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U.S. Internet Usage and Global Leadership Are Expanding

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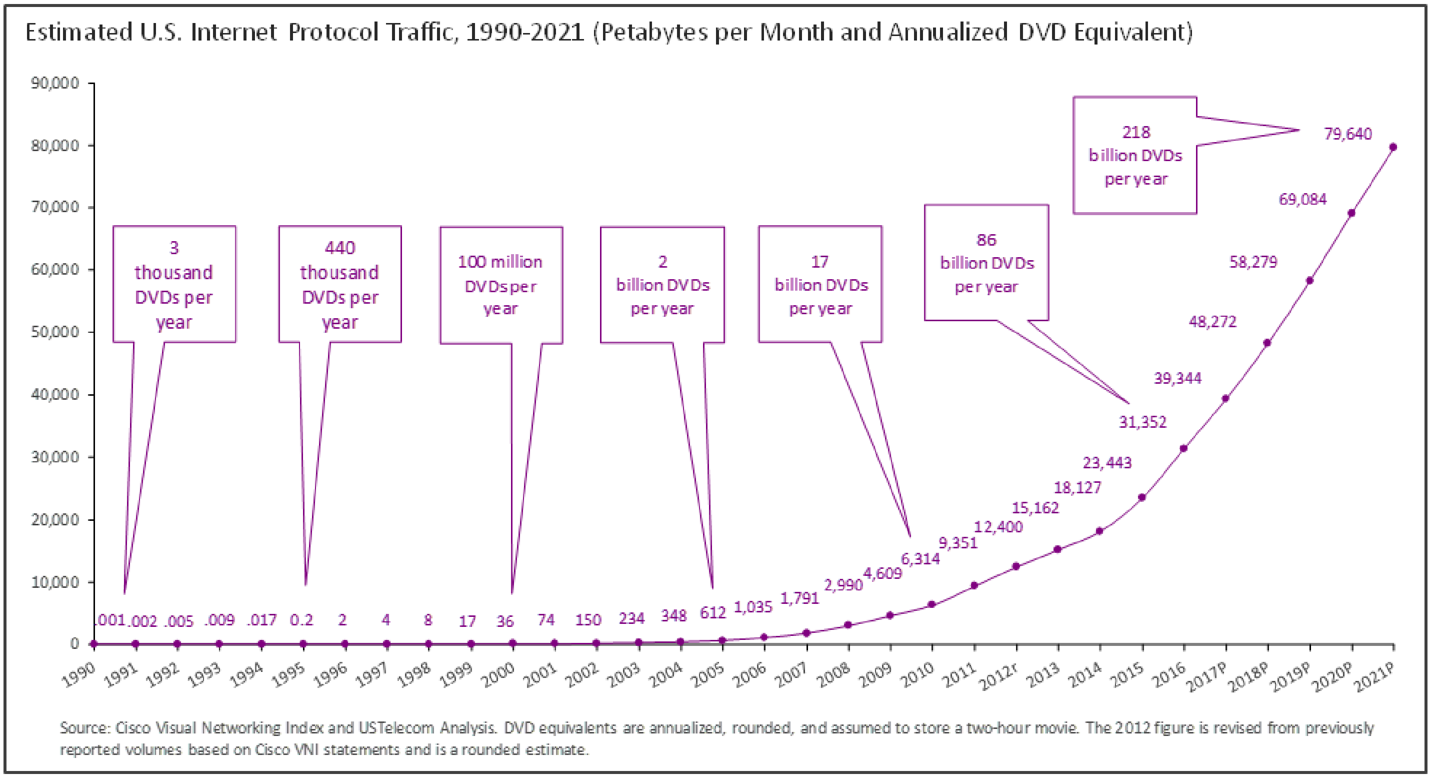
A new USTelecom analysis of annual Internet Protocol ("IP") traffic data from the Cisco Visual Networking Index ("VNI") shows that U.S. IP traffic has grown nearly three and a half times over the last five years, traffic is projected to grow two-and-a-half times again over the next five years. (See Chart 1.) A massive shift toward online consumer video is the primary driver of traffic growth. Other factors include mobile data traffic growth, continued Internet adoption, faster broadband connection speeds, new Internet of Things ("IOT") technologies, virtual reality, cloud services and data analytics. As USTelecom projected in its previous analysis of the Cisco VNI data, the U.S. overtook South Korea in 2015 to become the clear world leader in IP traffic on a per capita and per user basis, and it is expanding its international leadership.

Chart 1 — Historical and Projected Growth of U.S. IP Traffic



Over the last several decades, U.S. broadband providers have invested in world-leading networks that enabled tremendous internet traffic growth. U.S. attained leadership in internet usage with massive investment in broadband infrastructure, along with the development of compelling applications and content. Since the commercialization of the internet in the 1990s, U.S. firms have built an internet ecosystem that is the envy of the world under a bipartisan light-touch regulatory framework. The latest Cisco VNI data demonstrate that ongoing investment in broadband networks, including wireline networks, will be critical in sustaining U.S. momentum in IP traffic growth, maintaining U.S. international leadership and generating the economic benefits of increased migration to IP networks.

Yet, while traffic continues to expand, broadband capital expenditures have stalled and declined in the last few years. Annual broadband provider investment in 2016 was $76.0 billion, approximately $1.9 billion lower than $77.9 billion in 2015 and $2.4 billion lower than the recent peak of $78.4 billion in 2014. The Federal Communications Commission ("FCC") in 2015 abruptly changed course and reclassified broadband providers as heavily regulated utilities under Title II of the Communications Act. This shift imposed burdens on and created uncertainty for network providers, putting pressure on broadband investment over time.

The risk that regulation may slow investment and usage over time is especially pertinent with the internet since IP network evolution is a rapid and dynamic process. For example, according to Cisco VNI analysis, the acceleration toward online video is pushing an increasing portion of IP traffic from long haul backbones to local area networks. This is because more and more content is being stored locally on content distribution networks, which interconnect with broadband providers in the metro area to distribute the content more quickly to users. Network, content, and application providers will have to work together quickly and flexibly to craft network solutions that accommodate shifting video traffic patterns arising from online video and other media. Yet under Title II, the FCC extended its authority to include interconnection among these players and offered only general standards for case-by-case adjudication. That left it unclear which practices would be allowed or penalized. The approval process and uncertainty about standards and enforcement all cut against quick and flexible network investment. Similar issues may arise with the growing adoption of fifth generation ("5G") wireless networks and nascent applications, such as the Internet of Things.

To accommodate growth in demand and enable long-term innovation in information and communications technology ("ICT") for businesses and consumers, the U.S. will need to reignite broadband capital investment growth. The FCC needs to reverse its decision to classify broadband providers like utilities and return to a more investment-friendly policy climate that will encourage greater investment in broadband infrastructure, facilitate flexible business arrangements and sustain our international competitive edge.

U.S. Internet Protocol Traffic Continues to Grow Rapidly

U.S. internet IP traffic in 2016 was 31.4 exabytes per month (one exabyte =1,000 petabytes or one trillion million bytes). This is the equivalent of approximately 7 billion streamed DVDs per month or 86 billion streamed DVDs per year. (See Chart 1.) In 2016, the U.S. generated approximately 860 times more IP traffic than it generated in the year 2000, 195 thousand times more than in 1996, and 30 million times more than in 1990. From 1990 to 2016, U.S. IP traffic grew at an average compounded annual rate of 94 percent. From 2000 to 2016, U.S. IP traffic grew at an average compounded annual rate of 53 percent. From 2011 to 2016, U.S. IP traffic grew at an average compounded annual rate of 27 percent, a factor of three and a half times over the five-year period. Traffic growth accelerated over the last two years as annual traffic grew 34 percent in 2016, up from 29 percent in 2015 and 20 percent in 2014. Furthermore, Cisco projects U.S. IP traffic will grow again by a factor of two-and-a-half over the next five years to 79.6 exabytes a month—the equivalent of 18 billion streamed DVDs per month or 218 billion streamed DVDs per year. (See Chart 1.) During this period, traffic will continue to grow at an average 20 percent compounded annual rate. To put this in perspective, for each of the next five years, U.S. networks on average will have to accommodate an additional 116 exabytes of data per year, which is the equivalent of 27 billion DVDs per year or approximately 31 percent of the amount of all U.S. traffic carried in 2016. It is concerning that traffic accelerated over the last two years while broadband provider capital investment declined.

Fixed Networks Carry Nearly All U.S. IP Traffic

Fixed communications networks are a critical component of the internet ecosystem, transporting nearly all of the ever-increasing volume of IP traffic that consumers and businesses generate. The overwhelming majority of traffic today and in the foreseeable future travels to and from end-users via wired access connections or Wi-Fi, which is essentially a very short-range wireless extension of a wired network. According to the Cisco VNI, 96 percent of U.S. end user traffic in 2016 went over a fixed access network, including 61 percent over wired connection and 35 percent over Wi-Fi links. Just 4 percent used a mobile cellular connection. In 2021, the Cisco VNI projects that 93 percent of U.S. IP traffic will go over fixed access networks, including 50 percent over direct wired connections and 43 percent over Wi-Fi links, with 7 percent going over mobile cellular connections. (See Chart 2.)

While mobile data is the fastest growing segment of U.S. IP traffic, at a 34 percent compounded annual rate over the next five years, mobile data remains a small portion of overall traffic. By contrast, USTelecom estimates that consumer video via fixed network connections, wired and Wi-Fi, represented 23.7 exabytes per month, or 76 percent of U.S. IP traffic in 2016, assuming the amount of consumer file sharing that is video is approximately 80 percent to 90 percent. Fixed consumer video will grow to 59.6 exabytes by 2021, which accounts for more 74 percent of traffic growth in the next five years. (See Chart 3.) All video traffic, including fixed and mobile, consumer and business, represented 85 percent of U.S. IP traffic in 2016, growing to 91 percent in 2021. Wired and Wi-Fi fixed connections will generate 97 percent of this video traffic in 2016 and 94 percent in 2021. (See Appendix A.) Thus, fixed access networks are – and will remain – the predominant driver of demand for U.S. IP network capacity.

Chart 2 — Composition of U.S. IP Traffic by Access Network

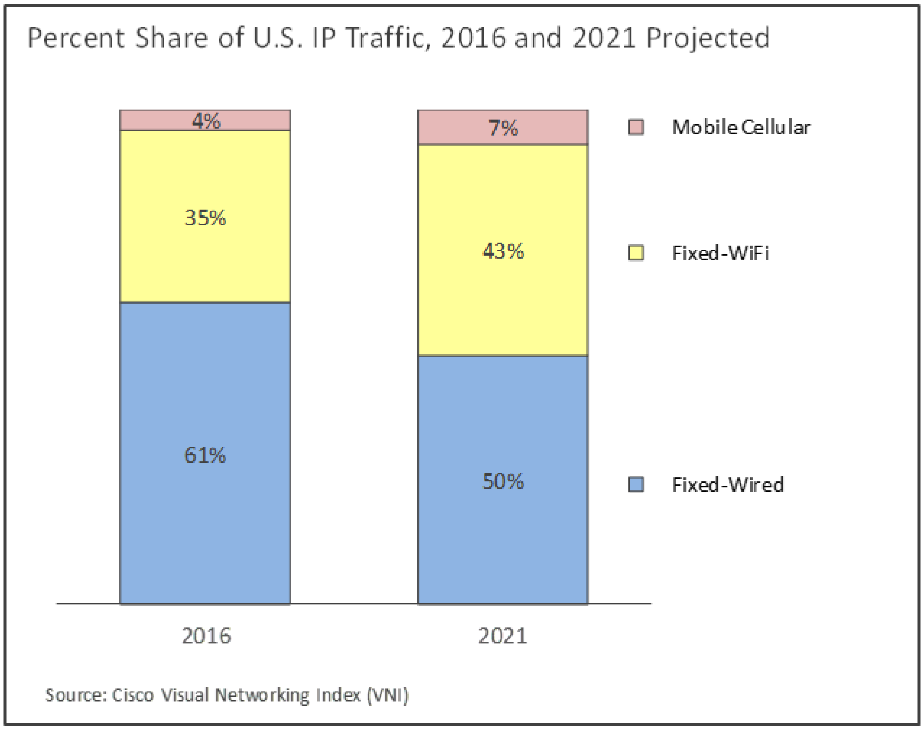
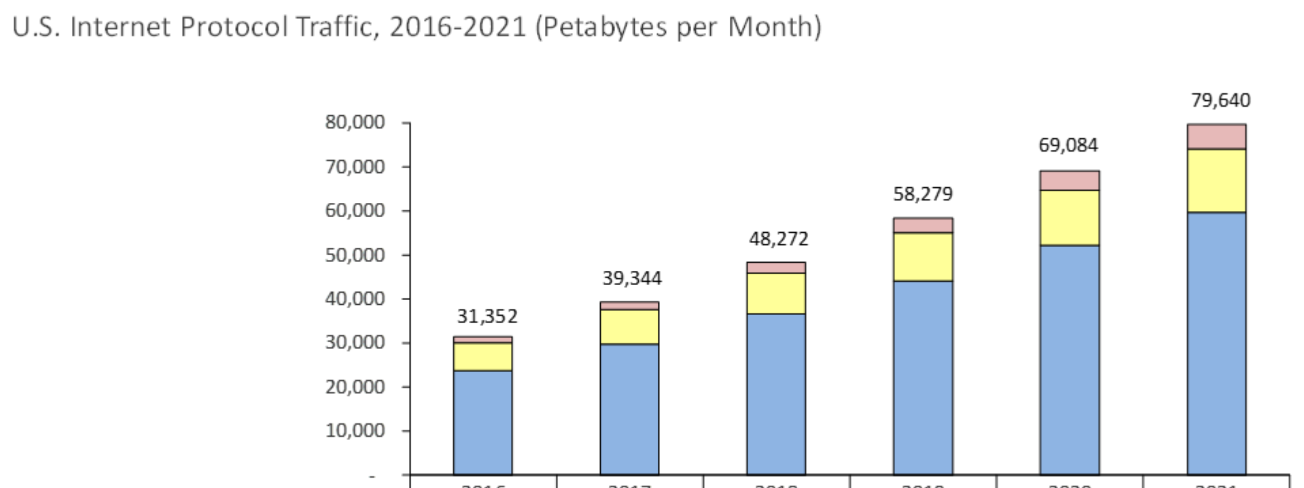


Chart 3 – Key Drivers of U.S. IP Traffic Growth



	2016	2017	2018	2019	2020	2021
Mobile	1,322	1,819	2,475	3,306	4,346	5,644
Fixed Consumer Data and Business	6,315	7,809	9,260	10,870	12,582	14,362
Fixed Consuer Video	23,715	29,716	36,537	44,104	52,157	59,634
Total	31,352	39,344	48,272	58,279	69,084	79,640

Source: Cisco Visual Networking Index and USTelecom analysis. Mobile and business include video; consumer data includes all consumer non-video.

In addition to consumer and business access networks, America's wireline network providers build and maintain the mobile backhaul connections, metro area networks and fiber backbones that transport nearly all internet traffic beyond the access portion of the network. In fact, nearly all mobile cellular traffic depends on fixed networks for backhaul from cell sites, and the mobile backhaul predominantly consists of wired connections. With fourth ("4G") generation wireless networks, backhaul has increasingly transitioned from traditional copper lines to fiber connections. The trend toward fiber backhaul will continue with the roll out of 5G wireless networks in the coming years, which will require deployment of smaller cells serving smaller geographic areas. Cellular networks will connect small cells via fiber deployed deeper into the network to accommodate the large anticipated volumes of traffic.

Broadband Investment Is Essential to Ongoing Internet Usage Growth

As USTelecom reported in its October 2017 Research Brief, broadband providers have invested more than $1.6 trillion since 1996 in large part to build and expand the broadband network capacity needed to accommodate traffic growth. Broadband provider investment generates complementary investments in information and communications technology ("ICT") across the economy. U.S. private firms invested $697 billion in ICT in 2016, including broadband communications networks, software, computer hardware, research and development in computing and semiconductors and long-lived content. The vast majority of U.S. businesses use the internet, connecting their employees, suppliers, and customers to maximize the value of their investments in ICT and create new business opportunities. Meanwhile, in 2016, 88 percent of U.S. consumers were using the internet and at least 75 percent had adopted fixed broadband technology at home to use with a growing array of bandwidth-intensive devices, including increasingly powerful computers, television set-tops, consoles, smartphones and tablets. Some consumers are using mobile broadband only, and many of these consumers have fixed broadband available to them.

According to the Cisco VNI online data, the average end-user fixed broadband connection speed in the U.S. is projected to more than double from 36.1 megabits per second ("Mbps") in 2016 to 75.5 Mbps in 2021. The Cisco VNI also projects that mobile connection speeds will double from 11.4 Mbps in 2016 to 21 Mbps in 2021. In addition, as consumer video IP traffic grows, traffic is shifting to content distribution networks ("CDNs") and toward metro areas networks from long-haul national and regional backbones. CDNs store content on servers located closer to end-users for faster delivery. At a global level, the Cisco VNI projects internet traffic delivered via backbones to fall from 78 percent of traffic in 2016 to 65 percent in 2021, while traffic delivered exclusively over metro area networks will grow from 22 percent to 35 percent. The metro-only traffic will quadruple during this period; but at the same time national and regional backbone traffic will double and triple, respectively, requiring investment in capacity. According to the Telecommunications Industry Association ("TIA") Market Review and Forecast 2016-20 (subscription required), data center construction spending grew from $15 billion in 2010 to $27.5 billion in 2016. TIA projected data center construction spending would grow to $36 billion by 2020. Finally, according to the Cisco VNI, peak time internet traffic will grow at a compounded annual average rate of 32 percent over the next five years, compared to 24 percent for overall internet traffic. Since network providers build to peak demand, providers will need to make incremental capacity investments.

With demand rising rapidly, broadband providers will have to make large capital investments to upgrade capacity and expand networks. Providers will have to build faster and smarter broadband access for growing online video, mobile, and cloud services, as well as nascent applications like the tele-health, online education, the Internet of Things, data analytics, and much more. They will need to upgrade access, metro, long haul, and cell backhaul networks, as well as connectivity for data centers and content distribution networks. Unfortunately, broadband capital expenditures have stalled and started to decline in the last couple of years. Annual broadband provider investment in 2016 was $76.0 billion, approximately $1.9 billion lower than $77.9 billion in 2015 and $2.4 billion lower than the recent peak of $78.4 billion in 2014. To accommodate growth in demand and enable long-term innovation in ICT for both businesses and consumers, the U.S. will need to reignite broadband capital investment growth. The FCC can help by reversing its counterproductive 2015 decision to regulate broadband internet providers as public utilities.

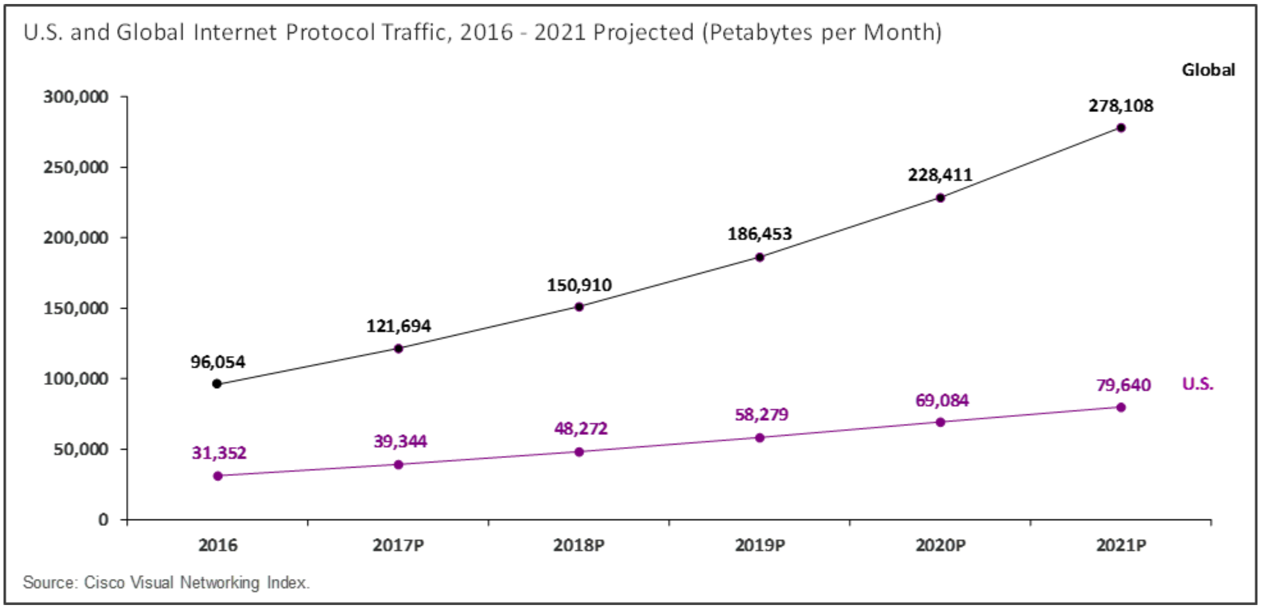
The United States Leads the World in Internet Usage

The Cisco VNI data show that the U.S. is the world leader in internet traffic per user and is expanding its leadership. At the global level, IP traffic was 96,054 petabytes per month in 2016, or the equivalent of streaming 263 billion DVDs per year. Global IP traffic grew by a factor of more than three from 2011 to 2016 and Cisco projects that it will triple again through 2021 to 278,108 petabytes month. This is the equivalent of 762 billion streamed DVDs annually.

While the U.S. represented approximately 4.4 percent of the world population in 2016, it generated almost one-third of global IP traffic. Cisco projects that in 2021 the U.S. will represent 4.3 percent of the world population and will still generate 29 percent of IP traffic, even as the Internet penetration accelerates in developing world. (See Chart 4.) It is natural that the U.S. share should decline, given the relatively advanced state of U.S. internet deployment and adoption relative to most of the globe, especially developing countries. According to the Cisco VNI, U.S. internet penetration will grow from 89 percent in 2016 to 90 percent in 2021. By contrast, the global average internet penetration was 44 percent in 2016, growing to 58 percent in 2021. (See Appendix B.) That means that while global growth is a function of both increased penetration and increased traffic per user, growth in the U.S. and other industrialized nations is predominantly a function of traffic per user. The growing Internet of Things market will also affect network demand across all nations, though many connected IoT devices will consume small amounts of bandwidth and it is difficult to foresee its overall impact of traffic volume.

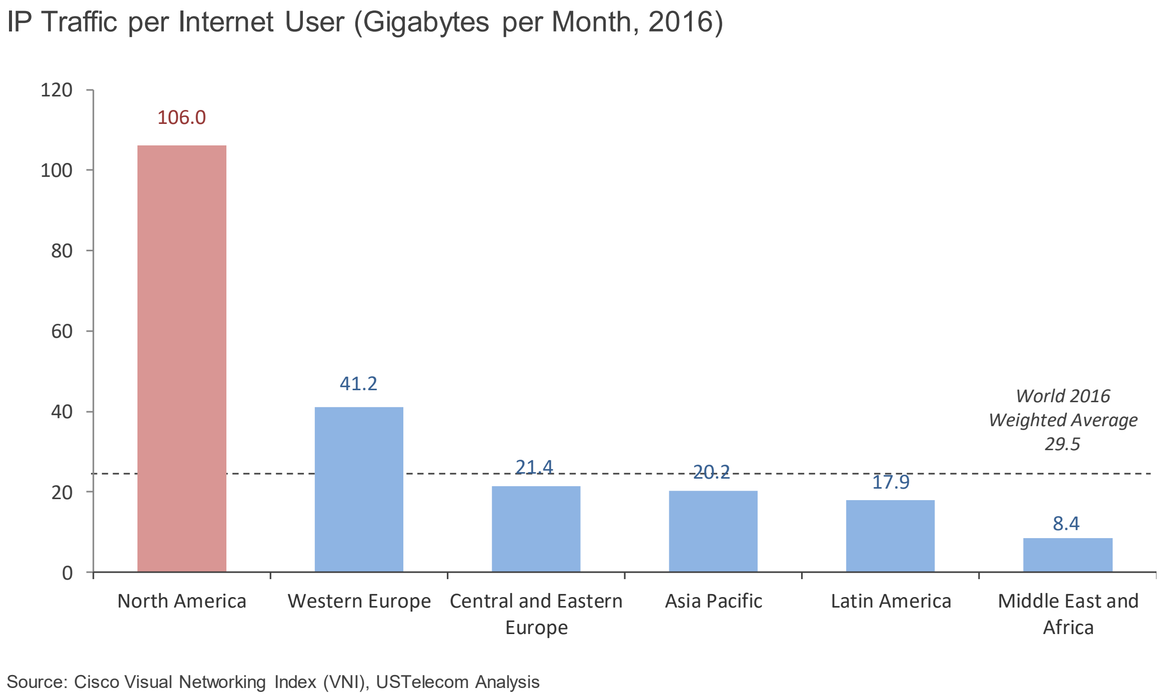
In terms of total IP traffic, the U.S. generates more than any other nation in the world. In 2016, U.S. IP traffic was 84 percent greater than the next largest user, China, which has a population four times larger than the U.S. In 2021, the U.S. will still generate 46 percent more traffic than China. Similarly, U.S. IP traffic in 2016 was more than double that of all of Western Europe and will still be more than double the Western European traffic in 2021. Detailed country and region data are available in Appendix B.

Chart 4 – Comparison of U.S. and Global IP Traffic



To account for differences among regions and countries in size and internet penetration, USTelecom normalizes the data as either traffic per internet user or traffic per capita. On a regional basis, North America has the heaviest internet usage, with more than double the usage of Europe and four times that of Asia. (See Chart 5.) The available data limit potentially insightful comparisons among smaller areas that typically perform well in broadband metrics, such as certain U.S. states and some smaller Asian and European countries.

Chart 5 - Comparison of Internet Usage among Regions



Nonetheless, the U.S. as a whole performs well in international comparisons of internet usage. In stark contrast to inaccurate claims by those supporting aggressive U.S. broadband regulatory policy that the U.S. is lagging in internet capabilities, internet usage data show the U.S. is ahead and gaining ground on this important metric. Since 2009, the U.S. has moved to the top of the pack in global internet usage comparisons.

In previous research, USTelecom showed that the U.S. led the industrialized nations in IP traffic per user and per capita, with the exception of South Korea. In 2015, the U.S. overtook South Korea to become the clear world leader. In 2009, the first year for which USTelecom collected this data, the average U.S. user generated 19 gigabytes ("GB") per month, compared to 33 GB per month for the average South Korean user. By 2014, the U.S. had closed most of the gap with 66 GB per U.S. user per month compared to 68 GB per South Korean user per month. By 2015, the average U.S. user generated 82 GB per month compared to 71 GB per month for the average South Korean user. In 2016, U.S. momentum continued and the average U.S. user generated 109 GB of IP traffic per month while the average South Korean user generated 83 GB per month. (See Chart 6.) From 2009 to 2016, the U.S. traffic per user grew more than 5.7 times, from 19 GB/user/month to 109 GB/user/month, while South Korean traffic merely doubled, from 41 GB/user/month to 83 GB/user/month. In 2009, the U.S. generated 53 percent less traffic than South Korea; by 2014 the gap was only 2 percent less; and by 2016 the U.S. generated 36 percent more traffic than South Korea.

The U.S. also outperforms all other industrialized nations for which Cisco provides data. Even countries that grew relatively rapidly over the last several years still lag the U.S. by substantial margins. Examples include Australia, Canada, Japan, Sweden, and the U.K., all of which proponents of aggressive broadband regulation cite as strong broadband performers compared to the U.S. Large continental European countries are lagging in particular. France, Germany, Italy, and Spain were all generating less than 36 GB/user/month in 2016. (See Chart 7.)

Chart 6 – Internet Traffic per User in the U.S. and South Korea over Time

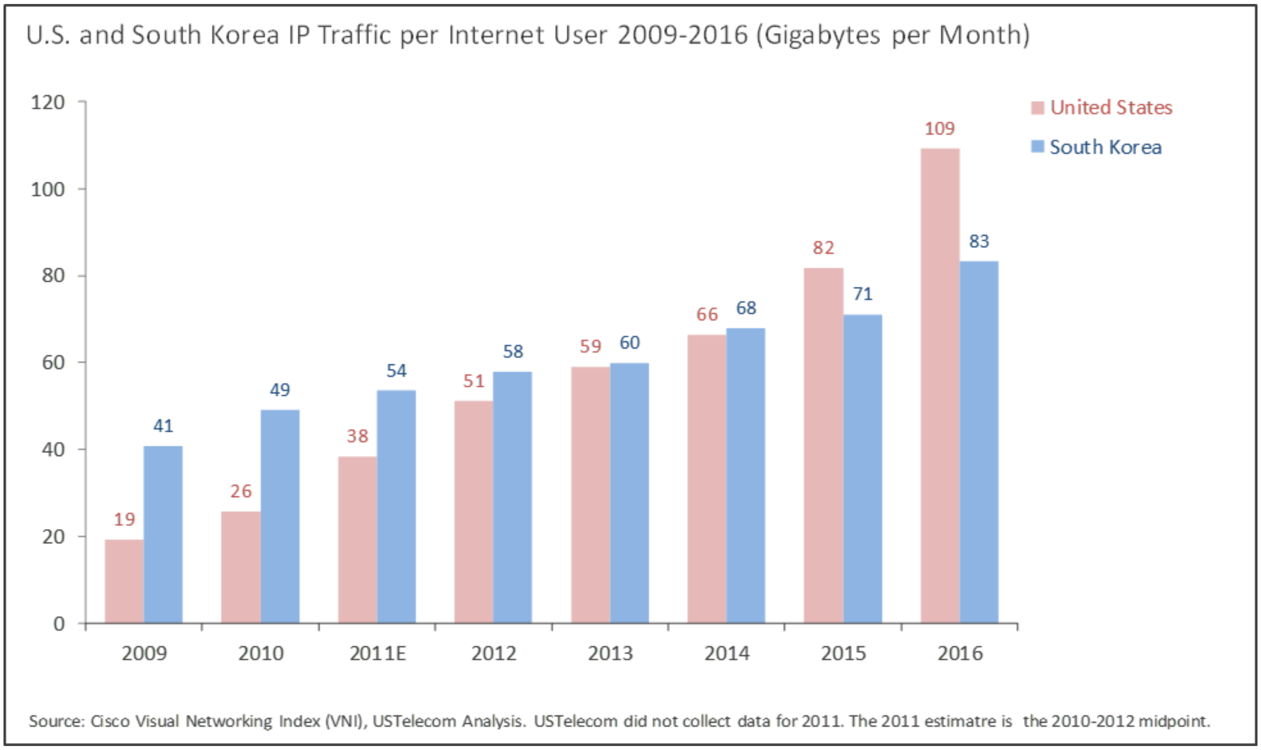
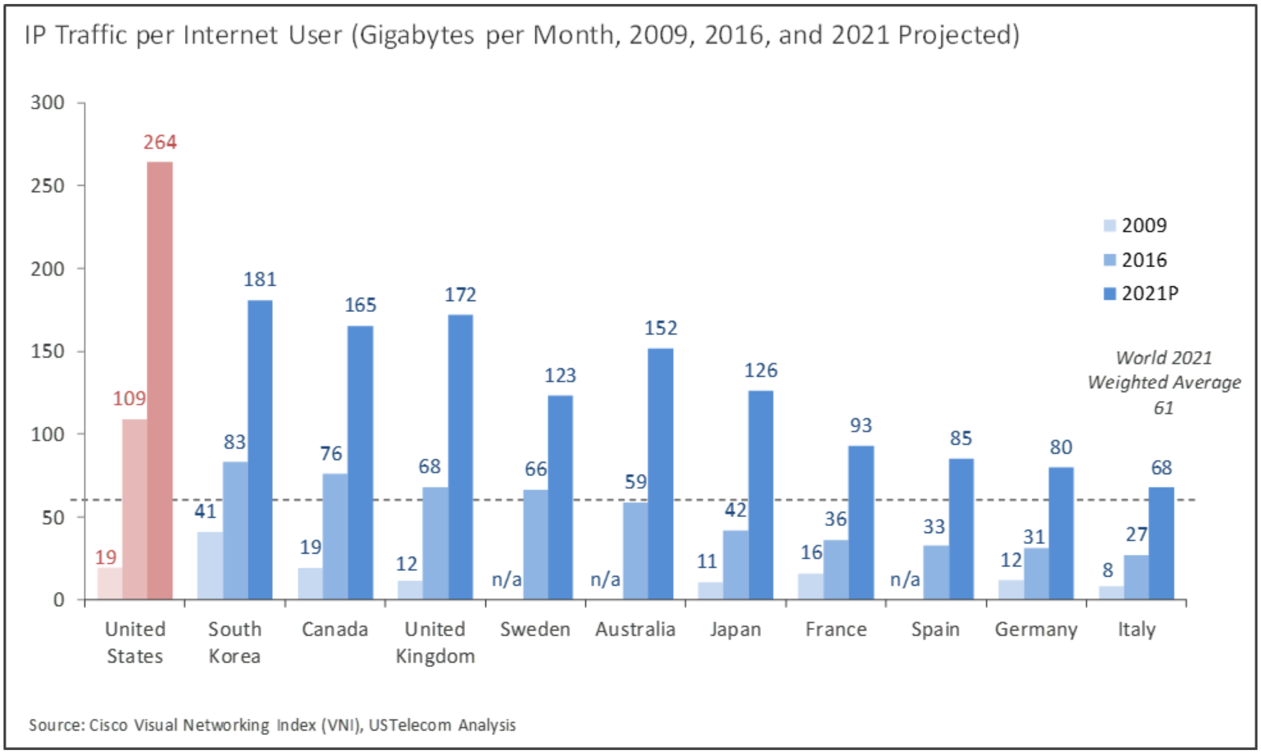


Chart 7 - Comparison of Internet Usage among Selected Industrialized Countries



Looking forward, the Cisco VNI projects that the U.S. will maintain its global leadership. U.S. internet traffic per user will grow almost two-and-a-half times from 2016 to 2021, from 109 GB/user/month per user per month to 264 GB/user/month. During the same period, Cisco projects worldwide traffic per user will more than double, from 29 GB/user/month to 61 GB/user/month. By 2021, according to Cisco VNI projections, the average U.S. user will generate 1.45 times as much IP traffic per user as the average South Korean user. The UK and Canada will be on par with South Korea, too, by 2021.

Cisco VNI data also indicate that the U.S. is now, and will remain, the top country in the world in connected devices per capita, just ahead of South Korea and Japan. The number of connected devices per capita is an indicator of the growth of the Internet of Things, which leverages the internet to bring a range of economic and social benefits to those who adopt it. From 2016 to 2032, Cisco projects devices per capita to grow from 7.8 to 13.2 in the U.S. For South Korea, the corresponding figures are 6.7 and 12.0; for Japan they are 6.4 and 11.4; and for Western Europe, they are 5.3 and 8.9.

Appendix A – U.S. Internet Protocol Traffic Details

United States Projected IP Traffic 2016-2021	Petabytes Per Month						Normalization		Growth		Distributions	
	2016	2017	2018	2019	2020	2021	Traffic per User 2016	Traffic per Pop 2016	5-Year CAGR	5-Year Growth Multiple	2016	2021
Total	31,352	39,344	48,272	58,279	69,084	79,640	109.2	96.7	20%	2.5	100%	100%
Annualized Total	376,218	472,126	579,269	699,344	829,010	955,682	1,310	1,161				
DVD Eqivalent Annually (Billions)	86	108	132	160	189	218						
Segment												
Consumer	27,005	33,583	41,087	49,441	58,409	66,947	94.0	83.3	20%	2.5	86%	84%
Business	4,346	5,760	7,186	8,838	10,675	12,693	15.1	13.4	24%	2.9	14%	16%
Network Type												
Fixed Internet	20,410	26,477	33,346	41,369	50,123	58,368	71.1	63.0	23%	2.9	65%	73%
Managed IP	9,619	11,048	12,451	13,604	14,616	15,629	33.5	29.7	10%	1.6	31%	20%
Mobile	1,322	1,819	2,475	3,306	4,346	5,644	4.6	4.1	34%	4.3	4%	7%
Application Type												
File Sharing	1,245	1,476	1,701	1,938	2,162	2,373	4.3	3.8	14%	1.9	4%	3%
Video	25,404	32,107	39,682	48,045	56,918	65,251	88.5	78.4	21%	2.6	81%	82%
Web and Other Data	4,342	4,968	5,564	6,152	6,663	7,060	15.1	13.4	10%	1.6	14%	9%
Online Gaming	362	792	1,325	2,143	3,342	4,956	1.3	1.1	69%	13.7	1%	6%
Key Traffic Drivers												
Fixed Consuer Video	23,715	29,716	36,537	44,104	52,157	59,634	82.6	73.2	20%	2.5	76%	75%
Mobile	1,322	1,819	2,475	3,306	4,346	5,644	4.6	4.1	34%	4.3	4%	7%
Fixed Consumer Data and Business	6,315	7,809	9,260	10,870	12,582	14,362	22.0	19.5	18%	2.3	20%	18%
Video and Non-Video - Fixed and Mobile												
Video (includes online gaming, portion of file sharing)	26,761	34,110	42,436	51,855	62,162	72,343	93.2	82.6	22%	2.7	85%	91%
Non Video	4,591	5,234	5,836	6,424	6,922	7,297	16.0	14.2	10%	1.6	15%	9%
Video by Mobile or Non-Mobile Network Type												
Non-Mobile Video	25,909	32,882	40,691	49,422	58,825	67,822	90.2	79.9	21%	2.6	97%	94%
Mobile Video	852	1,229	1,746	2,433	3,337	4,521	3.0	2.6	40%	5.3	3%	6%

Source: Cisco Visual Networking Index and USTelecom Analysis

Appendix B – Internet Usage Calculations by Region and Country

Regional and Country Internet Traffic per User and per Capita, 2016

	IP Traffic 2016 (PB/Month)	Growth (CAGR) 2016-2021	Consumer Traffic 2016 (PB/Month)	Business Traffic 2016 (PB/Month)	Internet Users 2016 (millions)	Population 2016 (millions)	IP Traffic per User (GB/Month)	IP Traffic per Pop (GB/Month)	Consumer IP Traffic per Pop (GB/Month)	Business IP Traffic per Pop (GB/Month)	Users per Capita 2016
Global	96,054	24%	78,250	17,804	3,257	7,432	29.49	12.93	10.53	2.40	43.8%
North America	33,648	20%	28,776	4,872	317	360	106.03	93.36	79.84	13.52	88.0%
United States	31,352	20%	27,005	4,346	287	324	109.18	96.73	83.32	13.41	88.6%
Canada	2,297	19%	1,771	526	30	36	76.09	63.28	48.79	14.49	83.2%
Western Europe	14,014	22%	11,206	2,808	340	417	41.17	33.64	26.90	6.74	81.7%
France	2,111	22%	1,727	384	58	65	36.20	32.65	26.70	5.94	90.2%
Germany	2,114	23%	1,712	401	67	81	31.40	26.20	21.22	4.98	83.4%
Italy	1,036	23%	818	218	39	60	26.86	17.32	13.68	3.64	64.5%
Spain	1,095	23%	873	223	34	46	32.68	23.78	18.95	4.84	72.8%
Sweden	602	14%	470	132	9	10	66.27	61.09	47.74	13.35	92.2%
United Kingdom	3,929	22%	3,326	603	58	65	67.97	60.34	51.08	9.27	88.8%
Rest of Western Europe	3,127	21%	2,281	847	76	90	41.26	34.60	25.23	9.37	83.8%
Central and Eastern Europe	6,210	22%	4,521	1,689	291	488	21.35	12.73	9.27	3.46	59.6%
Russia	2,728	17%	1,920	808	86	143	31.78	19.02	13.39	5.63	59.8%
Rest of Central and Eastern Europe	3,482	26%	2,600	881	205	344	16.99	10.11	7.55	2.56	59.5%
Asia Pacific	33,505	26%	27,039	6,466	1,656	4,032	20.23	8.31	6.71	1.60	41.1%
Australia	1,032	26%	751	281	18	24	58.89	42.47	30.91	11.56	72.1%
China	17,059	26%	13,663	3,397	742	1,382	22.99	12.34	9.88	2.46	53.7%
India	1,748	30%	1,452	296	373	1,327	4.68	1.32	1.09	0.22	28.1%
Indonesia	643	37%	556	87	85	261	7.58	2.47	2.13	0.33	32.5%
Japan	4,403	26%	3,408	994	106	126	41.69	34.85	26.98	7.87	83.6%
South Korea	3,858	18%	3,412	446	46	51	83.20	76.39	67.56	8.84	91.8%
Rest of Asia Pacific	4,762	29%	3,797	965	286	861	16.64	5.53	4.41	1.12	33.2%
Latin America	5,999	21%	4,844	1,155	335	641	17.92	9.36	7.56	1.80	52.2%
Argentina	666	22%	545	121	27	44	24.29	15.20	12.43	2.76	62.6%
Brazil	2,386	18%	1,919	467	135	210	17.65	11.39	9.16	2.23	64.5%
Mexico	1,263	22%	1,088	175	63	129	20.02	9.82	8.46	1.36	49.1%
Rest of Latin America	1,683	24%	1,291	392	109	259	15.44	6.51	4.99	1.51	42.1%
Middle East and Africa	2,679	42%	1,865	814	318	1,494	8.42	1.79	1.25	0.55	21.3%
South Africa	355	24%	215	140	26	55	13.75	6.46	3.91	2.55	47.0%
Rest of Middle East and Africa	2,324	44%	1,650	674	292	1,439	7.95	1.61	1.15	0.47	20.3%

Source: Cisco Visual Networking Index and USTelecom Analysis

Appendix B – Internet Usage Calculations by Region and Country (continued)

Regional and Country Internet Traffic per User and per Capita, 2021 Projected

	IP Traffic 2021 (PB/Month)	Growth (CAGR) 2016-2021	Consumer Traffic 2021 (PB/Month)	Business Traffic 2021 (PB/Month)	Internet Users 2021 (millions)	Population 2021 (millions)	IP Traffic per User (GB/Month)	IP Traffic per Pop (GB/Month)	Consumer IP Traffic per Pop (GB/Month)	Business IP Traffic per Pop (GB/Month)	Users per Capita 2021
Global	278,108	24%	232,655	45,452	4,565	7,836	60.92	35.49	29.69	5.80	58.3%
North America	85,047	20%	71,327	13,720	334	374	254.32	227.53	190.82	36.71	89.5%
United States	79,640	20%	66,947	12,693	302	336	263.96	237.10	199.31	37.79	89.8%
Canada	5,407	19%	4,379	1,027	33	38	165.34	142.61	115.52	27.09	86.3%
Western Europe	37,393	22%	30,924	6,469	365	421	102.42	88.76	73.40	15.35	86.7%
France	5,611	22%	4,624	988	60	66	92.87	85.05	70.08	14.97	91.6%
Germany	5,947	23%	5,034	913	74	80	80.03	74.05	62.68	11.36	92.5%
Italy	2,966	23%	2,390	576	44	60	67.75	49.68	40.03	9.65	73.3%
Spain	3,098	23%	2,532	566	36	46	85.23	67.07	54.83	12.25	78.7%
Sweden	1,161	14%	922	240	9	10	123.27	113.95	90.43	23.52	92.4%
United Kingdom	10,586	22%	9,071	1,516	62	67	171.83	157.82	135.22	22.60	91.8%
Rest of Western Europe	8,024	21%	6,353	1,671	79	92	101.27	87.35	69.16	18.19	86.3%
Central and Eastern Europe	17,059	22%	13,776	3,283	356	492	47.88	34.67	28.00	6.67	72.4%
Russia	5,990	17%	4,739	1,251	97	143	61.99	41.99	33.22	8.77	67.7%
Rest of Central and Eastern Europe	11,069	26%	9,037	2,032	260	349	42.63	31.68	25.87	5.82	74.3%
Asia Pacific	107,655	26%	90,185	17,469	2,586	4,201	41.63	25.63	21.47	4.16	61.6%
Australia	3,260	26%	2,512	748	22	26	151.54	125.86	96.98	28.87	83.1%
China	54,624	26%	45,693	8,931	1,026	1,406	53.22	38.84	32.49	6.35	73.0%
India	6,529	30%	5,685	845	829	1,404	7.88	4.65	4.05	0.60	59.0%
Indonesia	3,106	37%	2,852	254	182	275	17.07	11.31	10.39	0.93	66.3%
Japan	14,025	26%	11,276	2,749	111	125	126.43	112.52	90.46	22.05	89.0%
South Korea	8,834	18%	7,505	1,329	49	51	180.79	171.82	145.98	25.85	95.0%
Rest of Asia Pacific	17,277	29%	14,663	2,614	368	914	46.98	18.91	16.05	2.86	40.2%
Latin America	15,464	21%	12,938	2,526	446	672	34.66	23.01	19.25	3.76	66.4%
Argentina	1,780	22%	1,527	253	34	46	52.87	38.77	33.26	5.51	73.3%
Brazil	5,454	18%	4,663	792	180	217	30.28	25.08	21.44	3.64	82.8%
Mexico	3,384	22%	2,868	516	83	136	40.90	24.82	21.04	3.78	60.7%
Rest of Latin America	4,846	24%	3,880	966	150	272	32.38	17.79	14.24	3.54	54.9%
Middle East and Africa	15,490	42%	13,505	1,985	477	1,676	32.48	9.24	8.06	1.18	28.5%
South Africa	1,062	24%	819	243	46	57	23.14	18.61	14.35	4.26	80.4%
Rest of Middle East and Africa	14,428	44%	12,687	1,742	431	1,619	33.48	8.91	7.84	1.08	26.6%

Source: Cisco Visual Networking Index and USTelecom Analysis

Appendix C – Technical Discussion of Data and Methodology

Broadband rankings frequently focus on penetration and theoretical measure such as capacity, and price per bit. According to several studies (see OECD, Berkman Center, New America Foundation), the U.S. ranks in the middle of the pack on these measures. Such measures largely ignore actual usage of the internet (i.e., actual consumption).

USTelecom agrees with the Federal Communications Commission's 2010 National Broadband Plan, which stated, "Many international broadband plans emphasize speeds and networks, focusing only on technical capacity as a measure of a successful broadband system. Our plan must go beyond that. While striving for ubiquitous and fast networks, we must also strive to use those networks more efficiently and effectively than any other country. *We should lead the world where it counts—in the use of the Internet* and in the development of new applications that provide the tools that each person needs to make the most of his or her own life." [NBP Page 4, emphasis added.]

There are however, relevant measures available that take into account actual usage, such as traffic volume, traffic per user and traffic per capita. On these, the U.S. ranks very high. We believe that international rankings would paint a more accurate picture if they took into account these factors as alternative or additional criteria. For example, while measures of investment are important, they are often "nominal," in other words not adjusted for prices and increasing technological prowess. The usage data enhances our understanding of the "real" impacts of broadband and information technology investment by accounting for what consumers are actually doing with the internet. This is especially helpful when other measures such as capacity are often theoretical, i.e., they do not account for what users actually consume. Measures of throughput capacity are moderately helpful, but they are also often theoretical – consumers use less than maximum capacity available. Therefore, the amount of data users are actually consuming to pull value from their broadband connections provides an additional, more practical gauge of how successfully a country's broadband networks are providing residential and business consumers with what they demand.

How Can Usage Data Improve Rankings and Studies?

Usage could improve rankings and studies in several ways. First, usage, or bits/bytes consumed, is a better proxy for value received than simple capacity, either advertised or actual. For example, price per bit analyses are typically based on bit per second capacity rather than how consumers use such capacity and what they consume with it. Assuming legitimate pricing or revenue data were available – a big assumption – one could adjust prices to account for data actually consumed, in other words, what did users get for their money? Furthermore, usage – including business usage – may be a more precise explanatory variable than, say subscribers or penetration, when attempting to assess the economic impacts of Internet usage.

There are some challenges associated with usage data. For example, if underlying pricing data are of a poor quality, adjusting with usage data will not make the pricing data useful. In fact, it remains very difficult to find meaningful pricing and revenue data since these data do not typically account for variation in underlying costs structures. Price means very little but in relation to cost; but there is wide variation in cost among providers and countries resulting from differences in regulation, subsidies and public investment levels, demographics, geography, density, and allocation of costs among shared network services. In addition, traffic-based metrics reduce usage to bits, not distinguishing among applications, which may have different economic and consumer benefits.

Nonetheless, usage data has clear advantages over other common broadband ranking metrics. Therefore, one could use usage data in place of or, at a minimum, as a complement to other comparative metrics.

Data Approximation: Consumption per Internet User

This analysis has provided a rough approximation of bandwidth consumed per internet user across several regions and selected countries. In order to be useful, USTelecom must normalize the data. For example, when comparing country performance, it may make sense to normalize consumption either per internet user or per capita. Normalizing for users may be more appropriate when looking at how individuals utilize internet technology. In this case, using a per capita measure may skew the results due to significant variation in internet adoption rates across countries. On the other hand, a per capita measure may be more appropriate when analyzing broader macroeconomic impacts of internet diffusion, e.g., business usage.

Cisco publishes projected global IP traffic data and forecasts from 2016-2021 for the various regions of the world and selected countries. Regional aggregates are available from the Cisco Visual Networking Index: Forecast and Methodology, 2016–2021 (June 6, 2017). Within each region, Cisco reports data for selected countries and the "rest of" the region. Selected country data are available from Cisco VNI Forecast Widget for the Cisco Visual Networking Index IP Traffic Forecast, 2016-2021 (last visited November 20, 2017).

Cisco also publishes data on population and the number of internet users in each country and region for which it provides IP traffic data. These data are available at the Cisco VNI Forecast Highlights Tool (last visited November 20, 2017). It is possible to normalize the IP traffic data across the countries by number of users or by population. (NOTE: This is a change from USTelecom analyses for the 2012-2017 VNI Forecast and earlier, in which USTelecom developed estimates of population and internet users independently based on data from the International Telecommunications Union ("ITU") and the United Nations ("UN"). Since the VNI Forecast for 2013-18, Cisco has provided country-region mapping information. While previous USTelecom estimates were developed and checked rigorously, using Cisco data throughout the analysis ensures an even greater level of internal consistency.)

Using these data sources, USTelecom can *approximate* average consumption per user and per capita in each region. Specifically, the Cisco regional global IP traffic estimates, in Petabytes per Month, is divided by the number of internet users and population in that region, in millions. The traffic data includes *all* IP traffic – business and residential; fixed and mobile; IP voice, video, and data; and private and public internet. This is appropriate because all of these types of traffic contribute to the economic and consumer impacts of IP data usage.

On a regional level, North America consumes a significantly larger amount of bandwidth than other regions. Of course, a regional approach does not account for variation within regions. For example, while Cisco provides aggregate data for Western Europe or Asia and selected countries, it does not provide data for many countries that generally perform strongly in broadband rankings, e.g., many northern European countries, Switzerland, Hong Kong or Singapore. The inclusion of Sweden in recent releases helps by providing additional granularity reflecting Northern Europe. On the other hand, data are not available for individual U.S. states, which are more appropriate for comparing with smaller, denser countries.

Normalizing country and regional traffic by internet users has several limitations that imply some imprecision; but the broad results and relative country and regional performance should be directionally accurate. First, historically USTelecom has used data from several different sources and some inconsistency among sources is possible. As noted above, this latest analysis uses data from a single source: Cisco. But Cisco likely faces the same cross-country reporting inconsistencies that USTelecom did in its historical data. Moreover, USTelecom did not have access to historical population and internet user data from Cisco. As a result, USTelecom's analyses before and after the VNI Forecast for 2013 to 2018 are based two different user and population data sources, the former based on independently developed USTelecom estimates, the latter based on Cisco estimates. Second, the Cisco data reflect all IP traffic, which is a broader than just Internet traffic. There is no user data on IP adopters; USTelecom assumes internet users are a reasonable proxy.

Finally, USTelecom offers the following notes on interpretation: First, volume of traffic is one useful indicator of comparative activity and normalizing by users or population makes it more useful; but volume of traffic does not necessarily equate to value of traffic. These data cannot determine whether any country is using the Internet in a more or less economically productive or socially beneficial manner compared to other countries. To a certain extent, such judgments would be at least partially subjective. Second, the calculations of traffic per internet user and population are by definition means, as opposed to medians. Both measures have their place. If the mean is significantly greater than the median in a country, it may indicate there is a preponderance of high-bandwidth outliers. Finally, regions where there is widespread legacy of multi-channel video adoption (i.e., North America) undercount a great deal of video traffic currently delivered via radio frequencies. Should analyses ignore video that not IP video? Should analyses exclude non-IP voice traffic? One could argue either side, given the enhanced capabilities of IP video and telephony, but often users do not consume video or voice service differently on an IP versus a legacy network. Over time, these differences are diminishing as more U.S. adoption and consumption migrates to voice and video delivered via IP services—but a many traditional users remain, particularly in cable video.