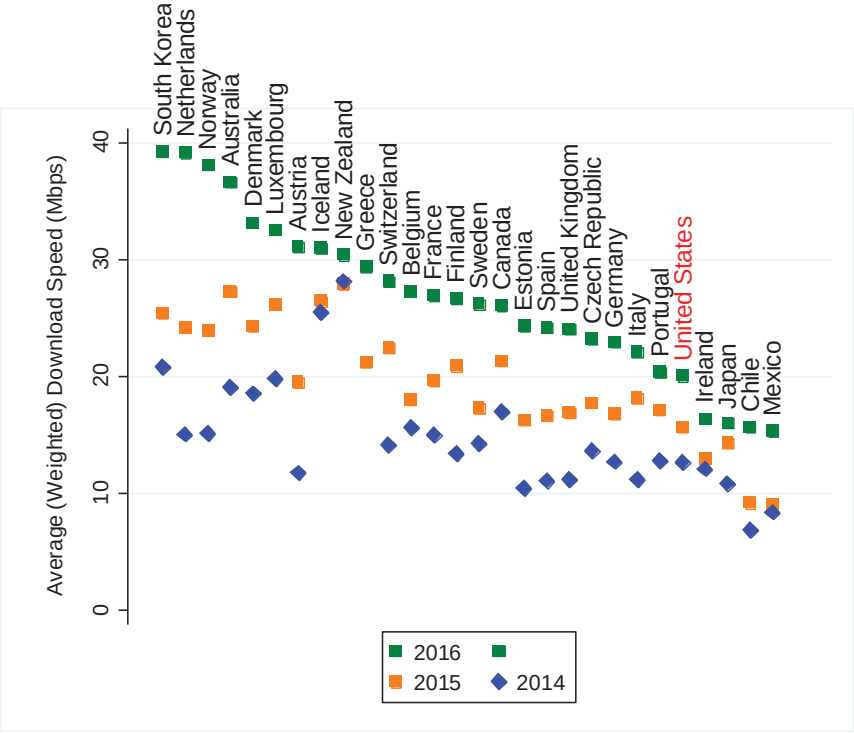
20. Below, Table 7 and Figure 2 show that the United States dropped from 18th (12.62 Mbps) in 2014 to 24th (15.58 Mbps) in 2015, and remained at 24th out of the 28 comparison countries (19.98 Mbps) in 2016. During this period, however, mobile download speeds in the United States increased by approximately 58 percent.

Table 7
Mean (Weighted) Mobile Download Speed by Country (2014-2016)

Country	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
South Korea	3	20.76	5	25.35	1	39.19
Netherlands	10	15.00	7	24.15	2	39.08
Norway	9	15.08	8	23.90	3	38.03
Australia	5	19.05	2	27.24	4	36.57
Denmark	6	18.49	6	24.22	5	33.12
Luxembourg	4	19.73	4	26.12	6	32.47
Austria	20	11.70	14	19.45	7	31.09
Iceland	2	25.43	3	26.41	8	30.93
New Zealand	1	28.09	1	27.85	9	30.36
Greece			11	21.15	10	29.34
Switzerland	13	14.12	9	22.42	11	28.07
Belgium	8	15.59	16	17.99	12	27.22
France	11	14.97	13	19.62	13	26.87
Finland	15	13.37	12	20.86	14	26.63
Sweden	12	14.24	18	17.22	15	26.15
Canada	7	16.92	10	21.26	16	26.02
Estonia	25	10.37	23	16.21	17	24.27
Spain	23	11.05	22	16.61	18	24.14
United Kingdom	21	11.11	20	16.92	19	24.00
Czech Republic	14	13.58	17	17.71	20	23.14
Germany	17	12.66	21	16.75	21	22.85
Italy	22	11.10	15	18.11	22	22.03
Portugal	16	12.72	19	17.05	23	20.31
United States	**18**	**12.62**	**24**	**15.58**	**24**	**19.98**
Ireland	19	12.05	26	12.92	25	16.34
Japan	24	10.80	25	14.28	26	15.95
Chile	27	6.82	27	9.13	27	15.61
Mexico	26	8.34	28	9.06	28	15.24

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.
Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Figure 2
Mean (Weighted) Mobile Download Speed by Country (2014-2016)



21. In Table 8, we present the median mobile weighted download speed by country for 2015 to 2016. In 2016, the median weighted download speed for the United States increased to 19.36 Mbps from 12.62 Mbps in 2014, and its ranking decreased from 17th to 24th of the 28 comparison countries. Similar to the United States, most countries have mean and median speeds that are fairly constant in the 2014, 2015, and 2016 data.[17] In terms of speed measurements, the United States has improved from 2014 to 2016 when comparing both the median and mean download speeds weighted by the sample size.

[17] *See supra* para. 20, Tbl. 7; *see infra* para. 21, Tbl. 8. Because the data are aggregated at the city level and do not have individual speed test records, we cannot compute a true median. Here, median refers to the median of the aggregated (mean) daily city speed tests weighted by sample size. As a summary statistic, medians are not affected by outliers in the data while means are.

Table 8
Median (Weighted) Mobile Download Speed by Country (2014-2016)

Country	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Netherlands	12	14.61	8	23.29	1	41.12
South Korea	3	20.79	7	23.58	2	38.91
Norway	8	16.68	5	25.64	3	36.59
Australia	5	20.32	2	27.91	4	35.88
New Zealand	1	31.87	1	29.99	5	32.94
Denmark	6	19.18	6	24.63	6	32.60
Austria	20	12.49	13	20.26	7	32.44
Luxembourg	4	20.66	4	25.88	8	32.43
Iceland	2	25.49	3	27.30	9	32.01
France	11	14.80	14	19.98	10	29.44
Switzerland	13	14.61	9	22.84	11	28.71
Finland	14	13.88	11	21.80	12	27.99
Greece			12	21.15	13	27.66
Estonia	25	10.66	23	16.29	14	27.31
Sweden	10	14.97	19	17.61	15	27.29
Belgium	9	15.88	16	18.65	16	26.77
Canada	7	17.14	10	21.82	17	26.30
Spain	21	11.99	20	17.54	18	25.53
United Kingdom	23	11.36	22	16.35	19	23.48
Germany	19	12.59	21	17.29	20	23.43
Czech Republic	18	12.59	18	17.89	21	23.37
Italy	22	11.71	17	18.43	22	23.01
Portugal	16	12.69	15	18.92	23	21.52
United States	**17**	**12.62**	**24**	**15.26**	**24**	**19.36**
Ireland	15	12.76	26	13.46	25	16.51
Japan	24	11.13	25	14.95	26	15.97
Mexico	26	8.29	28	8.97	27	15.39
Chile	27	6.53	27	9.61	28	15.28

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Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

22. In Table 9 below, we present the mean download speeds by U.S. states and foreign countries for 2014, 2015, and 2016. Given the large population density and area of several U.S. states we compare U.S. states to foreign countries. The highest ranked state for all three years is Washington, which ranked 20th out of 77 states and countries in 2016 with a mean speed of 23.70 Mbps, 13th in 2015 with a speed of 20.80 Mbps, and 8th in 2014 with a speed of 16.17 Mbps. Additionally, four U.S. states – Washington, Minnesota, Georgia, and Michigan – ranked in the top 25 for download speeds when compared to other U.S. states and countries in our study.

Table 9
Mean (Weighted) Mobile Download Speeds by
U.S. States and Countries (2014-2016)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
South Korea	3	20.76	5	25.35	1	39.04
Netherlands	12	15.00	7	24.15	2	38.21
Norway	10	15.08	8	23.90	3	36.46
Australia	5	19.05	2	27.24	4	35.77
Denmark	6	18.49	6	24.22	5	33.12
Luxembourg	4	19.73	4	26.12	6	32.25
Iceland	2	25.43	3	26.41	7	30.93
Austria	47	11.70	16	19.45	8	30.82
New Zealand	1	28.09	1	27.85	9	30.26
Greece			11	21.15	10	29.34
Switzerland	19	14.12	9	22.42	11	27.86
Belgium	9	15.59	20	17.99	12	27.17
France	13	14.97	15	19.62	13	26.70
Finland	25	13.37	12	20.86	14	26.61
Sweden	17	14.24	24	17.22	15	26.15
Canada	7	16.92	10	21.26	16	25.56
Estonia	65	10.37	34	16.21	17	24.04
Spain	55	11.05	29	16.61	18	23.88
United Kingdom	53	11.11	26	16.92	19	23.87
Washington	8	16.17	13	20.80	20	23.70
Minnesota	14	14.88	19	18.01	21	23.57
Georgia	11	15.00	14	20.31	22	23.51
Czech Republic	23	13.58	21	17.71	23	23.14
Michigan	22	13.75	17	18.92	24	22.79
Germany	37	12.66	27	16.75	25	22.77
Italy	54	11.10	18	18.11	26	22.03
Rhode Island	15	14.75	22	17.51	27	21.16
Ohio	30	12.97	38	15.79	28	21.10
Alabama	21	13.75	23	17.48	29	21.09
Oregon	28	13.04	30	16.60	30	21.08

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Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Table 9 (continued)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Illinois	29	13.03	33	16.23	31	20.91
Connecticut	18	14.18	28	16.64	32	20.80
New Jersey	24	13.55	32	16.37	33	20.80
New York	35	12.84	37	15.83	34	20.74
South Dakota	16	14.28	46	14.54	35	20.65
Indiana	45	11.97	42	15.04	36	20.63
Florida	39	12.22	31	16.58	37	20.55
Kansas	58	10.99	47	14.40	38	20.44
Wisconsin	34	12.92	39	15.56	39	20.30
Portugal	36	12.72	25	17.05	40	20.25
California	32	12.94	35	16.11	41	20.21
North Dakota	64	10.45	60	12.98	42	20.12
Pennsylvania	26	13.22	41	15.50	43	19.90
Delaware	33	12.93	40	15.50	44	19.81
Massachusetts	20	13.92	36	16.04	45	19.64
Missouri	49	11.46	53	13.78	46	18.93
Iowa	50	11.27	64	12.73	47	18.78
Kentucky	59	10.91	65	12.67	48	18.43
Maryland	46	11.85	51	14.02	49	18.25
Arkansas	27	13.18	43	14.96	50	18.10
Texas	40	12.13	45	14.57	51	17.93
New Hampshire	38	12.55	44	14.73	52	17.92
Tennessee	31	12.96	50	14.16	53	17.91
Virginia	48	11.65	52	13.79	54	17.70
Hawaii	63	10.53	48	14.38	55	17.67
Louisiana	52	11.14	54	13.76	56	17.52
Nebraska	57	10.99	59	13.22	57	17.03
North Carolina	42	12.04	58	13.50	58	16.98
South Carolina	43	12.01	56	13.70	59	16.89
Utah	68	10.03	62	12.79	60	16.82
Nevada	51	11.27	55	13.73	61	16.53
Ireland	41	12.05	61	12.92	62	16.34
Arizona	62	10.54	69	11.59	63	16.31

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Note: City-year observations are collapsed to the country-year level and are weighted by the number of tests.

Table 9 (continued)

Country/U.S. State	2014		2015		2016	
	Rank	Mbps	Rank	Mbps	Rank	Mbps
Oklahoma	44	11.98	57	13.54	64	16.19
Japan	60	10.80	49	14.28	65	15.84
Chile	76	6.82	75	9.13	66	15.49
Mississippi	66	10.30	66	12.04	67	15.28
Idaho	69	9.85	63	12.78	68	14.98
Mexico	74	8.34	76	9.06	69	14.96
Montana	75	8.30	73	10.28	70	14.26
Colorado	61	10.55	67	11.68	71	14.22
New Mexico	70	9.20	68	11.64	72	14.07
West Virginia	71	9.07	70	11.14	73	13.56
Maine	67	10.04	71	10.84	74	12.71
Alaska	56	11.01	74	9.80	75	12.56
Vermont	72	8.49	72	10.30	76	12.17
Wyoming	73	8.37	77	8.99	77	9.61

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Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

23. In Table 10 below, we compare mean mobile download speeds in the capital cities of U.S. states and the selected comparison countries. We present a comparison of U.S. state capitals with the capitals of the comparison countries, as directed by the BDIA that "[t]he Commission shall include in the comparison under this subsection . . . communities including the capital cities of such countries."[18] Lansing, Michigan ranks as the highest U.S. state capital with a 20th ranking out of 78 capitals in 2016 (26.16 Mbps).

[18] 47 U.S.C. § 1303(b)(2)

Table 10
Mean (Weighted) Mobile Download Speed by Country Capital and U.S. State Capital Cities (2014-2016)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Amsterdam, Netherlands							1	42.07	61,000
Oslo, Norway	6	16.74	68,099	3	27.37	118,402	2	40.68	119,217
Seoul, South Korea	2	20.79	7,412	1	31.11	35,576	3	38.91	92,812
Vienna, Austria				10	20.73	169	4	34.77	450,644
Helsinki, Finland							5	32.49	347,676
Luxembourg, Luxembourg	3	20.75	16,698	4	24.88	12,525	6	32.43	17,018
Reykjavik, Iceland							7	32.01	13,160
Stockholm, Sweden				26	16.85	707	8	31.42	24,710
Wellington, New Zealand	1	31.87	5,246	2	30.85	5,256	9	30.53	9,077
Copenhagen, Denmark				11	20.72	1,126	10	30.21	100,778
Paris, France							11	29.65	366,806
Bern, Switzerland				14	20.19	25	12	28.90	13,588
Madrid, Spain				5	24.87	34	13	28.36	200,331
Lisbon, Portugal	11	15.14	28,762	19	18.92	62,737	14	28.26	50,622
Prague, Czech Republic							15	27.75	79,886
Athens, Greece				8	21.15	1,678	16	27.66	138,488
Tallinn, Estonia							17	27.31	123,540
Canberra, Australia	57	8.67	160	7	21.93	5,168	18	26.42	14,528
Brussels, Belgium				20	18.46	430	19	26.31	28,546
Lansing, MI, U.S.	8	16.49	17,279	15	20.03	16,681	20	26.16	12,964
Salem, OR, U.S.	9	16.02	16,661	17	19.14	15,605	21	25.61	11,700
Saint Paul, MN, U.S.	16	13.98	64,825	25	17.05	71,902	22	25.14	28,216
Berlin, Germany	35	12.23	50,613	16	19.88	97,767	23	24.76	172,721
Montgomery, AL, U.S.	27	12.65	12,431	21	18.25	12,322	24	24.54	11,003

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Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

Table 10 (continued)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Rome, Italy	13	14.23	47,589	9	20.87	181,500	25	24.11	537,626
London, United Kingdom	42	11.36	875,046	30	16.35	960,512	26	23.48	794,560
Little Rock, AR, U.S.	10	15.35	19,742	23	17.85	15,900	27	23.32	13,844
Springfield, IL, U.S.	30	12.44	13,956	24	17.82	10,485	28	23.10	8,443
Tallahassee, FL, U.S.	12	14.98	19,444	13	20.43	16,238	29	23.08	12,244
Ottawa, Canada	4	17.30	24,570	12	20.64	28,881	30	22.49	46,039
Bismarck, ND, U.S.	51	10.01	3,772	53	13.17	2,191	31	22.37	1,926
Dover, DE, U.S.	5	17.05	4,357	6	23.40	3,280	32	22.31	2,742
Atlanta, GA, U.S.	20	13.65	206,342	18	19.03	182,204	33	22.28	170,471
Indianapolis, IN, U.S.	39	11.71	41,801	34	15.88	51,603	34	22.05	72,218
Columbus, OH U.S.	15	14.20	62,558	29	16.37	68,965	35	22.02	88,165
Harrisburg, PA, U.S.	7	16.67	9,571	22	18.03	8,157	36	21.41	7,399
Pierre, SD, U.S.	29	12.58	60	65	10.77	221	37	20.51	317
Des Moines, IA, U.S.	56	9.01	16,415	56	12.44	22,343	38	20.36	20,494
Dublin, Ireland	62	6.87	1	71	2.19	1	39	20.26	170,265
Annapolis, MD, U.S.	34	12.34	5,516	43	14.52	5,938	40	20.08	4,620
Lincoln, NE, U.S.	46	11.11	22,513	46	14.19	16,605	41	19.99	16,143
Washington, DC, U.S.	40	11.51	40,351	41	14.87	93,123	42	19.67	109,894
Austin, TX, U.S.	23	13.25	104,918	42	14.76	105,773	43	19.62	111,128
Providence, RI, U.S.	21	13.63	10,925	27	16.83	14,433	44	19.54	16,818
Sacramento, CA, U.S.	25	13.09	102,978	33	15.92	106,214	45	19.21	111,809
Juneau, AK, U.S.	63	6.67	21	47	14.11	948	46	19.09	662
Trenton, NJ, U.S.	19	13.65	9,610	31	16.14	7,823	47	19.07	6,216
Hartford, CT, U.S.	18	13.70	19,404	32	16.02	18,169	48	19.04	16,463
Raleigh, NC, U.S.	38	11.78	32,461	48	13.97	32,809	49	19.00	40,699
Albany, NY, U.S.	26	13.07	12,377	40	14.89	10,936	50	18.92	10,275
Olympia, WA, U.S.	17	13.71	6,611	38	15.13	6,055	51	18.58	4,688
Boston, MA, U.S.	32	12.41	31,974	37	15.14	64,185	52	18.25	88,039

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla.

Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

Table 10 (continued)

City, Country	2014			2015			2016		
	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests	Rank	Mbps	# of Tests
Salt Lake City, UT, U.S.	47	10.95	85,200	50	13.76	75,767	53	18.23	88,701
Frankfort, KY, U.S.	43	11.31	3,489	58	12.25	2,683	54	18.10	2,797
Nashville, TN, U.S.	33	12.37	61,272	51	13.44	64,362	55	17.75	80,705
Baton Rouge, LA, U.S.	31	12.41	45,621	44	14.48	29,842	56	17.70	20,941
Richmond, VA, U.S.	28	12.64	29,968	55	12.89	24,777	57	17.63	32,270
Honolulu, HI, U.S.	45	11.16	62,847	39	14.91	81,720	58	17.25	118,987
Carson City, NV, U.S.	14	14.22	795	28	16.82	1,877	59	17.14	2,945
Helena, MT, U.S.	55	9.05	1,182	66	10.69	1,592	60	17.13	1,529
Phoenix, AZ, U.S.	52	9.87	145,810	59	11.48	188,833	61	17.02	183,819
Madison, WI, U.S.	36	12.23	21,065	54	13.05	17,106	62	16.71	16,139
Jefferson City, MO, U.S.	37	11.99	7,055	49	13.94	5,013	63	16.70	3,351
Jackson, MS, U.S.	50	10.11	8,816	52	13.29	5,863	64	16.66	5,511
Mexico City, Mexico	59	8.29	115,018	69	8.97	284,585	65	16.15	576,975
Columbia, SC, U.S.	41	11.40	9,870	57	12.26	10,756	66	16.07	13,674
Boise, ID, U.S.	48	10.81	18,249	35	15.85	18,279	67	16.02	14,845
Tokyo, Japan	44	11.24	371,219	36	15.51	498,306	68	15.97	664,877
Oklahoma City, OK, U.S.	22	13.41	26,887	45	14.45	42,083	69	15.93	71,115
Topeka, KS, U.S.	61	7.76	11,441	63	11.05	7,620	70	15.56	7,240
Santiago, Chile							71	15.28	488,563
Denver, CO, U.S.	49	10.52	126,113	60	11.41	141,413	72	14.16	140,760
Augusta, ME, U.S.	24	13.16	401	61	11.35	572	73	13.66	968
Montpelier, VT, U.S.	53	9.65	478	62	11.10	407	74	13.39	307
Cheyenne, WY, U.S.	58	8.37	1,548	68	9.47	2,705	75	12.08	3,574
Charleston, WV, U.S.	60	7.91	3,984	64	10.86	4,945	76	11.93	4,657
Concord, NH, U.S.	54	9.21	926	67	10.25	1,215	77	11.33	1,443
Santa Fe, NM, U.S.	64	6.58	10,132	70	7.97	9,630	78	11.28	6,725

Source: Ookla SPEEDTEST intelligence data, © 2016 Ookla, LLC. All rights reserved. Published with permission of Ookla. We note that we cannot draw statistical conclusions from cities with less than 300 tests per year.
Note: City-year observations are collapsed to the country/state-year level and are weighted by the number of tests.

C. Historical Overview of Fixed Speeds from 2012 to 2016

24. Below, we present U.S. fixed download speeds and rankings from 2012 to 2016 to demonstrate how actual speeds have evolved over time.[19] We rely on data presented in prior International Broadband Data Reports to make this comparison. We note that the *Fourth International Broadband Data Report* and the *Fifth International Broadband Data Report* relied on Ookla speed data for 2012 to 2014 that consisted of daily speed test results for all cities.[20] As described above in our discussion of speed data for 2014 to 2016, we there rely on Ookla speed data that consists of city speed test results averaged up to the yearly level, which has far fewer observations than the prior methodology.[21]

[19] We do not have Ookla mobile speed data prior to 2014 to conduct a similar analysis.

[20] *See Fourth International Broadband Data Report*, 30 FCC Rcd at 15225, 15248, Appx. F; *Fifth International Broadband Data Report*, 31 FCC Rcd 2667, 2801, 2821, Appx. F.

[21] *See supra* para. 10.

25. Below, we present: (1) speed data for 2012 to 2013 under the previous methodology; (2) speed data for 2015 to 2016 under the new methodology; and (3) speed data for 2014 under both methodologies. Because of the different methodologies, we present separately the U.S. data from 2012 to 2013 (Table 11) and 2014 to 2016 (Table 12). We also note that, under the previous methodology for 2012, 2013, and 2014, the speed rankings were based on a 40-country sample. By comparison, this Report's analysis of 2014, 2015, and 2016 was based on a 28-country sample. By comparing the 2014 data under both methodologies, we find a number of differences. For the United States, the differences are relatively minor, while the differences for many of the other 27 countries are significantly greater. For instance, the speeds of only 9 of the 28 countries are within five percent in the two datasets, while the speeds of 13 of the 28 countries show more than a 10 percent differential. Based on the data, for the United States, both speeds and rank have been on a rising trend since 2012.

Table 11
Historical U.S. Fixed Broadband Speeds
Previous Method (2012-2014)

Year	USA Rank	# Countries Ranked	Relative USA Ranking	Mean Speed (Mbps)	Data Methodology
2012	25	40	0.63	14.50	Previous
2013	26	40	0.65	18.67	Previous
2014	26	40	0.65	26.68	Previous

Table 12
Historical U.S. Fixed Broadband Speeds
New Method (2014-2016)

Year	USA Rank	# Countries Ranked	Relative USA Ranking	Mean Speed (Mbps)	Data Methodology
2014	15	28	0.54	28.09	New
2015	11	28	0.39	40.38	New
2016	10	28	0.36	55.07	New

APPENDIX C

Broadband Price Comparison

1. In this Appendix, as directed by the BDIA, we compare the pricing of fixed and mobile broadband plans across the United States with the selected 28 comparison countries.[1] Between June and August of 2017, we collected a stratified random sample of advertised prices and terms for almost 3,000 fixed and mobile broadband plans from broadband providers' websites in the United States and the selected foreign countries.[2]

2. The BDIA directs the Commission to compare broadband pricing in "communities of a population size, population density, topography, and demographic profile that are comparable to the population size, population density, topography, and demographic profile of various communities within the United States."[3] In this Appendix, we have ranked the countries by fixed and mobile prices from the least expensive (1st) to most expensive (e.g., 29th) according to three different methodologies. As in previous reports, we continue to produce rankings based on unweighted average prices for standalone fixed broadband plans within certain download speed ranges and mobile plans within bands of data usage allowances. To more closely match the characteristics of the comparison communities and their broadband offerings with those in the United States, we present country rankings by two additional methodologies: a broadband price index[4] and a hedonic price index.[5] The additional assessments seek to better assess how the U.S. market is performing relative to other markets after accounting for quality differences as well as market-level cost and demographic differences that are known to affect pricing, such as population density, income, and education levels. The hedonic price index also allows an adjustment for observable differences in broadband quality across countries (e.g., speed and usage limits) and generates prices for a set of standardized broadband plans in every country to produce a price index that accounts for all of these factors and is comparable across countries.[6] The fixed and mobile analyses

[1] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers."). Our comparison of broadband pricing in communities includes comparison of broadband pricing in cities, as directed by the BDIA to include "a geographically diverse selection of countries" and "communities including the capital cities of such countries." 47 U.S.C. § 1303(b)(2).

[2] The fixed and mobile broadband price datasets are available on the FCC website. FCC, *International Broadband Data Report (Sixth)*, https://www.fcc.gov/reports-research/reports/international-broadband-data-reports/international-broadband-data-report-4.

[3] 47 U.S.C. § 1303(b)(2).

[4] The price index measures the dollar amount that U.S. broadband subscribers would need to have added or subtracted from their incomes to purchase the same basket of broadband services under the pricing structures in other countries. Quantity weights for the price index are the share of broadband subscribers in the United States that take each of the four broadband speed tiers chosen for analysis. *See infra* paras. 23-28.

[5] A hedonic regression provides an empirical summary of how prices vary with the characteristics of a good. In this Report, the hedonic regression builds on the price index by allowing adjustment of prices for cost and demographic differences across countries and then predicting broadband prices for each country at the average U.S. values of these variables. *See id.* at paras. 29-32.

[6] The pricing analysis in this Report is designed to account for: (1) the different costs of deploying and operating broadband networks; (2) demographic differences that affect demand for broadband service; (3) multi-product bundling in broadband pricing; (4) different product offerings in each country; and (5) the availability and quality of complementary content and applications. *Id.* at para. 7.

(continued….)

demonstrate that accounting for country differences in cost, demographic, and quality factors give different assessments of the state of the U.S. broadband economy relative to other countries.

I. OVERVIEW AND DATA HIGHLIGHTS

3. This Report seeks to improve upon our pricing analysis to better compare the broadband plans in the United States with the 28 comparison countries. The complexity of residential broadband offerings makes comparisons across countries difficult. Based on our data collection, we find that the features and quality of broadband service vary widely across countries and providers. Broadband service is also frequently purchased as part of a bundle of services, which makes it difficult to identify the price of the broadband service. The plans differ with respect to: (1) download and upload speeds; (2) type of technology used to deliver broadband services; (3) limitations on use, including limits on upload and download volumes; (4) contractual conditions; (5) additional services included; and (6) consequences of exceeding usage limits with some plans reducing speeds, imposing surcharges, or shutting off service.

4. *Fixed Broadband Pricing Results.* In this Report, we extend the analysis used in past reports to provide a more comprehensive assessment of why prices differ across countries. In contrast to recent reports, we include both standalone broadband and broadband plans that are bundled with video in our analysis to more accurately reflect what consumers in each country are paying for their broadband services. This is a particularly important issue for the United States where it is estimated that 75 percent of consumers purchase broadband in bundles at large discounts.[7] The results are summarized below.

- *Fixed Unweighted Average Prices.*
    - Based on unweighted average prices for standalone plans with download speeds less than 10 Mbps, we find that the United States ranks 8th out of 13 countries with such plans.[8]
    - Based on unweighted average prices for standalone plans with download speeds of at least 10 Mbps and less than 25 Mbps, we find that the United States ranks 18th out of 25 countries with such plans.[9]
    - Based on unweighted average prices for standalone plans with download speeds of at least 25 Mbps and less than 100 Mbps, we find that the United States ranks 18th out of 23 countries with such plans.[10]
- *Fixed Broadband Price Index*. Rather than allowing for comparisons only within a particular broadband speed tier, we combine the different offerings in each tier into a single broadband price index so that countries can be ranked and compared by a single measure of price. This weighted average Purchasing Power Parity (PPP) adjusted broadband price index estimates what U.S. consumers would expect to pay in each country for the broadband service that they consume today.[11]
    - For standalone broadband across all speed tiers, the United States ranks 21st out of the 29

[7] Kagan, a media research group within S&P Global Market Intelligence, estimates that 75% of U.S. broadband subscribers from the top 5 publicly reported MSO's subscribe to double or triple-play bundles.

[8] *See id.* at para. 22, Tbl. 1b.

[9] *Id.*

[10] *Id.*

[11] PPPs are currency conversion rates that convert to a common currency and equalize the purchasing power of different currencies. In other words, PPPs eliminate the differences in price levels between countries in the process of conversion. *See* OECD, *Purchasing Power Parities—Frequently Asked Questions (FAQs)*, http://www.oecd.org/std/prices-ppp/purchasingpowerparities-frequentlyaskedquestionsfaqs.htm (last visited Jan. 16, 2018).

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countries.[12]

- For broadband bundled with multichannel video service, the United States ranks 19th out of the 29 countries.[13]
- Based on the fixed broadband price index for both standalone and bundled offers in each country, the United States ranks 21st out of the 29 countries.[14]

- *Fixed Hedonic Price Index*. We adjust broadband prices for differences across countries in demographic and cost profiles using a hedonic regression. The hedonic regression also allows us to adjust for observable differences in broadband quality across countries (e.g., the speed and usage limits of each plan) and generate prices for a set of standardized broadband plans in every country to facilitate comparisons. We then calculate a hedonic price index to compare prices across countries. This index estimates what the average U.S. consumer would expect to pay for their service in each country if that country had demographic, cost, and quality profiles similar to the United States.[15]
  - After adjusting for differences across countries in the cost and demographic factors outlined in the BDIA, as well as differences in broadband plan characteristics, our hedonic price index estimates that, for U.S. broadband service levels, the United States ranks 14th out of the 29 countries.[16]
  - If in our hedonic analysis we then further adjust prices for the quality of broadband content, we find that the United States ranks 7th among the 29 countries.[17]

5. *Mobile Broadband Pricing Results.* Our mobile price comparison methodology is the same that we use for fixed broadband with two exceptions. First, we classify mobile broadband products by data usage allowances rather than by download speeds. Second, we account for bundling in this sector by analyzing multi-line shared data plans (i.e., family plans) rather than the video and broadband bundling that occurs in the fixed broadband sector.[18] The results of this analysis are summarized below.

- *Mobile Unweighted Average Prices.*
  - For individual plans with usage allowances of 2 GB or less, the United States ranks 18th out of the 22 countries that offer such plans.[19]
  - For the highest usage individual plans with data usage allowances greater than 10 GB, we find that the United States ranks 21st out of the 28 countries that offer plans with such high usage limits.[20]

[12] *See infra* para. 28, Tbl. 3.

[13] *Id.*

[14] *Id.*

[15] The country rankings would not change if we predicted prices at the values of these variables for any other country or the average of these variables across all countries. The only difference in our results would be in the levels of the predicted prices.

[16] *See id.* at para. 32, Tbl. 4, Model 2.

[17] *See id.* at para. 32, Tbl. 4, Model 4.

[18] In other words, a "bundled" mobile offering consists of a multi-line package rather than a combination of broadband and video.

[19] *See id.* at para. 47, Tbl. 5.

[20] *Id.*

(continued….)

- *Mobile Broadband Price Index*. We again combine the different product offerings at each provider within each country into a single broadband price index that measures what U.S. consumers would expect to pay in each country for their mobile broadband services.
    - For individual plan pricing, the United States ranks 25th out of the 29 countries at $76.87. However, similar to our findings for fixed pricing, the United States ranks significantly better in bundled (i.e., shared data) plan pricing at $51.00 for 18th place.[21]
    - Combining individual and shared data plan pricing, the overall rank of the United States is 20th out of the 29 countries.[22]
- *Mobile Hedonic Price Index*. As with our fixed analysis, we calculate a hedonic index that estimates what the average U.S. consumer would expect to pay for their level of service in each country if that country had demographic, cost, and broadband quality profiles similar to the United States.
    - After adjusting for differences across countries in the cost and demographic factors, as well as differences in broadband quality, our mobile hedonic price index estimates that, the United States ranks 20th out of the 29 countries.[23]
    - If we further adjust mobile prices for content quality differences, our mobile hedonic price index finds that the United States ranks 10th across the 29 countries at an average per-line monthly price of $60.63.[24]

6. *Combining Fixed and Mobile Hedonic Price Index Rankings.* Typical consumers in the United States subscribe to both fixed and mobile services, so we also measure overall broadband affordability by calculating the average monthly cost U.S. consumers would pay to subscribe to both services in each country. We find that the United States ranks 8th overall by this measure at $123.62 per month for a mobile and fixed broadband connection.[25]

II. FIXED BROADBAND PRICING ANALYSIS

7. The great challenge in conducting international price comparisons is that the supply and demand factors that generate different broadband prices and offerings vary widely from one country to the next. An analysis that seeks to make "apples to apples" comparisons of broadband prices across countries would, at a minimum, need to account for: (1) the different costs of deploying and operating broadband networks; (2) demographic differences that affect demand for broadband service; (3) multi-product bundling in broadband pricing; (4) different product offerings in each country; and (5) the availability and quality of complementary content and applications. We examine each of these factors below, describing how each factor may affect international price comparisons and how we account for it in our fixed pricing analysis.

8. *Cost and Demographic Differences.* Each country is a separate broadband market with different supply and demand conditions that give rise to the observed market structure and pricing. One primary factor in determining the costs of deploying a broadband network is population density. Countries with lower population densities (e.g., the United States) will have much higher per-household

[21] *See id.* at para. 52, Tbl. 7.

[22] *Id.*

[23] *See id.* at para. 54, Tbl. 8, Model 2.

[24] *See id.* at para. 54, Tbl. 8, Model 4.

[25] *See id.* at para. 70, Tbl. C18.

(continued….)

deployment costs than countries with much higher densities (e.g., South Korea).[26] Standard economic models of entry would predict relatively higher prices in the United States since for a given level of demand, the markup over marginal cost required to cover the fixed costs of deployment would need to be higher even if the market is competitive.[27] As a result, countries with high population densities would be expected, all else equal, to have lower markups over cost and lower broadband pricing.[28] On the demand side, we would expect that demographic characteristics such as higher income and education levels would lead to higher broadband demand, all else equal.[29] Therefore, in our hedonic price index, we adjust for the types of cost and demographic differences across countries outlined in the statute by including controls for population density, education, and income in the hedonic regression.[30] We then predict broadband prices for each country at the average United States values of these variables.

9. *Broadband and Video Bundling.* Consumer preferences for subscription video services, the quality of these services, and the extent of consumer bundling of video with broadband also vary widely across countries. The United States generally has both higher prices and subscription rates for multichannel video service than other countries. For example, while only 20 percent of German households subscribe to multi-channel video services, over 80 percent of U.S. households subscribe to such services despite much higher monthly fees.[31] The explanation for these differences may be in large part due to differences in the quality of video services across countries.[32] Table 1a shows the total and per capita investment costs of programming networks by country.[33] U.S. programming networks spend

[26] Fiber deployment costs in South Korea have been estimated to be as low as $110-$170 per location passed, whereas such costs are estimated at $1000-$1300 in Australia. *See* OECD, The Development of Fixed Broadband Networks at 8 (2014), http://www.oecd-ilibrary.org/science-and-technology/the-development-of-fixed-broadband-networks_5jz2m5mlb1q2-en.

[27] *See* Timothy F. Bresnahan and Peter C. Reiss, *Entry and Competition in Concentrated Markets*, 99 J. Pol. Econ. 977, 981 (1991) (Equation 3), http://pages.stern.nyu.edu/~acollard/bresnahan-reiss.pdf.

[28] This discussion assumes that fixed deployment costs are not subsidized by the government. To the extent they are, this may lower the markup required to cover fixed costs and therefore result in lower prices if the market is sufficiently competitive. In Appendix F, we indicate that many countries subsidize broadband deployment. However, we did not account for this in our pricing analysis. If we had, the U.S. ranking likely would have improved given the greater governmental broadband subsidization in the comparison countries relative to the United States. *See infra* Appx. F.

[29] Although generally we would expect higher demand to increase prices all else equal, the effect of higher demand on prices is indeterminate as it depends on how higher demand affects marginal costs, competition, and the elasticity of broadband demand.

[30] Income levels will also affect broadband input costs in a country since labor and materials will be more expensive in countries with higher income levels. We account for the effects of income levels on prices using two methods. The first uses the U.S. dollar (USD) broadband price as the dependent variable in the hedonic regression and includes country-level income as an independent variable. The second uses the PPP price as the dependent variable and does not include income as an independent variable in the regression. We find that the U.S. fixed and mobile broadband rankings are the same under either approach.

[31] Jorn Krieger, *German Pay-TV Market On the Rise* (Jul. 15, 2015), http://www.broadbandtvnews.com/2015/07/15/german-pay-tv-market-on-the-rise/; New Street Research, 4Q15 Cable Trends Review (2016), http://www.newstreetresearch.com/download/NSR-Cable_16-03-09_%284Q15_Cable_Trends%29.pdf.

[32] Another contributing factor may be the substantially larger public broadcasting sector in Germany and other European countries.

[33] The total investment costs of programming networks were obtained from Kagan, a media research group within S&P Global Market Intelligence. Kagan, a media research group within S&P Global Market Intelligence, *TV Network Summary*, https://platform.mi.spglobal.com/web/client?auth=inherit#industry/tv_NetworksSummary (subscription only) (last visited Jan. 16, 2018). FCC staff calculated the investment per capita costs by dividing the

(continued….)

nearly ten times more than networks in the United Kingdom, the second largest investors in programming, and nearly twice as much per capita. Economics would again predict that video bundles in the United States would need to cost significantly more than other countries in order to recoup their large fixed investment costs in programming quality.

Table 1a
2016 Programming Investment (USD)

Country	Investment ($000)*	Investment Per Capita
Denmark	531,335	93.10
Finland	223,222	40.68
France	2,304,892	34.53
Germany	2,148,024	26.14
Italy	1,674,811	27.61
Netherlands	1,181,428	69.58
Norway	528,743	101.47
Spain	1,038,761	22.37
Sweden	874,125	88.73
United Kingdom	6,600,854	100.96
United States	**61,270,385**	**189.62**

**Source*: Kagan, a media research group within S&P Global Market Intelligence

10. Differences in consumer preferences for video also lead to different firm pricing strategies across countries. While providers in the United States use mixed bundle pricing with steep discounts, pricing models with additive or minimal bundle discounts prevail in many other countries. These different pricing strategies are evident in our data. Table C2 in the Appendix of Supplementary Tables calculates the average percentage discount off broadband services when they are bundled with video for each country.[34] We find that consumers in the United States receive a 20 percent discount on average compared to only 11 percent across all other countries.[35] This impacts our broadband pricing comparisons for two reasons. First, broadband customers in the United States receive substantial discounts when they bundle video and broadband, and 75 percent of customers benefit from these discounts by purchasing bundled services.[36] Second, standalone broadband prices are likely higher in the United States than other countries due to a pricing structure that incentivizes customers to purchase bundles.[37] As a result, the data collection and analysis need to include both standalone and bundled offerings in each country to accurately reflect the prices that consumers actually pay for their broadband

total investment costs by the country population totals. We obtained the population size of each country from the OECD. *See infra* Appx. E, para. 1 and Tbl. 1.

[34] *See infra* para. 70, Tbl. C2.

[35] *Id.*

[36] *See supra* para. 4, note 7.

[37] When pursuing a mixed bundling strategy, firms will generally raise the price of the standalone goods in order to draw consumers into purchasing the bundled product. *See* Yongmin Chen and Michael H. Riordan, *Profitability of Product Bundling*, 54-1 International Economic Review 35-57 (2013), https://www.jstor.org/stable/23352318?seq=1#page_scan_tab_contents. Also, while consumers that purchase both goods are generally better off, those that purchase a single product are generally worse off. *See* Daniel R. Vincent, *Insights From Recent Economic Analysis of Bundling* (2016) https://transition.fcc.gov/bureaus/mb/docs/policy/video_marketplace/position_statement_Vincent_2016.pdf. A full analysis of the welfare consequences of different bundling strategies by country is beyond the scope of our work.

services. We account for bundled offerings in both our broadband price index and our hedonic price index by estimating the prices of various broadband speed tiers in each country when bundled with video services and including these prices in all of our indices.

11. *Different Product Offerings.* Different underlying consumer preferences for speed and other characteristics results in very different product offerings across countries. Speeds up to a gigabit are routinely available in the United States while these types of products are often not available in other countries. In our data, broadband offerings exhibit tremendous variation in their characteristics, including: download and upload speeds; type of technology; limitations on usage; and consequences of exceeding usage limits (e.g., access speed reductions, surcharges, service cut-off). As such, broadband quality differences need to be accounted for to not disfavor countries with demand for higher quality service. We account for quality differences in our hedonic index by using our hedonic regression to predict provider-specific prices for a set of standardized broadband products (e.g., plans with no long-term contract, unlimited usage, etc.) so that our index measures what the price would be for the exact same broadband plans in each country.

12. *Content Quality and Diversity*. Internet content quality and variety also vary widely across countries. Access to a broad range of valuable applications and content over both fixed and mobile connections increases the value that each user derives from broadband service. In the language of economics, Internet content would be considered a complement to broadband. Access to better content in one country, or even if the same content is more highly valued in one country compared to another, will increase the demand for broadband services. Access to high-quality content can affect both the demand for and costs of providing broadband, since: (1) consumers receive greater benefits from subscribing to broadband service; and (2) more or better content increases data usage and results in greater per subscriber variable costs due to increased bandwidth charges (i.e., transit payments) and fixed capital costs from increased capacity investment in the network. Since our hedonic price index seeks to calculate how much more or less consumers in the United States would pay for broadband holding the quality and benefits of the broadband service in each country fixed, we need to account for unobserved differences in content quality. We do so by including a proxy measure for content quality in our hedonic regression and then predict prices in each country at the U.S. value of this measure.[38]

13. Evidence that there are large differences in fixed broadband usage across countries is provided in Table C4 in the Appendix of Supplementary Tables.[39] It shows that the average monthly data

[38] Table C3 contains three measures of content quality by country. *See infra* para. 70, Tbl. C3. This table provides estimates for the number of websites in each country's top level domain(s) (e.g., ".fr" is the top level domain in France), the number of web pages in the top level domain(s) and the percent of the top ten million web sites that are in each country's dominant language. These measures are discussed in more detail in the Technical Appendix. Due to the large difference in English content relative to all other languages, we simply enter a dummy variable for whether the country's dominant language is English into the model to control for content availability. The coefficient on this dummy variable is approximately the percentage difference in broadband prices between English and non-English speaking countries. *See* infoplease, *Languages Spoken in Each Country of the World* (*infoplease, Languages Spoken*), https://www.infoplease.com/languages-spoken-each-country-world (last visited Jan. 16, 1018); W^{3}Techs, *Historical Trends in the Usage of Content Languages for Websites* (*W^{3}Techs, Usage of Content Languages*), https://w3techs.com/technologies/history_overview/content_language (last visited Jan. 16, 2018); DomainTools, *Domain Count Statistics for TLDs* (*DomainTools, TLD Count Statistics*), http://research.domaintools.com/statistics/tld-counts/ (last visited Jan. 16, 2018); google.com (using Google Search Engine).

[39] *See infra* para. 70, Tbl. C4; *see also OECD Broadband Subscriptions by Country Table 1.1*; Cisco, *Advanced Editor* (*Cisco, Advanced Editor*), https://www.cisco.com/c/dam/m/en_us/solutions/service-provider/vni-forecast-widget/forecast-widget/advanced.html (last visited Jan. 16, 2018); Cisco, *VNI Forecast Highlights Tool* (*Cisco, VNI Forecast*), https://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html# (last visited Jan. 16, 2018); tefficient, *Is High Mobile Data Usage Cannibalizing Fixed?* (Aug. 22, 2017) (*Tefficient Report*), http://tefficient.com/is-high-mobile-data-usage-cannibalising-fixed/#more-3480; Stats NZ, *Internet Service Provider*

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consumption per fixed Internet household varies widely across our sample of countries and that U.S. households consume considerably more data than those in other countries. Among the countries for whom we have individual country data, the United States is estimated to have the highest per Internet household usage at 161.5 GB while Germany and France have the lowest at 39.5 GB and 44.2 GB, respectively.[40] The high usage in the United States indicates that these households are likely deriving more benefits from the content and applications provided through their Internet connections than subscribers in other countries.

A. Data Collection

14. *Sampling Methodology*. To determine which providers to sample in each comparison country, we used the TeleGeography GlobalComms Database to select providers with broadband market shares of at least ten percent.[41] This threshold was chosen to balance data collection costs with maximizing the representativeness of our broadband pricing sample.[42] We then chose cities in each country by first including the country's capital, as directed by the statute,[43] and then adding major metropolitan areas from the OECD Metropolitan Database.[44] We chose major cities on the basis of ensuring geographic diversity within the country.[45] We selected between one and four cities in each of the selected countries with the exception of the United States. For the United States, we collected data from ten major cities due to the greater overall population and variation in provider offerings.[46] This resulted in a sample of 83 cities including all 29 capital cities. We then randomly sampled a set of ten postal codes in each city from which we randomly selected ten addresses contained within each postal

Survey: 2016 (*Stats NZ, ISP Survey*), http://archive.stats.govt.nz/browse_for_stats/industry_sectors/information_technology_and_communications/ISPSurvey_HOTP2016/Commentary.aspx (last visited Jan. 16, 2018); Australian Bureau of Statistics, *Type of Access Connection* (*Australian Bureau of Statistics, Access Connection*), http://www.abs.gov.au/ausstats/abs@.nsf/mf/8153.0 (last visited Jan. 16, 2018).

[40] Some countries are not separately reported in the Cisco data. For some of these countries, we used data compiled by the telecom consulting firm Tefficient. *See Tefficient Report*. Otherwise, we used the Cisco estimate of average household consumption reported for the group of countries in which a country is included (e.g., the rest of Western Europe) or an average of this measure and a Tefficient report of usage for a single provider in a country. By combining both Cisco and Tefficient data, we have some individual country level fixed usage data for 18 out of the 29 countries in our sample. For mobile, we have some individual data for every country.

[41] *TeleGeography GlobalComms*. We obtained these data on the TeleGeography GlobalComms Database as of June 2017. There were a few exceptions to the 10% rule. For example, Verizon is estimated to have a national broadband market share below 10% in the United States, but it was sampled due to being the largest FTTP provider as well as the second largest ILEC. Due to missing fixed market shares for Japan, we used estimates from Japan's Ministry of Communications and Telecommunications. *See* Ministry of Internal Affairs and Communications, Subscriptions Shares First Quarter 2017 Data Public Release, Appx. Section 2 Fixed Communications, (1) Data Communications 1. Fixed Broadband at 8 (2017) (first quarter 2017 results), http://www.soumu.go.jp/main_content/000494106.pdf; Ministry of Communications, General Communications Infrastructure Bureau, NTT East and West Fiber Wholesale Service Provisioning Conditions, No. 34-2 (2015), http://www.soumu.go.jp/main_content/000390866.pdf.

[42] On average, our sample covers 83.5 percent of all broadband subscribers over all countries.

[43] 47 U.S.C. § 1303(b)(2).

[44] OECD, Metropolitan Areas, https://stats.oecd.org/Index.aspx?DataSetCode=CITIES (last visited Jan. 16, 2018).

[45] 47 U.S.C. § 1303(b)(2).

[46] In all cases, we tried to collect at least three cities in each country. However, in some cases the OECD data were only available for a single city.

(continued….)

code.[47] These addresses were then entered into providers' websites to determine the product offerings at every address.[48] While many providers' websites displayed "promotional splash page" plans offered generally, entering an address allowed us to capture the variation in product availability within a city and more accurate pricing information. Where we could not collect address-level plan data because providers requested to call or e-mail customers back, we collected "promotional splash page" plans and assumed these plans were available at every address.

15. *Collection of Broadband Prices and Timeframe.* For our analysis, we collected fixed broadband plan prices and terms from providers' websites between June and August of 2017. Both standalone broadband plans as well as "double play" packages of broadband bundled with multichannel video services were sampled. With some exceptions, we did not collect information on "triple play" bundles of phone, Internet, and video since the extent of the bundle discount received did not tend to increase with the addition of phone service and doing so would have greatly increased the data collection burden (i.e., adding all triple play and standalone phone plans).[49] In cases where a provider did not offer Internet service without a customer also subscribing to voice services, we collected the phone plan that would result in the lowest price and indicated that the plan included phone service in the data.[50] In such cases, we also collected triple play bundles from the provider that included that particular phone plan to isolate the broadband price when bundled using the methodology described below. Finally, if the provider did not offer video service, there would be no bundled plans in the data for this provider.

16. Given the large number of countries, providers, and possible product offerings, we limited the scope of the collection along two dimensions. First, we assumed customers were new to the provider and did not receive any special discounts that were not available to all customers (e.g., student discounts). Second, we only recorded information for the combination of features that resulted in the lowest price for a given plan. For example, we did not select add-on features (e.g., HBO); always chose the lowest priced equipment required for the plan; and assumed consumers were willing to sign up for a two-year contract if this offered the lowest price.[51]

17. We collected three types of data for each plan: general information, pricing data, and non-pricing data. General information captures the name of the plan, date of collection, and currency. For pricing data, we collected all pricing information available on the provider's website including promotions, equipment fees, installation fees, and rebates to calculate the total cost of the broadband service plan. Non-pricing data capture information such as download and upload speeds, data usage allowances, number of channels, and contract duration.

18. *Data Review Process.* Upon completion of the data collection, we reviewed the data for accuracy and completeness. When certain variables essential for the analysis were unavailable, we made

[47] For most countries, we used the GeoNames Postal Code Database to identify postal codes in each city and then sampled addresses from each postal code to ensure that we collected plan data from different areas within every city. *See* GeoNames, *ReadMe for GeoNames Postal Code Files* (last updated Jan. 5, 2018), http://download.geonames.org/export/zip/. Where the GeoNames Postal Code Database did not have a particular city's postal codes, we used either alternative sources of postal codes or other sub-city geographies (e.g., for South Korea, we used Administrative Districts).

[48] Actual speeds are particularly important for DSL plans because providers will commonly advertise higher speeds than most customers will receive. For example, a provider may offer a DSL plan with up to 50 Mbps download speed, but on average, most customers receive a much lower speed. Sampling actual speeds at addresses within a city allows us to estimate the true speeds that the average customer of the DSL plan is receiving.

[49] When providers did not offer standalone broadband plans, we collected double plays with Internet and phone as well as triple plays with phone, Internet, and video.

[50] We did not collect fixed broadband plans bundled with mobile services.

[51] We only collected information for contracts exceeding two-year durations when a particular plan was only available beyond a two-year contract duration.

additional assumptions to complete the analysis such as the following:

- Plans that did not indicate a usage allowance were assumed to allow unlimited usage since the vast majority of fixed data plans did not have usage limits.
- If a plan advertised a promotional price but had no duration, we assumed it lasted 12 months since this was the modal promotional length for other plans.
- If there was no information on equipment rental costs (modems and set-top boxes (STB)), we assumed equipment was included in the price.

19. *Broadband Price Calculation.* After the data was reviewed, we then calculated the total cost of the plan over the first 24 months. A 24-month price was selected to produce a comparable pricing measure across plans that accounts for all promotional and regular pricing and amortizes one-time fees over a sufficiently long-term horizon. This price was calculated as follows.

$$\begin{aligned} Price_{24\,Month} = {} & (PromoPrice_1 * PromoDuration_1) + (PromoPrice_2 * PromoDuration_2) \\ & + (24 - PromoDuration_1 - PromoDuration_2) * NonPromoPrice + 24 \\ & * (ModemPrice + STBPrice + MonthlyOtherFees - MonthlyRebate) \\ & + ActivationFee + InstallationFee + OtherFees - OneTimeRebates \end{aligned}$$

All countries except Canada, Japan, and the United States included taxes in the prices listed on their websites.[52] To make the prices in these three countries match the post-tax prices in other countries, we added taxes for plans in these countries using OECD estimates.[53] All prices were then converted to United States and PPP adjusted dollars for our analysis.[54]

20. We then matched all bundle plans with their corresponding standalone Internet and video component plans to calculate the following bundle discount percentage:

$$D_B = \left(1 - \frac{(P_I + P_V) - P_B}{(P_I + P_V)}\right)$$

where P_I is the standalone Internet price, P_V is the standalone video price and, P_B is the bundle price. For most bundles, we were able to collect the exact corresponding Internet and video component plans. However, in cases where providers did not offer one or both components on a standalone basis, we

[52] Another form of taxes in many European and Asian countries are media licensing fees that are used to subsidize public television and radio networks. A recent paper estimates that "two-thirds of European countries and half of Asian countries, households pay a media licensing fee on top of subscription fees." These taxes are levied on all television users and on broadband subscribers in at least one country (e.g., Denmark). Given our methodology, our calculation of the implied broadband price when bundled with video is unaffected by the inclusion or exclusion of these fees. However, to the extent that broadband subscribers in a country are subject to these fees, our analysis understates the pricing for these countries. *See* Roslyn Layton and Michael Horney, Innovation, Investment, and Competition in Broadband and the Impact on America's Digital Economy (2014), https://www.mercatus.org/system/files/Layton-Competitionin-Broadband.pdf.

[53] *See* OECD, Triple and Quadruple Play Bundles of Communication Services (2015), http://dx.doi.org/10.1787/5js04dp2q1jc-en. For Japan, we added 5 percent to all prices according to this source.

[54] For converting from local currency units to U.S. dollars, we used the World Bank's Atlas Method which reduces the impact of exchange rate fluctuations in cross-country comparisons. *See* The World Bank, GNI, Atlas method (current US$), https://data.worldbank.org/indicator/NY.GNP.ATLS.CD (last visited Dec. 14, 2017); *see* The World Bank, GNI (current US$), https://data.worldbank.org/indicator/NY.GNP.MKTP.CN (last visited Dec. 12, 2017). OECD, Purchasing Power Parities (PPP), https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm (last visited on Jan. 16, 2018) (measuring PPP in terms of national currency per U.S. dollar).

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assumed a bundle discount of zero for that particular bundled offering.

21. After calculating the discount amount from the standalone prices for each bundled plan, we applied the bundle discount percentage equally to the standalone broadband and video component plan prices to arrive at the implied price of broadband when purchased in a bundle.[55] To illustrate, suppose the standalone prices for a particular video and broadband plan are $100 and $50, respectively, but the two can be purchased in a bundle for $120. Then the bundle discount is 20 percent and the implied price of the video plan when purchased in a bundle is $80 while the implied price of broadband when bundled is $40. This implied broadband price when bundled and the associated broadband characteristics would then be included as a plan in the dataset. In this manner, our analysis does not compare video and broadband bundles across countries, but rather isolates an implied price of broadband when bundled to avoid the video product comparability issues discussed above.[56]

B. Unweighted Average Prices

22. Table 1b below provides results comparable to previous Reports by calculating unweighted average prices for standalone broadband within certain speed tiers in each country. It also provides the number of plans that fall into each category on which the calculations are based. Using this methodology, we find that the United States ranks 18th out of 23 countries that offer plans with download speeds of at least 25 Mbps and less than 100 Mbps. For the highest speed plans with download speeds of 100 Mbps or greater, we find that the United States ranks 26th out of 28 countries in this category. Table C6 in the Appendix of Supplementary Tables provides unweighted average monthly prices for bundled products (in particular, the estimated average cost of the broadband component video-broadband bundles after accounting for the bundle discount).[57] We find that the United States ranks 10th out of 20 countries that offer bundle plans with download speeds of at least 25 Mbps and less than 100 Mbps.[58] For the highest speed bundle plans with download speeds at or above 100 Mbps, we find that the United States ranks 23rd out of 25 countries.[59]

[55] Allocating the bundle discount percentage equally to each of the standalone components is equivalent to allocating the bundle discount amount in proportion to the standalone component prices. In a few rare cases where we calculated a slightly negative bundle discount, we assumed that the consumer would purchase the two separate standalone services and therefore set the bundle discount to zero.

[56] The resulting price indices and rankings are robust to alternative methods of calculating implied broadband prices. We also produced analyses that included video plan dummy variables in the hedonic regression to remove the video component price from the bundle and found similar results to those reported here.

[57] *See infra* para. 70, Tbl. C6.

[58] *Id.*

[59] *Id.*

Table 1b
Fixed Unweighted Monthly Prices for Standalone Products (PPP)

Country	0.2 ≤ Mbps < 10			10 ≤ Mbps < 25			25 ≤ Mbps < 100			100 ≤ Mbps		
	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans
Australia	63.49	11	11	46.29	16	65	65.22	19	69	71.50	19	35
Austria				34.20	2	10	44.44	7	10	97.32	25	28
Belgium							37.35	4	4	68.18	16	6
Canada	39.89	6	4	58.48	22	7	69.65	21	20	95.43	24	16
Chile	70.33	12	6	98.07	25	6	54.26	15	12	80.17	21	12
Czech Republic				39.90	10	3	51.00	14	5	54.07	10	7
Denmark	32.56	3	2	34.93	3	5	36.59	3	10	61.98	13	12
Estonia	28.19	1	4	39.96	11	8	43.43	6	8	55.13	11	12
Finland	34.50	4	3	32.23	1	14	31.85	1	19	39.63	2	16
France				37.04	7	6				44.18	5	12
Germany				38.75	8	15	41.06	5	15	45.73	7	22
Greece	41.07	7	2	36.56	6	8	44.71	8	10			
Iceland				39.83	9	4				44.66	6	15
Ireland				58.09	21	4				65.19	15	14
Italy	31.66	2	3	35.93	5	12				38.44	1	12
Japan	38.29	5	8	41.47	13	8	35.21	2	10	49.96	8	17
Latvia				35.56	4	1	47.76	11	1	43.44	4	4
Luxembourg				55.52	20	2				92.20	23	6
Mexico				49.70	17	7	75.39	23	4	104.90	27	3
Netherlands							49.72	13	6	58.64	12	15
New Zealand				59.90	23	12	59.61	17	20	68.39	17	39
Norway	48.79	9	2	52.72	19	4	70.18	22	12	113.30	28	13
Portugal				42.32	14	7	47.85	12	2	53.29	9	9
South Korea										43.19	3	30
Spain	62.76	10	6	76.15	24	3	69.65	20	21	87.50	22	15
Sweden				43.56	15	9	45.83	9	10	69.29	18	31
Switzerland	77.57	13	4				47.15	10	12	74.14	20	24
United Kingdom				40.03	12	16	55.17	16	36	63.20	14	12
United States	**47.08**	**8**	**12**	**52.29**	**18**	**7**	**61.78**	**18**	**30**	**104.00**	**26**	**42**
Average	47.40		67	47.18		243	51.52		346	67.40		479

Note: Unweighted mean prices are simple averages of all plans in the country and speed tier.

C. Fixed Broadband Price Index

23. For purposes of comparing broadband pricing across countries, we need an estimate of "the price" of broadband in each country that accounts for all of the factors discussed above. Our approach is to follow well-established practices in the price index literature. We calculate a broadband price index for the same fixed set of broadband services to facilitate comparisons across countries. In general, a price index calculates the change in prices for a set of products or services by comparing the prices in the "base period" to those in the "comparison period." One such index is the Consumer Price Index calculated by the Bureau of Labor Statistics of the U.S. Department of Labor.[60] While the classic setting involves measuring price changes across time, our application to price changes across countries is analogous with the two periods now corresponding to two different countries. Our goal is to calculate the

[60] *See* U.S. Department of Labor, Bureau of Labor Statistics, *Frequently Asked Questions (FAQs)*, https://www.bls.gov/cpi/questions-and-answers.htm (last visited Jan. 16, 2018).

(continued….)

following Laspeyres broadband price index.[61]

$$L(p) = \frac{\sum_{j=1}^{N} p_{j,t} q_{j,0}}{\sum_{j=1}^{N} p_{j,0} q_{j,0}}$$

24. In the formula above, p_{jt} is the price of product j in comparison country t, p_{j0} is the price of product j in the base country and q_{j0} is the share of product j in the base country. The index is therefore the ratio of the weighted average price of all of the j broadband products sold in the comparison country to the weighted average price of these same products in the base country where the weights are the percentage of broadband consumers that choose each product in the base country.

25. Ideally, we would calculate the price index over every broadband plan offered in every country. However, there are at least two difficulties in doing so. First, we would need to know the number of households that subscribe to each base country plan, and we do not have these data. Second, the broadband products available in each country are not the same, thus even if we had such weights, they would not be applicable in the comparison countries. Therefore, we need to aggregate all the available broadband plans in each country into a smaller more uniform set of products for which we have information on purchase quantities.[62] We do this by aggregating all the broadband products offered in each country into j = 8 products. We define four standalone products classified by the following download speed tiers: at least 200 kbps but less than 10 Mbps; at least 10 Mbps but less than 25 Mbps; at least 25 Mbps but less than 100 Mbps; at 100 Mbps or above. We also define four additional products when these speed tiers are purchased in a video bundle.[63] The resulting broadband products and their estimated U.S. market shares are shown in Table 2 below.

[61] The Laspeyres price index is an upper bound for the average compensating variation from a price change. Compensating variation measures the dollar amount by which a given consumer would need to have their income adjusted to obtain the same level of utility under the comparison prices and product choice set.

[62] Aggregating products in this manner is common in the differentiated products demand model literature. *See* Steven Berry, James Levinsohn, and Ariel Pakes, *Automobile Prices in Market Equilibrium*, 63-4 Econometrica 841 (1995), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.554.3931&rep=rep1&type=pdf; Aviv Nevo, *Measuring Market Power in the Ready-to-Eat Cereal Industry*, 69-2 Econometrica 307 (2001), http://www.agecon.purdue.edu/academic/agec619/PP/IO_mats/Nevo%202001.pdf; Austan Goolsbee and Amil Petrin, *The Consumer Gains from Direct Broadcast Satellites and the Competition with Cable TV*, 72-2 Econometrica 351 (2004), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.476.3034&rep=rep1&type=pdf.

[63] The speed tier cutoffs were chosen to match quantity data available in the FCC's 477 broadband subscription data collection.

Table 2
Fixed U.S. Shares by Broadband Product

Product Name	U.S. Product Share
Standalone: 0.2 ≤ Mbps < 10	4.98%
Standalone: 10 ≤ Mbps < 25	5.79%
Standalone: 25 ≤ Mbps < 100	9.81%
Standalone: 100 ≤ Mbps	4.42%
Bundled: 0.2 ≤ Mbps < 10	14.93%
Bundled: 10 ≤ Mbps < 25	17.38%
Bundled: 25 ≤ Mbps < 100	29.42%
Bundled: 100 ≤ Mbps	13.27%

Source: *FCC 2017 Internet Access Report.*
Note: Product Shares were calculated by dividing each speed tier's connections by the total connections, and then multiplying by 25% for Standalone and 75% for Bundled Products.

26. The price index we calculate uses the United States as the base country to which other countries' prices are compared. While the price index and relative country rankings will in general depend on which country is chosen as the base due to the use of different quantity weights, we chose the United States for several reasons. First, the focus of this Report is to evaluate whether the prices of broadband products purchased in the United States are comparable to other countries. Second, we have better estimates of the quantity weights for the United States than for any other country. Finally, the Laspeyres index ensures that U.S. broadband consumers would be at least as well-off as in higher ranked countries by measuring the dollar amount that U.S. broadband subscribers would need to have added or subtracted from their incomes to purchase the same basket of broadband services under the pricing structures in other countries.

27. The quantity weights for our price index were calculated using the FCC's Form 477 data and are the share of broadband subscribers in the United States that subscribe to each of the four broadband speed tiers we have chosen for analysis.[64] However, Form 477 does not provide an estimate of the percentage of U.S. subscribers that purchase broadband service bundled with video. For this we rely on the estimate from Kagan that 75 percent of U.S. consumers purchase broadband in a bundle.[65] Calculating meaningful prices for each of our eight broadband products is more difficult. We again follow the price-index literature in implementing two common approaches: market basket and hedonic analyses. The market basket approach, discussed in Section II.C.1, calculates a simple weighted average price in each country for our eight products using the United States quantities as weights. The hedonic index discussed in Section II.D then extends the analysis by better accounting for missing product prices, quality differences within product groupings, and differences in the broadband cost and demand structures in each country.

1. Fixed Broadband Price Index Results

28. In Table 3 below, we present country rankings based on the fixed broadband price index, as well as this index divided by the average data consumption per user discussed above to calculate a

[64] FCC, Internet Access Services: Status as of June 30, 2016 at 3, Fig. 2a (WCB 2017) (*FCC 2017 Internet Access Report)*, https://apps.fcc.gov/edocs_public/attachmatch/DOC-344499A1.pdf.

[65] *See supra* para. 4, note 7.

(continued….)

$/GB price.[66] The United States ranks 21st out of 29 countries in standalone pricing, but higher for broadband bundled with video service at 19th due to large bundle discounts.[67] Combining standalone and bundled pricing, the overall rank of the United States is 21st. On a dollar per GB of data consumed basis, the United States ranks 2nd out of 29 countries behind only South Korea. However, it may not be appropriate to divide the price by average data consumption. The problem is that data consumption not only affects broadband pricing as described above, but broadband pricing also likely affects data consumption. One could argue that for fixed broadband, the monthly subscription price should not affect usage since once this price is paid, most plans have no usage allowances or allowances that far exceed expected usage for most households. The flaw in this reasoning is that consumers choose whether or not to adopt broadband based on their expected monthly data usage and how much they value that usage.[68] If prices are high in a country, then we would expect that consumers with lower expected data usage would not subscribe to broadband. Conversely, in countries with low prices, we would expect more low usage consumers to subscribe. As a result, given the same content, we would expect average fixed data usage to be higher for countries with high prices and lower for countries with low prices. Since higher prices in a country may lead to higher average data usage per household, it is problematic to divide price by usage that is uncorrected for this issue since this unfairly advantages countries with higher subscription prices and disadvantages those with lower prices. To account for content quality and the resulting data usage differences across countries, we enter a proxy measure of content quality that does not suffer from this issue directly into our hedonic regression. This isolates the effect of content quality on prices and allows us to predict prices from the hedonic regression holding content quality fixed.

[66] The table presents the weighted average prices in each country for the indicated products. The Laspeyres index for each country would be calculated by dividing the given country's price with the U.S. price.

[67] We note that the bundle and standalone pricing measures are not strictly comparable in Table 3 because the plans that are included in each calculation may be different. For this reason, the bundle price in a country may be higher than the standalone price.

[68] This is known as selection bias in the econometrics literature.

Table 3
Fixed Broadband Price Indices (PPP)

Country	Standalone		Bundled		Overall		$/GB	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Australia	60.78	20	70.26	27	67.89	27	0.70	12
Austria	50.69	16	39.31	6	42.15	8	0.65	8
Belgium	42.53	7	57.79	21	53.98	20	0.54	5
Canada	63.54	24	59.51	25	60.52	24	0.70	13
Chile	80.71	29	79.98	29	80.16	29	0.98	23
Czech Republic	48.29	14	45.40	16	46.12	16	1.30	28
Denmark	39.80	3	39.80	7	39.80	6	0.80	15
Estonia	44.47	9	42.78	15	43.20	12	1.21	26
Finland	35.11	1	29.89	2	31.19	2	0.70	11
France	40.41	4	26.09	1	29.67	1	0.67	9
Germany	44.81	11	40.87	9	41.86	7	0.84	18
Greece	44.55	10	56.76	20	53.71	19	0.83	17
Iceland	49.35	15	40.25	8	42.53	11	0.86	19
Ireland	63.17	23	58.54	23	59.70	23	0.57	6
Italy	35.98	2	39.05	5	38.28	5	0.90	21
Japan	40.46	5	42.74	14	42.17	9	0.73	14
Latvia	41.18	6	32.56	3	34.71	3	0.98	22
Luxembourg	71.30	27	61.72	26	64.12	26	1.00	24
Mexico	69.61	26	46.47	17	52.25	18	1.03	25
Netherlands	51.64	18	41.91	11	44.34	14	0.89	20
New Zealand	61.84	22	58.28	22	59.17	22	0.67	10
Norway	68.73	25	59.06	24	61.48	25	1.24	27
Portugal	46.52	12	41.00	10	42.38	10	0.65	7
South Korea	43.55	8	33.85	4	36.28	4	0.27	1
Spain	73.70	28	73.70	28	73.70	28	1.47	29
Sweden	47.14	13	42.23	12	43.46	13	0.43	4
Switzerland	57.24	19	50.08	18	51.87	17	0.81	16
United Kingdom	50.98	17	42.53	13	44.64	15	0.42	3
United States	**61.65**	**21**	**52.62**	**19**	**54.88**	**21**	**0.34**	**2**
Average	52.75		48.45		49.52		0.80	

Note: The Standalone Index is calculated by averaging each country's weighted mean price by speed tier (Table C7) using US Product Shares as weights (Table 2). The Bundled Index is calculated by averaging each country's weighted mean price by speed tier (Table C8) using the US Product Shares as weights (Table 2). When a country did not have plans within certain speed tiers, we first assumed, if the highest speed tier was missing, the price of the highest speed tier is equal to the next highest available speed tier, and then we assumed that any other missing prices were equal to the next lowest available speed tier price. The Overall Index is the weighted average of the Standalone Index and Bundled Index using US Bundling Share (75%).

D. Fixed Hedonic Price Index

29. A hedonic regression provides an empirical summary of how prices vary with the characteristics of a good and is a standard technique used to estimate and compare quality-adjusted prices and has been used for years in price index applications.[69] To account for the remaining issues with our price index that we identified above, we develop a hedonic price index that accounts for differences between countries in: (a) cost and demographic factors; (b) quality of broadband offerings; and (c) content quality.

30. To do so, we estimate four hedonic regressions and then construct hedonic price indices from each model. Our hedonic regression is a multilevel model that allows the coefficients on each characteristic to vary by broadband provider to estimate provider-specific prices for each of our eight standardized broadband plans. While the details of the hedonic modeling are contained in the Technical Appendix, we summarize the basic approach here. The first model regresses the logarithm of each broadband plan's price on the characteristics of that plan to account for how differences in plan characteristics (e.g., download speeds) explain differences in plan prices across countries. The second model builds upon the first by adding average income, population density, and a dummy variable for whether the country is highly educated into the model to capture how country-level differences in these demographic and cost factors influence pricing.[70] The third model adds data usage per fixed Internet household to provide a comparison to the final model where we instead add a proxy variable for content quality into the regression due to the issues with using data usage discussed above.[71] This final specification accounts for all of the price comparison issues we have identified.

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[69] U.S. Department of Labor, Bureau of Labor Statistics, *Consumer Price Index, Quality Adjustment in the CPI* (Nov. 20, 2017), https://www.bls.gov/cpi/quality-adjustment/home.htm.

[70] *See* The World Bank, Urban Population (*World Bank, Urban Population*), https://data.worldbank.org/indicator/SP.URB.TOTL?name_desc=false (last visited Jan. 16, 2018); The World Bank, Rural Population (*World Bank, Rural Population*), https://data.worldbank.org/indicator/SP.RUR.TOTL (last visited Jan. 16, 2018); The World Bank, Population Total (*World Bank, Population Total*), https://data.worldbank.org/indicator/SP.POP.TOTL (last visited Jan. 16, 2018); The World Bank, Urban land area (sq. km) (*World Bank, Urban Land Area*), https://data.worldbank.org/indicator/AG.LND.TOTL.UR.K2 (last visited Jan. 16, 2018); The World Bank, Rural land area (sq. km) (*World Bank, Rural Land Area*), https://data.worldbank.org/indicator/AG.LND.TOTL.RU.K2 (last visited Jan. 16, 2018); The World Bank, Agricultural land (sq. km) (*World Bank, Agricultural Land Area*), https://data.worldbank.org/indicator/AG.LND.AGRI.K2 (last visited Jan. 16, 2018); The World Bank, Land area (sq. km) (*World Bank, Land Area*), https://data.worldbank.org/indicator/AG.LND.TOTL.K2 (last visited Jan. 16, 2018); The World Bank, GNI per capita, PPP (current international $) (*World Bank, GNI per capita (PPP)*), https://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CDv (last visited Jan. 16, 2018); The World Bank, GNI Per capita, Atlas method (current US$) (*World Bank, GNI per capita (Atlas)*), https://data.worldbank.org/indicator/NY.GNP.PCAP.CD (last visited Jan. 16, 2018). *See also* OECD, OECD.Stat: Education and Training (2016) (*OECD Tertiary Education*), http://stats.oecd.org/ (last visited Jan. 16, 2018) (To access the data, click the left-hand column titled "Data by Theme" and click "Education and Training," then "Education at a Glance," then "Educational Attainment and Outcomes," then "Educational Attainment and Labour-Force Status," then "Educational Attainment of 25-64 Year-Olds," then "Tertiary Education"). A country is classified as highly educated if the percentage of its population with a tertiary education exceeds the average in our samples. This classification is based on OECD data. *OECD Tertiary Education*.

[71] As discussed in detail in the Technical Appendix, the content quality measure we use is whether the dominant language in the country is English. The results do not change substantially if we use the other measures of content quality reported in Table C3 in the specification instead of the dummy variable. Robustness checks not reported here also show that the results do not change significantly if we drop the United States from the estimation sample and then predict prices.

(continued….)

1. Hedonic Price Index Results

31. To calculate our cross-country comparison measures based on categories of download speeds, we predict firm-specific prices from the hedonic regression in each country for each of the eight standardized broadband products. For these predictions, we set the income, population density, education, and content quality variables to the U.S. values while the plan characteristics are standardized across all countries.[72] This procedure effectively estimates what the prices of each plan would be in each country if income, population density, education, and content quality were at U.S. levels. We then aggregate these firm-specific price predictions for each of the eight products by using the same steps described in the Technical Appendix for the fixed broadband price index discussed above to arrive at the price that U.S. consumers would pay in each country for their broadband services if those countries had U.S. cost and demographic profiles.

32. The resulting country rankings under each model are shown in Table 4 below. These are the overall rankings over the standalone and bundled products in each country. In the unadjusted Model 1, we find that the United States ranks 23rd out of the 29 countries in our sample with an average broadband price of $58.00. Countries with lower average incomes like Latvia, the Czech Republic, and Estonia rank near the top before we correct the price levels for income. In Model 2, after we correct price levels for differences in income, education and population density, we find that the United States ranks 14th due to being a country with high income and education levels and low population density. We observe that countries with either high population densities such as South Korea or low income levels like Latvia exhibit the greatest price changes between Models 1 and 2. Model 3 includes the data usage variable but does not account for the issues with including this variable. Countries with higher prices and higher usage improve dramatically in rank if we enter this variable into the hedonic regression without correcting for prices causing higher data usage. For example, Sweden increases from 7th to 3rd and the United States jumps to 6th. Model 4 enters our content quality proxy variable of whether the country is English speaking into the hedonic regression, and finds that the United States ranks 7th least expensive out of the 29 countries.

[72] We predict prices from the hedonic regression for broadband plans at the following download speeds for both standalone and bundled plans: 10 Mbps, 25 Mbps, 100 Mbps, and 1 Gbps. The plans are standardized to include only no contract plans with no phone service, a modem rental, and unlimited data usage allowances.

Table 4
Fixed Hedonic Broadband Price Indices

Country	Model 1		Model 2		Model 3		Model 4	
	Price	Rank	Price	Rank	Price	Rank	Price	Rank
Australia	78.30	28	82.81	27	102.63	26	84.45	23
Austria	48.04	17	60.59	15	73.17	11	74.02	17
Belgium	46.82	16	66.62	21	75.29	13	81.09	22
Canada	69.66	27	74.99	25	92.73	24	76.57	19
Chile	33.42	8	73.60	23	83.81	20	88.97	25
Czech Republic	26.83	3	49.18	6	69.91	9	60.49	6
Denmark	43.46	14	52.27	8	69.37	8	63.85	8
Estonia	30.65	6	56.91	12	81.68	19	69.06	12
Finland	35.00	9	37.95	1	57.49	2	51.61	1
France	30.12	5	44.04	4	61.96	4	54.25	3
Germany	36.00	12	53.62	10	75.09	12	66.06	11
Greece	35.38	10	64.51	19	80.72	17	78.66	21
Iceland	65.78	25	73.96	24	94.85	25	90.39	26
Ireland	56.79	22	62.37	16	76.46	14	64.83	9
Italy	29.62	4	48.00	5	68.80	7	59.00	5
Japan	40.12	13	53.58	9	81.47	18	72.12	15
Latvia	20.29	1	42.78	3	63.05	5	52.20	2
Luxembourg	56.32	21	54.32	11	76.83	15	72.51	16
Mexico	35.58	11	91.29	29	120.40	29	109.64	29
Netherlands	44.39	15	63.89	18	89.51	21	77.88	20
New Zealand	59.51	24	81.42	26	90.55	22	76.25	18
Norway	88.41	29	71.77	22	103.98	27	96.95	27
Portugal	30.82	7	58.27	13	72.83	10	71.15	14
South Korea	25.45	2	42.07	2	52.01	1	56.28	4
Spain	54.95	20	87.69	28	115.51	28	106.53	28
Sweden	52.48	19	52.16	7	61.08	3	70.41	13
Switzerland	66.88	26	65.01	20	91.15	23	84.46	24
United Kingdom	50.77	18	63.75	17	79.88	16	65.44	10
United States	**58.00**	**23**	**59.84**	**14**	**64.75**	**6**	**62.94**	**7**
Average	46.55		61.70		80.24		73.73	

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

III. MOBILE OVERVIEW AND DATA HIGHLIGHTS

33. The issues with comparing mobile broadband pricing across countries are very similar to those encountered in our fixed broadband pricing analysis. Mobile products also vary considerably with respect to data allowances, technology of service, speeds, contract length requirements, and other attributes that are important to consumers. Given similar issues involved in fixed and mobile price

comparisons, we use a very similar approach in the mobile broadband pricing analysis, though certain changes were necessary. The two major differences are described below, and we explain in greater detail in the discussion that follows.

- We again define a set of standardized products over which we calculate a weighted average price index in each country. However, mobile plans are generally sold by data usage allowances instead of download speed, thus we define the products by usage. In order to calculate the shares for each mobile broadband product in the weighted average, we need to estimate the percentage of U.S. consumers that would subscribe to each plan based on data usage profiles.
- Mobile bundling involves the number of lines on a given plan rather than bundling other products such as video. In the United States, Cisco estimates that 75 percent of subscribers obtain their mobile service through shared data plans (i.e., "family plans").[73] Similar to fixed bundled broadband, these bundled plans are offered at greatly discounted rates and therefore need to be properly accounted for in order for our price index to reflect actual consumer purchases.

34. We again find that before adjusting for cost and demographic differences across countries, the United States ranks 20th out of 29 countries overall (combining individual and shared line plans) in our mobile broadband price index at $57.46 per month (PPP).[74] However, after accounting for cross country differences in population density, income, education and broadband quality using our hedonic regression, we find that the United States now ranks 10th overall in our mobile hedonic index.[75]

IV. MOBILE BROADBAND PRICING ANALYSIS

35. While the methodology used in our mobile analysis is quite similar to our fixed methodology, there are some differences that we highlight below.

36. *Product Quality Differences.* Mobile broadband service offerings also vary substantially across countries, which makes price comparisons difficult. Data usage allowances, activation fees, roaming charges, contract lengths, and consequences of exceeding usage allowances are some of the plan characteristics that may differ both within and between mobile broadband providers. We use the same techniques for addressing these comparability issues in mobile broadband as we did with fixed broadband. We first define a set of five mobile broadband products based on the data usage allowances offered by the plan and whether the plan is a shared data plan. Our mobile broadband products consist of a three line shared data plan and four single line products based on the following usage allowances: 2 GB or less; 5 GB or less but greater than 2 GB; 10 GB or less but greater than 5 GB; and greater than 10 GB.[76]

37. In our hedonic price index analysis, we further standardize these products by predicting prices out of the hedonic regression for a set of standardized plans across all countries with exactly the same characteristics and with data usage allowances set at the upper threshold of the previously given

[73] *See* Cisco, *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper* at 30, Fig. 36 (2017) (*Cisco White Paper*), https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html.

[74] *See id.* at para. 52, Tbl. 7.

[75] *See id.* at para. 54, Tbl. 8, Model 4.

[76] The shared plan product is assumed to have three lines because this is Ericsson's estimate for the average number of lines on shared data plans in the United States. *See* Ericsson, North American Ericsson Mobility Report (2016) (*Ericsson 2016*), https://www.ericsson.com/assets/local/mobility-report/documents/2016/north-america-ericsson-mobility-report-june-2016.pdf.

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ranges. We also control for 4G network availability in each country as an additional measure of mobile broadband product quality and predict prices at U.S. levels of coverage.[77]

38. *Shared Plans.* Mobile broadband consumers often bundle a number of lines on the same plan to receive a discount off what the service would cost if purchased as individual line plans. In the United States, these types of shared or family plans are the norm while they are much less prevalent in other countries. Cisco estimates that 75 percent of all mobile broadband subscribers in the U.S. purchase their services through shared data plans.[78] This is not surprising given that our data show that U.S. consumers achieve significant savings by bundling multiple lines on a single plan. Table 5 estimates the average monthly per line cost for each of our five products at the country level. We estimate that a single line plan with a data usage allowance over 10 GB costs $93.48 on average in the United States while a shared plan that would allow similar per line data usage would cost only $49.52 per line.[79] Thus, U.S. consumers save nearly $44 per line when they choose shared data plans over individual plans. In most other countries, shared plans either do not exist or do not offer as great of a savings compared to individual line plans.

39. *Content Quality and Diversity.* We again find that there are large differences in data usage per subscriber across countries. Table C5 in the Appendix of Supplementary Tables shows the average monthly data consumption per mobile broadband subscriber for each of the countries.[80] Finland is estimated to have the highest data usage at 9.6 GB per month.[81] The United States ranks 10th at 2.9 GB per subscriber per month.[82] These findings are noteworthy because higher usage increases the costs of service both through higher fixed and operating costs and indicates that consumers are benefiting more from their broadband service.

A. Mobile Data Collection

40. *Collection of Broadband Prices and Timeframe.* For our analysis, we collected mobile broadband plan prices and terms from providers' websites between June and August of 2017.[83] Given the wide scope of offerings by mobile providers, we attempted to only collect information for postpaid smartphone plans that allowed both unlimited voice calling and texting.[84] However, where providers did not offer plans with unlimited minutes or unlimited text messages, we collected plans with the highest number of minutes and text messages available. We collected plan information in three broad categories: (a) general information including country, provider, plan name, and date of collection; (b) pricing information including all types of recurring and non-recurring costs of the plan such as promotional

[77] *See* Open Signal, *The State of LTE (November 2017)*, https://opensignal.com/reports/2017/11/state-of-lte (last visited Jan. 16, 2018).

[78] *See Cisco White Paper* at 30, Fig. 36.

[79] *See infra* para. 47, Tbl. 5.

[80] *Id.*; *see also* Cisco, *VNI Forecast*; tefficient, Industry Analysis #1 2017, Mobile data – full year 2016 at 4, Fig. 2 (July 11, 2017) (*tefficient, Industry Analysis*), http://media.tefficient.com/2017/07/tefficient-industry-analysis-1-2017-mobile-data-usage-and-revenue-FY-2016-per-country-11-July.pdf; OECD, Broadband Portal, Mobile Data Usage per Mobile Broadband Subscription, 2016, Table 1.14 (Dec. 2016) (*OECD, Mobile Data Usage*), http://dx.doi.org/10.1787/888933585343.

[81] *See infra* para. 70, Tbl. C5. We use the average of the reported data usage estimates by country across the Cisco Mobile VNI, Tefficient and OECD data sources.

[82] *Id.*

[83] As with the fixed price data collection, we used the TeleGeography GlobalComms Database as of June 2017 to select providers with broadband market shares of at least ten percent.

[84] By postpaid plans, we refer to plans that paid after usage (i.e., not prepaid or "pay-as-you-go" plans). By smartphone plan, we refer to only plans that have a data component.

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prices, activation fees, and rebates; and (c) non-price information such as technology, usage allowance, number of minutes and text messages (when not unlimited), and above-cap data usage policy. We collected only plans available online and to new customers without any special discounts (e.g., youth or senior discounts).

41. We attempted to collect pricing information excluding the cost of handsets due to both the complexity that handsets introduce in measuring price and because most providers allow customers to bring their own devices. However, when pricing information was unavailable without selecting a handset (less than four percent of all plans), we selected the latest version of a widely available high-end handset (e.g., Apple iPhone, Samsung Galaxy) without insurance and noted whether a handset was included in the prices in a data field.

42. One of the most important price factors for mobile broadband service is the data usage allowance. We recorded the monthly allowance for each plan and any promotional data and the duration of the promotional data.[85] In general, providers set a "soft" data limit per month before the provider imposes a consequence for exceeding these usage allowances.[86] If a consumer exceeds the allowance, the provider may decrease mobile broadband speeds for the remainder of the month, charge overage fees (i.e., a consumer can have extra data at an extra cost), or stop the service entirely (i.e., a "hard" data limit). The structure of the data allowance policies varies by provider and can be quite complex. For example, some providers have several data allowance thresholds with different consequences for surpassing each one while other providers limit the amount of extra data a customer can buy. Some providers allow customers to choose from various data allowances. To simplify this issue for our data collection, we recorded overage fees whenever available, but recorded only the first consequence for surpassing the original usage allowance in the dataset. For overage fees, we recorded the amount of additional data and its cost (e.g., $15 for 1 GB), and if the provider offered multiple levels of additional data, we recorded the lowest priced extra data option.

43. We encountered a few issues unique to a small number of providers that required making assumptions about customer preferences.[87] For providers that offered a plan with a set number of units to split between talk, text messages, and data, we split these equally across the services and recorded the exchange rate among the services (e.g., 1 unit = 1 minute = 1 text = 1 MB). Another issue was that Telia in Scandinavia offered a choice of included add-on options, including additional monthly data. If a customer could increase data on the plan without increasing the cost, we assumed the consumer would choose the additional data over the other services.[88]

44. *Data Review Process.* When the data collection was completed, we began reviewing the data for issues. When certain essential variables were missing, we made the following assumptions to complete the analysis:

- If the website did not list usage allowances or consequences of exceeding usage, we assumed the plan offers unlimited data usage.
- If a plan advertised a promotional price or data without specifying a duration, we again assumed the promotion lasts 12 months since this is the most frequent promotional length.

[85] One complication is that some providers zero-rate data usage for certain services (e.g., music or video streaming) or include additional restricted-use data (e.g., extra data for outside the country). For the data allowance, we record only the generally available data provided with the plan. We also restricted the sample to plans with a monthly usage allowance greater than 200 MB.

[86] In our regressions, "unlimited" is reserved for those plans that do not have a soft data usage allowances. For all plans, the data usage allowance is coded as the point at which such consequences begin for a user of the plan even though it may be possible to exceed this usage allowance in the month.

[87] These issues affected only four providers and not all of the plans they offered.

[88] For example, Telia in Denmark offered a 15 GB plan with the choice of optional services such as digital newspaper subscription, HBO Nordic, and 10 GB of additional monthly data.

- If activation fees, access fees, other recurring and non-recurring fees, and rebates were not listed clearly on the providers' website, we assumed that these fees were included or did not apply to the plan.

45. *Broadband Price Calculation.* After the data was reviewed, we then calculated the total cost of the plan over the first 24 months. A 24-month price was selected to produce a comparable pricing measure across plans that accounts for all promotional and regular pricing and amortizes one-time fees over a sufficiently long-term horizon. This price for individual plans was calculated using the formula below. For shared data plans, we also included the extra monthly cost of two additional lines.

$$Price_{24\,Month} = (PromoPrice_1 * PromoDuration_1) + (PromoPrice_2 * PromoDuration_2) + (24 - PromoDuration_1 - PromoDuration_2) * NonPromoPrice + 24 * (lines * AccessFee + MonthlyOtherFees - MonthlyRebate) + lines * ActivationFee + OtherFees - Rebate$$

46. Finally, we determined that all countries except some plans in Canada, Greece, and the United States included taxes in the prices listed on their websites. To allow the prices in these three countries to match the post-tax prices in other countries, we added the same percentage tax to the plan price as we used for our fixed pricing analysis.[89]

B. Unweighted Average Prices

47. Table 5 below presents the plan counts and unweighted average per line prices for all mobile broadband plans within the shared plan and data usage allowance categories that define our five products. These results are comparable to findings in previous Reports because we calculate simple averages within each data allowance usage. We find that the United States ranks relatively low in these price comparisons. For individual plans with usage limits of 2 GB or less, the United States ranks 18th out of 22 countries that offer such plans. For the highest usage individual plans with usage allowances greater than 10 GB, we find that the United States ranks 21st out of the 28 countries that offer plans with such high usage limits. As expected, we also observe that the per line monthly price in the United States for subscribers on shared data plans is significantly lower than comparable individual plans. A shared data plan with total usage allowances generally exceeding 20 GB costs only $49.52 per line. It is also worth noting that only 12 out of 29 countries in our study have any providers that offer shared data plans.[90]

[89] *See supra* para. 19.

[90] Shared plans may not have comparable usage limits to the individual plans in some countries. As a result, it is difficult to make direct price comparisons between shared and individual plans based on Table 5. We account for these usage differences in our hedonic analysis of mobile prices. *See infra* paras. 53-54.

Table 5
Mobile Unweighted Monthly Prices by Usage Allowance Tiers (PPP)

Country	0 < Data (GB) ≤ 2			2 < Data (GB) ≤ 5			5 < Data (GB) ≤ 10			10 < Data (GB)			Shared Data Plans		
	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans
Australia	19.44	4	2	25.01	8	3	31.19	7	7	46.35	6	13	0.00	0	0
Austria	12.54	1	1	18.76	3	2	30.50	5	2	59.28	11	4	0.00	0	0
Belgium	0.00	0	0	41.20	16	1	54.31	15	4	56.18	8	1	0.00	0	0
Canada	74.69	22	6	85.24	26	6	111.53	23	6	166.91	28	6	58.67	11	24
Chile	0.00	0	0	67.02	23	2	112.90	24	2	84.30	19	7	0.00	0	0
Czech Republic	58.24	19	1	61.27	22	2	75.81	18	3	145.28	27	4	0.00	0	0
Denmark	0.00	0	0	21.02	4	3	26.05	2	4	40.34	4	9	24.82	2	9
Estonia	19.57	5	5	27.40	9	3	34.17	8	2	48.03	7	7	28.31	6	6
Finland	0.00	0	0	13.43	1	1	25.86	1	1	35.38	1	6	0.00	0	0
France	28.07	9	5	0.00	0	0	0.00	0	0	60.39	12	20	0.00	0	0
Germany	43.82	16	4	49.99	19	6	85.71	20	8	139.69	25	5	25.04	3	5
Greece	48.44	17	1	133.10	27	4	274.62	25	2	0.00	0	0	65.99	12	1
Iceland	16.98	2	3	23.37	6	2	30.93	6	3	56.30	9	14	27.49	5	12
Ireland	0.00	0	0	37.10	13	1	0.00	0	0	63.08	15	5	0.00	0	0
Italy	0.00	0	0	37.12	14	2	48.63	12	5	41.63	5	1	0.00	0	0
Japan	63.29	20	4	80.47	25	5	108.39	22	3	145.10	26	10	56.00	10	10
Latvia	18.07	3	5	22.85	5	2	36.06	9	2	38.26	2	3	0.00	0	0
Luxembourg	28.47	10	1	17.08	2	1	28.47	3	4	62.38	14	9	0.00	0	0
Mexico	31.39	11	3	48.19	17	5	83.51	19	12	132.13	24	3	0.00	0	0
Netherlands	63.60	21	3	49.72	18	1	68.36	16	2	107.67	23	6	0.00	0	0
New Zealand	0.00	0	0	39.06	15	3	51.70	14	4	75.85	17	3	26.04	4	3
Norway	26.49	8	3	34.79	12	3	42.27	11	2	62.21	13	6	0.00	0	0
Portugal	36.83	13	7	50.07	20	2	0.00	0	0	84.46	20	1	31.33	8	3
South Korea	40.53	14	11	57.34	21	8	75.22	17	6	99.64	22	13	0.00	0	0
Spain	34.75	12	1	0.00	0	0	50.70	13	3	66.79	16	3	0.00	0	0
Sweden	24.67	6	4	30.68	10	3	38.12	10	3	57.62	10	14	29.34	7	6
Switzerland	42.14	15	1	33.24	11	1	0.00	0	0	78.81	18	10	0.00	0	0
United Kingdom	25.38	7	5	24.99	7	6	29.75	4	10	39.61	3	19	18.94	1	3
United States	**55.53**	**18**	**3**	**72.99**	**24**	**2**	**102.36**	**21**	**3**	**93.48**	**21**	**7**	**49.52**	**9**	**6**
Average	28.03		79	41.47		80	57.14		103	75.42		209	15.22		88

Note: Unweighted mean prices are simple averages of all plans in the country and data allowance tier.

C. Mobile Broadband Price Index

48. In this section, we present a comparison of mobile broadband pricing across countries by calculating a mobile broadband price index using the same Laspeyres formula we used for fixed broadband.[91] For each provider, we first calculate the average plan price for all of their offerings that fall into each of our five product categories. We then average these provider level prices for each product to the country level weighting by the market share of each provider. Finally, we calculate a weighted average of these product prices at the country level to form a single price index by using the estimated percentage of consumers in the United States that subscribe to each product to weight the product prices.

49. *Product Market Shares.* To perform the last step described above requires an estimate of the percentage of U.S. consumers that subscribe to each one of our five products defined by the data usage allowance. To estimate these product shares, we use Cisco Mobile VNI data coupled with an assumption on the shape of the usage distribution.[92] Based on the Cisco data, we know that in the United States, 35 percent of mobile subscribers use less than 2 GB of data per month, 28 percent of mobile subscribers use between 2 GB and 5 GB, 17 percent of mobile subscribers use between 5 GB and 10 GB

[91] We again calculate a Laspeyres price index that estimates how much consumers in the United States would pay for their mobile broadband plans in each of the comparison countries. The formula is identical to that used for fixed broadband. *See supra* para. 23-24.

[92] *See Cisco White Paper*.

and 10 percent of mobile subscribers use more than 10 GB. Cisco also finds that 75 percent of users subscribe to shared plans with an average usage of 4.1 GB, and 25 percent of users subscribe to individual plans with average usage of 5.5 GB of data per month. However, we do not have an estimate of the percentage of individual plan customers that fall into each of our data usage allowance categories. We only know that on average these customers have higher usage than shared plan customers and therefore need a way to estimate these percentages from the available Cisco data.

50. Consumer usage over nearly every communications network, including broadband, has been shown to be well approximated by the log-normal distribution.[93] This makes estimating the distribution of data usage in a population particularly simple since a log-normal distribution is entirely determined by only two parameters; a location parameter that pins down the mean and a scale parameter that determines the shape of the usage distribution.[94] Another important property of the distribution is that the percentiles are preserved if the mean of the distribution is shifted up or down.[95] Using these properties of the distribution and the Cisco data, we are able to estimate the percentage of subscribers in the United States that have usage between the data usage allowances of each of our standardized mobile broadband products. The results of this approach are summarized in Table 6 below. The column with the heading "Cisco" presents Cisco's estimate of the percentage of all U.S. mobile broadband consumers that have usage between the specified ranges of data consumption. The next column provides our estimates using a log-normal distribution calibrated to the Cisco data. We find that our estimates are a close match and that the log-normal assumption fits this data well. The next two columns provide our estimates for the percent of individual and shared plan subscribers that fall into each usage bucket. These serve as the product shares in our price index and would likely closely match the Cisco data if Cisco reported the data separately for individual and shared plans.

Table 6
Mobile Product Share Calculations

Product	Cisco	Estimated		
	Overall Usage	Overall Usage	Single Plan Usage	Shared Plan Usage
0 < Usage (GB) ≤ 2	35.0%	35.7%	27.8%	39.0%
2 < Usage (GB) ≤ 5	38.0%	36.8%	36.8%	36.3%
5 < Usage (GB) ≤ 10	17.0%	18.3%	21.9%	16.8%
10 < Usage (GB)	10.0%	9.2%	13.5%	7.9%
Distribution Parameters				
Plan Type	**Mean**		**Standard Deviation**	
Overall	1.042		0.95	
Individual	1.253		0.95	
Shared	0.960		0.95	

Source: *Cisco White Paper*.

51. *Results*. In Table 7 below, we present the country rankings based on the price index calculations described above. We present an index for individual plans, another for shared plans and an

[93] I. Antoniou, V. Ivanov, Valery Ivanov & P.V Zrelov, On the Log-Normal Distribution of Network Traffic, Physica D: Nonlinear Phenomena, Volume 167, Issues 1–2, 1 (2002) at 72–85.

[94] *See* George S. Ford, Approximating the Distribution of Broadband Usage from Publicly-Available Data at 7, n.5 (2012), http://www.phoenix-center.org/perspectives/Perspective12-03Final.pdf. A random variable is log-normally distributed if the logarithm of the variable is normally distributed.

[95] *Id*.

(continued….)

overall index that is a weighted average of the individual and shared plan indices.[96] For the overall mobile broadband price index, we allocate 75 percent of the weight to the family plan product since this fraction of customers in the United States subscribes to this product. If a country does not offer shared data plans, then the shared product price is the same as the individual product price index since customers would be required to purchase these plans instead of bundling lines at discounted rates. For the four individual plan products, we multiply the percentage of subscribers with usage that falls into each individual plan data usage category shown in the third column of Table 6 by the 25 percent of customers that subscribe to individual plans. If a country does not offer one of the four individual plan products, we follow the same procedure used in the fixed pricing analysis whereby we use the price of a plan for that provider with the next highest usage allowance. This assures that U.S. consumers are at least as well off with the plan provided as they would have been with the plan available in the United States. For example, T-Mobile USA only offers a single $70 unlimited plan, and we use this price for all four individual products for this provider.

52. Similar to our findings for fixed pricing, the United States ranks relatively lower in standalone (individual) plan pricing at 25th out of the 29 countries at $76.87 PPP, but significantly better in bundled (shared) pricing at $51.00 for 18th place.[97] In individual plan pricing, Finland ranks first at $19.08 PPP per line per month while Latvia is the top country in shared data pricing at only $21.87 per line per month. Combining individual and shared data plan pricing, the overall rank of the United States is 20th.

[96] The product prices by country that were used in the mobile price index calculations are presented in Table C13 of the Appendix of Supplementary Tables. *See infra* para. 70, Tbl. C13.

[97] *See infra* para. 52, Tbl. 7.

Table 7
Mobile Broadband Price Indices (PPP)

Country	Single		Shared		Overall		$/GB	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Australia	26.61	5	40.90	13	37.32	11	21.48	14
Austria	25.09	4	30.28	7	28.98	7	5.87	3
Belgium	45.85	13	48.54	17	47.87	16	70.24	25
Canada	99.96	28	60.48	23	70.35	25	51.38	22
Chile	79.07	26	92.60	28	89.21	28	74.35	26
Czech Republic	74.64	24	75.05	27	74.95	27	101.08	28
Denmark	24.94	3	22.83	2	23.36	2	5.93	4
Estonia	29.33	7	24.57	3	25.76	3	7.03	5
Finland	19.08	1	30.69	8	27.79	5	2.89	1
France	50.73	17	33.85	9	38.07	12	30.79	17
Germany	62.78	21	46.88	16	50.86	18	55.31	23
Greece	162.30	29	121.52	29	131.71	29	183.44	29
Iceland	27.49	6	26.47	4	26.72	4	7.72	6
Ireland	48.94	16	55.01	20	53.49	19	19.10	11
Italy	37.82	12	42.93	14	41.65	14	31.67	18
Japan	92.38	27	62.03	24	69.61	24	29.52	16
Latvia	24.82	2	21.87	1	22.61	1	3.42	2
Luxembourg	29.66	8	37.12	12	35.25	9	12.11	8
Mexico	65.21	22	56.33	21	58.55	22	50.43	21
Netherlands	68.67	23	74.90	26	73.34	26	90.33	27
New Zealand	47.38	14	43.84	15	44.72	15	42.31	20
Norway	37.63	11	34.77	10	35.49	10	16.15	9
Portugal	57.93	19	35.29	11	40.95	13	38.62	19
South Korea	62.16	20	57.00	22	58.29	21	16.38	10
Spain	48.29	15	51.62	19	50.79	17	58.34	24
Sweden	33.99	10	29.87	6	30.90	8	8.50	7
Switzerland	52.13	18	68.41	25	64.34	23	23.73	15
United Kingdom	31.04	9	27.22	5	28.17	6	20.48	13
United States	**76.87**	**25**	**51.00**	**18**	**57.46**	**20**	**20.02**	**12**
Average	53.20		48.41		49.61		37.88	

Note: The Single Index is calculated by averaging each country's weighted mean price by data allowance tier (Table C13) using the Single Plan Usage Shares (Table 6). The Shared Index is calculated by averaging each country's weighted mean price of shared plans. For countries without shared data plans, we used a weighted average of the four single-line data allowance tiers using the Shared Plan Usage Shares as weights (*see supra* Table 6).

D. Mobile Hedonic Price Index

53. The mobile broadband price index in Table 7 does not account for several factors that likely affect the observed price levels in each country. We estimate a hedonic regression model to adjust prices for country-level differences in cost and demographic factors, differences in mobile broadband

product quality (e.g., plan usage limits), and content quality. We then predict prices out of this hedonic model for a standardized set of mobile broadband products at the U.S. averages of the other control variables in order to estimate the mobile broadband prices that would be observed in each country if that country resembled the United States in cost and demographic characteristics.[98] These predicted prices are then weighted together in the same manner that we used to calculate the previous price index to arrive at our hedonic price index measure for comparing mobile broadband prices across countries.

54. Our hedonic price indices for individual plans, shared plans, and overall are provided in Table 8. The differences between the four models presented are the same as our fixed pricing analysis. We again find that adjusting for cost and demographic factors is important when ranking countries by broadband pricing. Before adjusting for these income, education, and population density factors, the United States ranks 25th across the 29 countries in mobile broadband pricing (Model 1). Correcting for these factors in Model 2 changes the U.S. ranking to 20th. The U.S. ranking improves to 17th when we add actual data usage in Model 3. If we instead add our proxy measure for content quality in Model 4, we find that the United States ranks 10th overall in mobile broadband pricing.

[98] For the greater than 10 GB plan, we predict the price for a 20 GB plan and for the family plan we predict at 5 GB of data usage per line. The other plan characteristics for the predictions are set to have: no contract, long distance included, unlimited text and voice, a limited data usage allowance and the handset not included in the price.

Table 8
Mobile Hedonic Broadband Price Indices

Country	Model 1		Model 2		Model 3		Model 4	
	Price	Rank	Price	Rank	Price	Rank	Price	Rank
Australia	32.16	12	36.49	7	39.54	4	45.65	5
Austria	22.94	3	33.47	6	65.68	21	47.40	6
Belgium	54.13	22	77.56	25	59.13	15	101.89	26
Canada	75.77	29	79.84	26	48.04	7	91.62	23
Chile	44.09	20	76.63	24	82.10	25	123.58	27
Czech Republic	27.31	6	41.12	9	37.86	2	55.94	8
Denmark	23.52	4	32.02	4	55.37	11	43.35	4
Estonia	16.41	2	24.21	2	41.01	5	34.58	2
Finland	24.24	5	27.27	3	53.05	10	49.40	7
France	28.12	7	50.28	14	62.37	19	82.72	19
Germany	33.23	14	50.32	15	50.66	8	70.22	12
Greece	70.83	27	105.96	29	85.07	28	146.34	29
Iceland	30.68	9	44.47	12	59.34	16	76.27	15
Ireland	30.98	10	47.54	13	72.37	23	64.16	11
Italy	36.89	17	61.55	21	77.75	24	91.18	22
Japan	56.12	23	59.14	19	58.06	14	82.09	18
Latvia	13.52	1	20.87	1	51.62	9	30.21	1
Luxembourg	33.74	15	43.01	10	63.54	20	71.99	14
Mexico	32.61	13	57.71	17	66.82	22	87.62	21
Netherlands	51.62	21	66.18	23	61.51	18	81.09	17
New Zealand	61.47	26	97.32	28	83.07	26	92.02	24
Norway	40.76	18	43.84	11	47.43	6	71.55	13
Portugal	34.52	16	55.42	16	56.67	13	79.68	16
South Korea	58.98	24	58.79	18	83.90	27	85.29	20
Spain	42.80	19	65.07	22	55.73	12	92.89	25
Sweden	32.14	11	32.15	5	35.71	1	57.46	9
Switzerland	73.78	28	80.64	27	90.61	29	134.40	28
United Kingdom	28.95	8	38.20	8	39.51	3	41.75	3
United States	**61.01**	**25**	**60.89**	**20**	**60.99**	**17**	**60.68**	**10**
Average	40.46		54.07		60.16		75.62	
Model 1: Unadjusted for demographics and content quality								
Model 2: Adjusted for demographics but not content quality								
Model 3: Adjusted for demographics and data usage								
Model 4: Adjusted for demographics and content quality								

V. TECHNICAL APPENDIX

A. Fixed and Mobile Broadband Price Index Calculations

55. The methodology used to calculate the fixed broadband price indices in Table 3 and the mobile broadband price indices in Table 7 are provided below. The supplementary tables of broadband prices by individual product type referenced here are available in the appendix of supplementary tables.

56. *Step 1.* To calculate our fixed broadband price index, we need estimates for each country's price of each of the eight products in our Laspeyres price index formula. We first calculate a weighted average price within each of the products for each broadband provider where the weights are the product of city population and product availability. We then calculate a weighted average price across providers within each country and product type. The weight is now the estimated market share of each provider in each country. This weighted average is therefore more representative of the prices consumers in each country are actually paying for their broadband services. The resulting prices for each standalone product are shown in Table C7 and for each bundle product are shown in Table C8. For mobile, we assume that all plans are available on a nationwide basis in each country. We first calculate the average price for each product within each provider and then calculate a weighted average price for each product using estimated market shares for each provider as the weight. The resulting prices for each of the five products are shown in Table C13.

57. *Step 2.* While most of the eight products are offered in the United States, a number of countries do not have some products available. We therefore need a method to fill in these missing prices to establish a complete price index. For example, Belgian fixed providers do not have offerings below 25 Mbps, and providers in Spain and Denmark do not offer bundles. For missing standalone prices for fixed and mobile, we substitute the price of the next highest speed or usage tier that is available in the country.[99] This method was chosen to ensure that our calculated price index is "proper," meaning an upper bound to the compensation required to make the average consumer no worse off from the different prices and product choices in the comparison country. The reason that it is still an upper bound is that the primary product characteristics of broadband (e.g., speed and usage limits) are what economists call "vertical," meaning that consumers always prefer greater amounts of them.[100] Therefore, giving consumers more of certain broadband characteristics like download speed and data usage limits guarantees that consumers prefer the product that is actually available in the comparison country to the product that is only available in the base country.[101] For missing fixed bundled prices, we use the standalone price that corresponds to the given bundle product's speed tier since these products are not offered in a bundle and must be purchased on a standalone basis. For missing mobile shared data plan prices, we use the weighted average of the standalone prices in each country where the weights are the product shares calculated in Table 6.

58. *Step 3.* To calculate our price index for each country, we must put these eight product prices together into an overall weighted average price for broadband in each country. A Laspeyres price index would then be calculated as the ratio of this price in each comparison country to the United States average price.[102] To calculate this overall average price, we first calculate the standalone and bundle country broadband rankings shown in Table 3 for fixed and Table 7 for mobile. For fixed, we calculate a weighted average price of the four products within each product category (i.e., standalone or bundled) using the percentage of U.S. consumers that subscribe to each speed tier as determined by data collected

[99] For the highest speed tier, it was sometimes necessary to choose the price of the next lowest tier to fill in missing prices.

[100] *See* Ariel Pakes, A Reconsideration of Hedonic Price Indices with an Application to PC's (2002), http://www.nber.org/papers/w8715.pdf. For a discussion of these issues and the recommendation to use the approach outlined here.

[101] The hedonic method improves upon this approach by estimating the missing prices directly from the hedonic regression. Hedonic price estimates are frequently employed in the analogous problem that arises in consumer price index calculations when a product is no longer found on store shelves.

[102] *See supra* paras. 23-24 for Laspeyres price index formula. The difference between the comparison country price and the United States price is an estimate of the compensating variation. This measures the dollar amount that U.S. consumers would need to have their incomes adjusted by to ensure they are at least as well-off in the other country.

(continued….)

in Form 477 as the weights.[103] To calculate the overall country-level price that accounts for both standalone and bundled broadband pricing, we combine the speed tier shares with the Kagan estimate that 75 percent of U.S. consumers bundle broadband with video to estimate the product shares shown in Table 2.[104] For mobile, we combined the four single-line products into an overall single-line product using the product shares in Table 6, and then we combined the overall single index and shared index to produce an overall mobile broadband price index with a 25 percent weight on the single and a 75 percent weight on the shared index.

59. *Step 4.* To produce the Table 3 ($/GB) rankings, in the final step we simply divide the overall broadband price calculated in step 3 by the estimated average per Internet household data consumption in each country for fixed or the average per user data consumption for mobile.

B. Hedonic Price Index Details

60. While the classic hedonic framework involves adjusting for changing product quality over time, accounting for product differences across firms and countries is analogous. Griliches (1961) proposes a linear hedonic regression of price on product characteristics of the form.

$$\ln(p_{ijk}) = a_k + x_i'b + e_i$$

In this equation, p_{ijk} is the price of plan i at provider j in country k, x_i is a vector of plan characteristics and e_i is a scalar error term. Under this approach, the country specific intercepts a_k estimate the difference in the average price levels across countries accounting for differences in product characteristics x_i. This is called the "time dummy hedonic price index" and has been widely used in comparing prices across time or space.[105] However, this approach is not ideal for cross-country broadband pricing comparisons because it assumes that coefficients on product characteristics (the slope parameters *b*) are the same for each country. While it is plausible that the supply and demand conditions that generate the *b* coefficients are similar in adjacent time periods or even possibly cities within the same country, it is implausible that these conditions are similar from country to country. If broadband cost structures, determinants of demand (e.g. demographics), product offerings, ownership structure, regulatory conditions, subsidies or other conditions that impact prices vary across countries then we would expect the slope parameters to be different as well.

61. We estimate a more flexible model where the slope coefficients for certain characteristics are allowed to differ across countries and firms. However, due to sample size limitations in our pricing data, we do not estimate all of the *j* possible slope parameters for each product characteristic at the provider level, but rather use multilevel modeling techniques similar to those recently proposed in broadband price hedonic work at the OECD.[106] The multilevel model recognizes that plans are nested within providers which are nested within countries and that prices are likely correlated within these nests. Rather than estimating separate parameters for each provider and product characteristic, the model assumes normally distributed mean-zero random effects on some product characteristics at the provider level and then estimates the variance of each random effect. The model is therefore more parsimonious since it estimates a single unknown variance parameter for each product characteristic rather than a separate slope parameter for each provider by product characteristic combination. Our base multilevel

[103] This assumes that broadband bundle subscribers have the same probability of choosing each speed tier as standalone subscribers.

[104] *See supra* para. 4, note 7.

[105] *See* W. Erin Diewert, Saeed Heravi and Mick Silver, Hedonic Imputation versus Time Dummy Hedonic Indexes 161 (2009), http://www.nber.org/chapters/c5073.pdf.

[106] *See* Carol Corrado and Olga Ukhaneva, Hedonic Prices for Fixed Broadband Services: Estimation Across OECD Countries (2016), http://www.oecd-ilibrary.org/docserver/download/5jlpl4sgc9hj-en.pdf?expires=1513350160&id=id&accname=guest&checksum=C9D52D13FAEA93DFFA6B2ECBD6888F4D. These models are also called "random coefficients models," "hierarchical linear models," and "mixed models."

(continued….)

hedonic pricing equation (Model 1 in table 5 above) is as follows.

$$\ln(p_{ijk}) = a_j + a_k + x_i'b + b_{1j}x_1 + u_j + u_k + e_i$$

62. In this formulation, a_j and a_k are fixed provider and country level intercepts, while u_j and u_k are random intercepts for both providers and countries that measure country and provider differences from the sample means. The x_i vector is the same set of product characteristics as before but now certain product characteristics, the first characteristic x_1 in the example above, are assumed to have random slopes b_{1j} that allow providers to have different costs and markups on this product characteristic.[107] This random effect measures how each provider's pricing of characteristic one differs from the pricing of the average provider in the sample as measured by the coefficient b_1. In our fixed broadband hedonic models, the product characteristics with random coefficients are four download speed splines, the bundling dummy variable, the contract dummy variable, the dummy for whether phone service is included and the unlimited data usage dummy.[108] In our mobile broadband hedonic models, there are random coefficients on three data usage allowance splines and the dummy indicatory variables for whether it is a shared data plan, has a contract, and whether long distance included.[109]

63. It is important to understand the correct interpretation of the hedonic coefficients. Under perfect competition, the *b* vector estimates both the marginal consumer value and marginal production costs for each product characteristic.[110] However, in markets with substantial fixed costs like broadband, the coefficient also includes the markup over cost for that characteristic and these markups are complex functions of the characteristics of competing products, firm costs, consumer preferences, and market structure.[111] Since we do not observe the product markup term, this is absorbed into the error term and will be correlated with the product characteristics. As such, in imperfectly competitive markets, hedonic coefficients should only be considered a reduced-form description of how prices (costs and markups) vary with changes in product characteristics and should not be given any interpretation beyond this.[112] The focus should not be on the particular value or precision of any one coefficient, but rather on how

[107] For the mobile hedonic model, there were an insufficient number of plans at each provider to estimate provider specific random effects on product characteristics. Instead, we estimate a model with country specific random effects on product characteristics and a provider random intercept parameter.

[108] We control for download speed using a linear spline in the logarithm of download speed with knot points at the top-end of our speed categories used to define the eight broadband products (i.e., 10, 25, 100 and above 100 Mbps).

[109] We control for data allowance using a linear spline in the logarithm of the data allowance with knot points at the top-end of our data allowance categories used to define mobile broadband products with the three highest data allowances (i.e., 2, 5, 10 and above 10 GB). There is no random coefficient on the 2 GB and less category because the fixed effect explained all of the variation in the data.

[110] *See* Sherwin Rosen, Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition (1974), http://www.stern.nyu.edu/networks/phdcourse/Rosen_Hedonic_prices.pdf.

[111] *See* Ariel Pakes, A Reconsideration of Hedonic Price Indexes with an Application to PC's (2003) (*2003 Reconsideration of Hedonic Price Indexes Paper*), https://scholar.harvard.edu/files/pakes/files/hedonics_8-03.pdf; Robert C. Feenstra and Gordon H. Hanson, Foreign Investment, Outsourcing and Relative Wages (1995), http://www.nber.org/papers/w5121.pdf; Diane Bruce Anstine, How Much Will Consumers Pay? A Hedonic Analysis of the Cable Television Industry (2001), https://www.jstor.org/stable/41799034?seq=1#page_scan_tab_contents. Even if the broadband market is competitive in a country, pricing will still need to be above marginal cost in order for firms to recover their fixed deployment costs.

[112] In fact, under plausible conditions the coefficients may have the opposite sign as would be expected, implying that goods with greater quantities of desirable characteristics have lower prices. *See 2003 Reconsideration of Hedonic Price Indexes Paper*; Ariel Pakes, Hedonics and the Consumer Price Index (2005), https://scholar.harvard.edu/files/pakes/files/hedonics-cpi_5-11-05.pdf; *Ericsson 2016* (explicit derivations and Monte Carlo simulations).

(continued….)

predictive the hedonic pricing function is of provider prices in each country.[113] We follow the standard hedonic approach as well but differ in that we also correct price levels for exogenous country-level factors that we expect may be correlated with costs and markups. These proxy variables include: (a) the logarithm of urban population density; (b) an indicator variable for whether the country is above the sample average in tertiary educational attainment; (c) the logarithm of income in Atlas adjusted U.S. dollars; (d) our dummy variable for whether it is a predominantly English-speaking country. The coefficients on these variables are again reduced form estimates of how prices are correlated with country-level factors and should not be given a causal interpretation for how we would expect price to change if, for example, we increased the income level of a country.

64. In Table C3, we report various proxy measures for content quality as well as each country's primary language. The number of websites in top-level domains (TLDs) shows the count of all domains in each country's main TLD (e.g., Germany uses .de) according to DomainTools.com. For the United States, we aggregate over several major domains: .com, .net, .org, .us, .gov, and .edu. Similarly, we used the same TLDs to report the number of web pages in the TLDs by searching Google's search engine ("site:de") and recording the number of search results. Another proxy measure is the percent of the top 10 million websites in each country's primary language.[114] From this data, we find that English-based website represent over 50 percent of the top 10 million websites. Although these statistics are not perfect measurements of content quality, they demonstrate that English language content is the dominant form of content available to broadband subscribers. Since the number of English language web sites is an outlier, we were concerned that adding this variable would result in estimating the effect based on the assumed functional form rather than the data. Therefore, we simply use an English dummy variable in the hedonic regressions to control for content quality differences between English and non-English speaking countries.[115]

65. The hedonic estimation equation we use for our final country rankings for fixed broadband is as follows.

$$\ln(p_{ijk}) = a_j + a_k + x_i'b + z_j'd + b_{1j}x_1 + u_j + u_k + e_{ijk}$$

All terms are as before except now we include a vector of exogenous country level variables (income, education, population density, and the English language dummy) and the parameter vector d measures their effects on broadband prices.[116] For our mobile broadband specification, we also add the availability of 4G LTE networks in each country to capture these quality differences.[117] The last issue that we have not accounted for in the hedonic regression is product bundling. As noted above, most U.S. consumers purchase broadband and video service in a bundle at steeply discounted rates while significant bundle discounts and purchasing are much less common in other countries.[118] It is very difficult to compare multichannel video products across countries. The product offerings in terms of channels included are

[113] *See 2003 Reconsideration of Hedonic Price Indexes Paper*.

[114] *See* W3Techs, *Usage of Content Language for Websites*, https://w3techs.com/technologies/overview/content_language/all (last visited Jan. 16, 2018).

[115] We have found our results to be robust to using different measures of content quality as well as dropping the United States from the sample and then running the estimation. The United States ranks higher when we use the number of web pages or websites in English rather than the dummy variable.

[116] The effective sample size for estimating the country level parameters is only 29. While this is not large, it is likely sufficient according to Monte Carlo simulations with multilevel models. *See* Mark L. Bryan Stephen P. Jenkins, Multilevel Modelling of Country Effects: A Cautionary Tale (2016), http://eprints.lse.ac.uk/61357/2/Jenkins_Multilevel%20modelling.pdf.

[117] For our availability measure, we use the proportion of times that users in each country are able to connect to an LTE network from OpenSignal. *See* OpenSignal, The State of LTE (June 2017), https://opensignal.com/reports/2017/06/state-of-lte.

[118] *See supra* paras. 4, 9-10, note 7.

completely different across countries and even the same content may be highly watched in some countries (e.g., soccer in Europe) but uninteresting to most viewers in another country (e.g., soccer in the United States). Therefore, unlike broadband where a download speed of 25 Mbps is a more uniform product characteristic, there is no standardized video product that would be comparable across countries that would hold consumer utility fixed. Also, given the large differences in network investments in programming quality by country shown in Table 1a, it is unlikely that standard measures used to correct for video plan quality differences (e.g., number of channels) would be sufficient to account for these quality differences.

66. Since we did not believe the observable measures captured quality differences across countries, we explored alternative methods to account for broadband bundling with video services. The first is to directly control for video plan fixed effects in the hedonic regression. Including a video plan fixed effect essentially subtracts the average standalone price of the video service from the bundle so that we recover the implied price of broadband service when bundled. The method we chose to use instead, primarily due to greater simplicity, is to calculate a bundle discount and allocate this across the standalone component pricing as described above. We estimated the hedonic model using both methods and found that the estimates and resulting country rankings were similar. However, the first method was substantially more computationally demanding due to the extremely large number of video plan fixed effects in the model, so we instead chose the simpler approach.

67. *Fixed Hedonic Results.* Table C9 contains the coefficient estimates and robust standard errors clustered at the country level for the fixed broadband hedonic models.[119] Table C10 contains the likelihood ratio tests and measures of model fit (R-squared). Each column provides the estimates for one of our four models. Model 1 regresses the logarithm of the U.S. dollar (USD) plan price on just the product characteristics. Model 2 adds the country-level z_j measures to adjust for exogenous country level factors that would be expected to affect prices. Model 3 adds the country-level data usage measure to the previous model but does not correct for the endogeneity issue when including this measure. Model 4 then adds the content quality proxy in place of the data usage variable.

68. The estimated coefficients on each product characteristic generally conform to expectations. Across all models, we find that prices increase in download speeds, data usage limits, and when phone is included; they decline when consumers sign long term contracts or bundle broadband with video.[120] For example, the estimated coefficient on bundling broadband with video in Model 1 indicates that the model estimates that consumers across all countries receive a 12.5 percent discount on average when they bundle broadband with video. Importantly, we also estimate that there is a large degree of heterogeneity in the hedonic function across countries and providers within countries as demonstrated by the random effects variance estimates in Table C10.

69. Adding the country-level regressors that adjust for income and population density in Model 2 shows that these variables are economically important. For example, Model 2 estimates that raising a country's average income by 10 percent is expected to raise fixed broadband prices by 4.9 percent. Similarly, increasing the population density by ten percentage points would lower fixed broadband prices by 1 percent. Given that the United States is one of the wealthiest and least densely populated countries in the sample, adjusting for these factors has a significant impact on the estimated U.S. rankings. Evidence of this can be seen in how the estimated country random effect for the United States changes across model specification in Table C11. The estimated random intercept for the United States is .344 in Model 1 but this drops to only .059 in Model 2, which is just above the sample average. Including the content variable in Model 4 further lowers the estimated U.S. intercept below the sample average.

[119] The mobile hedonic estimates can be found in Table C14. *See infra* para. 70, Tbl. C14.

[120] Nearly 24%, or 571 out of 2,424 plans had phone service included with broadband. These are mostly DSL plans since DSL service is less costly to provide when a household also subscribes to phone service.

VI. APPENDIX OF SUPPLEMENTARY TABLES

70. This appendix provides the supplementary tables referenced in the text.

Table C1
Population Density, Gross National Income Per Capita, and Tertiary Education

Country	Overall Population Density	Urban Population Density	Rural Population Density	Gross National Income Per Capita (Atlas Method, USD)	Gross National Income Per Capita (PPP)	% of Population with Tertiary Education
Australia	3	477	1	54,420	45,970	43.7
Austria	106	254	82	45,230	49,990	31.4
Belgium	353	721	102	41,860	46,010	37.5
Canada	4	231	1	43,660	43,420	56.3
Chile	24	669	13	13,530	23,270	22.5
Czech Republic	137	213	121	17,570	32,710	23.0
Denmark	132	407	54	56,730	51,040	38.2
Estonia	31	359	10	17,750	28,920	38.8
Finland	17	173	7	44,730	43,400	43.6
France	116	533	37	38,950	42,380	34.6
Germany	232	929	83	43,660	49,530	28.3
Greece	87	462	25	18,960	26,900	30.2
Iceland	4	226	1	56,990	52,490	40.5
Ireland	66	484	28	52,560	56,870	42.8
Italy	205	620	68	31,590	38,230	17.7
Japan	343	962	84	38,000	42,870	50.5
Latvia	35	498	10	14,630	26,090	33.4
Luxembourg	200	494	67	76,660	75,750	42.9
Mexico	59	695	24	9,040	17,740	16.8
Netherlands	487	1054	148	46,310	50,320	36.0
New Zealand	17	432	4	39,070	37,860	36.3
Norway	16	165	5	82,330	62,510	43.0
Portugal	117	579	42	19,850	29,990	23.8
South Korea	488	1903	86	27,600	35,790	46.9
Spain	93	473	31	27,520	36,340	35.7
Sweden	22	194	9	54,630	50,000	41.1
Switzerland	202	703	71	81,240	63,660	41.2
United Kingdom	258	908	50	42,390	42,100	46.0
United States	**33**	**312**	**7**	**56,180**	**58,030**	**45.7**

Sources: *World Bank, Urban Population*; *World Bank, Rural Population*; *World Bank, Population Total*; *World Bank, Urban Land Area*; *World Bank, Rural Land Area*; *World Bank, Agricultural Land*; *World Bank, Land Area*; *World Bank, GNI per capita (PPP)*; *World Bank, GNI per capita (Atlas)*; *OECD Tertiary Education*.
Note: In the Hedonic Regressions, the Higher Education Dummy Variable was defined as one if percent of population with tertiary education is greater than the sample mean.

Table C2
Fixed Weighted Broadband Bundled Discount Rate

Country	Mean	Rank	Median	Minimum	Maximum	# of Plans
Australia	4.9%	21	7.3%	0.0%	8.1%	121
Austria	11.1%	14	9.0%	9.0%	17.6%	16
Belgium	13.2%	10	16.4%	6.8%	16.4%	6
Canada	11.2%	13	11.8%	1.7%	25.2%	67
Chile	9.8%	16	8.5%	6.6%	13.1%	24
Czech Republic	6.3%	18	3.4%	3.1%	29.7%	15
Estonia	4.1%	22	0.0%	0.0%	21.9%	57
Finland	16.3%	7	18.0%	13.0%	22.5%	18
France	14.6%	8	14.0%	10.5%	20.3%	38
Germany	11.8%	12	2.4%	0.6%	34.0%	62
Greece	0.4%	26	0.0%	0.0%	1.4%	8
Iceland	3.9%	23	3.9%	3.9%	3.9%	2
Ireland	5.1%	20	5.5%	0.0%	11.1%	16
Italy	0.1%	27	0.0%	0.0%	0.6%	9
Japan	7.9%	17	8.2%	3.1%	18.8%	25
Latvia	20.7%	4	19.8%	19.8%	23.7%	10
Luxembourg	10.2%	15	4.4%	1.9%	23.9%	20
Mexico	28.2%	1	27.6%	26.3%	30.7%	4
Netherlands	19.4%	6	33.9%	0.0%	36.0%	33
New Zealand	2.8%	25	2.9%	2.3%	3.2%	24
Norway	13.0%	11	13.0%	12.6%	13.5%	6
Portugal	23.4%	2	23.4%	22.4%	24.4%	6
South Korea	23.2%	3	32.2%	5.5%	42.0%	198
Sweden	5.8%	19	5.5%	0.0%	20.0%	74
Switzerland	3.1%	24	0.6%	0.1%	11.7%	47
United Kingdom	14.2%	9	11.1%	11.1%	24.0%	80
United States	**19.8%**	**5**	**19.2%**	**7.4%**	**39.5%**	**369**
Total	11.3%		8.5%	0.0%	42.0%	1355
Total w/o U.S.	11.0%		8.3%	0.0%	42.0%	986

Note: Mean discount rates are the average discount rates weighted by city population and provider market share.

Table C3
Various Measures of Content Quality

Country	Number of Websites in Top-Level Domains	Number of Web Pages in Top-Level Domains (mm)	Percent of Top 10 Million Websites in Country's Language	Primary Language
Australia	2,805,837	820	51.2	English
Austria	1,247,824	158	5.6	German
Belgium	1,451,700	658	1.4	Dutch
Canada	2,514,057	1,200	51.2	English
Chile	409,448	16.8	5.1	Spanish
Czech Republic	1,195,334	185	0.9	Czech
Denmark	1,296,288	107	0.3	Danish
Estonia	109,189	79.8	0.1	Estonian
Finland	401,210	119	0.3	Finnish
France	3,094,932	1,390	4.1	French
Germany	14,400,000	1,450	5.6	German
Greece	384,040	94.3	0.5	Greek
Iceland	55,755	215	0.01	Icelandic
Ireland	224,570	390	51.2	English
Italy	2,714,357	1,420	2.4	Italian
Japan	1,355,492	2,030	5.6	Japanese
Latvia	107,224	85.4	0.1	Latvian
Luxembourg	76,479	158	5.6	German
Mexico	720,071	113	5.1	Spanish
Netherlands	4,997,405	529	1.4	Dutch
New Zealand	648,009	302	51.2	English
Norway	678,893	280	0.1	Norwegian
Portugal	248,152	102	2.6	Portuguese
South Korea	960,106	80.2	0.9	Korean
Spain	1,857,971	669	5.1	Spanish
Sweden	1,661,108	251	0.5	Swedish
Switzerland	1,775,969	632	5.6	German
United Kingdom	10,400,000	1,710	51.2	English
United States	**159,000,000**	**35,167**	**51.2**	**English**

Sources: *infoplease, Languages Spoken*; *W*^{3} *Techs, Usage of Content Languages*; *DomainTools, TLD Count Statistics*; *google.com (using Google Search Engine)*.

Note: For Number of Web Pages in Top-Level Domains (TLDs), we used Google's search engine ("site:de") and recorded the approximate number of search results. For the United States, we aggregate over several major domains: .com, .net, .org, .us, .gov, and .edu.

Table C4
Fixed Subscriptions and Average Monthly Internet Usage per Household (2016)

Country	Subscriptions	Cisco	Cisco Note	Other	Other Note	Average
Australia	7,374,000	86.8	Individual Country	106.1	Australian Bureau of Statistics	96.5
Austria	2,510,500	64.4	Country Group: All Western Europe			64.4
Belgium	4,265,026	49.7	Country Group: Rest of Western Europe	150.0	Tefficient: Provider - Telenet	99.9
Canada	13,347,882	85.9	Individual Country			85.9
Chile	2,904,580	53.0	Country Group: All Latin America	110.0	Tefficient: Provider - Movistar	81.5
Czech Republic	3,038,394	35.6	Country Group: Rest of Central & Eastern Europe			35.6
Denmark	2,430,002	49.7	Country Group: Rest of Western Europe			49.7
Estonia	384,787	35.6	Country Group: Rest of Central & Eastern Europe			35.6
Finland	1,712,000	64.4	Country Group: All Western Europe	25.0	Tefficient: Provider - DNA	44.7
France	27,683,000	44.2	Individual Country			44.2
Germany	31,867,148	39.5	Individual Country	60.0	Tefficient: Individual Country	49.8
Greece	3,616,705	64.4	Country Group: All Western Europe			64.4
Iceland	128,023	49.7	Country Group: Rest of Western Europe			49.7
Ireland	1,360,309			105.0	Tefficient: Individual Country	105.0
Italy	15,563,279	42.6	Individual Country			42.6
Japan	38,743,212	57.9	Individual Country			57.9
Latvia	519,154	35.6	Country Group: Rest of Central & Eastern Europe			35.6
Luxembourg	203,100	64.4	Country Group: All Western Europe			64.4
Mexico	16,277,627	50.9	Individual Country			50.9
Netherlands	7,135,000	49.7	Country Group: Rest of Western Europe			49.7
New Zealand	1,554,206			88.0	Stats New Zealand	88.0
Norway	2,120,360	49.7	Country Group: Rest of Western Europe			49.7
Portugal	3,372,571			65.0	Tefficient: Individual Country	65.0
South Korea	20,555,683	136.4	Individual Country			136.4
Spain	14,163,442	50.0	Individual Country			50.0
Sweden	3,679,768	101.2	Individual Country			101.2
Switzerland	4,198,150	64.4	Country Group: All Western Europe			64.4
United Kingdom	25,250,011	105.8	Individual Country	105.0	Tefficient: Individual Country	105.4
United States	**106,327,000**	**161.5**	**Individual Country**			**161.5**

Sources: *OECD Broadband Subscriptions by Country Table 1.1*; *Cisco, Advanced Editor*; *Cisco, VNI Forecast*; *Tefficient, Is High Mobile Data Usage Cannibalising Fixed?* (Aug. 22, 2017); *Stats NZ, ISP Survey*; *Australian Bureau of Statistics, Access Connection*.
Note: For Cisco Individual Countries, we calculated average monthly internet usage per household by using Cisco's VNI Forecast Widget to collect each available country's 2016 Consumer Fixed Internet (All Applications) average monthly usage and dividing by the OECD's number of fixed subscriptions. When available, we used individual country average monthly usage per household, but when country-level data was unavailable from Cisco or other sources, we averaged aggregate country groups and country-specific provider usage data

Table C5
Mobile Subscriptions and Average Monthly Internet Usage per Household (2016)

Country	Subscriptions	Cisco	Tefficient	OECD	Average
Australia	31,544,000	1.8	1.9	1.5	1.74
Austria	7,585,400		3.6	6.3	4.94
Belgium	7,480,397		0.5	0.9	0.68
Canada	24,973,809	1.3		1.5	1.37
Chile	12,914,417		1.2		1.20
Czech Republic	8,534,191		0.5	1.0	0.74
Denmark	7,058,216		3.5	4.4	3.94
Estonia	1,607,838		3.2	4.1	3.66
Finland	8,070,000		8.3	10.9	9.62
France	53,361,000	1.1	1.0	1.6	1.24
Germany	63,094,865	0.9	0.6	1.2	0.92
Greece	5,709,261			0.7	0.72
Iceland	353,903		3.0	3.9	3.46
Ireland	4,697,555		2.5	3.1	2.80
Italy	53,076,750	1.4	0.9	1.7	1.32
Japan	193,237,268	2.5	2.5	2.1	2.36
Latvia	1,555,566		5.0	8.2	6.61
Luxembourg	482,000			2.9	2.91
Mexico	74,512,528	1.6		0.7	1.16
Netherlands	15,017,000		0.6	1.0	0.81
New Zealand	4,916,375			1.1	1.06
Norway	5,038,159		1.8	2.6	2.20
Portugal	6,477,160		0.6	1.5	1.06
South Korea	55,713,362	3.2	3.6	3.8	3.56
Spain	41,471,985	0.8	0.9		0.87
Sweden	12,140,358	2.9	3.6	4.4	3.64
Switzerland	8,221,700			2.7	2.71
United Kingdom	58,706,343	1.1	1.2	1.8	1.38
United States	**409,173,000**	**2.9**	**3.0**	**2.7**	**2.87**

Sources: *Cisco, VNI Forecast*; *tefficient, Industry Analysis*; *OECD Broadband Subscriptions by Country Table 1.1*.
Note: For Cisco, we calculated average monthly internet usage per household by using Cisco's VNI Forecast Widget to collect each available country's Consumer Mobile Internet (All Applications) average monthly usage and dividing by the OECD's number of mobile subscriptions.

Table C6
Fixed Unweighted Monthly Prices for Bundled Products (PPP)

Country	0.2 ≤ Mbps < 10			10 ≤ Mbps < 25			25 ≤ Mbps < 100			100 ≤ Mbps		
	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans	Mean	Rank	# Plans
Australia	74.40	5	8	49.56	14	41	73.62	20	51	84.37	25	21
Austria				35.71	7	2	34.99	4	8	44.05	9	6
Belgium										60.12	17	6
Canada				52.55	16	11	60.04	18	39	79.04	24	17
Chile	62.92	4	6	149.33	18	3	47.27	13	9	69.51	19	6
Czech Republic				36.30	8	3	47.14	12	5	47.26	12	7
Denmark												
Estonia	28.19	1	4	31.42	4	14	36.92	5	14	49.06	13	25
Finland	28.91	2	2	30.12	3	7	27.64	2	8	32.61	2	1
France				23.37	1	12	17.74	1	3	34.52	4	23
Germany				42.07	12	12	39.41	6	21	39.99	7	29
Greece				43.76	13	6	66.28	19	2			
Iceland										40.25	8	2
Ireland										57.80	16	16
Italy							39.84	7	3	38.21	6	6
Japan				37.68	10	3				45.96	11	22
Latvia				28.00	2	1	34.81	3	1	34.63	5	8
Luxembourg				51.46	15	5				75.20	22	15
Mexico				35.05	5	3	55.11	15	1			
Netherlands							39.87	8	12	51.48	14	21
New Zealand				57.30	17	4	55.94	16	8	65.93	18	12
Norway							56.77	17	4	69.73	20	2
Portugal				35.22	6	2				45.38	10	4
South Korea										33.34	3	198
Spain												
Sweden				39.02	11	8	40.87	9	14	55.88	15	52
Switzerland							44.01	11	24	71.10	21	23
United Kingdom				37.48	9	20	50.60	14	56	20.73	1	4
United States	**35.32**	**3**	**60**				**43.57**	**10**	**176**	**77.96**	**23**	**133**
Average	45.95		80	45.30		157	45.62		459	52.96		659

Note: Unweighted mean prices are simple averages of all plans in the country and speed tier.

Table C7
Fixed Weighted Monthly Prices for Standalone Products (PPP)

Country	0.2 ≤ Mbps < 10		10 ≤ Mbps < 25		25 ≤ Mbps < 100		100 ≤ Mbps	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Australia	64.08	11	47.46	16	61.67	18	72.53	20
Austria			36.92	6	46.05	7	94.49	26
Belgium					37.36	2	66.60	17
Canada	42.26	7	57.26	21	67.82	20	86.22	23
Chile	81.19	13	124.00	25	54.86	16	80.77	21
Czech Republic			42.98	13	51.55	14	54.00	8
Denmark	32.56	2	34.69	2	37.72	3	59.27	12
Estonia	34.56	3	39.24	8	46.33	8	58.32	11
Finland	35.63	5	33.26	1	32.13	1	43.54	3
France			36.20	4			43.60	5
Germany			43.49	15	44.50	5	48.73	6
Greece	41.07	6	39.02	7	48.01	12		
Iceland			39.83	9			56.56	10
Ireland			61.70	23			64.29	16
Italy	31.66	1	36.30	5			37.35	1
Japan	34.75	4	39.88	10	39.64	4	49.45	7
Latvia			35.56	3	47.76	10	40.28	2
Luxembourg			52.00	18			85.91	22
Mexico			49.79	17	75.46	23	104.90	27
Netherlands					49.84	13	60.00	13
New Zealand			60.18	22	60.09	17	69.77	18
Norway	48.79	9	52.13	19	68.99	21	112.33	28
Portugal			41.99	11	47.85	11	54.58	9
South Korea							43.55	4
Spain	62.76	10	76.15	24	71.79	22	87.02	24
Sweden			43.31	14	44.90	6	61.44	14
Switzerland	77.57	12			46.59	9	71.92	19
United Kingdom			42.81	12	54.48	15	63.12	15
United States	**45.32**	**8**	**52.36**	**20**	**63.65**	**19**	**87.78**	**25**
Average	48.63		48.74		52.13		66.37	

Note: First, plan prices are averaged to a provider-speed-tier level weighting by the product of availability and city population (an approximate measure of the number of people in the city who have access to the plan). Then, these provider-speed-tier prices are weighted by provider market shares to produce the country-speed-tier mean prices.

Table C8
Fixed Weighted Monthly Prices for Bundled Products (PPP)

Country	0.2 ≤ Mbps < 10		10 ≤ Mbps < 25		25 ≤ Mbps < 100		100 ≤ Mbps	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Australia	74.43	5	52.78	16	72.67	20	83.12	25
Austria			35.71	6	41.13	8	44.05	9
Belgium							57.79	16
Canada			51.66	15	60.93	18	75.47	24
Chile	74.00	4	149.33	18	46.78	11	69.51	20
Czech Republic			41.30	11	49.13	12	47.12	12
Denmark								
Estonia	34.56	2	37.36	7	44.11	9	56.21	15
Finland	28.76	1	29.93	2	29.20	2	32.61	2
France			30.10	3	17.74	1	34.86	4
Germany			40.04	10	40.46	6	43.80	8
Greece			44.18	13	66.28	19		
Iceland							40.25	7
Ireland							58.54	17
Italy					39.84	5	35.37	5
Japan			37.92	8			46.39	11
Latvia			28.00	1	34.81	3	38.67	6
Luxembourg			48.49	14			71.74	22
Mexico			35.05	4	55.11	15		
Netherlands					39.72	4	52.09	13
New Zealand			57.30	17	55.89	16	65.99	18
Norway					56.77	17	69.73	21
Portugal			35.22	5			45.38	10
South Korea							33.85	3
Spain								
Sweden			37.96	9	41.01	7	55.33	14
Switzerland					45.37	10	72.03	23
United Kingdom			41.90	12	53.05	13	20.73	1
United States	**35.41**	**3**			**53.52**	**14**	**68.80**	**19**
Average	49.43		46.35		47.17		52.78	

Note: First, plan prices are averaged to a provider-speed-tier level weighting by the product of availability and city population (an approximate measure of the number of people in the city who have access to the plan). Then, these provider-speed-tier prices are weighted by provider market shares to produce the country-speed-tier mean prices.

Table C9
Fixed Hedonic Estimation Results (USD)

Log(Price (USD))	Coefficient (Standard Error)			
	Model 1	Model 2	Model 3	Model 4
Spline: 0.2 ≤ Mbps < 10	-0.028 (.084)	-0.028 (.084)	-0.030 (.084)	-0.029 (.085)
Spline: 10 ≤ Mbps < 25	0.122 (.032)	0.123 (.032)	0.123 (.032)	0.124 (.032)
Spline: 25 ≤ Mbps < 100	0.114 (.026)	0.113 (.026)	0.112 (.026)	0.113 (.026)
Spline: 100 ≤ Mbps	0.219 (.026)	0.215 (.026)	0.215 (.026)	0.216 (.026)
Bundle Dummy	-0.134 (.018)	-0.134 (.018)	-0.134 (.018)	-0.134 (.018)
Phone Dummy	0.024 (.018)	0.025 (.018)	0.026 (.018)	0.023 (.018)
Contract Dummy	-0.142 (.039)	-0.158 (.039)	-0.173 (.039)	-0.165 (.038)
Unlimited Data Dummy	0.050 (.029)	0.042 (.029)	0.046 (.029)	0.047 (.029)
Log of Data Cap	0.106 (.026)	0.107 (.026)	0.107 (.026)	0.107 (.026)
Bring-Your-Own-Device Dummy	-0.009 (.093)	-0.005 (.087)	-0.011 (.084)	-0.010 (.085)
Log of Income (USD)		0.400 (.097)	0.387 (.085)	0.395 (.086)
Higher Education Dummy		0.160 (.106)	0.016 (.107)	0.054 (.100)
Log of Urban Population Density		-0.100 (.076)	-0.161 (.071)	-0.099 (.067)
Log of Data Usage			0.349 (.122)	
English Language Dummy				0.306 (.105)
Constant	3.832 (.078)	3.838 (.076)	2.449 (.491)	3.816 (.069)
Observations	2,478	2,478	2,478	2,478
Log Likelihood	1399.32	1412.96	1416.51	1416.66
Likelihood Ratio Test vs. Linear Model				
P-Value	0.000	0.000	0.000	0.000
Model 1: Unadjusted for demographics and content quality				
Model 2: Adjusted for demographics but not content quality				
Model 3: Adjusted for demographics and data usage				
Model 4: Adjusted for demographics and content quality				

Note: All continuous independent variables are recentered at grand means.

Table C10
Fixed Estimated Variances of Random Effects (USD)

Random Effect Parameters	Coefficient (Standard Error)			
	Model 1	Model 2	Model 3	Model 4
Country: Variance(Constant)	0.126 (.036)	0.044 (.014)	0.032 (.011)	0.032 (.011)
Provider: Variance(0.2 ≤ Mbps < 10)	0.093 (.057)	0.092 (.056)	0.093 (.056)	0.095 (.057)
Provider: Variance(10 ≤ Mbps < 25)	0.021 (.009)	0.021 (.009)	0.021 (.010)	0.021 (.009)
Provider: Variance(25 ≤ Mbps < 100)	0.043 (.009)	0.043 (.009)	0.042 (.009)	0.042 (.009)
Provider: Variance(100 ≤ Mbps)	0.036 (.008)	0.036 (.008)	0.036 (.008)	0.036 (.008)
Provider: Variance(Bundle Dummy)	0.019 (.004)	0.019 (.004)	0.019 (.004)	0.019 (.004)
Provider: Variance(Contract Dummy)	0.016 (.008)	0.019 (.008)	0.020 (.009)	0.018 (.008)
Provider: Variance(Unlimited Data Dummy)	0.004 (.004)	0.004 (.005)	0.004 (.004)	0.004 (.004)
Provider: Variance(Log of Data Cap)	0.009 (.004)	0.009 (.004)	0.009 (.004)	0.009 (.004)
Provider: Variance(Bring-Your-Own-Device Dummy)	0.101 (.051)	0.088 (.046)	0.081 (.044)	0.084 (.044)
Provider: Variance(Constant)	0.009 (.007)	0.007 (.007)	0.007 (.007)	0.008 (.007)
Variance(Residual)	0.012 (.000)	0.012 (.000)	0.012 (.000)	0.012 (.000)
Likelihood Ratio Test		**1 vs. 2**	**2 vs. 3**	**2 vs. 4**
P-Value		0.000	0.008	0.007
R-Squared Values				
FE Only	0.061	0.402	0.388	0.537
FE and RE	0.946	0.946	0.946	0.946
FE and RE (no country RE)	0.460	0.800	0.810	0.876
FE and RE (no country and provider RE)	0.401	0.779	0.798	0.864
Model 1: Unadjusted for demographics and content quality				
Model 2: Adjusted for demographics but not content quality				
Model 3: Adjusted for demographics and data usage				
Model 4: Adjusted for demographics and content quality				

Table C11
Fixed Country Random Effect Estimates (USD)

Country	Country Random Effect			
	Model 1	Model 2	Model 3	Model 4
Australia	0.531	0.263	0.211	0.107
Austria	0.145	0.062	-0.005	0.073
Belgium	0.083	0.105	-0.021	0.111
Canada	0.491	0.241	0.187	0.086
Chile	-0.208	0.232	0.103	0.229
Czech Republic	-0.472	-0.183	-0.102	-0.155
Denmark	-0.057	-0.173	-0.152	-0.149
Estonia	-0.338	-0.059	0.015	-0.047
Finland	-0.179	-0.390	-0.246	-0.264
France	-0.390	-0.311	-0.235	-0.279
Germany	-0.173	-0.094	-0.028	-0.068
Greece	-0.296	-0.023	-0.062	-0.009
Iceland	0.284	0.086	0.068	0.099
Ireland	0.254	0.034	-0.024	-0.097
Italy	-0.451	-0.279	-0.185	-0.246
Japan	-0.145	-0.165	-0.022	-0.057
Latvia	-0.665	-0.242	-0.131	-0.214
Luxembourg	0.311	-0.024	0.044	0.065
Mexico	-0.254	0.298	0.289	0.279
Netherlands	0.030	0.063	0.117	0.072
New Zealand	0.262	0.244	0.092	0.012
Norway	0.650	0.130	0.219	0.232
Portugal	-0.320	-0.013	-0.050	0.003
South Korea	-0.402	-0.214	-0.255	-0.110
Spain	0.157	0.289	0.288	0.289
Sweden	0.196	-0.110	-0.200	-0.002
Switzerland	0.421	0.079	0.142	0.149
United Kingdom	0.190	0.096	0.057	-0.047
United States	**0.344**	**0.059**	**-0.113**	**-0.061**
Total	0.000	0.000	0.000	0.000

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

Table C12
Fixed Hedonic Broadband Price Indices (PPP)

Country	Model 1		Model 2		Model 3		Model 4	
	Price	Rank	Price	Rank	Price	Rank	Price	Rank
Australia	70.65	25	73.77	27	87.77	26	74.94	21
Austria	54.74	17	61.36	17	70.84	12	72.90	20
Belgium	53.55	16	64.87	21	70.86	13	76.86	24
Canada	72.11	26	71.01	26	84.47	25	72.25	19
Chile	56.17	19	68.23	24	76.23	19	80.85	26
Czech Republic	50.23	10	55.86	10	73.92	17	66.56	13
Denmark	41.06	6	47.98	6	59.84	5	56.97	6
Estonia	50.81	12	58.49	12	78.50	21	69.23	16
Finland	36.19	3	35.20	1	49.20	2	46.03	1
France	34.94	2	41.76	3	54.66	3	49.89	2
Germany	43.26	7	53.73	9	69.87	11	64.04	10
Greece	51.92	14	60.64	16	72.44	15	72.10	18
Iceland	52.90	15	58.83	13	71.76	14	70.27	17
Ireland	63.61	24	66.70	22	78.04	20	68.41	15
Italy	38.19	5	46.29	5	61.58	7	55.20	5
Japan	43.47	8	48.22	7	67.72	9	62.57	8
Latvia	37.55	4	44.54	4	61.07	6	52.92	4
Luxembourg	58.39	23	61.38	18	80.50	23	78.64	25
Mexico	78.16	29	94.92	29	119.93	29	111.94	29
Netherlands	50.68	11	63.96	20	83.35	24	75.68	22
New Zealand	57.82	21	67.40	23	73.49	16	63.72	9
Norway	74.02	27	70.57	25	95.03	27	91.82	27
Portugal	47.89	9	57.39	11	68.48	10	68.22	14
South Korea	33.33	1	39.15	2	46.20	1	50.48	3
Spain	74.99	28	88.07	28	110.18	28	104.47	28
Sweden	51.91	13	50.59	8	57.20	4	65.74	12
Switzerland	55.62	18	60.32	15	79.32	22	76.09	23
United Kingdom	57.35	20	63.00	19	75.43	18	64.14	11
United States	**57.89**	**22**	**59.24**	**14**	**62.55**	**8**	**61.55**	**7**
Average	53.43		59.77		73.81		69.81	

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

Note: The dependent variable is log of prices (PPP) and income is not controlled for in Models 2, 3, and 4.

Table C13
Mobile Weighted Monthly Prices by Data Allowance Tiers (PPP)

Country	0 < Data (GB) ≤ 2		2 < Data (GB) ≤ 5		5 < Data (GB) ≤ 10		10 < Data (GB)		Shared Data Plans	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Australia	19.44	5	22.96	6	28.17	3	48.78	7	40.90	13
Austria	12.54	1	18.77	3	32.81	7	55.66	9	30.28	7
Belgium			41.20	16	53.22	14	56.18	10	48.54	17
Canada	75.54	22	87.39	26	114.06	23	161.67	28	60.48	23
Chile			67.02	23	113.22	22	81.36	19	92.60	28
Czech Republic	58.24	19	61.49	22	75.25	19	143.31	27	75.05	27
Denmark			21.30	5	26.37	2	40.04	4	22.83	2
Estonia	19.14	4	27.61	8	34.34	8	46.86	6	24.57	3
Finland			13.43	1	25.86	1	35.10	1	30.69	8
France	29.67	10					58.84	12	33.85	9
Germany	40.40	14	50.88	20	65.48	16	136.96	24	46.88	16
Greece	48.44	17	130.90	27	284.35	25			121.52	29
Iceland	16.75	3	23.35	7	30.86	6	55.39	8	26.47	4
Ireland			37.10	14			70.53	16	55.01	20
Italy			34.74	13	44.54	12	41.63	5	42.93	14
Japan	63.69	20	82.19	25	116.70	24	139.81	25	62.03	24
Latvia	15.51	2	21.03	4	35.73	9	36.64	2	21.87	1
Luxembourg	28.47	9	17.08	2	30.78	5	64.56	14	37.12	12
Mexico	32.60	11	49.58	18	86.24	20	140.86	26	56.33	21
Netherlands	67.63	21	49.72	19	73.76	17	114.21	23	74.90	26
New Zealand			39.72	15	53.52	15	74.03	17	43.84	15
Norway	26.32	7	34.29	12	42.77	11	61.71	13	34.77	10
Portugal	35.97	13	49.00	17			84.46	20	35.29	11
South Korea	40.70	15	56.86	21	74.74	18	100.37	22	57.00	22
Spain	34.75	12			50.46	13	66.72	15	51.62	19
Sweden	24.17	6	30.25	9	38.41	10	57.26	11	29.87	6
Switzerland	42.14	16	33.24	11			79.62	18	68.41	25
United Kingdom	27.23	8	32.58	10	29.69	4	36.89	3	27.22	5
United States	**56.84**	**18**	**73.16**	**24**	**103.32**	**21**	**85.32**	**21**	**51.00**	**18**
Average	37.10		44.70		66.59		77.67		48.41	

Note: Plan prices are averaged to a country-data-allowance-tier level weighting by provider market shares. For countries without shared data plans, we used a weighted average of the four single-line tiers using the Shared Plan Usage product shares as weights (*see supra* Table 6).

Table C14
Mobile Hedonic Estimation Results (USD)

Log(Price (USD))	Coefficient (Standard Error)			
	Model 1	Model 2	Model 3	Model 4
Spline: 0 < Data (GB) ≤ 2	0.136	0.136	0.135	0.135
	(.029)	(.029)	(.029)	(.029)
Spline: 2 < Data (GB) ≤ 5	0.230	0.230	0.231	0.231
	(.051)	(.051)	(.051)	(.051)
Spline: 5 < Data (GB) ≤ 10	0.304	0.305	0.302	0.304
	(.057)	(.057)	(.057)	(.057)
Spline: 10 < Data (GB)	0.344	0.342	0.343	0.342
	(.044)	(.043)	(.043)	(.043)
Shared Dummy	-0.322	-0.322	-0.032	-0.323
	(.045)	(.045)	(.072)	(.045)
Unlimited Data Dummy	0.063	0.057	0.069	0.061
	(.068)	(.068)	(.068)	(.068)
Contract Dummy	0.111	0.090	0.011	0.115
	(.125)	(.129)	(.125)	(.128)
Handset Dummy	0.442	0.454	0.386	0.451
	(.131)	(.131)	(.129)	(.130)
Long Distance Dummy	0.256	0.255	0.259	0.254
	(.059)	(.059)	(.057)	(.060)
Unlimited Minutes Dummy	0.674	0.735	0.773	0.760
	(.790)	(.790)	(.785)	(.792)
Log of Minutes	0.112	0.116	0.122	0.115
	(.101)	(.101)	(.101)	(.102)
Unlimited Texts Dummy	-0.209	-0.248	-0.301	-0.280
	(.586)	(.586)	(.581)	(.587)
Log of Texts	-0.033	-0.032	-0.033	-0.031
	(.072)	(.072)	(.072)	(.072)
Log of 4G Availability		0.657	1.323	1.173
		(.559)	(.398)	(.563)
Log of Population Density		-0.011	-0.093	0.033
		(.064)	(.044)	(.063)
Log Income (USD)		0.112	0.261	0.127
		(.198)	(.136)	(.182)
Higher Education Dummy		0.207	0.381	-0.062
		(.236)	(.158)	(.249)
Log of Data Usage			-0.556	
			(.098)	
English Language Dummy				0.564
				(.257)
Constant	3.062	2.988	3.364	2.985
	(.564)	(.574)	(.567)	(.571)
Observations	556	556	556	556
Log Likelihood	21.18	23.57	33.74	25.73
Likelihood Ratio Test vs. Linear Model				
P-Value	0.000	0.000	0.000	0.000
Model 1: Unadjusted for demographics and content quality				
Model 2: Adjusted for demographics but not content quality				
Model 3: Adjusted for demographics and data usage				
Model 4: Adjusted for demographics and content quality				

Note: All continuous independent variables are recentered at grand means.

Table C15
Mobile Estimated Variances of Random Effects (USD)

Random Effect Parameters	Coefficient (Standard Error)			
	Model 1	Model 2	Model 3	Model 4
Country: Variance(2 < Data (GB) ≤ 5)	0.024 (.014)	0.024 (.014)	0.023 (.014)	0.024 (.014)
Country: Variance(5 < Data (GB) ≤ 10)	0.032 (.020)	0.031 (.019)	0.031 (.019)	0.031 (.019)
Country: Variance(10 < Data (GB))	0.030 (.013)	0.030 (.013)	0.030 (.013)	0.030 (.013)
Country: Variance(Shared Dummy)	0.013 (.009)	0.013 (.009)	0.014 (.009)	0.013 (.009)
Country: Variance(Contract Dummy)	0.102 (.058)	0.114 (.067)	0.143 (.084)	0.119 (.070)
Country: Variance(Long Distance Dummy)	0.034 (.019)	0.035 (.020)	0.032 (.018)	0.021 (.037)
Country: Variance(Constant)	0.230 (.072)	0.180 (.062)	0.056 (.029)	0.142 (.054)
Provider: Variance(Constant)	0.028 (.007)	0.028 (.007)	0.029 (.007)	0.028 (.007)
Variance(Residual)	0.028 (.002)	0.028 (.002)	0.028 (.002)	0.028 (.002)
Likelihood Ratio Test		**1 vs. 2**	**2 vs. 3**	**2 vs. 4**
P-Value		0.310	0.000	0.038
R-Squared Values				
FE Only	0.215	0.343	0.547	0.369
FE and RE	0.929	0.929	0.929	0.929
FE and RE (no country RE)	0.903	0.903	0.904	0.903
FE and RE (no country and provider RE)	0.857	0.857	0.854	0.856

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

Table C16
Mobile Country Random Effect Estimates (USD)

Country	Country Random Effect			
	Model 1	Model 2	Model 3	Model 4
Australia	-0.033	-0.197	-0.228	-0.302
Austria	-0.506	-0.432	0.026	-0.414
Belgium	0.257	0.305	-0.071	0.233
Canada	1.042	0.798	0.167	0.599
Chile	0.062	0.261	0.139	0.345
Czech Republic	-0.216	-0.114	-0.256	-0.141
Denmark	-0.346	-0.324	-0.003	-0.334
Estonia	-0.694	-0.591	-0.206	-0.543
Finland	-0.376	-0.546	-0.053	-0.300
France	-0.683	-0.410	-0.314	-0.261
Germany	0.148	0.246	0.089	0.231
Greece	0.460	0.537	0.171	0.497
Iceland	0.083	0.150	0.247	0.333
Ireland	-0.222	-0.108	0.075	-0.134
Italy	-0.253	-0.067	0.017	-0.030
Japan	0.562	0.321	0.143	0.302
Latvia	-0.915	-0.764	-0.114	-0.696
Luxembourg	-0.340	-0.388	-0.127	-0.230
Mexico	-0.151	0.071	0.047	0.122
Netherlands	0.210	0.159	-0.017	0.043
New Zealand	0.501	0.645	0.312	0.265
Norway	0.029	-0.152	-0.145	-0.034
Portugal	-0.032	0.120	0.007	0.132
South Korea	0.488	0.201	0.328	0.225
Spain	0.098	0.209	-0.073	0.219
Sweden	-0.102	-0.341	-0.274	-0.139
Switzerland	0.501	0.292	0.226	0.440
United Kingdom	-0.138	-0.158	-0.233	-0.387
United States	**0.566**	**0.277**	**0.121**	**-0.040**
Total	0.000	0.000	0.000	0.000

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

Table C17
Mobile Hedonic Broadband Price Indices (PPP)

Country	Model 1		Model 2		Model 3		Model 4	
	Price	Rank	Price	Rank	Price	Rank	Price	Rank
Australia	32.86	9	36.68	8	43.38	3	46.43	6
Austria	26.96	5	31.20	5	69.01	20	45.12	5
Belgium	62.26	24	67.15	23	56.78	13	89.60	20
Canada	79.43	28	88.45	27	49.51	7	101.68	25
Chile	72.13	25	93.55	28	91.70	29	150.78	28
Czech Republic	49.71	16	53.56	14	46.25	4	72.40	13
Denmark	22.20	1	24.18	1	49.29	6	33.37	1
Estonia	27.76	6	30.01	4	49.07	5	42.97	3
Finland	25.84	4	28.00	3	54.91	11	51.26	7
France	32.14	8	46.10	12	65.76	19	77.53	18
Germany	39.34	14	48.16	13	50.66	10	68.13	11
Greece	95.62	29	113.85	29	84.50	26	156.29	29
Iceland	24.52	2	32.55	7	49.51	8	57.33	8
Ireland	36.06	11	55.16	15	86.52	27	75.02	14
Italy	47.85	15	61.15	19	82.40	25	92.05	23
Japan	61.22	22	58.10	16	56.12	12	80.97	19
Latvia	25.13	3	27.76	2	65.55	18	40.17	2
Luxembourg	38.67	12	45.03	11	71.21	21	76.36	16
Mexico	73.00	26	87.43	26	87.80	28	131.89	27
Netherlands	60.00	19	60.08	17	62.37	16	75.12	15
New Zealand	60.34	20	80.17	25	74.21	22	76.69	17
Norway	39.17	13	41.68	10	50.26	9	69.36	12
Portugal	53.85	17	62.38	20	62.49	17	90.08	21
South Korea	75.65	27	62.56	21	82.09	23	90.22	22
Spain	59.94	18	68.58	24	60.41	14	99.03	24
Sweden	31.58	7	31.88	6	35.37	1	57.67	9
Switzerland	62.12	23	66.33	22	82.39	24	112.88	26
United Kingdom	32.99	10	40.67	9	42.24	2	44.42	4
United States	**61.04**	**21**	**61.02**	**18**	**61.40**	**15**	**60.83**	**10**
Average	48.60		55.29		62.87		78.13	

Model 1: Unadjusted for demographics and content quality
Model 2: Adjusted for demographics but not content quality
Model 3: Adjusted for demographics and data usage
Model 4: Adjusted for demographics and content quality

Note : The dependent variable is log of prices (PPP) and income is not controlled for in Models 2, 3, and 4.

Table C18
Fixed & Mobile Hedonic Broadband Price Indices (USD)

Country	Fixed Broadband		Mobile Broadband		Fixed + Mobile	
	Price	Rank	Price	Rank	Price	Rank
Australia	84.45	23	45.65	5	130.10	11
Austria	74.02	17	47.40	6	121.42	7
Belgium	81.09	22	101.89	26	182.98	24
Canada	76.57	19	91.62	23	168.19	21
Chile	88.97	25	123.58	27	212.55	27
Czech Republic	60.49	6	55.94	8	116.42	6
Denmark	63.85	8	43.35	4	107.21	5
Estonia	69.06	12	34.58	2	103.63	3
Finland	51.61	1	49.40	7	101.01	2
France	54.25	3	82.72	19	136.97	13
Germany	66.06	11	70.22	12	136.29	12
Greece	78.66	21	146.34	29	225.00	29
Iceland	90.39	26	76.27	15	166.66	20
Ireland	64.83	9	64.16	11	128.99	10
Italy	59.00	5	91.18	22	150.18	16
Japan	72.12	15	82.09	18	154.21	18
Latvia	52.20	2	30.21	1	82.41	1
Luxembourg	72.51	16	71.99	14	144.50	15
Mexico	109.64	29	87.62	21	197.26	25
Netherlands	77.88	20	81.09	17	158.96	19
New Zealand	76.25	18	92.02	24	168.28	22
Norway	96.95	27	71.55	13	168.50	23
Portugal	71.15	14	79.68	16	150.83	17
South Korea	56.28	4	85.29	20	141.58	14
Spain	106.53	28	92.89	25	199.43	26
Sweden	70.41	13	57.46	9	127.88	9
Switzerland	84.46	24	134.40	28	218.85	28
United Kingdom	65.44	10	41.75	3	107.20	4
United States	**62.94**	**7**	**60.68**	**10**	**123.62**	**8**
Average	73.73		75.62		149.35	

Note: These hedonic price indices are based on our hedonic regressions that adjust for cost and demographic differences across countries. The reported price levels for each country are what an average U.S. consumer would pay for their broadband service in each country if that country had the same demand and cost profile as the United States.

APPENDIX D

High-Speed Broadband Deployment Comparison with Europe

1. In this Appendix, as directed by the BDIA, we compare "the extent of broadband service capability" by examining fixed high-speed broadband deployment[1] in the United States and 21 European countries (EU21).[2] To match the European Commission's (EC) definition of fixed high-speed broadband and its choice of technologies in our comparison, we examine U.S. deployment of fixed broadband with download speeds of 30 Mbps or higher,[3] and do not include satellite technology. For the first time, we also compare mobile high-speed broadband deployment in the United States and EU21 by focusing exclusively on LTE, which is the baseline industry standard for the marketing of mobile broadband service.[4] For our primary fixed and mobile analysis, we rely on data gathered in June 2015 and June 2016 by the FCC and the EC.[5] We also present a historical overview of fixed deployment in the United States and the EU21 countries by presenting summaries of data from 2012 to 2016. Finally, we present maps that show fixed high-speed broadband deployment in the United States and Europe.

I. DATA HIGHLIGHTS

2. Similar to previous years, the data show that the United States has better fixed broadband coverage than Europe, including in rural areas. The data further show that this is also true for mobile LTE broadband deployment.

3. *Fixed High-Speed Broadband.* In the United States, fixed high-speed broadband reached 90 percent of all households and 62 percent of rural households as of June 2016, which is up from 89 percent of all households and 58 percent of rural households as of June 2015. In the EU21, fixed high-speed broadband reached 76 percent of all households and 41 percent of rural households as of June 2016, which is up from 72 percent of all households and 30 percent of rural households as of June 2015. Our historical overview for 2012 to 2016 shows that the United States had higher deployment rates than the EU21 countries as a whole during the period both generally and separately in rural and non-rural areas. Deployment increased during the period, with the EU21countries having a somewhat higher growth rate.

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[1] 47 U.S.C. § 1303(b)(1) ("As part of the assessment and report required by section 1302 of this title, the Federal Communications Commission shall include information comparing the extent of broadband service capability (including data transmission speeds and price for broadband service capability) in a total of 75 communities in at least 25 countries abroad for each of the data rate benchmarks for broadband service utilized by the Commission to reflect different speed tiers.").

[2] We refer to the set of countries that we compare here as the EU21, as we selected only 21 of the 31 European countries addressed in the *EC Broadband Report* as comparison countries for purposes of this Report. The *EC Broadband Report* discusses the 28 member countries of the European Union (EU), as well as Iceland, Norway, and Switzerland. *See EC Broadband Report* at 5. The 21 countries we include in our analysis are: Austria (AT), Belgium (BE), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (IT), Latvia (LV), Luxembourg (LU), Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), United Kingdom (UK), Iceland (IS), Norway (NO), and Switzerland (CH).

[3] *EC Broadband Report* at 11.

[4] *Twentieth Mobile Wireless Competition Report*, 32 FCC Rcd at 9018, para. 73. We note that the *2018 Broadband Deployment Report* analyzes mobile LTE coverage data associated with 5 Mbps/1 Mbps and higher minimum advertised speeds in the United States and supplements that data with actual on the ground 10 Mbps/3 Mbps and higher median speed data measurements. In this Appendix, we analyze mobile LTE coverage regardless of minimum advertised speeds or actual speeds to match the *EC Broadband Report*.

[5] We assess deployment as of June 2016 and June 2015 to match the European data. This speed standard differs from that used for the fixed broadband deployment data for the United States contained in the *2018 Broadband Deployment Report*, which shows deployment of fixed broadband with 25 Mbps download and 3 Mbps upload speed as of December 2012 to December 2016. *See 2018 Broadband Deployment Report* at para. 15.

(continued….)

4. *Mobile LTE Broadband.* In the United States, mobile LTE coverage was already nearly ubiquitous by the end of June 2016, reaching almost 100 percent of all households and 98 percent of rural households. In the EU21, during the same period, mobile LTE coverage reached 97 percent of all households and 83 percent of rural households. This is a significant increase from the 88 percent of all households and 41 percent of rural households that mobile LTE reached as of June 2015.[6]

II. DATA SOURCES

5. *Deployment Data*. Both the FCC and the EC monitor broadband deployment. For comparison purposes, we rely on the FCC's Form 477 fixed and mobile LTE deployment data to estimate U.S. broadband deployment.[7] The Form 477 data reflect data gathered by the Commission as of the end of June in 2015 and 2016.[8] We rely on data from the State Broadband Initiative (SBI) as of December 2012, 2013, and 2014, which the Commission relied on prior to the revision of the Form 477 data collection.[9] We employ the centroid methodology to evaluate the deployment of LTE.[10] We consider a census block to be covered by LTE if there is at least one service provider that reports coverage based on their Form 477 submission. For the EU21, we rely on fixed and mobile LTE deployment data provided in the *EC Broadband Report*.[11] To match the fixed technologies used by the EC, we do not include satellite technology in the comparison of U.S. and EU21 deployment.[12] The data gathered by the EC reflect data

[6] We note that mobile LTE can be provided at various speeds in different countries. The mobile LTE deployment comparison in this Appendix is only a technology comparison.

[7] FCC, Fixed Broadband Deployment Data from FCC Form 477, https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477; FCC, Mobile Broadband Deployment Data from FCC Form 477, https://www.fcc.gov/mobile-deployment-form-477-data. References to the United States in this Appendix refer only to data collected from the 50 states and the District of Columbia. *2018 Broadband Deployment Report* at para. 44.

[8] FCC, FCC Form 477: Local Telephone Competition and Broadband Reporting—Instructions at 32 (2016), https://transition.fcc.gov/form477/477inst.pdf.

[9] *See Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, GN Docket No. 11-121, Eighth Broadband Progress Report, 27 FCC Rcd 10342, 10364-65, para. 28 (2012) (*Eighth Broadband Progress Report*). The SBI data were collected semi-annually through state-led efforts and maintained by the National Telecommunications and Information Administration for the National Broadband Map, in collaboration with the Commission. *Id.* at 10365, para. 28.

[10] *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, 2016 Broadband Progress Report, 31 FCC Rcd 699, 730, para. 75, n.234 (*2016 Broadband Progress Report*) (explaining that the Commission evaluated the ability of mobile wireless providers to provide services throughout a census block by evaluating whether the provider's shapefile overlaps the centroid of the census block); *id.* at 734-35, para. 82, Tbls. 4 and5 (reporting proportion of population with access to LTE technology). In the *Twentieth Mobile Wireless Competition Report*, the Commission presented coverage analysis based on both the centroid methodology and the actual area coverage methodology (which calculates the exact area of the block covered by each service provider by technology). *See Twentieth Mobile Wireless Competition Report*, 32 FCC Rcd at 9016-18, para. 71-72. At the aggregate national level, the results in terms of population covered will be similar whether the centroid methodology or the actual area coverage methodology is utilized and therefore, at that aggregate level, the centroid approach is a reasonable approach to take when comparing population based coverage. *Id*. at 9017-18, para. 72.

[11] Previously, the EC reported deployment data as of the end of December of the targeted year. *EC Broadband Report* at 5.

[12] *Id.* at 11.

(continued….)

as of the end of June 2015 and June 2016.[13] We rely on data as of December 2012, 2013, and 2014.[14] The *EC Broadband Report* provides a measure of progress towards Europe's broadband coverage objectives.[15] The *EC Broadband Report* is "designed to monitor the progress of EU Member States toward their specific broadband coverage objectives – namely: Universal Broadband Coverage with speeds at least 30 Mbps by 2020 and Broadband Coverage of 50 percent of households with speeds at least 100 Mbps by 2020."[16]

6. *Speeds.* To facilitate an "apples to apples" comparison, we limit the scope of our regional comparison to fixed high-speed broadband service with at least 30 Mbps download speed, the same minimum speed used in the *EC Broadband Report*.[17] We compare the U.S. fixed and mobile LTE deployment data to the EU21 fixed and mobile LTE deployment data as of June 2015 and June 2016. The *EC Broadband Report* also presents speed tier data at 2 Mbps, 30 Mbps, and 100 Mbps, which we also present below and which include any fixed technology capable of meeting those speeds.[18] These data were calculated differently from the data used in the rest of this Appendix.[19]

7. *Rural Definition.* The *EC Broadband Report* includes data at the sub-national level—corresponding to counties, departments, or provinces—and are also broken down into rural and non-rural areas. The *EC Broadband Report* classifies European households as rural if they are within any square kilometer with a population of less than 100 people.[20] The *EC Broadband Report* focuses on sub-national geographic areas with populations ranging from 150,000 to 800,000 (a geographical category known as the nomenclature of units for territorial statistics (NUTS-3)).[21] NUTS-3 is a political-bureaucratic

[13] *Id.* at 5.

[14] *See Eighth Broadband Progress Report*, 27 FCC Rcd at 10364-65, para. 28. The SBI data were collected semi-annually through state-led efforts and maintained by the National Telecommunications and Information Administration for the National Broadband Map, in collaboration with the Commission. *Id.* at 10365, para. 28.

[15] *See generally EC Broadband Report*. The EC tracks progress in 28 member states: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), and the United Kingdom (UK) and three additional countries: Iceland (IS), Norway (NO), and Switzerland (CH).

[16] *Id.* at 5.

[17] In the *Fifth International Broadband Data Report*, we used 25 Mbps given the Form 477 collected by speed tiers and was the closest speed to the EC's 30 Mbps data for fixed high-speed broadband in the United States. *See Fifth International Broadband Data Report*, 31 FCC Rcd at 2671-72, para. 15.

[18] *EC Broadband Report* at 11. The EC does not include satellite in the speed tiers.

[19] *Id.* at 18. The speed tiers data are coverage by broadband networks capable of "realistically achieving" at least 2 Mbps, 30 Mbps, and 100 Mbps download speeds. These speed metrics were obtained at the country level only, not at the rural/regional level of the technology metrics. *Id*. at 19.

[20] *Id.* at 15-16. In the *EC Broadband Report,* rural areas are defined by "using the Corrine land cover database and creating a database of population and land type in every square kilometre across Europe." *Id.* at 16. The *EC Broadband Report* adds that households in square kilometers with population less than 100 were classified as rural. *Id*. The *EC Broadband Report* obtained from Point Topic updated estimates of rural population for 2015, which show that roughly 14 percent of households in the 31 EU study countries are rural. *Id*. According to U.S. Census block data, the U.S. rural share of households is slightly higher at 20 percent.

[21] There are 1,357 NUTS-3 regions in the 31 EC study countries and 3,143 counties and county equivalents in the United States. *EC Broadband Report* at 11. Only 350 counties fall within the NUTS-3 population range of 150,000 to 800,000. Over 115 million Americans live in the 74 counties with populations above the NUTS-3 range, while 112 million and 87 million Americans live in counties within and below the NUTS-3 range respectively. The four least populous U.S. states (plus the District of Columbia) fall within the NUTS-3 population range.

(continued….)

jurisdiction that is a subdivision of NUTS-2. In this Report, we consider U.S. states as comparable to NUTS-2, and U.S. counties as comparable to NUTS-3 areas. There are 3,143 counties, parishes or boroughs (counties) in the United States, which would be equivalent to NUTS-3.[22]

8. The United States also relies on households as the unit of measurement. We rely on the U.S. Census Bureau's method for identifying a U.S. census block[23] as rural or non-rural,[24] and then determine rural populations with or without broadband deployment in each county. Each county consists of multiple census blocks. In the maps below, we aggregate census block data to the county level to more closely match the level of aggregation in the *EC Broadband Report*.[25]

9. *Technologies*. The *EC Broadband Report* reports the following technologies that are capable of at least 30 Mbps download speed: VDSL, Fiber, and DOCSIS 3.0.[26] The U.S. Form 477 deployment data include the following fixed technologies that are capable of at least 30 Mbps download speed: asymmetric xDSL, ADSL2, symmetric xDSL, VDSL, Cable Modem—DOCSIS 1, 1.1 and 2, Cable Modem—DOCSIS 3.0, Optical Carrier/Fiber to the End User, Copper Wireline, and Fixed Wireless.

III. FIXED HIGH-SPEED BROADBAND COMPARISON

10. The figures and maps below compare fixed high-speed deployment in the United States and EU21 as of June 2015 and June 2016.

A. Total and Rural Household Fixed High-Speed Broadband Deployment

11. As shown below in Figure 1, as of June 2015, fixed high-speed broadband was deployed to 89 percent of total U.S. households, while total coverage in the EU21 was 72 percent.

[22] The population of U.S. counties varies widely outside of the NUTS-3 range, with the smallest having a population under 100 and the largest having a population over 10 million.

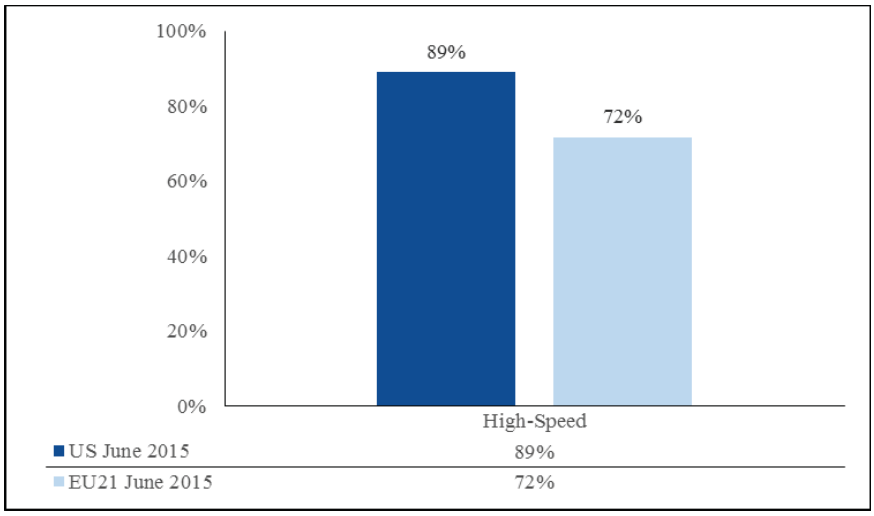
[23] U.S. Census Bureau, Geographic Terms and Concepts—Block, https://www.census.gov/geo/reference/gtc/gtc_block.html (last viewed Jan. 16, 2018).

[24] The U.S. Census Bureau defines rural areas as all territory, population, and housing units located outside urbanized areas and urban clusters. The U.S. Census Bureau defines an urbanized area as "consist[ing] of densely developed territory that contains 50,000 or more people," and defines an urban cluster as "consist[ing] of densely developed territory that has at least 2,500 people but fewer than 50,000 people." U.S. Census Bureau, Geographic Terms and Concepts—Urban and Rural, http://www.census.gov/geo/reference/gtc/gtc_urbanrural.html (last visited Jan. 16, 2018).

[25] The Commission's website provides online broadband maps. FCC, Maps, https://www.fcc.gov/reports-research/maps/ (last visited Jan. 16, 2018).

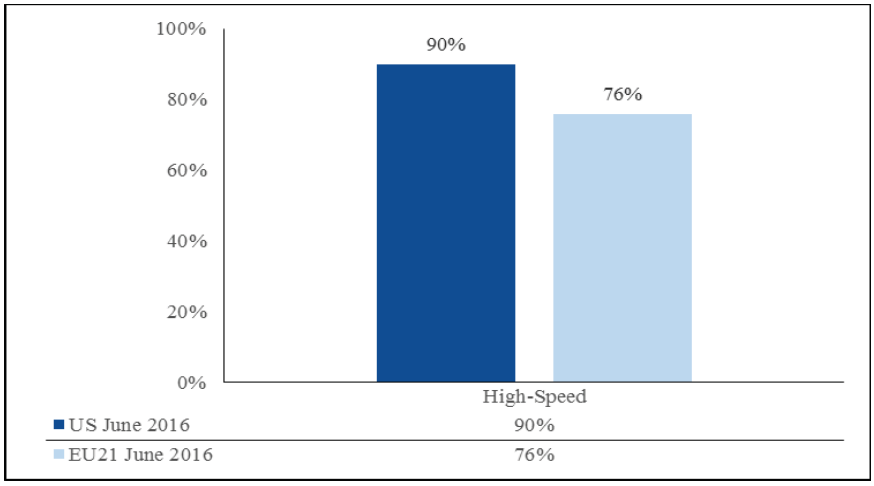
[26] *EC Broadband Report* at 11. The EC includes all homes which are covered by at least one high-speed fixed technology capable of delivering 30 Mbps. The EC does not include satellite in the high-speed category.

Figure 1
Fixed High-Speed Broadband Deployment
All Households (June 2015)



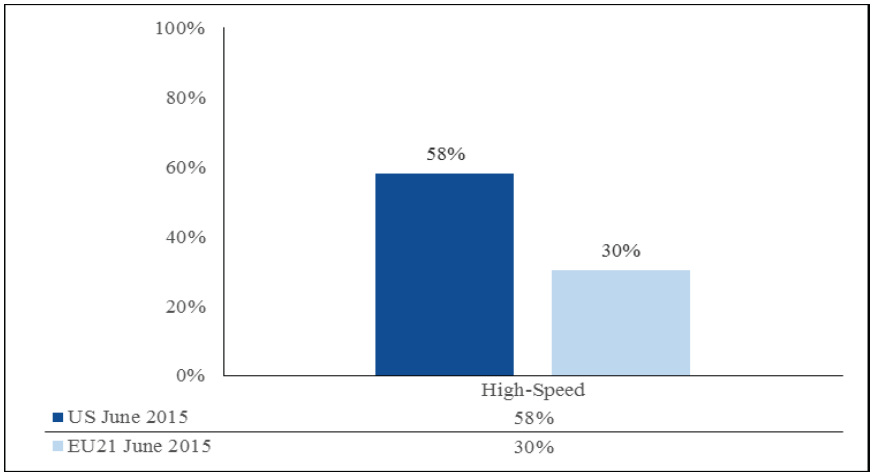
12. Figure 2 presents fixed high-speed broadband deployment in the United States as of June 2016. We see that deployment rose from 89 percent as of June 2015 to 90 percent as of June 2016. In the EU21, deployment increased from 72 percent as of June 2015 to 76 percent as of June 2016.

Figure 2
Fixed High-Speed Broadband Deployment
All Households (June 2016)



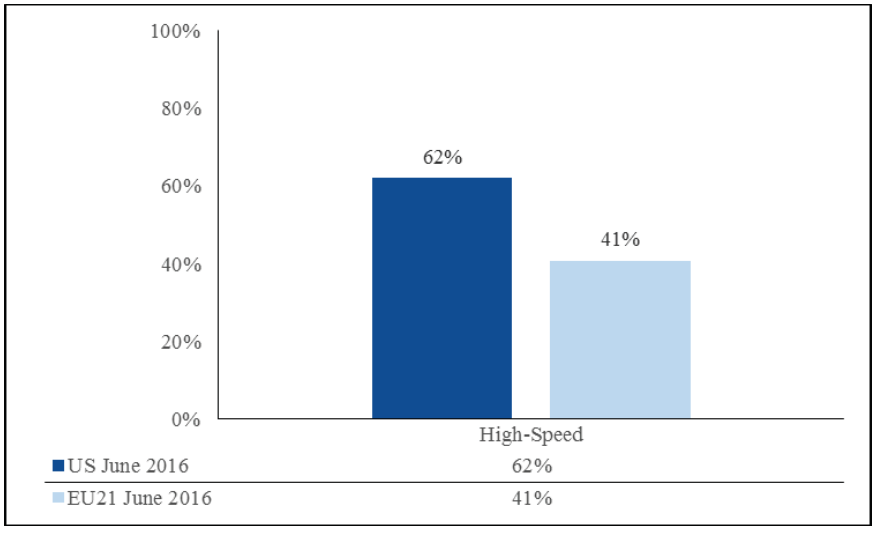
13. Figure 3 below presents the fixed high-speed broadband deployment for all rural households in both the United States and EU21 as of June 2015. By June 2015, the United States had a greater percentage of rural household coverage at 58 percent as compared to the EU21's rural coverage at 30 percent.

Figure 3
Fixed High-Speed Broadband Deployment
All Rural Households (June 2015)



14. Figure 4 compares rural household fixed high-speed broadband deployment for the United States with the EU21 rural household coverage as of June 2016. By June 2016, the United States had a greater percentage of rural household coverage of 62 percent as compared to the EU21's rural coverage at 41 percent.

Figure 4
Fixed High-Speed Broadband Deployment
All Rural Households (June 2016)

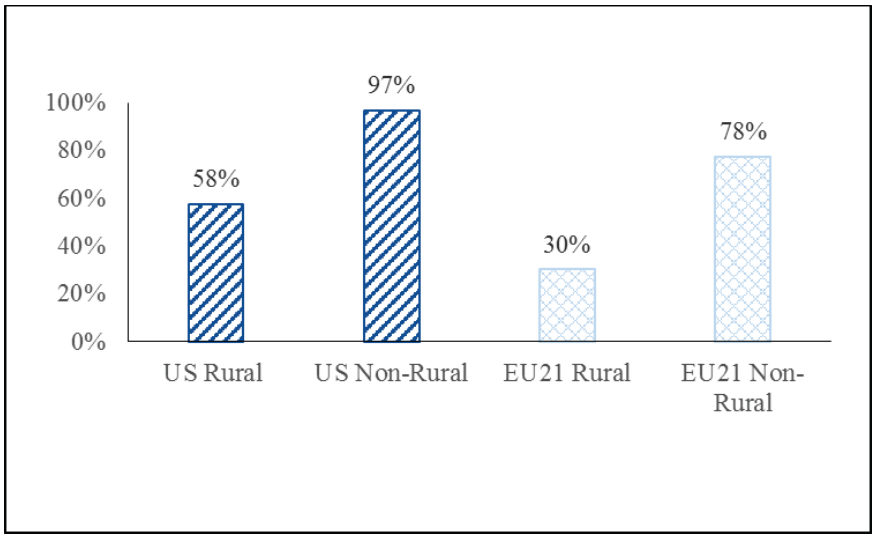


B. High-Speed Rural and Non-Rural Household Broadband Deployment

15. If we compare deployment in rural areas and non-rural areas, we observe deployment in rural areas lagging behind deployment in urban areas.[27] In Figures 5 and 6 below, we compare the United States and EU21 rural and non-rural fixed high-speed broadband deployment as of June 2015 and June 2016.

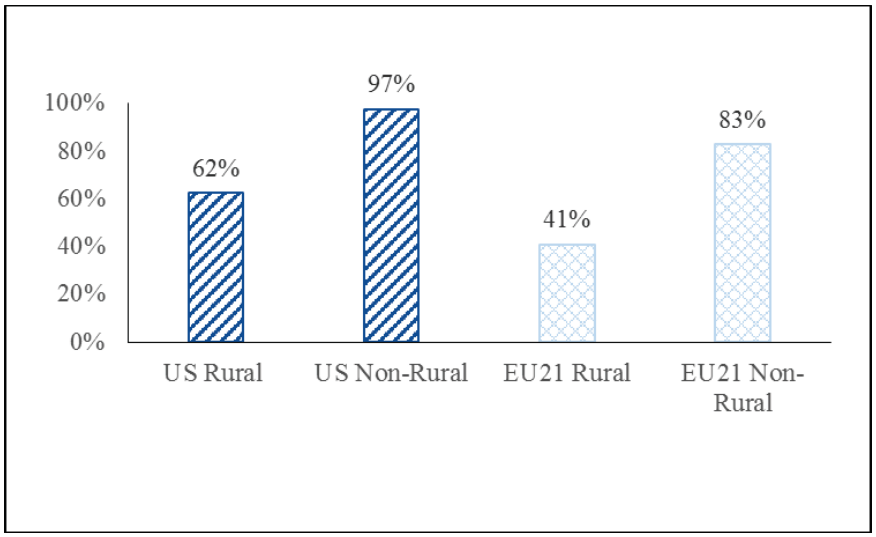
16. Figures 5 and 6 below show that the U.S. deployment gap between non-rural and rural areas decreased from 39 percentage points in June 2015 to 35 percentage points as of June 2016. In the EU21, the gap between non-rural and rural areas decreased from 48 percentage points as of June 2015 to 42 percentage points as of June 2016.

Figure 5
United States and EU21 Rural vs. Non-Rural Fixed High-Speed Broadband Deployment (June 2015)



[27] We calculate the non-rural household coverage for both the United States and the EU21. We derive the non-rural households by subtracting the absolute number of rural households from the absolute number of total households.

Figure 6
United States and EU21 Rural vs. Non-Rural Fixed High-Speed Broadband Deployment (June 2016)



C. Total High-Speed Broadband Deployment by Country

17. Figures 7 and 8 below present the status of fixed high-speed broadband deployment for the United States and the EU21. In 2015, the United States ranked 11th among the 22 countries. In 2016, the United States ranked 10th among the 22 countries.

Figure 7
Fixed High-Speed Broadband Deployment by Country for All Households (June 2015)

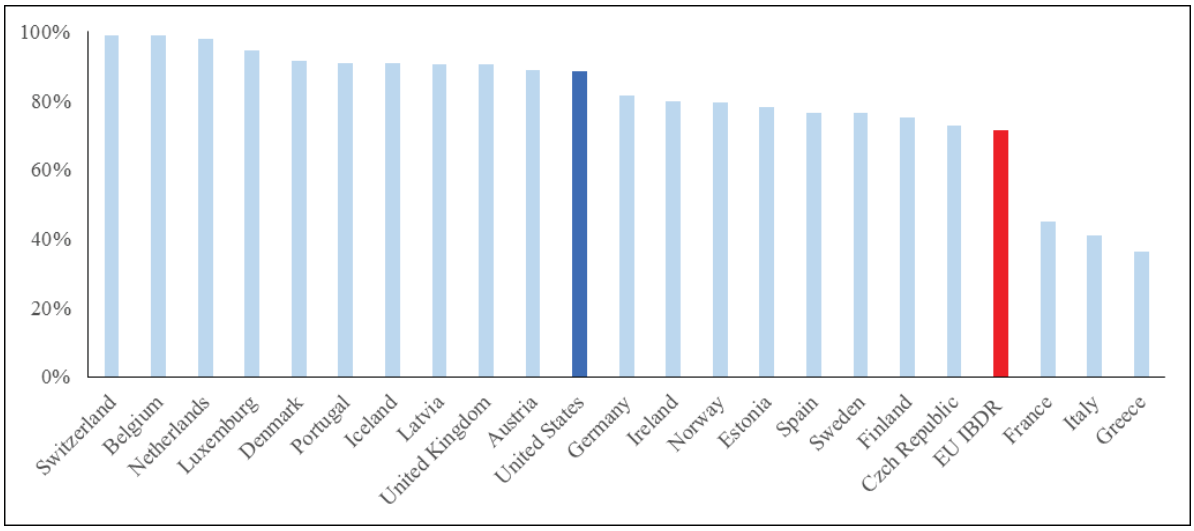
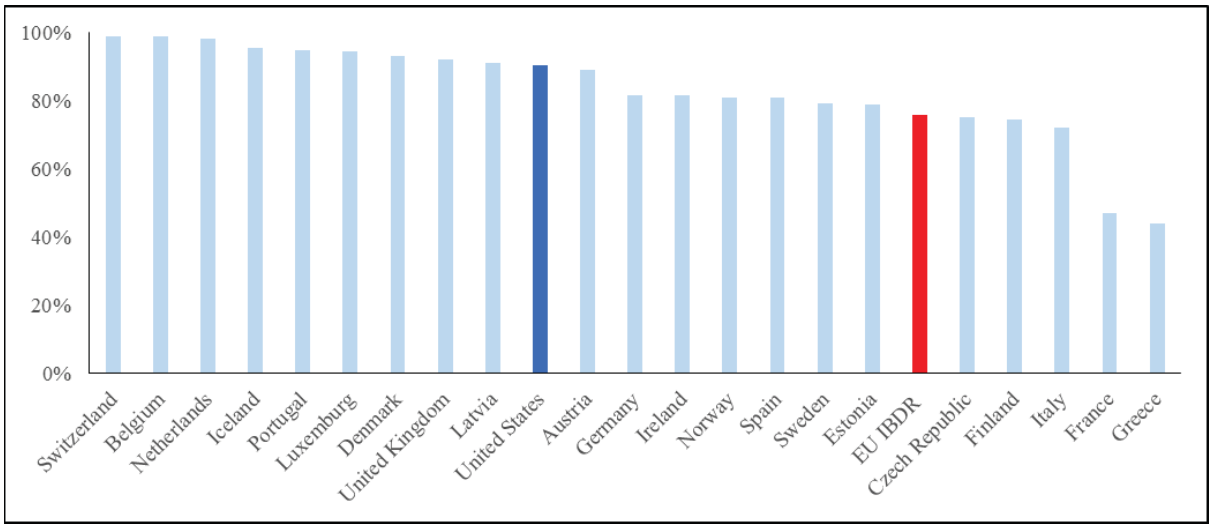


Figure 8
Fixed High-Speed Broadband Deployment by Country for All Households (June 2016)



D. Rural High-Speed Broadband Deployment by Country

18. Figures 9 and 10 below show the status of rural fixed high-speed broadband deployment across the United States and the EU21. The United States ranked 10th out of 22 countries in 2015 and 9th out of 22 countries in 2016 in terms of its rural coverage of high-speed broadband.

Figure 9
Fixed High-Speed Broadband Deployment by Country for All Rural Households (June 2015)

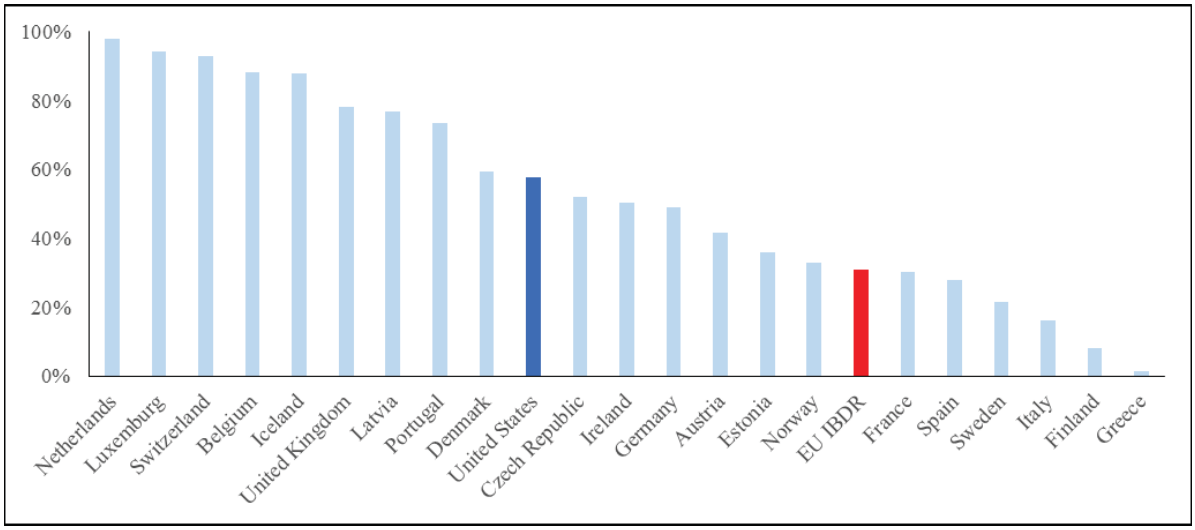
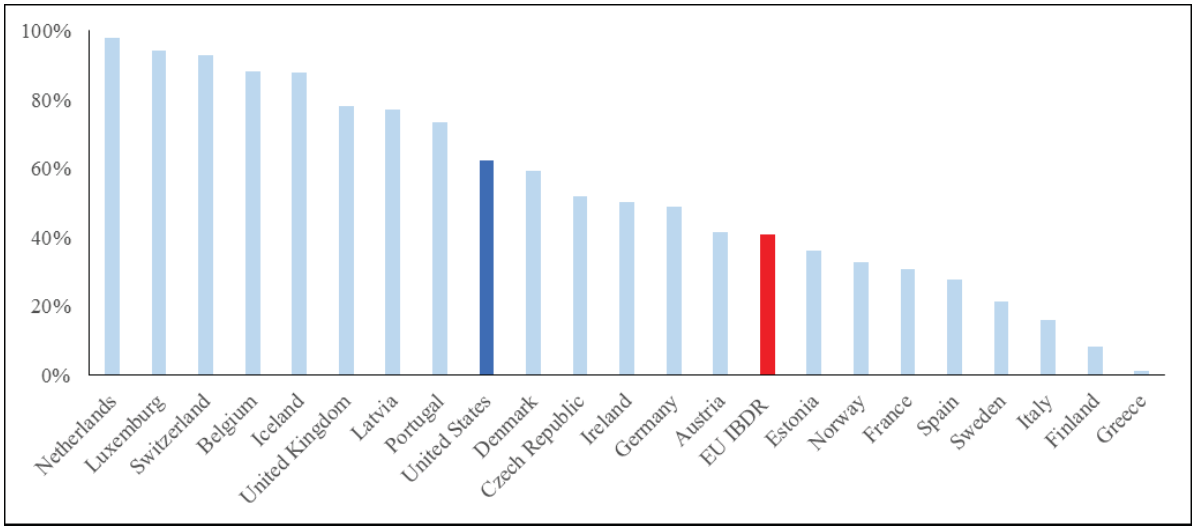


Figure 10
Fixed High-Speed Broadband Deployment by Country for All Rural Households (June 2016)



E. High-Speed Fixed Broadband Deployment by Technology and Technology Combination

19. With regard to fixed high-speed broadband, cable is deployed to more U.S. households than any other technology. Similarly, DOCSIS 3.0 cable is deployed to more EU21 households than any other technology, though to a lesser extent than in the United States.

Figure 11
Fixed High-Speed Broadband Deployment by Technology (June 2015)

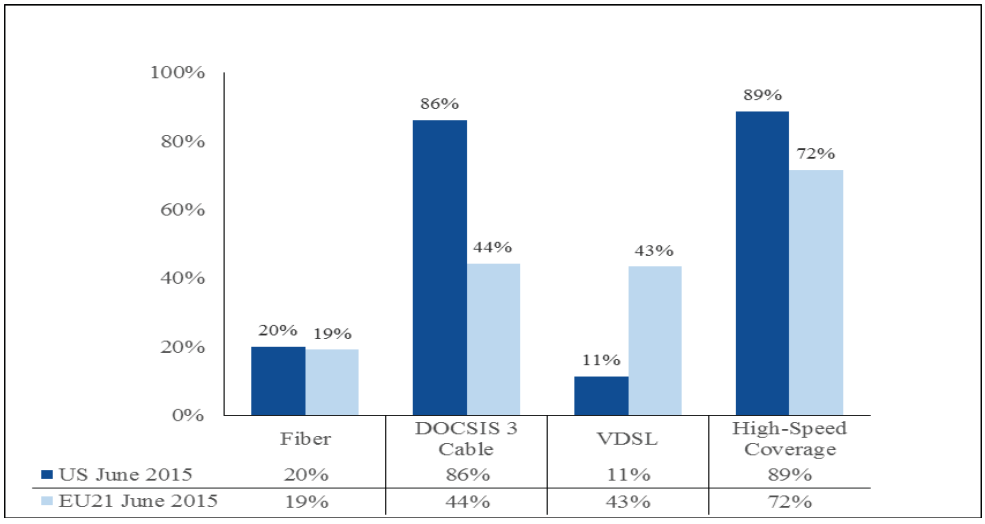
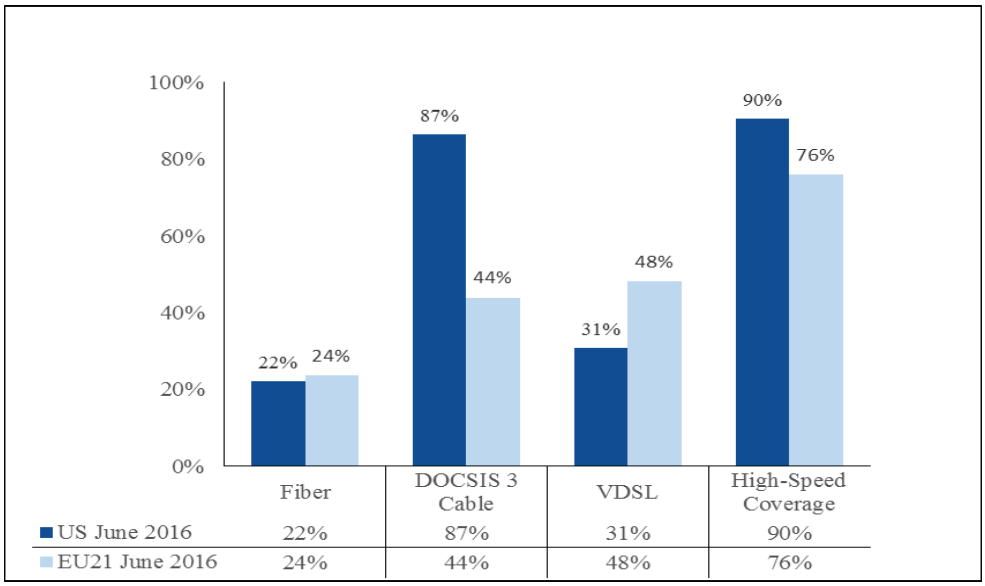


Figure 12
Fixed High-Speed Broadband Deployment by Technology (June 2016)



F. Comparison of 2 Mbps, 30 Mbps, and 100 Mbps Fixed Broadband Deployment in the United States and the EU21

20. The charts below compare broadband at these speeds in the United States and the EU21 for 2015 and 2016. In both 2015 and 2016, the United States led at the highest speeds of broadband.

Figure 13
Fixed High-Speed Broadband Deployment for All Households by Speed (June 2015)

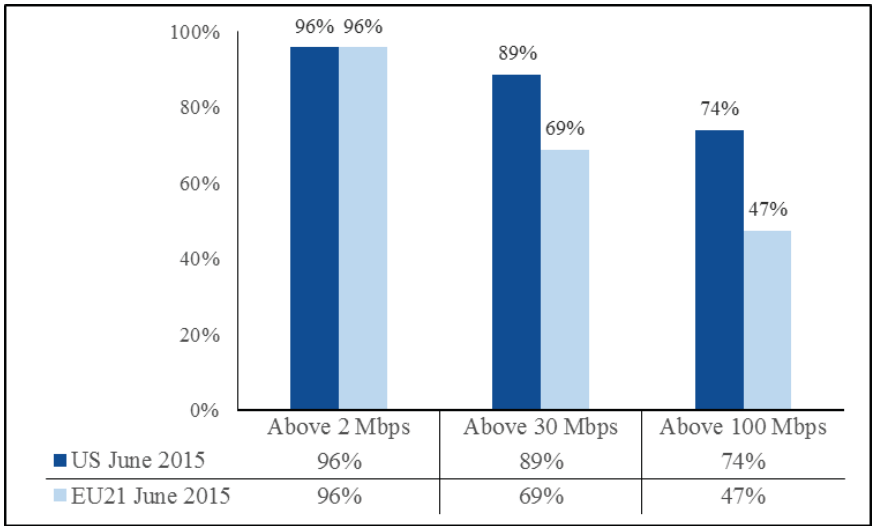
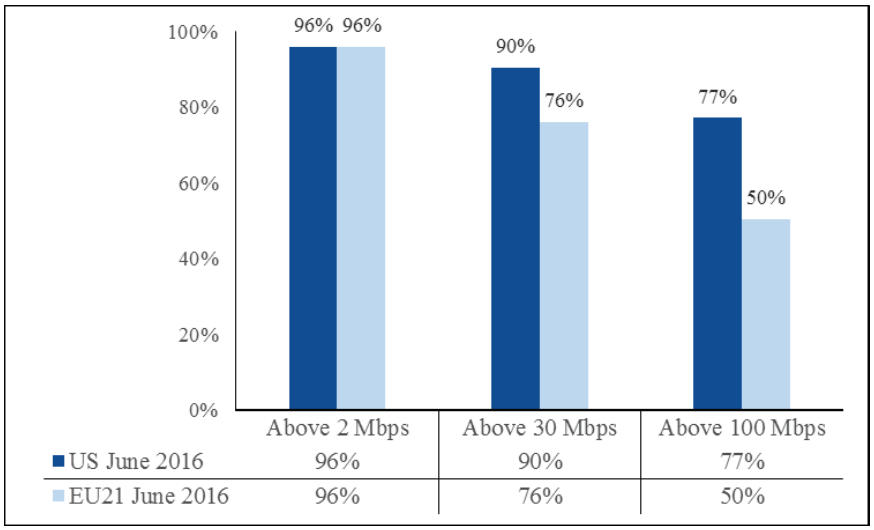


Figure 14
Fixed High-Speed Broadband Deployment for All Households by Speed (June 2016)



IV. MOBILE HIGH-SPEED BROADBAND COMPARISON

21. We also compare mobile LTE broadband deployment in the United States and the EU21. The Figures below show mobile LTE broadband coverage for households overall and rural households in the United States and the EU21. In the United States, by June 2016, LTE mobile coverage reached nearly 100 percent of all households and 98 percent of rural households. In the EU21, by June 2016, mobile LTE coverage reached 97 percent of all households and 83 percent of rural households.

Figure 15
Mobile LTE Broadband Deployment for All Households (June 2015)

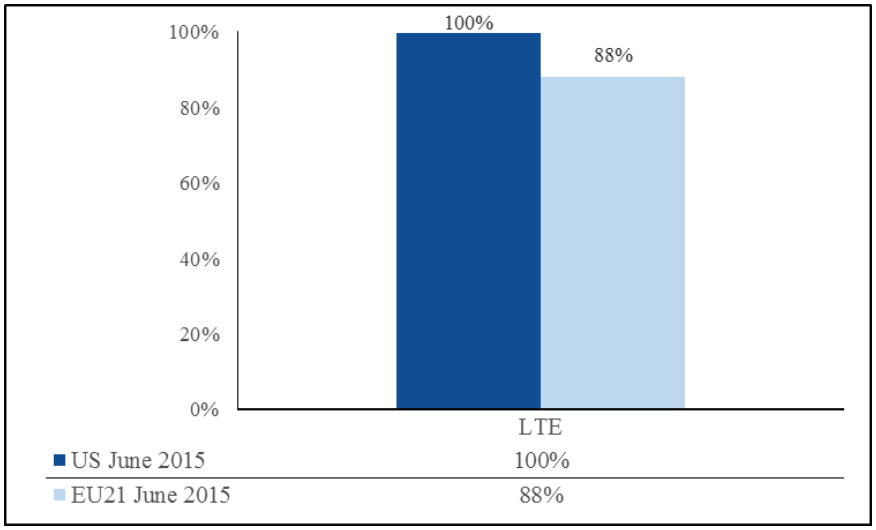


Figure 16
Mobile LTE Broadband Deployment for All Rural Households (June 2015)

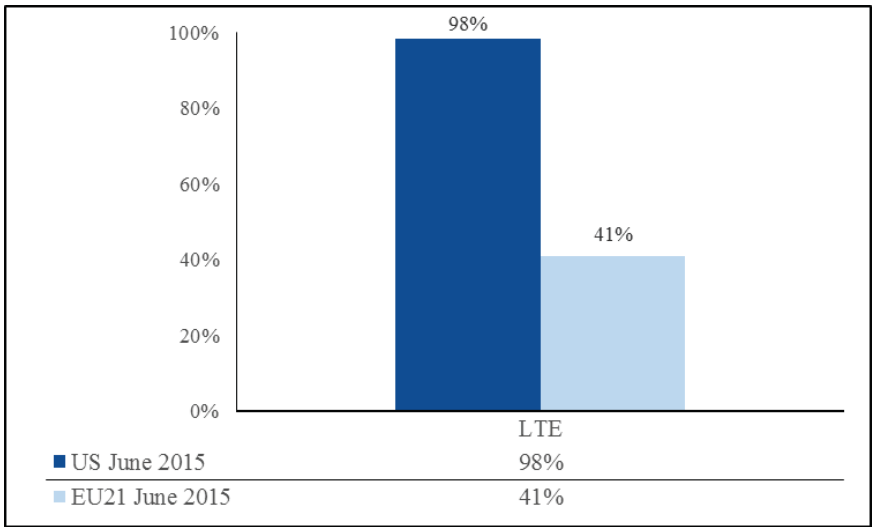


Figure 17
Mobile LTE Broadband Deployment for All Households (June 2016)

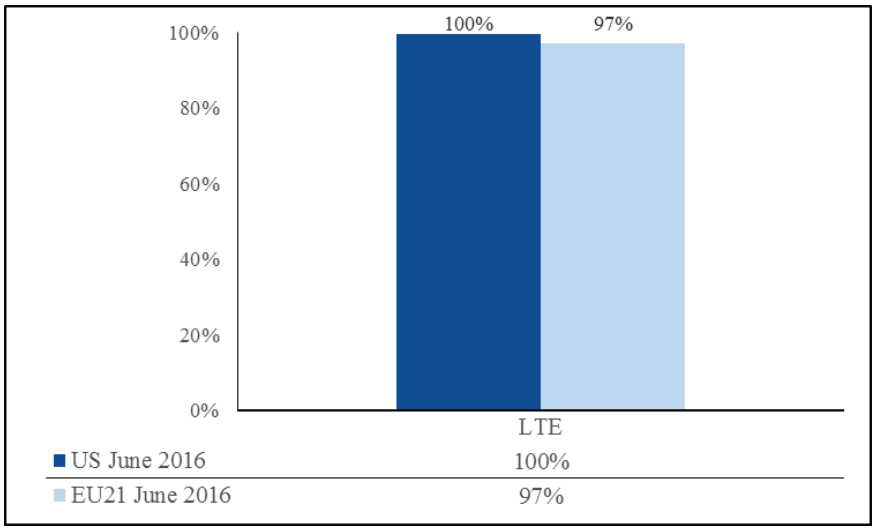
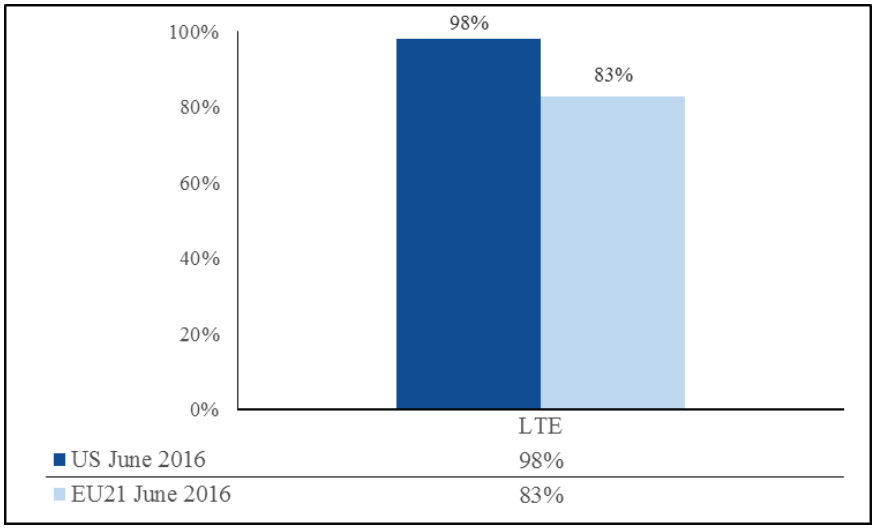
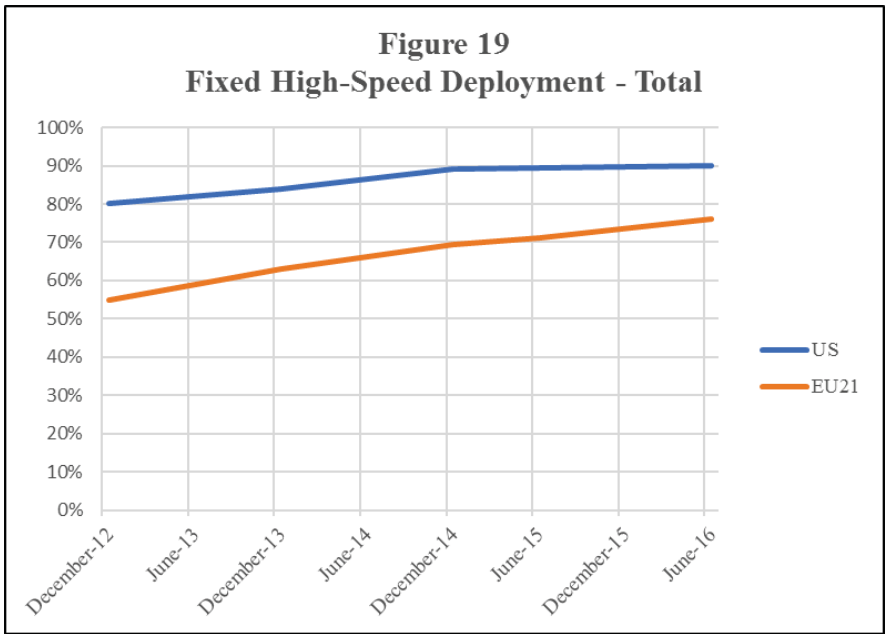


Figure 18
Mobile LTE Broadband Deployment for All Rural Households (June 2016)



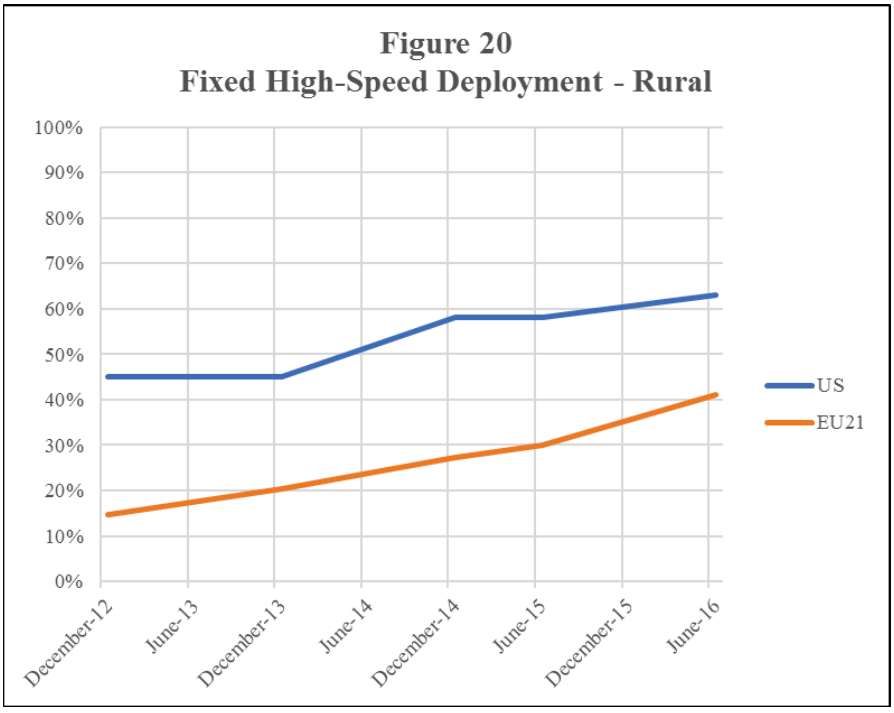
V. HISTORICAL OVERVIEW OF FIXED HIGH-SPEED DEPLOYMENT, 2012-2016

22. Below, we present deployment of fixed high-speed broadband from 2012 to 2016 in the United States and EU21 at either 25 Mbps or 30 Mbps or above depending on data availability.[28] We separately provide data for total, rural, and non-rural deployment. As of December 2012, the United States had a higher deployment than the EU21 and both continued to increase deployment in total, rural, and non-rural areas, with the EU21 countries having a somewhat higher growth rate. As shown in Figure 19, the total fixed high-speed deployment in the United States as of December 2012 was 80 percent, increasing to 90 percent by June 2016. By comparison, as of December 2012, the EU21 total deployment for fixed high-speed broadband was at 55 percent and increased to 76 percent by June 2016.

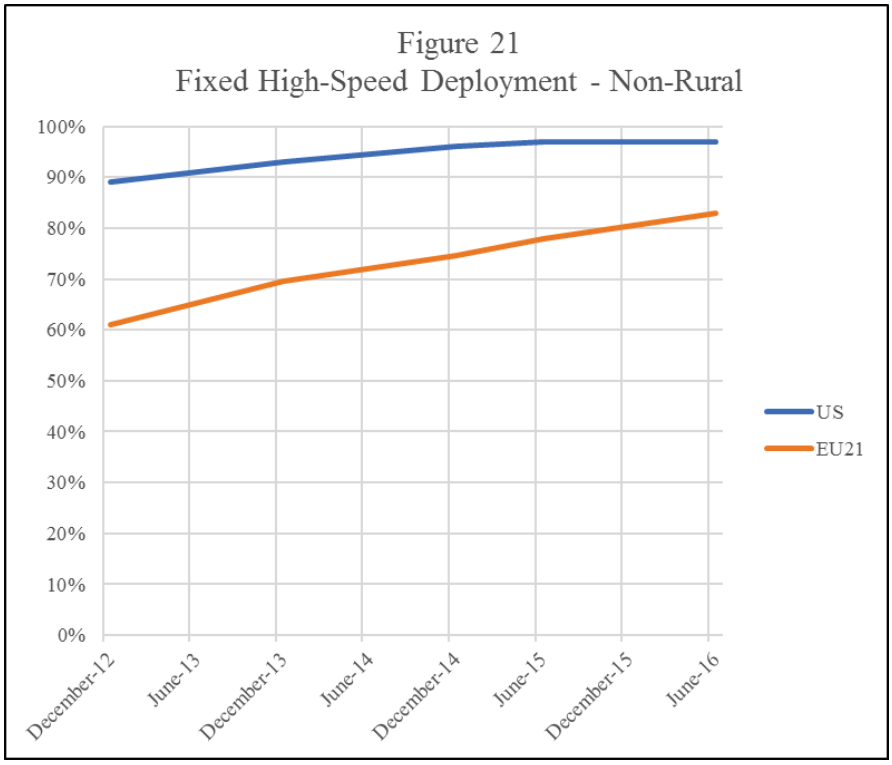


23. Below, Figure 20 shows that rural fixed high-speed broadband deployment in the United States as of December 2012 was 45 percent and increased to 63 percent by June 2016. As of December 2012, rural fixed high-speed broadband deployment in the EU21 was 15 percent, increasing to 41 percent by the end of June 2016.

[28] For purposes of our fixed high-speed broadband deployment comparison for 2012 to 2014, we used the SBI data for 25 Mbps, which most closely matches the 30 Mbps threshold in the EC study.



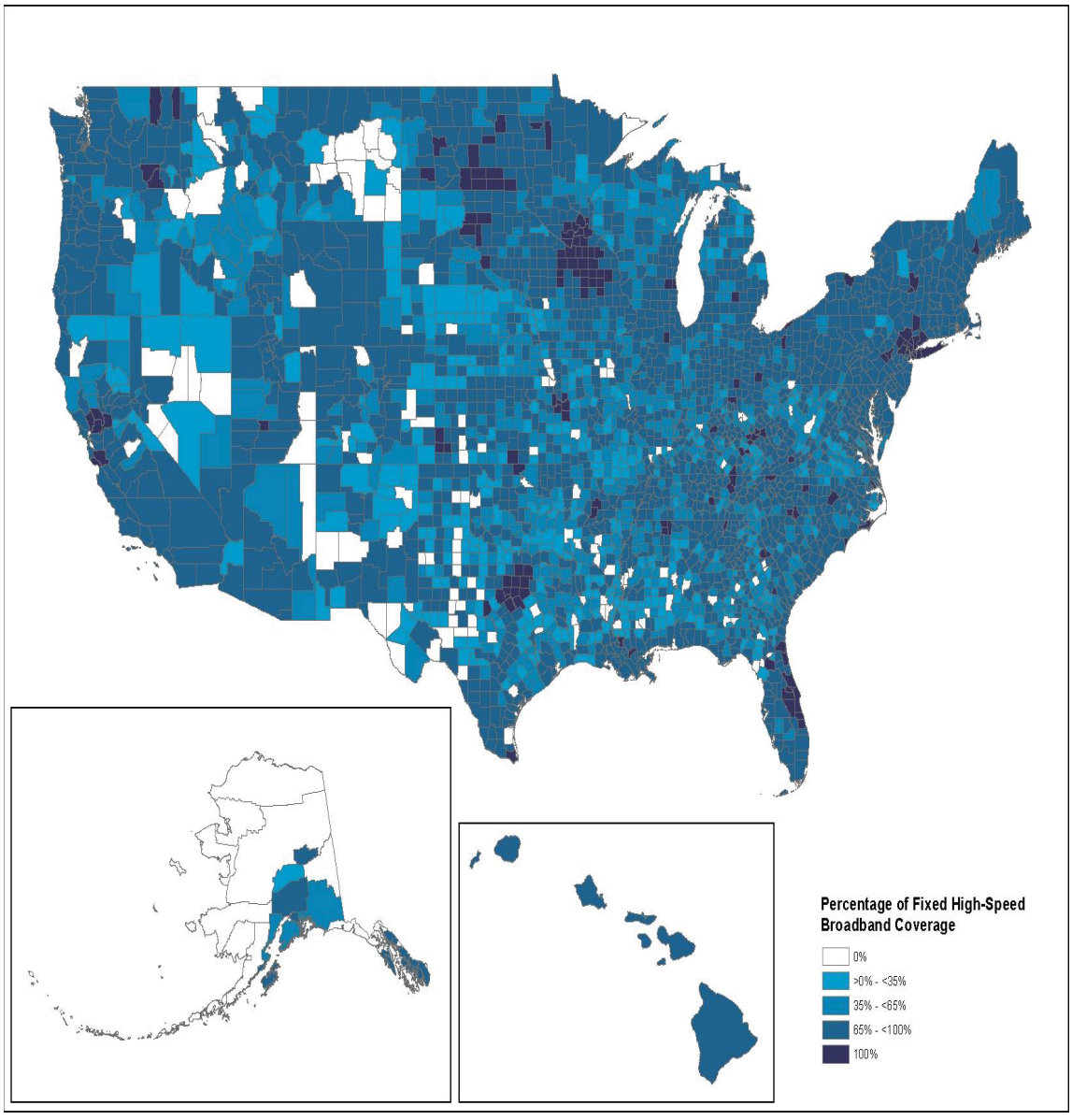
24. Figure 21 shows that non-rural fixed high-speed broadband deployment in the United States increased from 89 percent as of December 2012 to 97 percent as of June 2016. By comparison, non-rural fixed high-speed broadband deployment in the EU21 increased from 61 percent as of December 2012 to 83 percent as of June 2016.



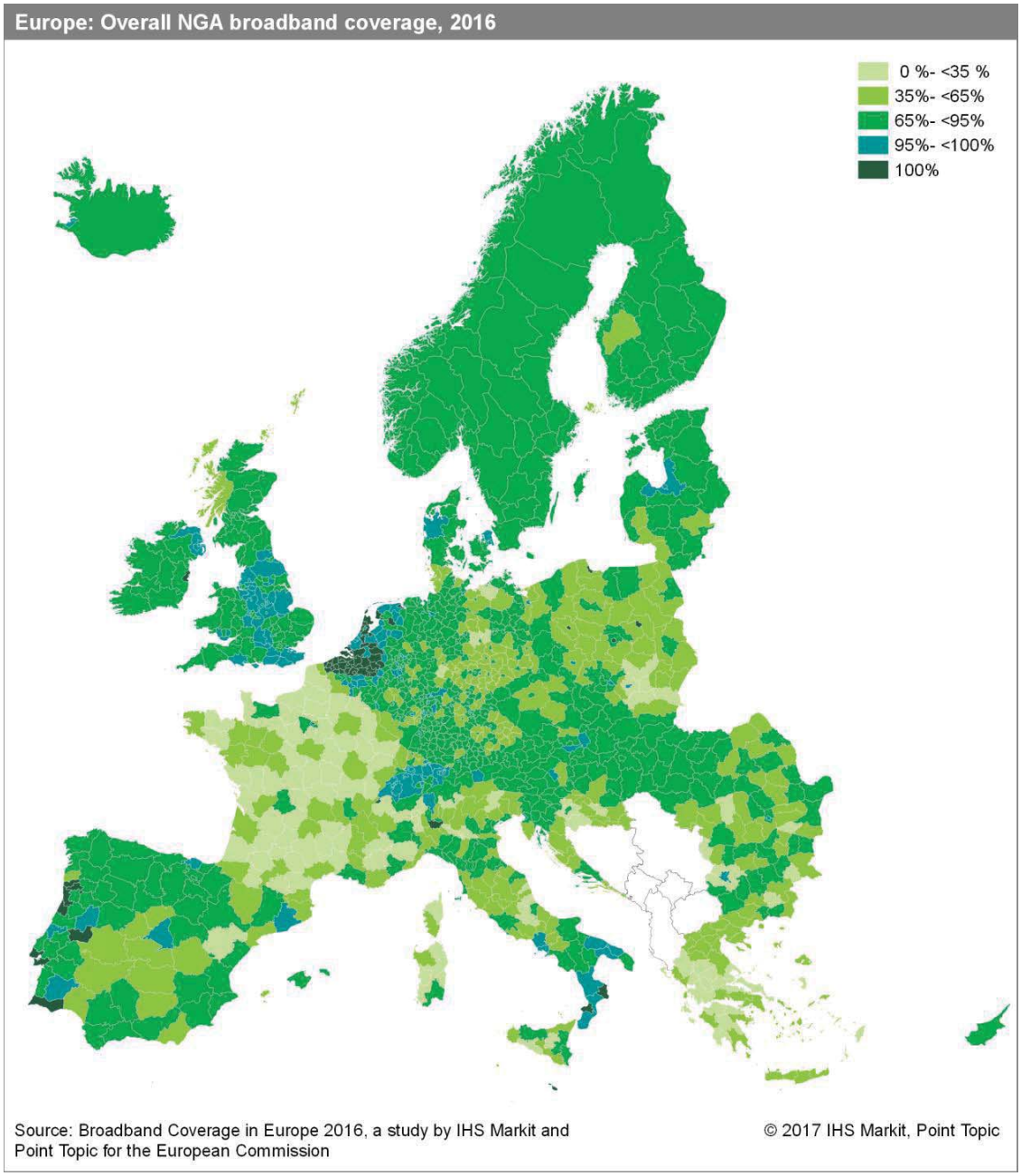
VI. FIXED HIGH-SPEED BROADBAND COVERAGE MAPS FOR THE UNITED STATES AND EUROPE

25. Below are maps of fixed high-speed fixed broadband coverage in the United States and Europe as of June 2016. Given that the EC Broadband Report already provides a map of their data, we reproduce that map below.

Map 1
United States Fixed High-Speed Broadband Coverage Map (30 Mbps)
June 2016



Map 2
Europe Fixed High-Speed Broadband Coverage (30 Mbps)
June 2016[29]



[29] *EC Broadband Report* at 47.

APPENDIX E

Demographics Dataset

1. The BDIA directs the Commission to compare broadband development in communities comparable to U.S. communities in terms of population size, population density, topography, and demographic profile.[1] In this Appendix, we present data on the population size, population density, and other indicators such as gross domestic product (GDP) and educational attainment for the United States and the comparison countries and, in the aggregate, almost 300 province/county communities. For the selected countries excluding the United States and Canada, we present the Organization for Economic Cooperation and Development's (OECD's) most recent published data ranging from 2012 to 2016.[2] For the United States, we present 2016 data from the U.S. Census Bureau.[3] For Canada, we present 2016 data from the Canadian Radio-television and Communications Commission.[4] The topography information for the United States and the comparison countries is based on information from the Central Intelligence Agency's The World Factbook.[5]

Table 1
Demographics Dataset

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Australia (ALA0)	**86***	**24,127,200**	**3**	**1,077,540**	**45,294**	**45**
New South Wales (AU1)	85	7,725,880	10	350,643	46,030	48
Victoria (AU2)	86	6,068,040	27	243,807	41,062	50
Queensland (AU3)	86	4,844,470	3	205,893	43,084	39
South Australia (AU4)	82	1,708,180	2	65,329	38,459	40
Western Australia (AU5)	88	2,617,170	1	156,080	60,257	41
Tasmania (AU6)	81	519,128	8	17,034	32,975	34

[1] 47 U.S.C. § 1303(b)(2).

[2] *OECD Regions and Cities* (To access the data on households with broadband (%), population size, population density, GDP total, GDP per capita, and educational attainment, click the left-hand column titled "Data by Theme," and then click on "Regions and Cities," then "Regional Statistics," and then the following sub-categories: "Regional Social and Environmental Indicators" (select "Internet Broadband Access"); "Regional Demography" (select "Population by Age and Gender" and "Population Density and Regional Area"); "Regional Economy" (select "Regional Gross Domestic Product (GDP)" and "Regional GDP per Capita"); "Regional Innovation" (select "Educational Attainments of the Labour Force" and then "Customize"—"Selection"—"Indicator"—"Share of Labour Force with Tertiary Education (in % of labour force"). In Table 1a below, we identify the sources. The term PPP refers to Purchasing Power Parity.

[3] *U.S. Census Households With Broadband Subscription*. In Table 1, the data for the percentage of households with broadband in all of the communities except Canada represent fixed and mobile broadband.

[4] *Canada Communications Monitoring Report*. In Table 1, the data for the percentage of households with broadband in Canada represent fixed broadband subscription.

[5] *CIA World Factbook* (accessing topography information of each country via the drop-down list that displays the text, "Please select a country to view," and selecting a country-specific webpage). *See also infra* para. 1, Tbl. 2.

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Northern Territory (AU7)	89	244,880	0.2	15,002	61,407	44
Australian Capital Territory (AU8)	94	396,141	169	23,747	60,779	65
Austria (AT0)	**85**	**8,690,080**	**105**	**369,329**	**42,780**	**32**
Burgenland (AT0**)**	83	290,608	79	8,651	29,896	28
Lower Austria (AT12)	83	1,652,320	87	58,033	35,300	31
Vienna (AT13)	88	1,837,440	4,652	94,031	51,776	42
Carinthia (AT21)	84	559,846	60	20,222	36,210	31
Styria (AT22)	82	1,230,760	76	47,078	38,411	28
Upper Austria (AT31)	86	1,451,920	124	63,172	43,759	27
Salzburg (AT32)	86	545,074	77	27,103	50,043	31
Tyrol (AT33)	84	738,455	59	33,426	45,573	27
Vorarlberg (AT34)	88	383,657	151	17,511	45,969	26
Belgium (BE0)	**82**	**11,311,100**	**373**	**459,555**	**40,762**	**42**
Brussels Capital Region (BE1)	86	1,201,290	7,461	83,544	70,047	49
Flemish Region (BE2)	84	6,492,000	486	269,481	41,635	42
Wallonia BE3	79	3,617,830	215	106,227	29,434	39
Canada	**83**	**36,286,400**	**4**	**1,515,440**	**42,273**	**27**
Newfoundland and Labrador (CA10)	84	530,128	1	22,966	43,440	20
Prince Edward Island (CA11)	83	148,649	26	4,720	32,165	21
Nova Scotia (CA12)	79	949,501	18	30,691	32,533	25
New Brunswick (CA13)	86	756,780	11	25,218	33,432	20
Quebec (CA24)	80	8,326,090	6	290,676	35,193	24
Ontario (CA35)	84	13,983,000	15	582,369	42,210	30
Manitoba (CA46)	79	1,318,130	2	50,252	38,775	22
Saskatchewan (CA47)	76	1,150,630	2	60,593	53,515	22
Alberta (CA48)	87	4,252,880	7	249,064	59,589	23
British Columbia (CA59)	88	4,751,610	5	190,732	40,642	28
Yukon (CA60)	--	37,492	0.8	2,068	55,296	--
Northwest Territories (CA61)	--	44,469	0.04	3,684	83,259	--
Nunavut (CA62)	--	37,082	0.02	1,667	51,107	--
Chile	**53***	**18,191,900**	**25**	**375,261**	**20,840**	**33**
Tarapacá (CL01)	56	344,760	8	8,768	26,036	30
Antofagasta (CL02)	73	631,875	5	35,891	57,644	38
Atacama (CL03)	57	316,692	4	7,350	23,522	29

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Coquimbo (CL04)	48	782,801	19	10,954	14,206	26
Valparaíso (CL05)	56	1,842,880	112	32,705	17,913	38
O'Higgins (CL06)	47	926,828	57	17,243	18,768	25
Maule (CL07)	38	1,050,320	35	12,170	11,669	20
Bio-Bio (CL08)	49	2,127,900	57	28,384	13,425	29
Araucanía (CL09)	39	995,974	31	9,048	9,141	24
Los Lagos (CL10)	46	847,495	17	11,886	14,131	28
Aysén (CL11)	53	109,317	1	2,179	20,113	27
Magallanes y Antártica (CL12)	67	165,547	1	3,256	19,775	38
Santiago Metropolitan (CL13)	62	7,399,040	480	187,924	25,693	40
Los Ríos (CL14)	42	407,300	22	4,993	12,345	24
Arica Y Parinacota (CL15)	57	243,149	14	2,510	10,494	27
Czech Republic	**80**	**10,553,800**	**137**	**313,253**	**29,703**	**22**
Prague (CZ01)	91	1,267,450	2613	76,527	60,579	41
Central Bohemian Region (CZ02)	84	1,326,880	123	36,304	27,480	22
Southwest (CZ03)	82	1,214,450	71	31,876	26,269	18
Northwest (CZ04)	75	1,120,650	132	24,917	22,209	15
Northeast (CZ05)	79	1,507,210	123	36,865	24,462	18
Southeast (CZ06)	78	1,684,500	123	46,690	27,732	24
Central Moravia (CZ07)	74	1,219,390	134	30,169	24,725	19
Moravia-Silesia (CZ08)	79	1,213,310	228	29,902	24,601	18
Denmark (DK0)	**92**	**5,707,250**	**133**	**253,126**	**44,537**	**33**
Capital (DK) (DK01)	93	1,789,170	699	102,037	57,368	44
Zealand (DK02)	91	827,499	115	25,268	30,666	27
Southern Denmark (DK03)	89	1,211,770	99	48,869	40,429	28
Central Jutland (DK04)	92	1,293,310	99	51,411	39,915	30
North Jutland (DK05)	92	585,499	74	21,559	36,911	26
Estonia	**85**	**1,315,940**	**30**	**34,182**	**25,986**	**39**
Finland (FI0)	**91**	**5,487,310**	**18**	**208,113**	**37,980**	**41**
Western Finland (FI19)	88	1,379,120	24	46,887	34,020	38
Helsinki-Uusimaa (FI1B)	95	1,620,260	178	80,418	49,893	48
Southern Finland (FI1C)	93	1,160,490	37	38,985	33,576	37
Eastern and Northern Finland (FI1D)	89	1,298,460	6	40,423	31,108	36
Åland (FI20)	--	28,983	19	1,337	46,184	29
France	**79**	**66,760,000**	**105**	**2,455,870**	**36,862**	**36**

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Île de France (FR10)	85	12,142,800	1011	742,928	61,319	46
Champagne-Ardenne (FR21)	75	1,339,570	52	41,557	31,016	27
Picardy (FR22)	73	1,935,560	100	53,331	27,567	25
Upper Normandy (FR23)	81	1,864,110	151	59,244	31,810	28
Centre-Val de Loire (FR24)	79	2,587,000	66	78,532	30,376	30
Lower Normandy (FR25)	80	1,479,130	84	43,429	29,353	28
Burgundy (FR26)	77	1,640,690	52	50,911	31,013	31
Nord-Pas-de-Calais (FR30)	76	4,094,750	330	122,863	30,031	35
Lorraine (FR41)	82	2,333,590	99	65,661	28,104	32
Alsace (FR42)	80	1,885,150	228	64,369	34,192	33
Franche-Comté (FR43)	74	1,179,470	73	33,554	28,451	29
Pays de la Loire (FR51)	77	3,743,980	117	123,061	32,977	33
Brittany (FR52)	74	3,310,340	122	103,182	31,241	36
Poitou-Charentes (FR53)	79	1,808,710	70	54,808	30,339	30
Aquitaine (FR61)	83	3,399,090	82	108,561	32,064	35
Midi-Pyrénées (FR62)	82	3,027,280	67	99,418	32,965	44
Limousin (F 63)	71	735,295	43	20,481	27,818	31
Rhône-Alpes (FR71)	81	6,574,710	150	240,516	36,734	40
Auvergne (FR72)	78	1,365,940	53	41,081	30,097	30
Languedoc-Roussillon (FR 81)	76	2,802,890	102	76,737	27,499	34
Provence-Alpes-Côte d'Azur (FR82)	81	5,024,190	160	172,020	34,301	37
Corsica (FR83)	62	330,354	38	9,715	29,542	26
Germany (DE0)	**90**	**82,175,700**	**230**	**3,473,470**	**42,522**	**27**
Baden-Württemberg (DE1)	89	10,879,600	304	528,828	48,974	29
Bavaria (DE2)	89	12,843,500	182	630,422	49,377	29
Berlin (DE3)	91	3,520,030	3946	142,526	40,781	37
Brandenburg (DE4)	84	2,484,830	84	74,951	30,328	28
Bremen (DE5)	91	671,489	1,603	36,262	54,392	27
Hamburg (DE6)	94	1,787,410	2367	125,433	70,662	34
Hesse (DE7)	91	6,176,170	293	302,410	49,292	29
Mecklenburg-Vorpommern (DE8)	89	1,612,360	69	45,766	28,501	24
Lower Saxony (DE9)	92	7,926,600	166	296,770	37,677	23
North Rhine Westphalia (DEA)	90	17,865,500	524	741,081	41,747	25
Rheinland-Palatinate (DEB)	91	4,052,800	204	151,468	37,565	25
Saarland (DEC)	88	995,597	388	40,210	40,521	21

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Saxony (DED)	88	4,084,850	222	129,322	31,774	29
Saxony-Anhalt (DEE)	88	2,245,470	110	65,533	28,803	24
Schleswig-Holstein (DEF)	90	2,858,710	181	98,273	34,545	23
Thüringen (DEG)	88	2,170,710	134	65,214	30,140	28
Greece (GR0)	**68**	**10,783,700**	**82**	**255,977**	**23,656**	**31**
Attica (EL30)	--	3,781,270	--	122,918	32,329	--
North Aegean (EL41)	--	196,654	--	3,575	18,133	--
South Aegean (EL42)	--	334,791	--	8,846	26,421	--
Crete (EL43)	--	631,812	--	12,805	20,272	--
Eastern Macedonia, Thrace (EL51)	--	604,504	--	10,046	16,590	--
Central Macedonia (EL52)	--	1,883,340	--	34,436	18,233	--
Western Macedonia (EL53)	--	273,843	--	6,033	21,928	--
Epirus (EL54)	--	336,834	--	5,663	16,755	--
Thessaly (EL61)	--	729,442	--	12,968	17,727	--
Ionian Islands EL62	--	206,141	--	4,551	22,030	--
Western Greece (EL63)	--	668,258	--	11,667	17,394	--
Central Greece (EL64)	--	555,830	--	11,210	20,132	--
Peloponnese (EL65)	--	581,026	--	11,259	19,338	--
Iceland	**93**	**332,529**	**3**	**13,095**	**40,446**	**33**
Capital Region (IS01)	--	213,619	217	--	--	--
Other Regions (IS02)	--	118,910	1	--	--	--
Ireland	**86**	**4,724,720**	**69**	**269,794**	**58,284**	**42**
Border - Midlands and Western (IE01)	82	1,250,090	39	--	--	36
Southern and Eastern (IE02)	87	3,474,630	96	--	--	44
Italy (IT0)	**77**	**60,665,600**	**206**	**2,015,050**	**33,180**	**19**
Piedmont (ITC1)	78	4,404,250	177	155,975	35,333	18
Aosta Valley (ITC2)	75	127,329	39	5,357	41,910	16
Liguria (ITC3)	76	1,571,050	295	58,369	37,009	21
Lombardy (ITC4)	82	10,008,300	439	437,436	43,720	20
Abruzzo (ITF1)	78	1,326,510	125	39,913	30,031	18
Molise (ITF2)	73	312,027	71	7,399	23,663	19
Campania ITF3	70	5,850,850	437	123,129	21,025	18
Apulia (ITF4)	70	4,077,170	212	88,338	21,632	17
Basilicata (ITF5)	70	573,694	59	14,021	24,377	18
Calabria (ITF6)	68	1,970,520	134	40,162	20,350	19

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Sicily (ITG1)	69	5,074,260	200	107,012	21,052	17
Sardinia (ITG2)	79	1,658,140	69	39,777	23,952	16
Province of Bolzano-Bozen (ITH1)	76	520,891	71	26,315	50,635	16
Province of Trento (ITH2)	82	538,223	88	22,788	42,371	20
Veneto (ITH3)	80	4,915,120	280	185,695	37,732	17
Friuli-Venezia Giulia (ITH4)	80	1,221,220	162	43,681	35,682	19
Emilia-Romagna (ITH5)	81	4,448,150	207	183,112	41,155	20
Tuscany (ITI1)	79	3,744,400	165	135,115	36,045	19
Umbria (ITI2)	79	891,181	108	26,254	29,400	21
Marche (ITI3)	78	1,543,750	162	49,711	32,128	19
Lazio (ITI4)	80	5,888,470	348	223,668	37,971	26
Japan (JP0)	**62***	**126,969,000**	**340**	**4,685,010**	**36,804**	**43**
Hokkaido (JPA)	51	--	--	168,270	30,983	35
Tohoku (JPB)	57	--	--	296,832	32,637	29
Northern-Kanto, Koshin (JPC)	64	--	--	354,158	35,882	36
Southern-Kanto (JPD)	76	--	--	1,509,060	42,161	54
Hokoriku (JPE)	66	--	--	192,156	35,850	35
Toukai (JPF)	67	--	--	609,130	40,474	40
Kansai Region (JPG)	71	--	--	731,748	35,177	46
Chugoku (JPH)	58	--	--	258,027	34,542	40
Shikoku (JPI)	54	--	--	125,482	32,134	38
Kyushu, Okinawa (JPJ)	53	--	--	440,154	30,312	36
Latvia (LV00)	**75**	**1,968,960**	**32**	**43,949**	**22,224**	**32**
Luxembourg (LU00)	**97**	**576,249**	**223**	**49,670**	**87,202**	**48**
Mexico	38*	**122,273,000**	**62**	**1,873,410**	**15,482**	**21**
Aguascalientes (ME01)	40	1,304,740	232	23,820	18,498	23
Baja California Norte (ME02)	56	3,534,690	49	56,553	16,231	20
Baja California Sur (ME03)	58	786,864	11	14,587	19,094	22
Campeche (ME04)	40	921,517	16	48,646	53,582	22
Coahuila (ME05)	40	2,995,370	20	66,534	22,473	25
Colima (ME06)	47	735,724	131	11,364	15,708	22
Chiapas (ME07)	13	5,317,960	72	32,137	6,118	14
Chihuahua (ME08)	41	3,746,280	15	56,682	15,278	19
Distrito Federal (ME09)	63	8,833,420	5952	313,525	35,408	33
Durango (ME10)	28	1,782,210	14	23,375	13,246	19

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Guanajuato (ME11)	36	5,864,020	192	83,430	14,341	15
Guerrero (ME12)	21	3,588,260	56	28,458	7,976	16
Hidalgo (ME13)	32	2,913,150	140	32,945	11,446	16
Jalisco (ME14)	47	8,022,180	102	127,866	16,122	21
Mexico (ME15)	40	17,118,500	767	177,443	10,518	20
Michoacán (ME16)	25	4,627,900	79	45,038	9,798	15
Morelos (ME17)	40	1,943,040	397	22,028	11,471	20
Nayarit (ME18)	34	1,246,200	45	13,096	10,701	21
Nuevo Leon (ME19)	59	5,157,780	80	141,131	27,750	28
Oaxaca (ME20)	18	4,037,360	43	30,022	7,483	14
Puebla (ME21)	25	6,254,600	183	60,611	9,786	18
Queretaro (ME22)	43	2,034,030	174	44,005	21,953	23
Quintana Roo (ME23)	49	1,619,760	38	31,010	19,691	20
San Luis Potosi (ME24)	40	2,778,000	45	37,871	13,754	20
Sinaloa (ME25)	38	3,009,950	53	41,181	13,798	26
Sonora (ME26)	57	2,972,580	17	55,465	18,912	23
Tabasco (ME27)	21	2,407,860	97	43,518	18,255	21
Tamaulipas (ME28)	44	3,583,300	45	57,317	16,176	23
Tlaxcala (ME29)	23	1,295,780	324	10,742	8,403	19
Veracruz (ME30)	26	8,106,140	113	93,422	11,610	18
Yucatán (ME31)	47	2,145,880	54	29,458	13,903	19
Zacatecas (ME32)	27	1,588,420	21	20,133	12,774	17
Netherlands (NL0)	**95**	**16,979,100**	**504**	**769,032**	**45,398**	**34**
Groningen (NL11)	98	583,721	251	29,741	50,942	--
Friesland (NL12)	95	646,040	194	20,664	31,979	--
Drenthe (NL13)	95	488,629	185	15,696	32,124	--
Overijssel (NL21)	95	1,144,280	344	42,301	37,026	--
Gelderland (NL22)	96	2,035,350	410	77,163	37,994	--
Flevoland (NL23)	100	404,068	286	14,014	34,779	--
Utrecht (NL31)	96	1,273,610	922	67,415	53,142	--
NL32 North Holland (NL32)	94	2,784,850	1,045	161,170	58,113	--
South Holland (NL33)	95	3,622,300	1,291	164,114	45,446	--
Zeeland (NL34)	92	381,252	214	13,452	35,308	--
North Brabant (NL41)	96	2,498,750	509	116,121	46,565	--
Limburg (NL) (NL42)	93	1,116,260	519	42,801	38,315	--
New Zealand (NZ0)	**75**	**4,692,700**	**18**	**149,885**	**33,236**	**38**

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Northland (NZ11) Region	--	171,400	--	3,647	21,972	--
Auckland Region (NZ12)	--	1,614,400	--	54,871	35,936	--
Waikato Region (NZ13)	--	449,200	--	12,211	28,345	--
Bay of Plenty Region (NZ14)	--	293,500	--	7,639	27,059	--
Gisborne Region (NZ15)	--	47,800	--	5,145	24,976	--
Hawke's Bay Region (NZ16)	--	161,500	--			--
Taranaki Region (NZ17)	--	116,700	--	5,441	47,399	--
Manawatu-Wanganui Region (NZ18)	--	236,900	--	5,715	24,583	--
Wellington Region (NZ19)	--	504,800	--	20,270	41,249	--
Tasman-Nelson-Marlborough (NZ21)	--	146,300	--	5,171	29,381	--
West Coast Region (NZ22)	--	32,500	--			--
Canterbury Region (NZ23)	--	599,900	--	20,435	35,582	--
Otago Region (NZ24)	--	219,200	--	6,322	29,877	--
Southland Region (NZ25)	--	98,000	--	3,018	31,279	--
Norway (NO0)	**96**	**5,210,720**	**17**	**307,691**	**59,301**	**42**
Oslo and Akershus (NO01)	96	1,251,690	250	77,208	--	53
Hedmark and Oppland (NO02)	93	384,221	8	13,128	--	33
South-Eastern Norway(NO03)	97	984,764	29	34,413	--	37
Agder and Rogaland (NO04)	98	768,179	33	37,151	--	37
Western Norway (NO05)	99	890,719	19	42,614	--	41
Trøndelag (NO06)	99	449,457	12	18,655	--	40
Northern Norway (NO07)	91	481,694	5	19,419	--	38
Portugal (PT0)	**73**	**10,341,300**	**112**	**276,281**	**26,673**	**23**
North (PT) PT11	70	3,603,780	169	81,444	22,543	20
Algarve (PT15)	71	441,929	88	12,089	27,369	19
Central Portugal (PT16)	68	2,256,360	80	52,262	23,123	20
Lisbon (PT17)	82	2,812,680	933	100,553	35,772	33
Alentejo (PT18)	62	724,391	23	17,643	24,205	18
Azores (PT) (PT20)	79	245,766	106	5,824	23,671	15
Madeira (PT) (PT30)	78	256,424	320	6,400	24,849	18
South Korea (KR0)	**99**	**50,801,400**	**511**	**1,696,970**	**33,654**	**43**
Capital Region (KR01)	99	25,268,200	2159	831,313	33,213	47
Gyeongnam Region (KR02)	98	7,832,300	635	276,130	35,296	40

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Gyeonbuk Region (KR03)	98	5,092,300	256	159,039	31,182	39
Jeolla Region (KR04)	98	5,072,170	247	157,638	31,084	38
Chungcheong Region (KR05)	97	5,432,010	328	214,296	40,302	39
Gangwon Region (KR06)	97	1,511,020	91	42,462	28,288	36
Jeju (KR07)	98	593,455	321	16,092	27,694	40
Spain (ES0)	**81**	**46,445,800**	**92**	**1,472,320**	**31,698**	**38**
Galicia (ES11)	78	2,720,540	93	76,407	28,012	37
Asturias (ES12)	79	1,041,030	99	29,126	27,860	45
Cantabria (ES13)	77	582,548	111	16,735	28,658	41
Basque Country (ES21)	82	2,164,140	301	91,097	42,084	51
Navarra (ES22)	82	637,540	62	25,302	39,722	46
La Rioja (ES23)	79	312,815	62	10,800	34,483	39
Aragón (ES24)	80	1,318,740	28	46,113	34,866	38
Comunidad de Madrid (ES30)	88	6,424,840	806	277,815	43,374	49
Castile and León (ES41)	77	2,454,860	26	73,316	29,725	37
Castile-la Mancha (ES42)	78	2,049,150	26	50,588	24,605	30
Extremadura (ES43)	78	1,085,120	27	23,643	21,723	30
Catalonia (ES51)	82	7,408,850	232	279,490	37,754	39
Valencia (ES52)	80	4,933,050	213	138,752	28,108	34
Balearic Island (ES53)	81	1,135,630	228	37,271	32,974	29
Andalusia (ES61)	80	8,405,300	97	196,894	23,433	30
Murcia (ES62)	81	1,466,510	130	37,680	25,718	29
Ceuta (ES63)	83	84,663	4456	2,179	25,733	--
Melilla (ES64)	85	84,777	6521	1,977	23,344	--
Canary Islands (ES70)	81	2,135,720	287	55,956	26,259	29
Sweden (SE0)	**89**	**9,851,020**	**24**	**432,516**	**44,138**	**37**
Stockholm (SE11)	90	2,231,440	342	137,714	62,181	45
East Middle Sweden (SE12)	89	1,638,830	43	61,611	37,793	35
Småland with Is (SE21)	83	834,276	25	30,785	37,079	29
South Sweden (SE22)	93	1,459,880	105	54,100	37,273	37
West Sweden (SE23)	89	1,963,470	67	84,447	43,238	37
North Middle Sweden (SE31)	87	838,747	13	29,409	35,171	27
Central Norrland (SE32)	82	371,273	5	14,014	37,821	29
Upper Norrland (SE33)	85	513,111	3	20,339	39,667	35
Switzerland (CH0)	**86**	**8,327,130**	**208**	**442,360**	**54,021**	**38**
Lake Geneva Region (CH01)	85	1,593,840	192	80,446	51,627	39

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Espace Mitteland (CH02)	81	1,842,250	188	89,987	49,515	35
Northwestern Switzerland (CH03)	87	1,128,720	579	61,825	55,660	40
Zurich (CH04)	93	1,466,420	883	95,126	66,246	44
Eastern Switzerland (CH05)	87	1,153,490	102	54,315	47,658	32
Central Switzerland (CH06)	87	790,458	185	40,924	52,584	35
Ticino (CH07)	77	351,946	128	19,738	56,646	35
United Kingdom (UK0)	**92**	**65,382,600**	**270**	**2,476,520**	**38,025**	**40**
North East (UKC)	91	2,632,290	307	73,807	28,074	31
North West (UKD)	92	7,187,230	510	233,071	32,498	36
Yorkshire and The Humber (UKE)	91	5,406,550	351	162,992	30,200	34
East Midlands (UKF)	89	4,693,620	300	145,435	31,120	34
West Midlands (UKG)	89	5,772,080	444	177,945	30,935	33
Eastern (UKH)	92	6,105,480	319	216,400	35,620	37
London (UKI)	93	8,759,410	5572	562,240	64,756	55
South East (UKJ)	95	8,992,570	472	370,207	41,352	43
South West (UKK)	93	5,492,330	230	187,214	34,240	39
Wales (UKL)	89	3,105,860	150	82,887	26,669	37
Scotland (UKM)	92	5,376,610	69	189,075	35,232	46
Northern Ireland (UKN)	88	1,858,540	137	51,125	27,593	36
United States (US0)	**81**	**323,128,000**	**35**	**16,489,800**	**51,303**	**40**
Alabama (US01)	75	4,863,300	37	183,725	37,811	35
Alaska (US02)	86	741,894	1	48,538	65,732	34
Arizona (US04)	83	6,931,070	24	267,691	39,205	37
Arkansas (US05)	71	2,988,250	22	109,419	36,740	29
California (US06)	85	39,250,000	97	2,283,350	58,331	40
Colorado (US08)	87	5,540,550	21	288,713	52,911	46
Connecticut (US09)	84	3,576,450	285	232,748	64,816	46
Delaware (US10)	83	952,065	188	63,240	66,855	41
District of Columbia (US11)	80	681,170	4284	112,400	167,205	64
Florida (US12)	81	20,612,400	148	817,224	40,314	39
Georgia (US13)	81	10,310,400	69	458,211	44,857	38
Hawaii (US15)	83	1,428,560	86	73,963	51,644	44
Idaho (US16)	79	1,683,140	8	60,319	36,448	36
Illinois (US17)	82	12,801,500	89	714,892	55,590	43
Indiana (US18)	79	6,633,050	71	309,238	46,715	35
Iowa (US19)	80	3,134,690	22	160,144	51,264	40

Community	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Kansas (US20)	80	2,907,290	14	137,701	47,293	41
Kentucky (US21)	77	4,436,970	43	177,852	40,192	34
Louisiana (US22)	74	4,681,670	42	220,210	47,147	31
Maine (US23)	81	1,331,480	17	52,725	39,663	40
Maryland (US24)	86	6,016,450	238	336,203	55,974	46
Massachusetts (US25)	86	6,811,780	335	446,248	65,679	50
Michigan (US26)	81	9,928,300	67	430,964	43,433	39
Minnesota (US27)	84	5,519,950	27	302,141	55,039	45
Mississippi (US28)	71	2,988,730	25	97,375	32,542	32
Missouri (US29)	79	6,093,000	34	270,993	44,544	38
Montana (US30)	79	1,042,520	3	41,627	40,300	37
Nebraska (US31)	82	1,907,120	10	104,243	54,975	42
Nevada (US32)	81	2,940,060	10	128,575	44,477	30
New Hampshire (US33)	86	1,334,800	57	67,973	51,084	45
New Jersey (US34)	84	8,944,470	466	522,436	58,321	46
New Mexico (US35)	74	2,081,020	7	85,891	41,193	35
New York (US36)	82	19,745,300	161	1,319,140	66,638	47
North Carolina (US37)	79	10,146,800	80	455,872	45,393	39
North Dakota (US38)	81	757,952	4	51,403	67,910	44
Ohio (US39)	81	11,614,400	110	562,180	48,408	37
Oklahoma (US40)	77	3,923,560	22	171,141	43,755	33
Oregon (US41)	85	4,093,470	16	200,264	49,706	39
Pennsylvania (US42)	81	12,784,200	110	653,128	51,016	41
Rhode Island (US44)	83	1,056,430	390	51,579	48,830	43
South Carolina (US45)	77	4,961,120	64	184,966	37,778	36
South Dakota (US46)	80	865,454	4	43,474	50,642	39
Tennessee (US47)	77	6,651,190	62	290,654	44,036	34
Texas (US48)	81	27,862,600	41	1,500,010	54,607	35
Utah (US49)	85	3,051,220	14	135,733	45,306	38
Vermont (US50)	81	624,594	26	27,641	44,152	43
Virginia (US51)	83	8,411,810	82	442,697	52,809	45
Washington (US53)	87	7,288,000	42	409,872	57,162	44
West Virginia (US54)	74	1,831,100	29	68,391	37,086	31
Wisconsin (US55)	81	5,778,710	41	277,972	48,164	40
Wyoming (US 56)	83	585,501	2	36,683	62,588	38

Figures marked with an asterisk (*) were calculated by FCC staff using simple averages of OECD data.

Table 1a
Sources for Demographics Dataset

Country	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP[1] (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Australia	2015, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Austria	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Belgium	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Canada	2016, CRTC	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2013, OECD
Chile	2013, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Czech Republic	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Denmark	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Estonia	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Finland	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
France	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Germany	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Greece	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Iceland	2014, OECD	2016, OECD	2016, OECD	2013, OECD	2013, OECD	2014, OECD
Ireland	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Italy	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Japan	2015, OECD	2016, OECD	2016, OECD	2013, OECD	2013, OECD	2010, OECD
Latvia	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Luxembourg	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD

Country	Households with Broadband (%)	Population Total	Population Density (Persons per Square km)	GDP Total (US$mm), PPP[1] (Constant Real Prices 2010)	GDP Per Capita, (US$) PPP (Constant Real Prices 2010)	Education (% of Labor Force with Tertiary Education)
Mexico	2015, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2010, OECD
Netherlands	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
New Zealand	2012, OECD	2016, OECD	2016, OECD	2014, OECD	2014, OECD	2012, OECD
Norway	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Portugal	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Spain	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
South Korea	2014, OECD	2016, OECD	2016, OECD	2014, OECD	2014, OECD	2014, OECD
Sweden	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
Switzerland	2014, OECD	2016, OECD	2016, OECD	2014, OECD	2014, OECD	2014, OECD
United Kingdom	2016, OECD	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2014, OECD
United States	2016, Census Bureau	2016, OECD	2016, OECD	2015, OECD	2015, OECD	2013, OECD

Table 2
Country Topography

Country	Topography
Australia	Located between the Indian Ocean and the Pacific Ocean, the country is the world's smallest continent but the sixth largest country. It is comprised of mostly low plateau with deserts and a fertile plain in the southeast.
Austria	A landlocked Central European country about the size of South Carolina and slightly more than two-thirds the size of Pennsylvania. The terrain is a mostly mountain to the west and south while mostly flats or gently sloping land along the eastern and northern margins.
Belgium	Bordering the North Sea, the country, about the size of Maryland, has flat coastal plains in the northwest, central rolling hills, and the rugged mountains of the Ardennes Forest in the southeast.
Canada	Slightly larger than the United states, it is the world's largest country that borders only one country. The third largest country in the world, the terrain is mostly plains with mountains in the west, and lowlands in the southeast.
Chile	Slightly smaller than twice the size of Montana, the South American country's terrain incudes low coastal mountains, a fertile central valley, and the rugged Andes in the east.
Czech Republic	About two-thirds the size of Pennsylvania and slightly smaller than South Carolina, the terrain consists of rolling plains, hills, and plateaus surrounded by low mountains to the west and very hilly areas to the east.
Denmark	Bordering the Baltic and North Sea, the area is slightly less than twice the size of Massachusetts, with the terrain composed of low and flat to gently rolling plains. The area also includes several major islands.
Estonia	About twice the size of New Jersey, the Eastern European country's terrain includes marshy lowlands, mostly flat in the north but hilly in the south.
Finland	Slightly smaller than Montana, the Northern European country's terrain is mostly low, with flat to rolling plains interspersed with lakes and low hills.
France	Slightly less than the size of Texas, the country has five overseas regions with varying terrain. In the French metropole in Western Europe, the terrain is mostly comprised of flat plains or gently rolling hills in the north and west. The remainder is mountainous.
Germany	Slightly smaller than Montana, the terrain consists of lowlands in the north, uplands in the center, and the Bavarian Alps in the south.
Greece	Slightly smaller than Alabama, the Southern European country borders the Aegean, Ionian, and the Mediterranean Seas. It has a mountainous terrain with ranges extending into the sea as peninsulas or chains of islands.
Iceland	Occupies an area about the same size as Kentucky. The terrain is mostly comprised of plateaus interspersed with mountain peaks and ice fields. The coast is deeply indented by bays and fiords.
Ireland	Occupies an area larger than West Virginia, The terrain is mostly flat to rolling interior plains which are surrounded by rugged hills and low mountains. The west coast has sea cliffs.

Country	Topography
Italy	Slightly larger than Arizona, the Southern European country borders the Mediterranean Sea. The terrain is mostly rugged and mountainous. Some plains and coastal lowlands also make up its terrain.
Japan	The island chain nation occupies an area slightly smaller than California. The terrain is mostly rugged and mountainous.
Latvia	The Eastern European country is slightly smaller than West Virginia. Low plains mark the terrain as most of the country is composed of fertile low-lying plains with some hills in the east.
Luxembourg	Occupies an area slightly smaller than Rhode Island. The terrain is mostly comprised of gently rolling uplands with broad, shallow valleys. In the north, there are uplands to slightly mountainous terrain and a steep slope down to Moselle flood plain in the southeast.
Mexico	Slightly less than three times the size of Texas, the terrain is comprised of high rugged mountains, low coastal plains, high plateaus, and desert.
Netherlands	Bordering the North Sea, it is less than twice the size of New Jersey. The terrain includes mostly coastal lowland and reclaimed land and some hills to the southeast.
New Zealand	An island archipelago in Oceania, it is almost twice the size of North Carolina and about the size of Colorado. The terrain is mostly mountainous with large coastal plains.
Norway	The Northern European country is slightly larger than New Mexico. It has a glaciated terrain, with mostly high plateaus and rugged mountains broken by fertile valleys. Small-scattered plains are also part of the terrain, as well as a coastline deeply indented by fjords, with arctic tundra in the north.
Portugal	Occupies an area slightly smaller than Virginia. The west-flowing Tagus River divides the country's terrain. The north is mountainous toward the interior, while the south is characterized by rolling plains.
South Korea	Occupies an area slightly smaller than Pennsylvania, while slightly larger than Indiana. The terrain is mostly hills and mountains with wide coastal plains in the west and south.
Spain	Slightly more than twice the size of Oregon, the terrain is large and flat with dissected plateaus surrounded by rugged hills. Mountains are in the north.
Sweden	Occupies an area slightly larger than California. The terrain is mostly flat or gently rolling lowlands, and mountains to the west.
Switzerland	The landlocked Central European country is slightly less than twice the size of New Jersey. The terrain is comprised of mostly mountains with a central plateau of rolling hills, plains, and large lakes.
United Kingdom	The Atlantic archipelago occupies an area slightly smaller than Oregon. The terrain is mostly rugged hills and low mountains, with level to rolling plains in the east and the southeast.
United States	Slightly larger than China and more than twice the size of the European Union, the terrain is comprised of a vast central plain, mountains in the west, hills and low mountains in the east, rugged mountains and broad river valleys in Alaska, and rugged, volcanic topography in Hawaii.

Source: *CIA World Factbook*

APPENDIX F

Market and Regulatory Developments

1. In this Appendix, as required by the BDIA, we identify the relevant similarities and differences between the United States and the 28 comparison countries with respect to multiple criteria.[1] First, we discuss the regulatory models for fixed broadband deployment.[2] Second, we provide a list of regulators and, where relevant, the ministries responsible for regulating broadband. Third, we provide information concerning the major fixed and mobile broadband competitors and the types of technologies used to provide broadband. Finally, we present data on the types of activities that consumers in the United States and the comparison countries engage in while using the Internet.

I. BROADBAND REGULATORY MODELS

A. Summary of Fixed Broadband Regulatory Models

2. Based on our analysis, there are two basic fixed broadband regulatory models – a facilities-based competition model, and an open access regulatory model – with some blending of the two models in most countries. There is also significant variation in regulatory approaches for implementing the same model. The facilities-based competition model relies on competition between the incumbent telecommunications operator and cable operators. The open access regulatory model features the use of mandated wholesale access to the incumbent's fixed network to create service-based competition by encouraging market entry at the retail level. Under either model, investment in fixed broadband networks may be primarily market- or state-aid-driven, depending on the extent to which governments subsidize network deployment.

3. Below, in Table 1, we identify the primary regulatory models for the United States and the comparison countries for the past 10-15 years.

[1] 47 U.S.C. § 1303(b)(3) ("The Commission shall identify relevant similarities and differences in each community, including their market structures, the number of competitors, the number of facilities-based providers, the types of technologies deployed by such providers, the applications and services those technologies enable, the regulatory model under which broadband service capability is provided, the types of applications and services used, business and residential use of such services, and other media available to consumers.").

[2] 47 U.S.C. § 1303(b)(3) ("The Commission shall identify . . . the regulatory model under which broadband service capability is provided.").

Table 1
Regulatory Models

Country[3]	Facilities-Based Competition	Open Access Regulations
Australia		X
Austria		X
Belgium		X
Canada	X	
Czech Republic		X
Denmark		X
Estonia		X
Finland		X
France		X
Germany		X
Greece		X
Iceland		X
Ireland		X
Italy		X
Japan		X
Latvia		X
Luxembourg		X
Netherlands		X
New Zealand		X
Norway		X
Portugal		X
South Korea	X	
Spain		X
Sweden		X
Switzerland		X
United Kingdom		X
United States	**X**	

4. *Regulatory Model Blending.* There is some blending of the two models within each group of countries. In the United States, the Commission initially imposed an unbundling obligation on traditional wireline services and facilities (e.g., digital subscriber line (DSL)),[4] but eliminated these requirements for wireline broadband Internet access service providers in 2005[5] and also declined to impose unbundling requirements on certain incumbent local exchange carrier (LEC) next-generation

[3] This chart includes the 28 comparison countries discussed in the Report except for Chile and Mexico because the regulatory model in these countries is unclear.

[4] *Appropriate Framework for Broadband Access to the Internet over Wireline Facilities et al.*, CC Docket Nos. 02-33 et al., Report and Order and Notice of Proposed Rulemaking, 20 FCC Rcd 14853, 14872, para. 31 (2005) (*Wireline Broadband Order*), *aff'd Time Warner Telecom, Inc. v. FCC*, 507 F.3d 205 (3d Cir. 2007).

[5] *Id.* at 14876, para. 41 ("[S]ubject to a one-year transition period for existing wireline broadband transmission services, all wireline broadband Internet access service providers are no longer subject to the *Computer II* requirement to separate out the underlying transmission from wireline broadband Internet access service and offer it on a common carrier basis.").

(continued….)

networks.[6] Canada likewise introduced unbundling requirements for DSL, but facilities-based competition between incumbent telecommunications and cable operators has been the dominant characteristic.[7]

5. South Korea initially relied on facilities-based competition between the incumbent and two entrants to achieve a high rate of broadband penetration.[8] During this initial phase, DSL was classified as a relatively unregulated service, and the two entrants provided broadband service through cable modem using cable facilities leased from the Korea Electric Power Corporation (KEPCO), a state-owned utility.[9] After the incumbent had surpassed the entrants to become the dominant market leader, South Korea then shifted to a regulatory regime that imposed open access and related requirements on the incumbent's legacy network.[10]

6. Similarly, the extent of facilities-based competition varies across countries with an open access regulatory model. In Europe, the cable network footprint ranges from no presence in several countries to nearly ubiquitous (over 95 percent) coverage of households in a few others,[11] but cable deployment, where it exists, "is generally limited to densely populated urban areas and, to a lesser extent, some suburban areas."[12] Facilities-based competition from cable operators is recognized as one of the

[6] *Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers et al.*, CC Docket Nos. 01-338 *et al*., Report and Order and Order on Remand and Further Notice of Proposed Rulemaking, 18 FCC Rcd 16978, 17141, para. 272 (2003) ("[W]e decline to attach unbundling requirements to the next-generation network capabilities of fiber-based local loops, *i.e.*, those loops that make use of fiber optic cables and electronic or optical equipment capable of supporting truly broadband transmission capabilities . . . ."); Richard Bennett, American Enterprise Institute G7 Broadband Dynamics: How Policy Affects Broadband Quality in Powerhouse Nations at 65-66 (2014) (*AEI Broadband Report*), http://www.aei.org/wp-content/uploads/2014/11/G7-Broadband-Dynamics-Final.pdf; Wolfgang Briglauer and Klaus Gugler, The Deployment and Penetration of High-Speed Fiber Networks and Services: Why are EU Member States Lagging Behind? at 820 (2013) (*EU Member States Paper*), https://www.wu.ac.at/fileadmin/wu/d/i/iqv/Gugler/Artikel/bg_tp.pdf; OECD, Broadband Networks and Open Access at 12 (2013) (*OECD Broadband Report*), http://www.oecd-ilibrary.org/docserver/download/5k49qgz7crmr-en.pdf?expires=1514991235&id=id&accname=guest&checksum=F273F202DDDA94BC2907BD4B211FB749.

[7] *OECD Broadband Report* at 11; *AEI Broadband Report* at v (identifying facilities-based competition as Canada's model).

[8] *See* Sujin Choi, Facilities to Service Based Competition, Not Service to Facilities Based, for Broadband Penetration and Investment: A Comparative Study between the United States and South Korea at 27-29 (2011) (*South Korea Comparative Study Paper*), https://ssrn.com/abstract=1989168; Kenji Kushida and Seung-Youn Oh, The Political Economies of Broadband Development in Korea and Japan, 47 Asian Survey, 481, 493 (2007) (*Korea and Japan Broadband Development Paper*), http://repository.brynmawr.edu/cgi/viewcontent.cgi?article=1029&context=polisci_pubs.

[9] One of the entrants provided broadband service through both cable modem and DSL.

[10] *See South Korea Comparative Study Paper* at 29; *Korea and Japan Broadband Development Paper* at 496-97; *OECD Broadband Report* at 12-14. The *OECD Broadband Report* finds that mandatory LLU is not available in South Korea, but the *South Korea Comparative Study Paper* indicates otherwise. The *OECD Broadband Report* also characterizes the availability of KEPCO's cable infrastructure as a type of open access arrangement, but the *South Korea Comparative Study Paper* cites studies concluding that government subsidies, rather than open access to cable facilities, were the main factor creating facilities-based competition.

[11] Body of European Regulators for Electronic Communications, Challenges and Drivers of NGA Rollout and Infrastructure Competition at 11 (2016) (*BEREC Report*) (identifying four countries—Belgium, Switzerland, Malta and the Netherlands—as having ubiquitous or nearly ubiquitous cable coverage and three countries—Italy, Greece and Iceland—as having no coverage), http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/6488-berec-report-challenges-and-drivers-of-nga-rollout-and-infrastructure-competition.

[12] *Id.* at 12.

(continued….)

main drivers of Next Generation Access (NGA) network rollout in a number of European countries, such as Belgium and the Netherlands.[13] National regulators in some European Union (EU) member states have decided to transition from uniform nationwide access pricing to geographically differentiated access regimes in which access prices and wholesale obligations vary according to the degree of facilities-based inter-platform competition prevailing in local geographic markets.[14]

7. *Regional and National Variation in Open Access Regimes*. The open access regulatory model varies depending on the access price and other non-price access terms and conditions such as the minimum number of lines competitors can lease. For example, the lower the access price, the greater the incentive for new providers to enter the retail market. Conversely, a high access price likely discourages retail entry. As the access price increases, an open access regime approaches and, at the limit, might effectively converge with a facilities-based model.[15]

8. There is significant regional and national variation in the scope and details of access regulations.[16] The EU regulatory framework extended open access regulations to fiber-based NGA networks in EU member states.[17] According to some European analysts, the EU regulatory framework imposes the most comprehensive and strict access obligations on NGA networks in comparison with regulatory policies in the leading East-Asian fiber nations as well as the United States.[18] The EU framework does not apply to all European countries, however. The regulatory model used in Switzerland, which is not a member of the EU, promotes infrastructure-sharing and co-investment arrangements for fiber-based NGA networks based on partnership agreements between the incumbent operator and local utilities, instead of mandatory fiber wholesale access obligations.[19]

9. In addition, although EU member states are bound by a common regulatory framework and other directives, implementation at the level of the individual EU member states has given rise to different national approaches to access pricing and other wholesale obligations for both legacy networks and NGA networks.[20] National regulators have some discretion to adapt the common EU legal framework for open access regulations to local market conditions and the national policy goals of their respective countries. In Germany and the United Kingdom, this resulted in what one analyst characterizes as a "contingent model" that differentiates the incumbent's wholesale access obligations based on the type

[13] *Id.* at 10-12, 29.

[14] *See* Roberto Balmer, Geographic Regulation and Cooperative Investment in Next Generation Broadband Networks: A Review of Recent Literature and Practical Cases (2013), https://ssrn.com/abstract=2369049; Marc Bourreau, Carlo Cambini and Steffen Hoernig, Geographic Access Markets and Investments at 3-5 (2015) (*Geographic Access Markets Paper*), http://docentes.fe.unl.pt/~shoernig/papers/geo_2013Dec28.pdf.

[15] *AEI Broadband Report* at 66.

[16] *See id.* at vi, 66-76.

[17] Wolfgang Briglauer, Carlo Cambini, and Michal Grajek, Centre for European Economic Research, Speeding Up the Internet: Regulation and Investment in European Fiber Optic Infrastructure at 3 (2017) (*Internet Regulation and Investment Paper*), https://ssrn.com/abstract=2962532.

[18] *Id*. at 1; Wolfgang Briglauer, Stefan Frubing, and Ingo Vogelsang, Centre for European Economic Research, The Impact of Alternative Public Policies on the Deployment of New Communications Infrastructure—A Survey at 4 (2015) (*Communications Infrastructure Deployment Public Policies Paper*), http://ftp.zew.de/pub/zew-docs/dp/dp15003.pdf.

[19] *See BEREC Report* at 129 (stating that, under Switzerland's regulatory approach, "[r]egulation occurs only upon request by an alternative operator (ex post regulation); ULL regulation is by law limited to copper local loops such that fibre local loops are not regulated . . . ."); *Communications Infrastructure Deployment Public Policies Paper* at 2, 16.

[20] *AEI Broadband Report* at 69-74; *BEREC Report* at 31-38, 44-129; *Internet Regulation and Investment Paper* at 19-20.

(continued….)

of network technology, with easy access to legacy networks and more restricted access to advanced networks.[21]

10. A similarly differentiated approach to the open access regulatory model was developed in Japan. Like the EU, the Japanese regulator extended wholesale access obligations to the incumbent's fiber infrastructure, but the unbundling requirements initially established for fiber allowed the incumbent to offer access terms and conditions that were viewed as less effective in promoting service-based competition than those for copper local loops.[22]

11. Finally, Australia and New Zealand adopted open access regimes for fiber NGA networks that differ from those in both European nations and Japan. Both countries opted to condition the deployment of publicly-funded national fiber access networks on a strict form of open access that involves structural separation of network ownership and wholesale operations from the provision of retail services.[23]

12. *Public Funding*. National regulatory models differ with respect to the use of other types of policy instruments, including public funding of broadband networks. The U.S. regulatory model reserves the use of subsidies primarily to improve network coverage and quality in rural areas, where network deployment may be unprofitable, while relying primarily on private investment to finance advanced network deployment in urban areas.[24] Canada has a similar approach, with broadband largely deregulated in urban markets but heavily subsidized in rural areas.[25] The main difference is Canadian geography and its vast, sparsely populated northern areas.

13. In Europe, national state aid projects for NGA fiber network deployment appear to be heavily targeted at rural areas and so-called "white areas," which are defined as locations that currently do not have broadband coverage by the same type of infrastructure (either basic broadband or NGA)[26] and where no deployment is likely to take place on a commercial basis within the next three years.[27] Examples include the national public funding programs for NGA network deployment of Finland, France,

[21] *AEI Broadband Report* at 71.

[22] *Id*. at 67-69 (explaining that competitors could lease a single line for ADSL but had to lease a bundle of eight strands for fiber, and that, as of 2007, the incumbent had installed about 79% of local fibers and controlled nearly 71% of the retail market for fiber, but controlled only about 37% of the retail market for ADSL despite having installed nearly 100% of copper lines); *EU Member States Paper* at 828.

[23] *See OECD Broadband Report* at 13, 18-19; Bronwyn Howell, *Mythological Musings From the Antipodes* (Dec. 18, 2013) (*Howell 2013*), http://www.aei.org/publication/mythological-musings-antipodes/; Jeffrey Eisenach, *Australia's Failed Experiment in Government-Owned Broadband* (Mar. 6, 2014) (*Eisenach 2014*), http://www.aei.org/publication/australias-failed-experiment-in-government-owned-broadband/.

[24] *AEI Broadband Report* at 9.

[25] *Id.* at 9, 67.

[26] *BEREC Report* at 27, n.47 (citing Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with internal market in application of Articles 107 and 108 of the Treaty, 26.6.2014 Official Journal of the European Union L187/1 at L187/29 (2014) ("'Basic broadband networks' means networks with basic functionalities which are based on technology platforms such as asymmetric digital subscriber lines (up to ADSL2+ networks), non-enhanced cable (e.g. DOCSIS 2.0), mobile networks of third generation (UMTS) and satellite systems"), https://publications.europa.eu/en/publication-detail/-/publication/1291bb4c-fcfe-11e3-831f-01aa75ed71a1/language-en.

[27] *BEREC Report* at 27. *See* European Commission, EU Guidelines for the Application of State Aid Rules in Relation to the Rapid Deployment of Broadband Networks at 14, paras. 63, 66 (2013) (defining "white areas" as those in which there is no broadband infrastructure and it is unlikely to be developed in a period of 3 years), http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:025:0001:0026:EN:PDF.

(continued….)

Germany, Portugal, and the United Kingdom.[28] Funding levels and the project design vary across countries, and not all European countries have established public funding programs.

14. Countries that rely on relatively more comprehensive public subsidy programs to drive broadband investment appear to be limited in number, but they include some national leaders in broadband performance. In Europe, for example, the northern European Scandinavian nations (Denmark, Iceland, Norway, and Sweden) have "a long-lasting history" of state aid programs that are credited with helping to make these countries "European forerunners" in broadband coverage and penetration."[29] In the case of Sweden, a package of measures adopted in 2000 to promote broadband development included funding for a national backbone network.[30] In addition, municipalities and community-owned local utilities have become the most important alternative operators in the Nordic countries and the Netherlands by directly investing in the deployment of fiber (FTTH/B) networks.[31] Sweden uses municipal networks to drive investment in advanced broadband networks. Municipal networks were deployed in over 200 of the 290 Swedish municipalities as of 2015, and accounted for 23 percent of fixed broadband investments in 2014.[32]

15. Japan and South Korea use public subsidies to drive investment in broadband networks.[33] Both countries have a history of offering direct and indirect forms of financial aid (tax incentives, low- or no-interest loans) to support the rollout of broadband networks by service providers.[34] The government of South Korea fostered the development of facilities-based competition by subsidizing network deployment for cable and DSL entrants as well as the incumbent telecom operator.[35] In both countries, the state-aid-driven approach continued with the subsequent establishment of major national public funding programs for the deployment of NGA fiber networks.[36]

16. The experience of other countries shows that government-subsidized broadband may not always be successful. For instance, the Australian government budgeted $43 billion AUD (about $40 billion USD) for its government-owned and operated National Broadband Network (NBN). The project was eventually scaled back after repeated delays and cost overruns that caused the budget to grow to $72.6 billion AUD in four years.[37]

17. *Relationship Between Regulatory Models and Public Funding*. In countries with the open access model, public funding for broadband deployment tends to be closely linked to open access requirements.[38] The structural separation arrangements for both Australia's and New Zealand's publicly-

[28] *BEREC Report* at 66-73, 106-10, and 130-33.

[29] *EU Member States Paper* at 826, 829.

[30] Bengt G Molleryd, Development of High-Speed Networks and the Role of Municipal Networks at 49 (2015) (*OECD High-Speed Networks Report*), http://www.oecd-ilibrary.org/docserver/download/5jrqdl7rvns3-en.pdf?expires=1511963783&id=id&accname=guest&checksum=254E92D62FAAF806F6F53E3E5D6724ED.

[31] *See EU Member States Paper* at 826, 829; *OECD High-Speed Networks Report* at 15; *BEREC Report* at 23-25, 27 (singling out Switzerland in addition to Denmark and Sweden as leading examples of investment by local municipalities and community-owned utilities in NGA rollout).

[32] *OECD High-Speed Networks Report* at 50.

[33] *See EU Member States Paper* at 826-29.

[34] *Id.*; *Korea and Japan Broadband Development Paper* at 494-502.

[35] *South Korea Comparative Study Paper* at 23.

[36] *EU Member States Paper* at 827-29.

[37] *See Eisenach 2014*; *Howell 2013*; Bronwyn Howell, *Government-Subsidized Fiber: Careful What You Wish For* (Mar. 26, 2014) (*Howell 2014*), http://www.aei.org/publication/government-subsidized-fiber-careful-wish/.

[38] *See OECD Broadband Report* at 19-23.

(continued….)

funded national fiber access networks illustrate this link. In addition, under EU guidelines on national state aid projects for broadband deployment, network operators are generally obligated to provide wholesale access to service providers for a period of at least seven years.[39] In Europe and elsewhere, many publicly-funded municipal networks also operate based on an open access model.[40]

18. In the case of the facilities-based model, South Korea's subsidization of broadband deployment differentiates the Korean approach from the U.S. and Canadian variants. The United States is widely regarded as having adopted a deregulatory and largely market-driven broadband strategy, and Canada's model is regarded as having a similar approach.[41] In South Korea, by contrast, the facilities-based model was combined with a state-aid-driven approach to encourage broadband investment.[42] South Korea's broadband strategy is often compared with that of Japan. Despite the differences in their regulatory models, the governments of both countries are viewed as taking a relatively interventionist approach to broadband development.[43]

II. REGULATORS FOR THE UNITED STATES AND THE COMPARISON COUNTRIES

19. Table 2 identifies the regulator and, where relevant, the ministry responsible for regulating broadband, in the United States and the respective comparison countries.

Table 2
Regulator and/or Ministry by Country (2017)

Country	Regulator/Ministry
Australia	Australian Communications and Media Authority
	Department of Communications and the Arts
	Australian Competition and Consumer Commission
Austria	Austrian Regulatory Authority for Broadcasting and Telecommunications
	Telecom Control Commission
	Austrian Communications Authority
Belgium	Belgian Institute for Postal Services and Telecommunications
	Minister of Development Cooperation, Digital Agenda, Telecom and Postal Services
Canada	Canadian Radio-television and Telecommunications Commission (CRTC)
	Innovation, Science and Economic Development Canada (ISED)
Chile	Subsecretaria de Telecomunicaciones
	Ministry of Transport and Telecommunications
Czech Republic	Czech Telecommunication Office
	Czech Association of Electronic Communications
Denmark	Danish Business Authority
	Danish Competition and Consumer Authority
	Danish Energy Agency
	Ministry of Energy, Utilities, and Climate
Estonia	Ministry of Economic Affairs and Communications
	Technical Regulatory Authority
Finland	Finnish Communications Regulatory Authority
	Ministry of Transport and Communications
France	Autorite de Regulation des Communications Electroniques et des Postes
	Ministry of the Economy, Finance and Industry
	National Frequency Agency

[39] *Id.* at 20; *BEREC Report* at 27.

[40] *See OECD Broadband Report* at 21-23; *OECD High-Speed Networks Report* at 16.

[41] *See EU Member States Paper* at 819; *AEI Broadband Report* at xii, 9, 67.

[42] *South Korea Comparative Study Paper* at 7-8.

[43] *See EU Member States Paper* at 828; *Korea and Japan Broadband Development Paper* at 482.

Country	Regulator/Ministry
Germany	Bundesnetzagentur
	Federal Ministry of Transport and Digital Infrastructure
Greece	Hellenic Telecommunications and Post Commission
	Ministry of Infrastructure, Transport, & Networks
Iceland	Post and Telecom Administration in Iceland
	Ministry of Transport and Local Government
Ireland	Commission for Communications Regulation
	Department of Communications, Climate Action, & Environment
Italy	Communications Regulatory Authority
	Ministry of Economic Development
Japan	Ministry of Internal Affairs and Communications
Latvia	Public Utilities Commission
	Ministry of Transport
	Electronic Communications Office
Luxembourg	Institut Luxembourgeois de Regulation
Mexico	Instituto Federal de Telecomunicaciones
	Secretaria de Comunicaciones y Transportes
Netherlands	Netherlands Authority for Consumers and Markets
	Ministry of Economic Affairs & Climate Policy
	Radiocommunications Agency
New Zealand	Commerce Commission
	Ministry of Business, Innovation, and Employment
Norway	Norwegian Communications Authority
	Ministry of Transport and Communications
Portugal	Autoridade Nacional de Comunicações
	Autoridade da Concorrencia
South Korea	Korea Communications Commission
	Ministry of Science and ICT
	Korea Communications Agency
Spain	Comision Nacional de los Mercados y la Competencia
	Ministerio de Energia, Turismo y Agenda Digital
Sweden	Swedish Post and Telecom Authority
	Ministry of Enterprise and Innovation
Switzerland	Federal Communications Commission (ComCom)
	Federal Office of Communications (OFCOM)
United Kingdom	Office of Communications
	Department for Digital, Media, Culture, and Sport
	Competition and Markets Authority
United States	Federal Communications Commission (FCC)

Source: *TeleGeography GlobalComms Database*.

III. INTERNATIONAL BROADBAND COMPETITION AND USAGE

20. Below, we provide information concerning the major fixed and mobile broadband competitors and the types of technologies used to provide broadband in the United States and in the 28 comparison countries. Generally, major competitors are those competitors with a market share of at least 10 percent.

A. Fixed Broadband Competition

21. In Table 3 below, we provide information concerning the major fixed broadband competitors in the United States and in the 28 comparison countries.

Table 3
Major Fixed Broadband Competitors and Types of Technology by Country (2017)

Country	Major Fixed Broadband Competitors	Types of Technology
Australia	iiNet	Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+, DSL SHDSL, DSL VDSL2, LAN/FTTx
	Singtel Optus	Cable HFC, DSL ADSL, DSL ADSL2+, Satellite
	Telstra	Cable HFC, Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH, Satellite
	TPG Telecom	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTB
Austria	A1 Telekom Austria	DSL ADSL, DSL ADSL2+, DSL G.fast, DSL VDSL2, VDSL2 Vectoring, LAN/FTTx FTTx
	UPC	Cable Ethernet over Cable TV, Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+
Belgium	Proximus	DSL ADSL, DSL ADSL2+, DSL SDSL, DSL VDSL, DSL VDSL2, VDSL2 Vectoring, LAN/FTTx FTTH
	Telenet	Cable HFC DOCSIS 3.0
Canada	Bell Canada Enterprises	DSL ADSL, DSL ADSL2+, DSL VDSL, DSL VDSL2, LAN/FTTx FTTB, LAN/FTTx FTTH, LAN/FTTx FTTN
	Rogers Communications	Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, DSL ADSL, LAN/FTTx FTTB, LAN/FTTx FTTH
	Shaw Communications	Cable HFC, Cable HFC DOCSIS 2.0, Cable HFC DOCSIS 3.0, LAN/FTTx FTTH
	Telus Corporation	Cable HFC, DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTB/FTTH, LAN/FTTx FTTN
	Videotron	Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1
Chile	Claro Chile	Cable HFC, DSL ADSL
	Movistar Chile	DSL ADSL, DSL VDSL, LAN/FTTx FTTB/FTTH
	VTR	Cable HFC DOCSIS 3.0
Czech Republic	O2 Czech Republic	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTx
	RIO Media	Cable HFC, LAN/FTTx FTTC/FTTH
	UPC Ceska Republika	Cable HFC DOCSIS 2.0, Cable HFC DOCSIS 3.0
Denmark	Stofa	Cable Ethernet over Cable TV, Cable HFC, Cable HFC DOCSIS 3.0, LAN/FTTx FTTB/FTTH
	TDC	Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, DSL ADSL, DSL ADSL2+, DSL VDSL2, DSL VDSL2 Vectoring, DSL VDSL2-Vplus, LAN/FTTx FTTx
Estonia	Telia Eesti	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx
	Starman	Cable HFC, Cable HFC DOCSIS 3.0
	STV Cable	Cable, LAN/FTTx FTTB/FTTH
Finland	DNA Finland	Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, DSL ADSL, DSL ADSL2+, DSL VDSL2
	Elisa Corporation	Cable HFC, Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+, DSL SDSL, DSL VDSL2, LAN/FTTx FTTB/FTTH

Country	Major Fixed Broadband Competitors	Types of Technology
	Telia Finland	Cable HFC, DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH
France	Bouygues Telecom	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH
	Iliad	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH
	Orange France	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH, LAN/FTTx FTTN
	SFR Group	Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTH, LAN/FTTx FTTN
Germany	Telekom Deutschland	DSL ADSL, DSL ADSL2+, DSL VDSL, DSL VDSL2 Vectoring, LAN/FTTx FTTH
	United Internet	DSL ADSL, DSL ADSL2+, DSL SHDSL
	Unitymedia	Cable HFC, Cable HFC DOCSIS 3.0, LAN/FTTx FTTB/FTTH
	Vodafone Germany	Cable Ethernet over Cable TV, Cable HFC DOCSIS 3.0, DSL ADSL, DSL SHDSL, DSL VDSL, DSL VDSL2 Vectoring, LAN/FTTx FTTH
Greece	Cosmote	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTC, Satellite
	Forthnet	DSL ADSL, DSL ADSL2+, DSL SHDSL, DSL VDSL2, LAN/FTTx FTTB, Satellite VSAT
	Vodafone Greece	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTB, Satellite
	Wind Hellas	DSL ADSL, DSL ADSL2+, DSL SDSL, DSL VDSL2, LAN/FTTx FTTC
Iceland	365 Media	DSL ADSL, DSL VDSL, LAN/FTTx FTTH
	Siminn	DSL ADSL, DSL ADSL2+, DSL SDSL, DSL VDSL, DSL VDSL2 Vectoring, LAN/FTTx FTTC, LAN/FTTx FTTH
	Vodafone Iceland	DSL ADSL, DSL ADSL2+, DSL VDSL, DSL VDSL2 Vectoring, LAN/FTTx FTTH
Ireland	eir	DSL ADSL, DSL ADSL2+, DSL VDSL2, DSL VDSL2 Vectoring, LAN/FTTx FTTC, LAN/FTTx FTTH
	Sky Ireland	DSL ADSL2+, LAN/FTTx FTTC
	Virgin Media Ireland	Cable HFC DOCSIS 2.0, Cable HFC DOCSIS 3.0
	Vodafone Ireland	DSL VDSL2, LAN/FTTx FTTB
Italy	Fastweb	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTC, LAN/FTTx FTTH
	Telecom Italia	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTC, Satellite VSAT
	Vodafone Italy	DSL ADSL2+, DSL VDSL, LAN/FTTx FTTC, LAN/FTTx FTTH
	Wind Tre	DSL ADSL, DSL ADSL2+, DSL SHDSL, LAN/FTTx FTTH
Japan	J:COM	Cable HFC, Cable HFC (DOCSIS 3.0)
	KDDI	Cable HFC (DOCSIS 3.0), LAN/FTTx FTTH
	NTT (NTT East & NTT West)	Cable Ethernet over Fibre, DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
	Softbank	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
Latvia	Baltcom	Cable HFC DOCSIS 3.0, LAN/FTTx FTTB/FTTH
	Lattelecom Group	DSL ADSL, DSL ADSL2+, DSL VDSL,

Country	Major Fixed Broadband Competitors	Types of Technology
		LAN/FTTx
Luxembourg	Post Luxembourg	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTB/FTTH
	Tango	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTx
Mexico	Megacable	Cable HFC, Cable HFC DOCSIS 3.0
	Telefonos de Mexico	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
Netherlands	KPN	DSL ADSL, DSL ADSL 2+, DSL VDSL2, DSL VDSL2 Vectoring, LAN/FTTx FTTH
	VodafoneZiggo	Cable Ethernet over Cable TV, Cable HFC DOCSIS 2.0, Cable HFC DOCSIS 3.0
New Zealand	CallPlus	DSL ADSL2+, DSL VDSL, LAN/FTTx FTTC/FTTH
	Spark	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTN
	Vodafone New Zealand	Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH, Satellite VSAT
Norway	Altibox	LAN/FTTx FTTH
	Telenor Norge	Cable Ethernet over Cable TV, Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+, DSL SHDSL, DSL VDSL2, LAN/FTTx FTTH/FTTN
	TDC Nordic	Cable HFC, Cable HFC DOCSIS 3.0, DSL ADSL, DSL SHDSL, DSL VDSL
Portugal	Nos	Cable HFC DOCSIS 3.0
	PT Portugal	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTB/FTTH
	Vodafone Portugal	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTx
South Korea	KT Corp	Cable Ethernet/LAN, DSL ADSL, DSL VDSL, LAN/FTTx FTTH, Satellite
	LG Uplus	Cable Ethernet/LAN, Cable HFC, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1, LAN/FTTx FTTC, Powerline (PLC or BPL)
	SK Broadband	Cable HFC, Cable HFC DOCSIS 3.0, DSL ADSL, DSL VDSL, LAN/FTTx Ethernet/LAN, LAN/FTTx FTTB/FTTH
Spain	Orange Espana	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
	Telefonica Espana	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH
	Vodafone Spain	Cable HFC, Cable HFC DOCSIS 2.0, Cable HFC DOCSIS 3.0, DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTH
Sweden	Com Hem	Cable HFC, Cable HFC DOCSIS 3.0, LAN/FTTx FTTB/FTTH
	Telenor Sweden	Cable HFC, DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx, LAN FTTx FTTB/FTTH
	Telia Sweden	DSL ADSL, DSL ADSL2+, DSL VDSL2, LAN/FTTx FTTB/FTTH
Switzerland	Swisscom	DSL ADSL, DSL G.fast, DSL SDSL, DSL VDSL2, DSL VDSL2 Vectoring, LAN/FTTx FTTB/FTTH
	Sunrise Communications	DSL ADSL, DSL ADSL2+, DSL VDSL, LAN/FTTx FTTH, LAN/FTTx FTTx
	UPC Switzerland	Cable HFC DOCSIS 3.0

Country	Major Fixed Broadband Competitors	Types of Technology
United Kingdom	BT Group	DSL ADSL, DSL ADSL2+, DSL G.fast, DSL SDSL, DSL VDSL2, LAN/FTTx FTTC, LAN/FTTx FTTH
	Sky	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
	TalkTalk	DSL ADSL, DSL ADSL2+, LAN/FTTx FTTH
	Virgin Media	Cable Ethernet over Fibre (EFM-F), Cable HFC, Cable HFC DOCSIS 3.0
United States	**AT&T**	**DSL ADSL, DSL G.fast, LAN/FTTx FTTH, LAN FTTx FTTN**
	Charter Communications	**Cable Ethernet over Fibre (EFM-F), Cable HFC, Cable HFC DOCSIS 3.0**
	Comcast Corp.	**Cable Ethernet over Cable TV, Cable HFC DOCSIS 3.0, Cable HFC DOCSIS 3.1**
	Verizon Communications	**DSL ADSL, LAN/FTTx FTTB/FTTH**

Sources: *TeleGeography GlobalComms Database*, as of January 2018; Ministry of Internal Affairs and Communications, Subscriptions Shares First Quarter 2017 Data Public Release, Appx. Section 2 Fixed Communications, (1) Data Communications 1. Fixed Broadband at 8 (2017) (first quarter 2017 results), http://www.soumu.go.jp/main_content/000494106.pdf; Ministry of Communications, General Communications Infrastructure Bureau, NTT East and West Fiber Wholesale Service Provisioning Conditions, No. 34-2 (2015), http://www.soumu.go.jp/main_content/000390866.pdf.

B. Mobile Broadband Competition

22. Table 4 provides information concerning the major mobile broadband competitors in the United States and in each of the 28 comparison countries.

Table 4
Major Mobile Broadband Competitors and Types of Technology by Country (2017)

Country	Major Mobile Broadband Competitors	Types of Technology
Australia	Optus Mobile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G TD-LTE, 4G LTE-Advanced
	Telstra	3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Hutchison Australia	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Austria	A1 Telekom Austria	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Hutchison Drei Austria	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	T-Mobile Austria	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Belgium	BASE Company	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Orange Belgium	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Proximus	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Canada	Bell Canada Enterprises	2.5G CDMA2000, 3G CDMA2000, 3G W-CDMA, 3.5G CDMA2000, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Rogers Communications	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telus Corporation	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Chile	Claro Chile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Entel Chile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Movistar Chile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Czech Republic	O2 Czech Republic	2G GSM, 2.5G GSM, 3G CDMA2000, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	T-Mobile Czech Republic	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Czech Republic	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Denmark	Hi3G Access Denmark	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	TDC	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telenor Denmark	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telia Denmark	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Estonia	Elisa	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Tele2 Eesti	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G

Country	Major Mobile Broadband Competitors	Types of Technology
		W-CDMA, 4G LTE, 4G LTE-Advanced
	Telia Eesti	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Finland	DNA Finland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Elisa Corporation	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telia Finland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
France	Bouygues Telecom	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Free Mobile (Iliad)	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Orange France	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	SFR Group	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Germany	Telefonica Deutschland Holding	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telekom Deutschland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Germany	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Greece	Cosmote	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Greece	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Wind Hellas	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Iceland	Nova	3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Siminn	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Iceland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Ireland	Eir Group Mobile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Hutchison 3G Ireland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Ireland	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Italy	Telecom Italia	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Italy	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Wind Tre	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Japan	KDDI (au)	3G CDMA2000, 3.5 CDMA2000, 4G LTE, 4G LTE-Advanced
	NTT DOCOMO	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Softbank Mobile	2G PHS, 3G W-CDMA, 3.5G W-CDMA, 4G PHS, 4G LTE
Latvia	Bite Latvia	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced

Country	Major Mobile Broadband Competitors	Types of Technology
	Latvijas Mobilais Telefons	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Tele2 Latvia	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Luxembourg	Orange Luxembourg	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Post Luxembourg	2G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Tango	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Mexico	AT&T Mexico	2.5G iDEN, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Movistar Mexico	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Telcel	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Netherlands	KPN	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	T-Mobile Netherlands	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced, 4G TD-LTE LTE-Advanced
	VodafoneZiggo	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
New Zealand	Spark	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Two Degrees Mobile	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Vodafone New Zealand	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
Norway	Telenor Norge	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telia Norge	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Portugal	Nos	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	PT Portugal	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Portugal	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
South Korea	KT Corp	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	LG Uplus	2.5G CDMA, 2.5G CDMA2000, 3.5G CDMA2000, 4G LTE, 4G LTE-Advanced
	SK Telecom	2.5G CDMA, 2.5G CDMA2000, 3G CDMA2000, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Spain	Orange Espana	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telefonica Espana	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Vodafone Spain	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Sweden	Hi3G Access Sweden	3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G TD-LTE, 4G LTE-Advanced, 4G TD-LTE

Country	Major Mobile Broadband Competitors	Types of Technology
		LTE-Advanced
	Tele2 Sweden	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telenor Sweden	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Telia Sweden	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
Switzerland	Salt	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Sunrise Communications	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Swisscom	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
United Kingdom	BT Group	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
	Hutchison 3G UK	3G W-CDMA, 3.5G W-CDMA, 4G LTE
	O2 UK	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE
	Vodafone UK	2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced
United States	**AT&T Mobility**	**3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced**
	Sprint Corporation	**2.5G CDMA 2000, 3G CDMA2000, 3.5G CDMA2000, 4G LTE, 4G LTE-Advanced, 4G TD-LTE**
	T-Mobile US	**2G GSM, 2.5G GSM, 3G W-CDMA, 3.5G W-CDMA, 4G LTE, 4G LTE-Advanced**
	Verizon Wireless	**2.5G CDMA2000, 3G CDMA2000, 3.5G CDMA2000, 4G LTE, 4G LTE-Advanced, 4.5G LTE-Advanced Pro**

Source: *TeleGeography GlobalComms Database*, as of January 2018.

IV. TYPES OF APPLICATIONS AND SERVICES USED[44]

23. Table 5 presents data on the types of activities that consumers in the United States and the 28 comparison countries engage in while accessing the Internet. We provide these data as required by BDIA to identify "the types of applications and services used" and "business and residential use of such services . . . ."[45]

Table 5
Types of Applications and Services Used by Country (2014-2017)

Country	Online News	Play or Download Games, Music, Videos	Watch Video on Demand	Make a Telephone or Video Call	Participate in Social Networks	Online Banking	Online Shopping
Australia[46]	N/A	24%	N/A	N/A	40%	N/A	18%
Austria[47]	66%	79%	14%	32%	58%	63%	68%
Belgium	65%	72%	12%	44%	80%	75%	65%
Canada[48]	55%	25% (gaming), 30% (music), 36% (video)	N/A	20%	59%	68%	46%
Chile[49]	51%	N/A	N/A	N/A	92%	41%	35%
Czech Republic	82%	72%	4%	40%	55%	63%	57%
Denmark	72%	90%	49%	60%	77%	91%	84%
Estonia	89%	84%	24%	47%	66%	90%	64%
Finland	85%	91%	37%	34%	66%	92%	72%
France	56%	75%	12%	34%	47%	69%	75%
Germany	72%	78%	23%	31%	56%	59%	82%

[44] The unit for the types of applications and services used in each country reflects the percentage of population. Country-specific data that were obtained from the European Commission's International Digital Economy and Society Index (DESI) 2017 reflect the percentage of individuals who used Internet in the last three months as of the publication of DESI 2017. *See* European Commission, Digital Economy and Society Index (DESI) 2017 (2017) (*DESI 2017*), https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2017.

[45] 47 U.S.C. § 1303(b)(3).

[46] *See* European Commission, International Digital Economy and Society Index (I-DESI) at 81-86 (2016) (*2016 I-DESI*), https://ec.europa.eu/digital-single-market/en/news/2016-i-desi-report. The numbers reflected in the chart represent approximates based on the 2015 data displayed in the I-DESI.

[47] *DESI 2017*. Data for the types of applications and services in the following countries were obtained from the Digital Economy and Society Index (DESI) 2017: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[48] Canadian Internet Registration Authority (CIRA), CIRA Internet Factbook 2016: Internet Use in Canada (2016), https://cira.ca/factbook/domain-industry-data-and-canadian-Internet-trends/internet-use-canada.

[49] Pew Research Center, Internet Seen as Positive Influence on Education but Negative on Morality in Emerging and Developing Nations: Internet Usage More Common Among the Young, Well-Educated and English Speakers at 23 (2015), http://assets.pewresearch.org/wp-content/uploads/sites/2/2015/03/Pew-Research-Center-Technology-Report-FINAL-March-19-20151.pdf.

(continued….)

Country	Online News	Play or Download Games, Music, Videos	Watch Video on Demand	Make a Telephone or Video Call	Participate in Social Networks	Online Banking	Online Shopping
Greece	85%	77%	12%	46%	68%	28%	45%
Iceland[50]	95%	54%	N/A	51%	84%	93%	68%
Ireland	49%	73%	24%	42%	70%	64%	71%
Italy	60%	79%	15%	34%	60%	42%	41%
Japan[51]	55.9%	28.2% (gaming), 51% (video)	20.2%	49.2%	51.0%	14.7%	45.6%
Latvia	84%	77%	15%	51%	71%	78%	55%
Luxembourg	89%	89%	29%	54%	69%	73%	80%
Mexico[52]	N/A	23%	6%	N/A	29%	N/A	9%
Netherlands	75%	88%	39%	39%	66%	91%	79%
New Zealand[53]	43%	28%	33%	N/A	42%	N/A	16%
Norway[54]	94%	89%	54%	48%	78%	94%	79%
Portugal	78%	83%	9%	39%	74%	41%	43%
South Korea[55]	76.9%	77.0%	N/A	39.9%	57.9%	50.8%	50.7%
Spain	78%	83%	27%	31%	67%	54%	54%
Sweden	87%	91%	49%	51%	75%	89%	80%
Switzerland[56]	76%	23%	19%	N/A	29%	60%	10%
United Kingdom	68%	80%	34%	49%	73%	68%	87%
United States	**43%[57]**	**49%**	**28%[61]**	**N/A**	**69%[62]**	**43%**	**79%**

[50] European Commission, Digital Economy and Society Index (DESI) 2015: Country Profile – Iceland, https://ec.europa.eu/digital-single-market/en/scoreboard/iceland (last visited Jan. 16, 2018).

[51] Data for the types of applications and services in Japan were provided by the Embassy of Japan. The data include specifically the percentage of individuals that subscribe to video on demand (20.2%).

[52] *See 2016 I-DESI* at 81-86. The numbers reflected in the chart represent approximates based on the 2015 data displayed in the I-DESI.

[53] *See id.*

[54] European Commission, Digital Economy and Society Index (DESI) 2017: Norway, https://ec.europa.eu/digital-single-market/en/scoreboard/norway (last visited Jan. 16, 2018).

[55] Data for the types of applications and services in South Korea were provided by the Embassy of South Korea. The data reflect information from a 2016 survey by the Ministry of Science and ICT and the Korea Internet and Security Agency. The data include information specifically pertaining to the percentage of subscribers to video on demand ("N/A").

[56] *See 2016 I-DESI* at 81-86. The numbers reflected in the chart represent approximates based on the 2015 data displayed in the I-DESI.

[57] Pew Research Center, Americans' Online News Use is Closing in on TV News Use (Sept. 7, 2017), http://www.pewresearch.org/fact-tank/2017/09/07/americans-online-news-use-vs-tv-news-use/.

[61] Pew Research Center, About 6 in 10 Young Adults in U.S. Primarily Use Online Streaming to Watch TV (Sept. 13, 2017), http://www.pewresearch.org/fact-tank/2017/09/13/about-6-in-10-young-adults-in-u-s-primarily-use-online-streaming-to-watch-tv/.

[62] Pew Research Center, Social Media Fact Sheet (Jan. 12, 2017), http://www.pewinternet.org/fact-sheet/social-media/.

(continued….)

Country	Online News	Play or Download Games, Music, Videos	Watch Video on Demand	Make a Telephone or Video Call	Participate in Social Networks	Online Banking	Online Shopping
		(gaming),[58] 41% (audio),[59] 78% (video)[60]				(mobile),[63] 62% (online)[64]	(ever),[65] 15% (weekly)[66]

[58] *See* Pew Research Center, Gaming and Gamers at 2 (2015), http://assets.pewresearch.org/wp-content/uploads/sites/14/2015/12/PI_2015-12-15_gaming-and-gamers_FINAL.pdf.

[59] IFPI, Music Consumer Insight Report at 6 (2016), http://www.ifpi.org/downloads/Music-Consumer-Insight-Report-2016.pdf.

[60] Statista, Percentage of Internet Users Who Watch Online Video Content on Any Device as of January 2017, by Country (2017), https://www.statista.com/statistics/272835/share-of-internet-users-who-watch-online-videos/.

[63] Board of Governors of the Federal Reserve System, Consumers and Mobile Financial Services at 1 (2016), https://www.federalreserve.gov/econresdata/consumers-and-mobile-financial-services-report-201603.pdf.

[64] Bank of America, Trends in Consumer Mobility Report at 5 (2016), http://newsroom.bankofamerica.com/files/press_kit/additional/2016_BAC_Trends_in_Consumer_Mobility_Report.pdf.

[65] Pew Research Center, Online Shopping and E-Commerce at 2 (2016), http://www.pewinternet.org/2016/12/19/online-shopping-and-e-commerce/.

[66] *Id.*