Catch me if you can!

US traffic boom leaves Europe way behind – with higher US NGA penetration maintaining similar connection speeds

Orange – DRG / Stephane Ciriani, Karine Fourneron –

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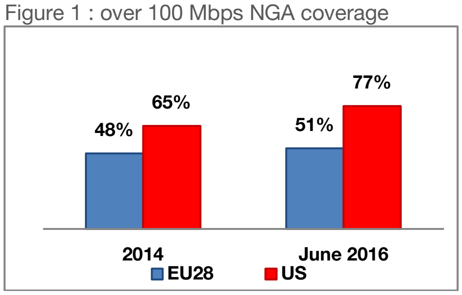
Main findings

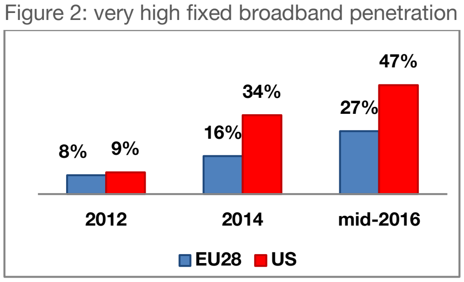
Figure 1 : over 100 Mbps NGA coverage



Source: FCC, US Telecom association & EC

The US NGA network coverage is at least 2.5 years ahead of the European one, for mobile broadband technologies and 4 years ahead European one for fixed basic NGA technologies. The US coverage is also notably higher for NGA which deliver over 100 Mbps advertised speed, with a 77.5% fixed network coverage, against only 50.8% across Europe at the end of June 2016. The US advance results from a wider availability of cable technology, with more than 86,3% of housing units covered with Docsis 3.x cable technology in 2016, whereas Europe is catching up US for VDSL and FTTH coverage.

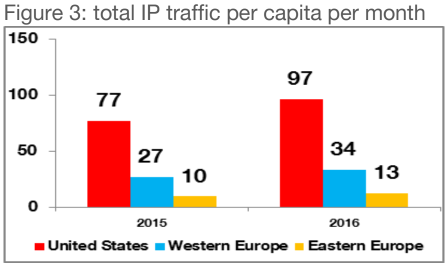
Figure 2: very high fixed broadband penetration



Source: FCC & EC

The commercial adoption of fixed NGA remains relatively low in both areas, but exhibits strong dynamics. Adoption rates are higher in the United States than in Europe, as 47% of the US household were connected to very high broadband (> 25 Mbps) in 2016, whereas 27% of the European households were connected to very high broadband (> 30 Mbps) at the same date. This gap has steadily widened since 2012.

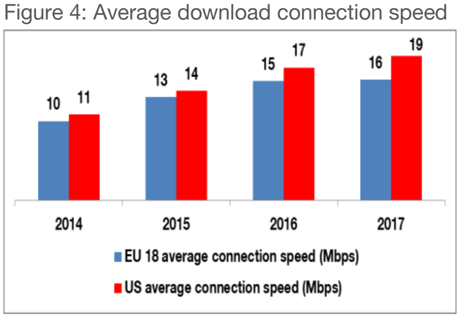
Figure 3: total IP traffic per capita per month



Source: Cisco

The United States are leaders in terms of fixed and mobile IP traffic per inhabitant. With 96.7 Gigabytes generated monthly in 2016 by the average connected user, the US are ahead of Western Europe and Eastern Central Europe (with only 33.6 and 12.7 Gigabytes generated monthly by the average connected household), according to Cisco VNI. In 2016, the average Western European internet user is generating the same total data traffic as its North American counterpart did in 2012.

Figure 4: Average download connection speed



Source: Akamai state of connectivity reports

Higher NGA coverage associated with much heavier usage per subscriber in the United States compared to Europe have led to similar average bandwidth being available per subscriber in each region, as average connection speed for a user is an increasing function of network capacity, but a decreasing function of the utilization rate of the network. Indeed, average fixed connection speed levels and evolutions have proven to be very close in Europe (EU18) and in the United States over the period 2005-2017, with the US ahead of Europe, or the opposite, depending on the source. As regards mobile connection speeds, there is no sufficiently representative data to provide a meaningful comparison between EU and the US. Existing information points to higher speeds in Europe, but is subject to bias because it only covers the most advanced EU countries.

Contents

Introduction

This study provides a contribution to the assessment of the gap between the US and the European Union in terms of global digital performance. It encompasses broadband access coverage, broadband penetration rate and the quality of telecommunication services per technology and overall. Prior to this analysis, an EU-US comparison of investment by the telecommunications operators has shown that the US stood well above the EU28 over the whole period 2000-2013[1]. Moreover, the gap has tended to increase in the recent period (after the 2009 macroeconomic downturn). The intensity of the US per capita investment in infrastructures was fifty percent higher than in the EU27 in 2003, and it was twice the European level in 2013. A research published by IDATE in June 2017 shows that this ratio has remained the same in 2015.[2]

This study provides a follow-up to the result of these investments in the roll-out of access networks. The analysis first assesses discrepancies in the amount of fixed capital spent to deploy telecommunications and Internet infrastructures. It then focuses on discrepancies in physical infrastructure which have been deployed over the last decade. The telecommunication services delivered to the end-user consist of a connection at a given speed, primarily depending on the technology used. The actual connection speed delivered to the end-user depends on a range of other factors, like the architecture of the network, the number of active users over a certain period and their intensity of usage.

The relevant information to consider in order to assess for the level of technological development of a country is primarily given by the level of network coverage (part 1) and the level of service adoption by the population (part 2). Bearing in mind that NGA adoption is directly related to data traffic consumption intensity, the latter is examined in part 3. Finally, connectivity quality is assessed from the end user point of view (part 4), considering available download speeds by technology.

1. Higher Broadband coverage in the US than EU28 for both fixed or mobile accesses

This section presents a comparison between the United States and the EU28 in terms of technological development[3]. It provides information on fixed and mobile networks coverage in the European Union and the United States. The information presented in this first section entails fixed technologies legacy networks (DSL copper lines) as well as Next Generation Access networks – NGA (copper VDSL, Cable Docsis 3.0, and optical fiber FTTP), and mobile technologies (high speed wireless broadband-LTE) as well. It provides a reliable EU-US comparison in terms of digital network coverage by technology and related advertised connection speed.

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1 http://www.orange.com/fr/content/download/32216/955794/version/2/file/telecom_investment_comparison_US_vs_EU.pdf

2 Digiword Watch Service n°5 : Telecom market dynamics: Europe vs. the USA, IDATE- June 2017

3 All information is retrieved from official national sources: the NTIA and the FCC for the US and the European Commission for the European Union. Information concerning the US is mainly provided by the annual “International Broadband Data Reports”, “the Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services”, and the “Broadband Progress Report”, which were published each year by the FCC until 2016. For the most recent data set (mid 2016), the FCC is not publishing a report any more, but raw data difficult to analyse indeed ; for this reason, the source of the latest availability figures per bandwidth and per technology is an aggregation of FCC, USTelecom, and Telcodata Census NBM.com, computed by the US Telecom broadband association. The Information for the European Union is provided by the annual “Digital Agenda Scoreboard”, and the 2016 “Europe's Digital Progress Report”. Those reports provide the data necessary to assess for both networks coverage by area, by technology and by the level of advertised speed (for fixed networks), as well as the data used to derive estimates of commercial adoption and penetration of technologies according to those specific categories.

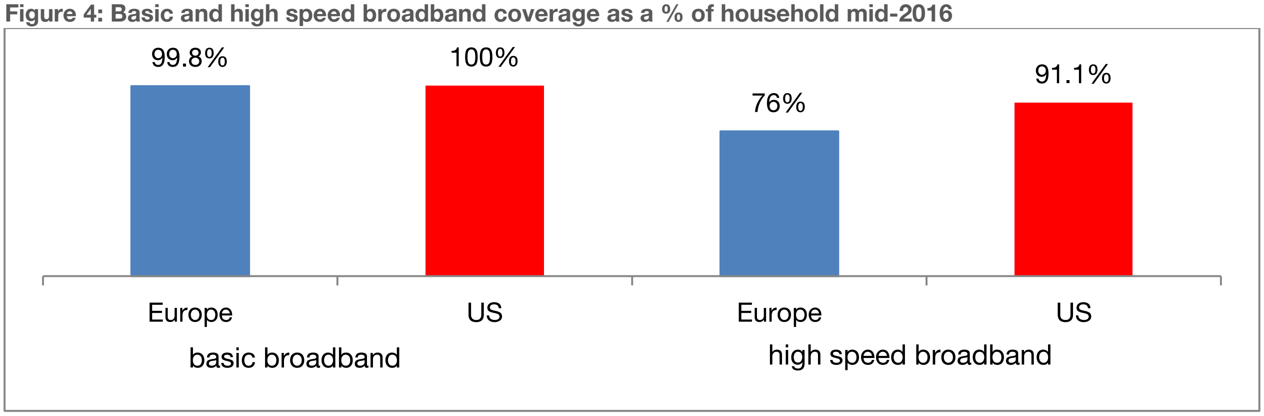
1.1. Higher bandwidth Internet access coverage focuses public interest

This first section firstly acknowledged that basic internet access is not an issue per se anymore, as full population coverage is nearly achieved in both the US and the EU28. However, in order to benefit from the current technological possibilities provided by the ongoing digitalization of the society, the level of connection speed is a variable of interest. As a result, the range of connection speed provides relevant information to assess the performance of a country in terms of connectivity. National Regulatory Agencies provide data on the percentage of population covered at a given speed, with regards to the theoretical bandwidth associated to each technology.

1.1.1. Overall Internet access coverage is nearly completed in both regions

The definitions of broadband vary greatly over time and across the two continents. Broadband is defined by a 144 kbps minimum download speed in the European Union and a 3 Mbps download speed in the United States. Therefore, it appears that general internet coverage at the lowest available bandwidth is a reasonable primary measure for estimating the extent to which technologies are made available to the population of a region. As shown in Figure 4, with nearly 100% of population already covered with basic broadband both in the European Union and the United States at mid-2016, basic internet access *per se* is neither an industrial nor a public policy issue anymore. The public policy priority has now shifted towards a wider availability of NGA and the availability of internet in the most remote and rural areas of each continent.

Figure 4: Basic and high speed broadband coverage as a % of household mid-2016



Sources: European Connectivity Report – EC and US broadband Availability – US Telecom, from FCC data

Those new networks enabling connections at greater speed levels are now labelled “Broadband” in the US (i.e. broadband at 25 Mbps or more combined advertised download speeds , and 3 Mbps or more upload speeds) and “NGA” in the European Union (broadband at 30 Mbps or more advertised download speeds). As the definition of “broadband” varies according to sources, high speed access networks are labeled “NGA” in this study. Indeed, such higher download speeds can only be reached with new technologies or enhanced legacy technologies: VDSL, FTTx, Docsis 3.x cable for fixed networks; LTE and, in the future, 5G for mobile networks.

The technological and industrial challenge for network operators now consists in moving from existing legacy networks (copper-DSL or standard cable) which deliver less than 25 Mbps download connection speeds to new or enhanced technologies (optical fiber and Docsis 3.x for cable, and VDSL for copper). For copper networks, the switch from DSL to FTTx requires heavy investments in the roll-out of a new infrastructure, even if some part of the copper trenching may be reused for fiber. The transition from DSL to VDSL does often require upgrading part of the local loop, and the actual download speed available to subscribers is closely linked to the length of the copper lines[4]. Industrial dynamics for cable technology are different because the shift from legacy-standard cable to NGA-Docsis 3.0 cable infrastructure does not require trenching. As a result, the technological transition for cable does not imply high costs related to infrastructure deployment[5]. Related connection speed depends however on the quality of the coaxial access line in the customer's premises.

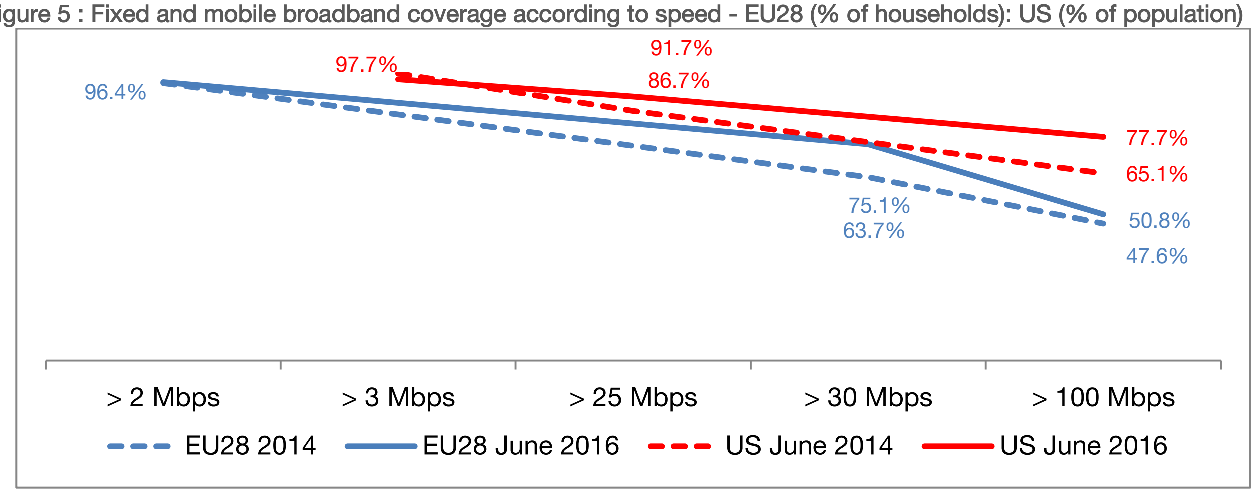
1.1.2. EU 28 is lagging at least 3.5 years behind the US for high bandwidth broadband coverage

This section presents the publicly available information on network coverage according to advertised connection speed. The related data are presented in Figure 5, which presents:

- For the US, the percentage of the population covered by a broadband offer at an advertised speed of, respectively, at least 3 Mbps, at least 25 Mbps and at least 100 Mbps, as of the end of June 2014 and 2016. US data for June 2014 are derived from the National Telecommunications and Information Administration (NTIA) and data for June 2016 are derived from the US Broadband availability Report of the US Broadband Association (computed thanks to the same Form-477 FCC raw data as NTIA).
- For the EU28, the percentage of households (a weighted average aggregation of each European country households) covered by a broadband offer at an advertised speed of at least 2 Mbps, at least 30 Mbps and at least 100 Mbps, as of the end of 2014 and the end of June 2016. Data for the European Union are provided in the Broadband Connectivity Reports[6].

Homogeneous information and fully comparable data in terms of period of time and level of connection speeds have not been provided by the authorities. As a result, it is not technically possible to derive a fully reliable comparison across regions in terms of advertised connections speed. However, it is still possible to build a comparison of network coverage figures in both regions for each ranges of connections speed.

Figure 5 : Fixed and mobile broadband coverage according to speed - EU28 (% of households): US (% of population)



Sources: NTIA, US Telecom Association and European Commission

[4] The speed allowed by VDSL decreases almost linearly with the length of the copper line. Starting from 40 or 50 Mb (excluding vectoring) to the MDF, it lands at 1 to 2 Mb at 2 km.

[5] In its connectivity for the Gigabit society published in November 2016, Liberty Global expected the upgrade of a cable line to Docsis 3.1 to cost € 20 per home, whereas the Canadian cable operator Rogers mentioned in February 2016 a cost of € 34 per home passed.

[6] https://ec.europa.eu/digital-single-market/en/download-scoreboard-reports

The Figure 5 shows that broadband coverage at an advertised speed of at least 2 Mbps was of 96.4% of households in Europe in June 2016 and fixed broadband coverage at an advertised speed of at least 3 Mbps was of 97.7% of population in the US in June 2016. The European Union was still lagging by 1.3 percentage points within the 2/3 Mbps range, despite a lower connection speed. Those percentages have remained nearly identical on the last years in Europe. For the US, the latest figure is related to fixed-only technologies, but in June 2014 the 3 Mbps fixed and mobile coverage figure provided by the FCC was 99.7%, showing in that case a potential over 3 percentage point gap between Europe and the US.

Within the 25/30 Mbps range, the US broadband coverage is also higher in 2016 with 91.7% of population covered, versus only 75.1% of households covered in the EU28. The gap between both areas is thus wider, and amounts to 16.6 percentage points. However, the European Union is experiencing a catch up, with a stronger deployment growth rate (+11.4 percentage points in Europe over 18 months, versus + 5.0 percentage points over 2 years in the US). As of today (mid-2016 figures), Europe is lagging more than 4 years behind the US for very high speed broadband coverage above 25/ 30 Mbps.

On the upper 100 Mbps bandwidth, the coverage rates reached 50.8% in the European Union and 77.7% in the US in 2016. This 26.9 percentage point gap has been widening over time, as in June 2012, the US had 47.1% population covered with 100 Mbps broadband and the EU28 had a comparable rate with 43.8% of households covered in 2013. As of today (mid-2016 figures), Europe is lagging 3.5 years behind the US for very high speed broadband coverage above 100 Mbps, as it has sharply increased in the US between 2012 and 2016 while it has been flattish in the EU28, at least until 2014.

Table 1: Fixed and mobile broadband coverage by download speed -EU28 (% of households); US (% of population)

	> 2 Mbps	> 3 Mbps	> 25 Mbps	> 30 Mbps	> 100 Mbps
EU 28 - 2013	96.3%			56.5%	43.8%
EU 28 - 2014	96.4%			63.7%	47.6%
EU 28 – June 2016	96.7%			75.1%	50.8%
US - June 2012		98.2%	78.5%		47.1%
US – 2013			85.7%		62.5%
US – June 2014		99.7%	86.7%		65.1%
US – June 2016*		97.7%	91.7%		77.7%

*Sources: NTIA, US Telecom Association and European Commission * related to fixed technologies only*

These data are obtained by using the theoretical connection speed according to the deployed technology. They are only a proxy to the actual connection speed delivered at the customer premises, which depends on a range of parameters. For copper technologies (VDSL), the actual connection speed is a decreasing function of the length of the copper line. For cable technology, the actual connection speed will also depend on the number of simultaneous active end-users and on the quantity of spectrum band allocated to the internet. For mobile broadband technology, the actual connection speed depends on the spectrum of the cell, on the type and the number of simultaneous active end-users as well as on the topographical environment.

1.2. Fixed High Broadband coverage is higher in the US thanks to cable availability

Public authorities are also providing coverage data according to each technology deployed. These data evidence the fundamental technological choice of the US to rely to cable to deploy high speed broadband network, whereas Europe relies more on its upgraded historical copper network while progressively switching to fiber. The gap in favour of the US is unambiguous; latest mid-2016 figures show however some catch-up to the benefit of Europe for VDSL and FTTP. The Appendix 3 shows that it is true for all types of areas, including rural ones.

1.2.1.Europe has moved ahead of the US in terms of VDSL Broadband coverage in 2016

The DSL technology is widely deployed and largely available in both the European Union and the United States, with a network coverage reaching 94.3% in the European Union and 87.8% in the US at the end of June 2016. Those very high coverage rates have remained quite stable during the last few years. A part of DSL connections can be upgraded to VDSL, thereby providing larger bandwidth and ideally delivering faster download connection speeds to end-users.

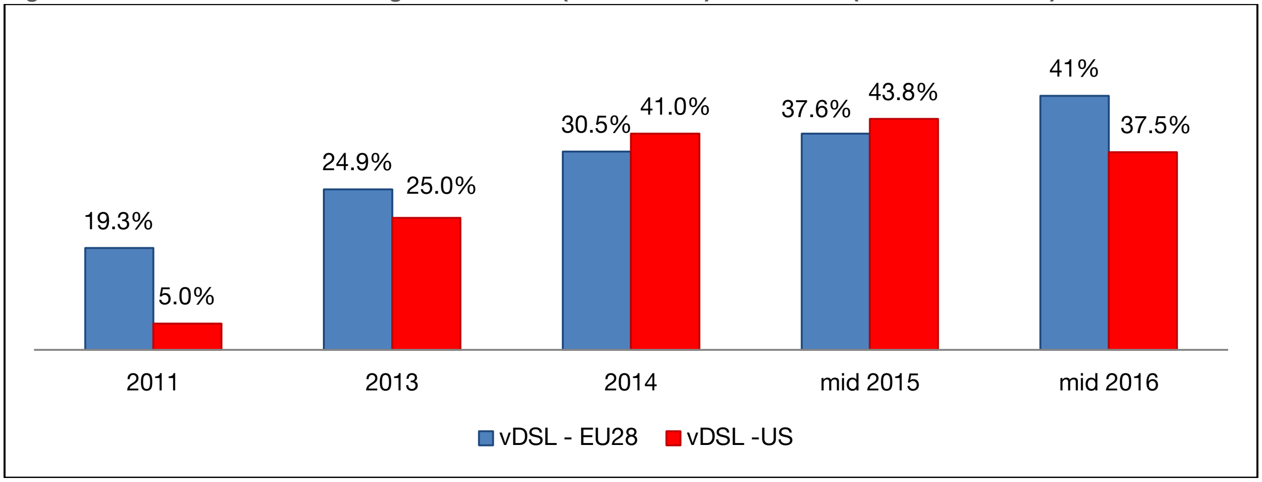
Only a part of VDSL connections, however, are considered to be "NGA". This is due to a rapid decline in the speed with the length of the copper access line. Not all national authorities in European Member States' have formally approved VDSL technology, which has slowed down the process of its adoption across the Union. Some regulatory issues are also impeding the deployment of VDSL, which further delays the substantial efficiency gain that would be delivered by vectoring. VDSL technology is notwithstanding commonly deployed by telecom operators as a mean to upgrade rapidly their customer service quality.

As shown in

Figure **6**, for VDSL the US have first been lagging behind the European Union, then have been catching-up, thanks to ATT deploying its "U-verse" (now renamed AT&T internet) service. However, the latest data show a reversing trend, with Europe now outpacing the US, thanks to a strong dynamic in some European countries, like Germany, where VDSL availability has enjoyed a dramatic increase to 58.8% households mid-June 2016, from 48.5% a year before, or Italy, where VDSL jumped to 66.4% coverage in June 2016, versus only 32.8% a year before.

The US coverage data reported in all the figures are expressed in terms of housing units, and the EU28 coverage data from the 2016 Europe's Digital Progress Report are expressed in terms of households.

Figure 6: VDSL broadband coverage in the EU28 (% of homes) and the US (% of households)



Sources: FCC, US Telecom Association and European Commission

1.2.2. Docsis 3.0 Cable broadband coverage far higher in the US than in the EU28

Cable infrastructure has been widely deployed in the US over the last four decades. Cable infrastructure HFC (Hybrid Fiber Coaxial) has been deployed since 1970 in order to provide TV channels to the customers. A dramatic shift to the Docsis 3.0 technology has occurred since 2011: standard cable coverage in the US has reached 52.6% of housing units in 2010, and has then dropped to 12.65% in 2012 due to the rapid migration to upgraded Docsis 3.0 cable technology, which covered 77.7% of housing units in 2012 against only 38.9 % two years before.

The wide historical reach of cable networks in the US can be explained by the nature of the infrastructure in place. Cable networks have indeed been heavily deployed in the 1980s' in order to originally handle a minimum of fifty TV channels. Therefore, the evolution from standard cable to "NGA"-Docsis 3.0 cable mainly amounts to an operation of deployment of access network and customer equipment by cable operators[7].

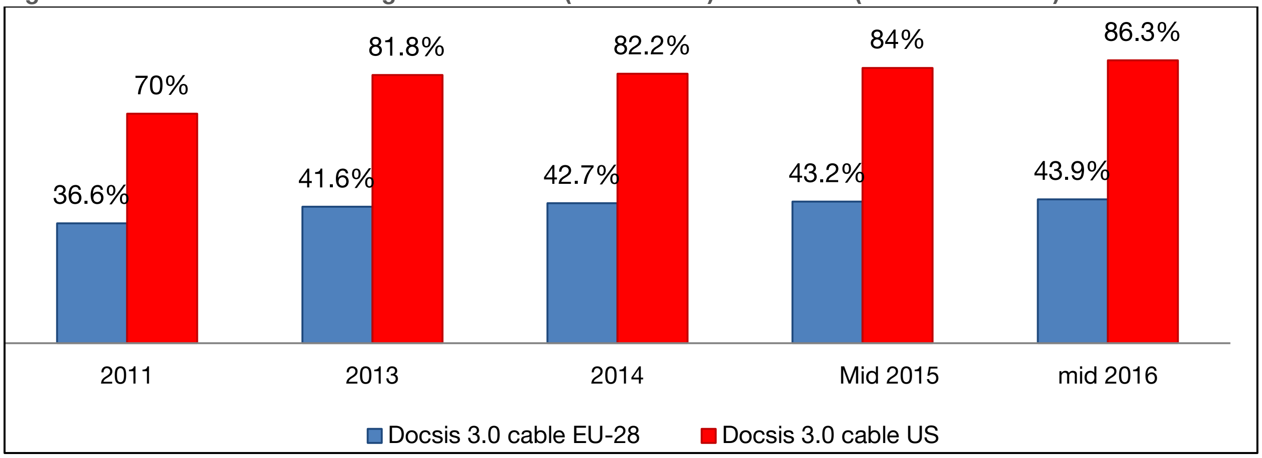
The technological transition from standard cable to Docsis 3.0 cable has also occurred across the European Union. Cable was available to 44.4% of European households in 2016 according to the European Commission's data, while the Docsis 3.0 technology had 43.9% coverage. In the European Union, 99% of cable infrastructure was Docsis 3.0 technology in 2016, versus 97% in 2014. Two-thirds of EU28 Member States had achieved complete switch to Docsis 3.0 cable technology in 2016.

Overall, it appears that the US are significantly above the EU28 in terms of NGA cable coverage: the Docsis 3.0 network coverage has increased from 77.8% to 86,3% from 2012 to mid-2016 in the US, whereas in the European Union, this coverage has only increased from 39.3% to 43,9% (

[7] see: http://www.persee.fr/doc/colan_0336-1500_1985_num_63_1_1667

Figure 7).

Figure 7: Docsis 3.0 cable coverage in the EU-28 (% of homes) and the US (% of households)

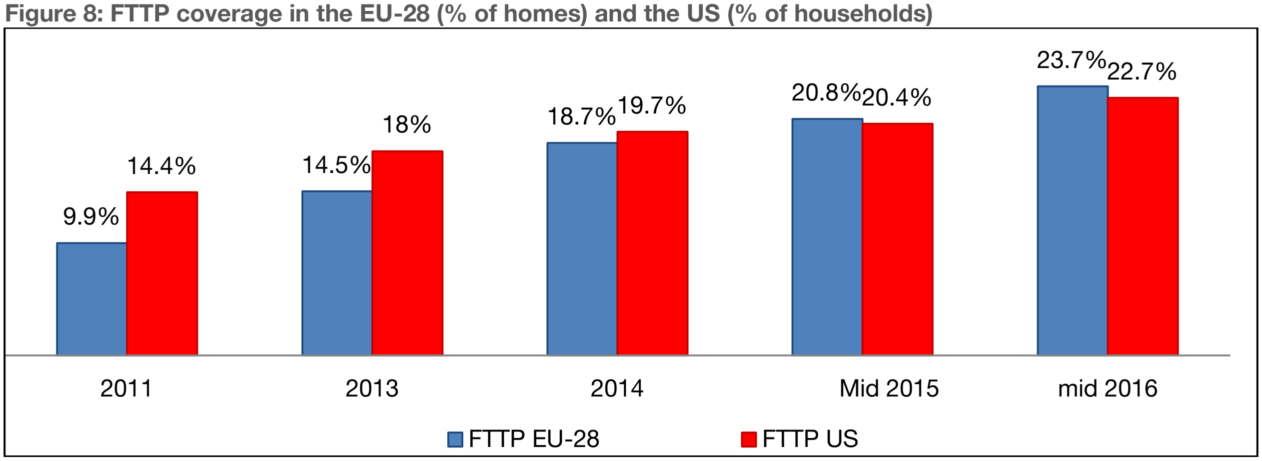


Sources: NTIA, US Telecom Association and European Commission

1.2.3. Europe now benefits from higher FTTP coverage than the US

As shown in Figure 8, optical fiber (Fiber To The Premises - FTTP) coverage is still in its early development stage in both the US and the EU28. Barely only 25% of the US housing units were covered with optical fiber mid 2016 (which represents a 8 points increase in 6 years, from 14.4% in 2011 to 22.7% in 2016). The European Union has been catching up in the most recent period and is now ahead of the US for FTTP availability, with network coverage of 23.7% of the total households. Indeed, FTTP rollout in the European Union has been relatively vivid. The deployment of fiber in Europe increased from nearly 10% to 23.7% between 2011 and 2016. In the United States, optical fiber access is delivered by more than 1100 providers, with only three of them covering more than ten million housing units, over several States. Verizon Fios is the leading operator with 33 million households covered over ten states [10.2% national coverage], followed by Lightower fiber networks, which covers 12.8 million households over twenty States [3.95% national coverage].

Figure 8: FTTP coverage in the EU-28 (% of homes) and the US (% of households)



Sources: NTIA, US Telecom Association and European Commission

1.3. The US are 2.5 years ahead of EU28 for wireless broadband coverage

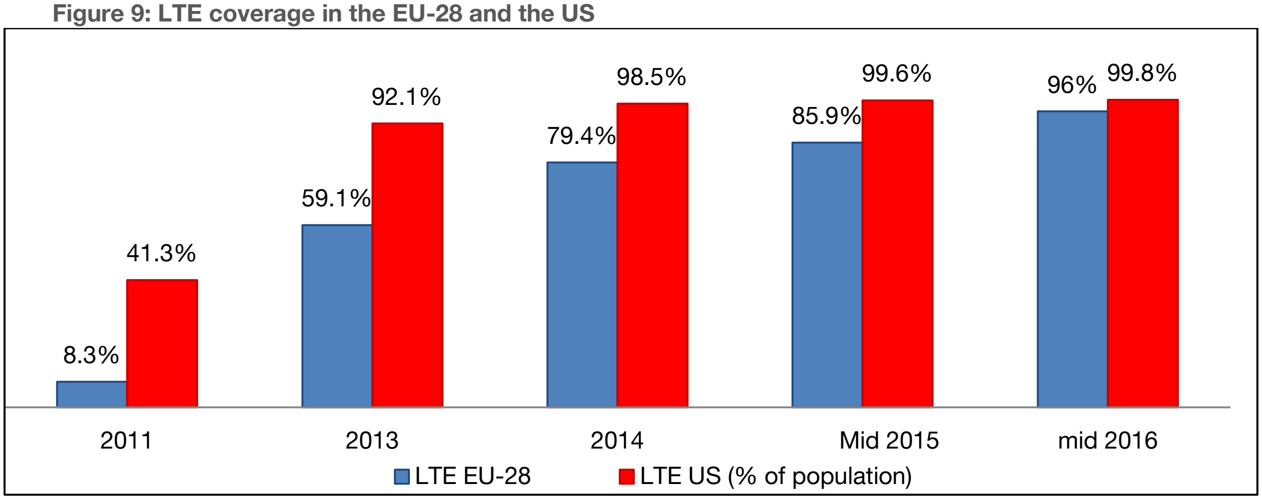
Valid detailed information on wireless broadband access by related bandwidth range is more difficult to obtain than information on fixed broadband access. Indeed, the theoretical connection speed associated to each mobile technology varies considerably according to the spectrum made available to network operators. Moreover, some uncertainties specific to mobile technology prevents from deriving a proper unbiased international comparison in terms of wireless broadband coverage.

1.3.1. Earlier deployment of LTE in the US leads to higher coverage than in the EU28

The comparison between the European Union and the United States in terms of LTE ("4G") mobile network coverage is derived on the basis of information provided by the FCC and the European Commission. The FCC provides mobile broadband coverage information in terms of percentage of population having access to the LTE technology, while the European Commission considers mobile broadband coverage in terms of homes covered. The nationwide LTE coverage is higher in the United States in December 2016 (with 99.8% of population covered, or 73.1% of territories), despite strong dynamics in the EU28. The deployment of LTE in the European Union has indeed been increasing at a very fast pace between 2011 and 2016, reaching 96% of homes covered mid-2016 (starting from 8.3% in 2011).

In the US, the operator Verizon Wireless launched the first LTE commercial offering in late 2010. As a result, at the end of 2016, the LTE coverage from Verizon reached 97% of population. The other three largest US mobile operators (AT&T, Sprint and T-Mobile US) also launched LTE offers between late 2011 and mid-2012, and are covering at the end of 2016 respectively 97.6%, 87.8% and 94.6% of the US population. In Europe, LTE commercial offerings have only started to widely expand since 2012. As a result, considering mid-2016 figures, Europe is lagging by two years and a half behind the US in terms of LTE coverage, despite an accelerated pace last year, as shown in Figure 10.

Figure 9: LTE coverage in the EU-28 and the US



Sources: FCC and European Commission –latest US figure relates to December 2016.

1.3.2. Bias affecting the comparison of between wireless broadband coverage

An unbiased and fully reliable comparison between the EU28 and the US in terms of wireless network remains uneasy, as the specifications for mobile internet technologies differ between the European Commission and the US authorities. The European Commission provides general statistics for LTE without specifications in terms of advertised connection speeds, while the US authorities provide LTE figures with either a minimum advertised speed of 200 kbps, or a minimum advertised speed of 10 Mbps (download speed) and 1 Mbps (upload speed).

As it was shown in Appendix1 on Figure 24, Figure 24 and Figure 24, there is a strong discrepancy between LTE "real world" actual download speed, and the minimum LTE download speed reported by the FCC for the US. In the 2016 edition of its Broadband Progress Report, the FCC affirms that in 2014, while 99% of US inhabitants had access to a mobile provider displaying LTE technology, only 47% of US inhabitants had access to a mobile service provider displaying LTE technology services at a minimum advertised speed of 10 Mbps/1 Mbps, and only 14.6% of them had access to LTE at an advertised speed of more than 25 Mbps[8]. Figures from previous FCC reports based on maximum advertised speed show that, in 2011, 73% of US inhabitants had access to at least one mobile provider using LTE technology to deliver services with a minimum advertised speed of 10 Mbps/1 Mbps while LTE coverage was 89% in 2012 and 97% in 2013. The latest FCC report for the year 2016 lags this information.

The European Commission does not provide any indications on the connection speed being actually delivered by LTE networks. However, according to information provided by the mobile telecommunications industry, the LTE technology delivers a theoretical maximum download speed of 150 Mbps, and an actual download speed of 20 Mbps. In the absence of any indication about the minimum advertised speed of LTE in the European Union, it is not possible to draw a direct comparison with the United States.

In the European Union, the Digital Agenda indicator for mobile broadband coverage is defined as the percentage of households living in areas that are covered by the third generation mobile broadband (HSPA protocol) as well as the "4G" (LTE) technology. LTE coverage has increased rapidly in Europe, starting at 8.3% in 2011 to reach a 96% homes coverage in 2016, whereas HSPA coverage was already 94.7% in 2011 and topped 98% in 2016.

[8] https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report

2. NGA adoption is higher in the US, but Europe is catching up

This section presents information on the commercial adoption of NGA networks and derives a comparison between the European Union and the US in terms of each type of NGA technologies. The rate of commercial adoption is measured by the penetration rates of each type of fixed and mobile access network. Network coverage is the main prerequisite for adoption by customers. However, other parameters are key to lead to commercial subscription:

- Advertised speed has to deliver an appropriate end-user experience at peak time, with a substantial benefit compared to connectivity experience delivered by former technological generations.
- The price should be such as not to prevent the adoption of NGA offers and their related services.
- Administrative procedure and terminal equipment installation operations have to be made as transparent as possible and as easy as possible for the end-user.

2.1. Very high fixed broadband adoption is higher in the US for all technologies

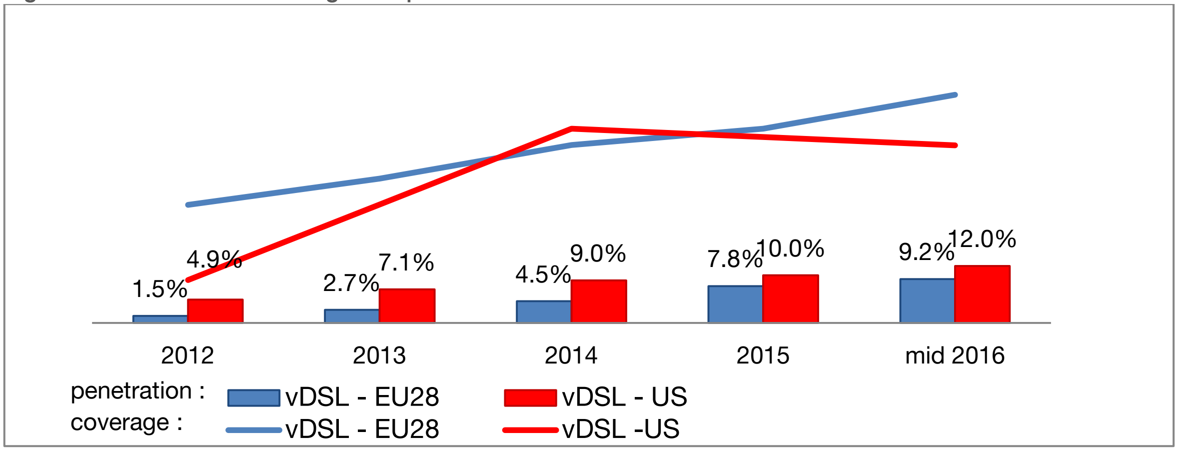
This section provides a comparison between the commercial adoption rates of NGA in the European Union and the United States. The NGA considered in this section are VDSL, FTTx and Docsis 3.x cable. The European Commission provides the number of NGA subscribers by technology, while the number of NGA subscribers in the US is derived from IDATE "World FTTx Markets" report of August 2017. The penetration rates of each network in the European Union and the United States are then obtained by dividing the number of subscribers by the total number of households (the size of European households is provided by the "Eurostat population and social conditions" database and the total number of US households is provided by the US Census).

The three figures which follow provide evidence of both network coverage (also in terms of households) and penetration rates, for VDSL, FTTx and Cable Docsis 3.x in both the US and the European Union. The NGA penetration rate is higher in the US than in the European Union for each NGA technology over the whole period. The most significant gap between the US and the EU28 relates to the penetration of cable technology, while VDSL and FTTx as well are still more widely adopted in the US.

2.1.1. VDSL adoption is higher in the US despite earlier and current wider deployment in Europe

The penetration rate of VDSL in the European Union has increased from 1.48% to 9.2% of households between 2012 and mid-2016, while in the US the penetration rate of VDSL has increased from 4.9% to 12% of households over the period. The rate of commercial adoption has been higher in the US despite a lag in the pace of network coverage. Figure 11 provides both VDSL penetration and VDSL network coverage rates in the US and the EU28 over 2012-2016.

Figure 10: NGA- VSDL coverage and penetration rate in the EU28 and the US

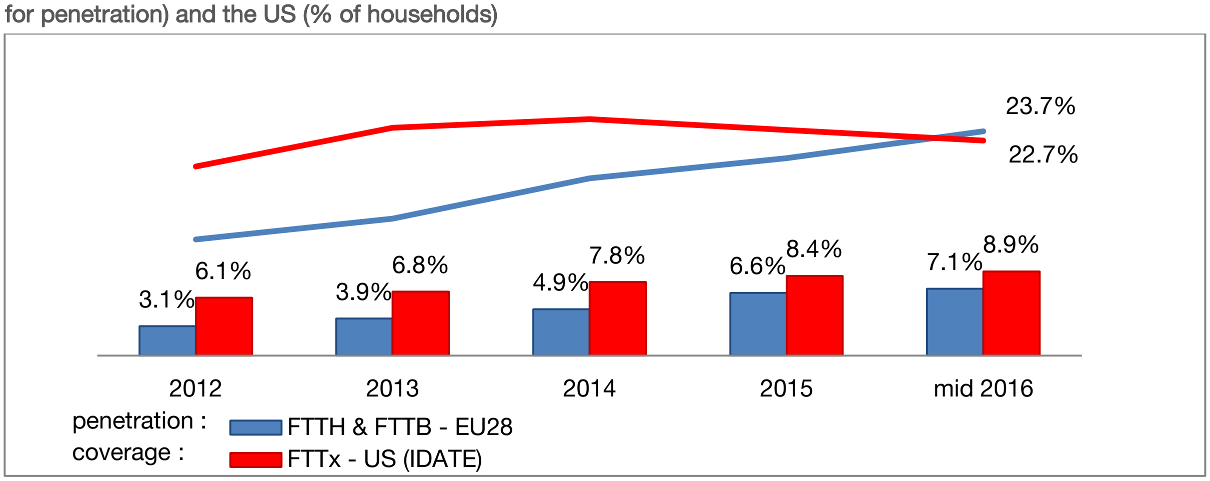


Sources: FCC, US Telecom Association, IDATE, and European Commission

2.1.2.Broadband adoption of optical fiber is also higher in the US

Figure 12 provides both the rates of penetration and of network coverage in the EU28 and the US for optical fiber technology (FTTP). The FTTP penetration rate in the European Union has increased from 3.10% to 7.1% of households between 2012 and mid-2016, while it has increased from 6.11% to 8.9% of households in the US over the period. Europe was lagging by 1.5 year behind the US in terms of fiber adoption at the end of June 2016.

Figure 11: NGA- FTTx coverage and penetration rate in the EU28 (% of homes for coverage and % of households for penetration) and the US (% of households)



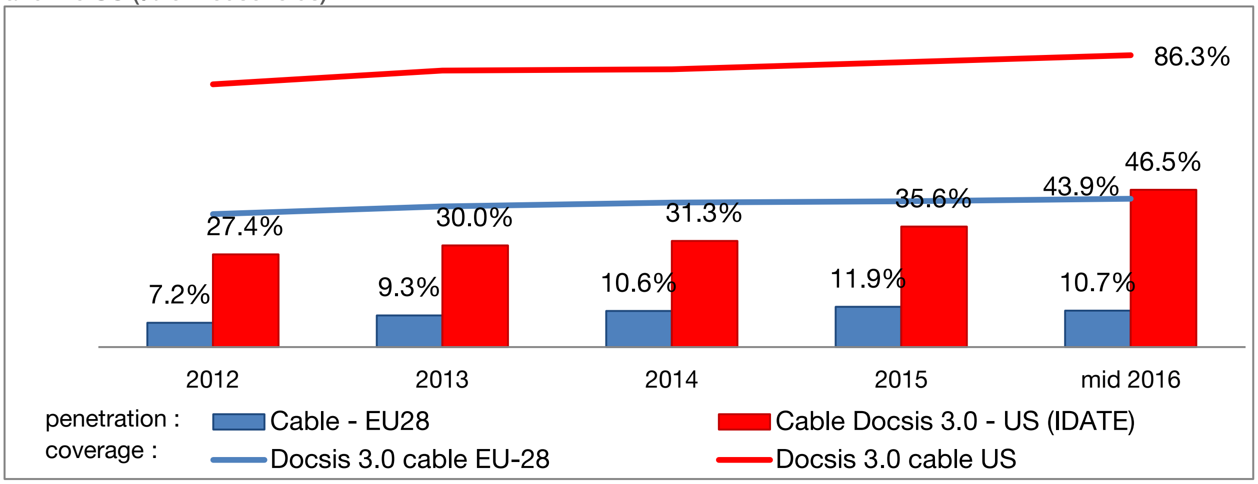
Sources: FCC, US Telecom Association, IDATE, and European Commission

2.1.3.Very high broadband adoption of cable is far higher in the US

For VDSL and optical fiber penetration rates, the European Union has, to a large extent, limited the gap with the US, even if it still lagged behind the US levels at mid-2016. On the contrary, for cable technology, the advance of the US was still very substantial. As shown in Figure 13, in 2016, 46.5% of US households had subscribed to a cable offer, while only 10% of European households had a subscription. The gap in favor of the US in terms of penetration rate is consistent with the gap in terms of network coverage (39.3% in Europe against 77.8% in the

US in 2012, and 43.9% in Europe against 86.3% in the US in 2016). Both coverage and penetration rates trends do not evidence any dynamics of European catch-up.

Figure 12 : NGA- Cable penetration rate in the EU28 (% of homes for coverage and % of households for penetration) and the US (% of households)



Sources: FCC, US Telecom Association, IDATE, and European Commission

2.1.4. Ratio of coverage to penetration questions NGA connectivity attractiveness

In both the United States and the European Union, a significant gap can be evidenced between the rate of NGA service penetration and the extent of network coverage, as shown by the ratios of penetration over coverage (the penetration rate divided by the coverage rate). The adoption rate is generally increasing at a higher pace than the roll-out of networks. The penetration over coverage ratio has been mainly increasing over 2012-2016. Such trends indicate that the dynamics of commercial adoption of services have been increasing relatively to the rate of network coverage over the period. The different ratios for the different technologies suggest that higher bandwidth technologies are more attractive to customers (ratios for FTTH are higher than for VDSL), and that adoption suffers from a lagged effect (cable in the US enjoys the highest ratio)

Table 2 : Adoption over coverage by technology in EU28 and US

	2012	2013	2014	2015	mid 2016
vDSL - EU28	5.9%	9.0%	12.1%	18.9%	19.2%
vDSL - US	19.7%	23.2%	23.8%	24.4%	24.9%
FTTH & FTTB - EU28	25.3%	27.1%	26.3%	31.8%	29.8%
FTTP - US	30.6%	28.1%	31.1%	35.4%	39.2%
Cable - EU28	18.2%	22.5%	24.9%	27.5%	24.5%
Cable Docsis 3.0 - US	35.2%	36.7%	38.1%	42.3%	53.8%

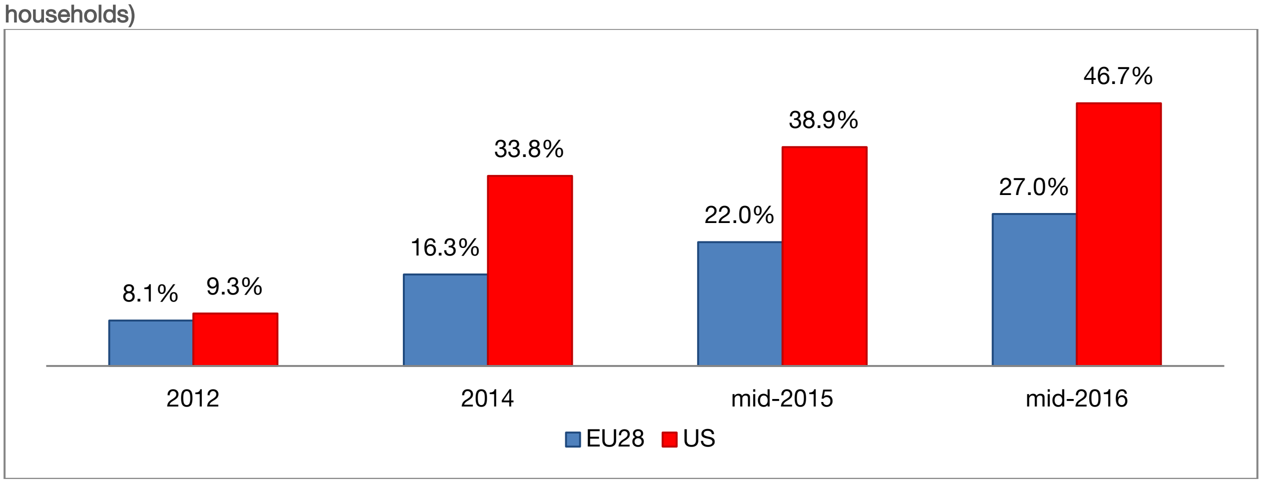
2.2. Very high broadband adoption by download speed confirms US advantage

This section presents the rates of fixed broadband penetration according to the advertised download speed delivered by NGA technologies. The European Commission provides penetration rate information on the basis of population at the beginning of the period; in order to bring some consistency between the previous analysis in terms of adoption per housing units and this section, per population data have been translated into data per housing units, with population and household figures provided by the European Commission. The penetration rates in the US are here obtained by dividing the number of subscribers (as provided by the 2017 IDATE report) by the total US housing units provided by the Census bureau.

As shown in Figure 13, the penetration rate of high speed broadband (at an advertised speed of more than 25 Mbps) in the US and in the EU28 (at an advertised speed of more than 30 Mbps) were reaching respectively 18.3% and 11.6% of their population in 2016.

The gap between the EU28 and the US has been widening since 2012 when the US operators have shifted their cable network to the Docsis 3.0 technology. This technological shift has allowed to increase the share of US population having access to high speed broadband. This increase in the availability of high-speed cable technology is shown by the rapid increase in the penetration rate in the US after 2012. While NGA penetration rates were almost similar in both regions in 2012 (around an average of 8.5%), NGA penetration rate reached 33.8% in the US in 2014 against 16.3% in the EU28. The penetration rate of NGA has continued to increase at a faster rate in the US since then.

Figure 13: Fixed broadband penetration with at least 25/30 Mbps download speed in the US and the EU28 (% of households)

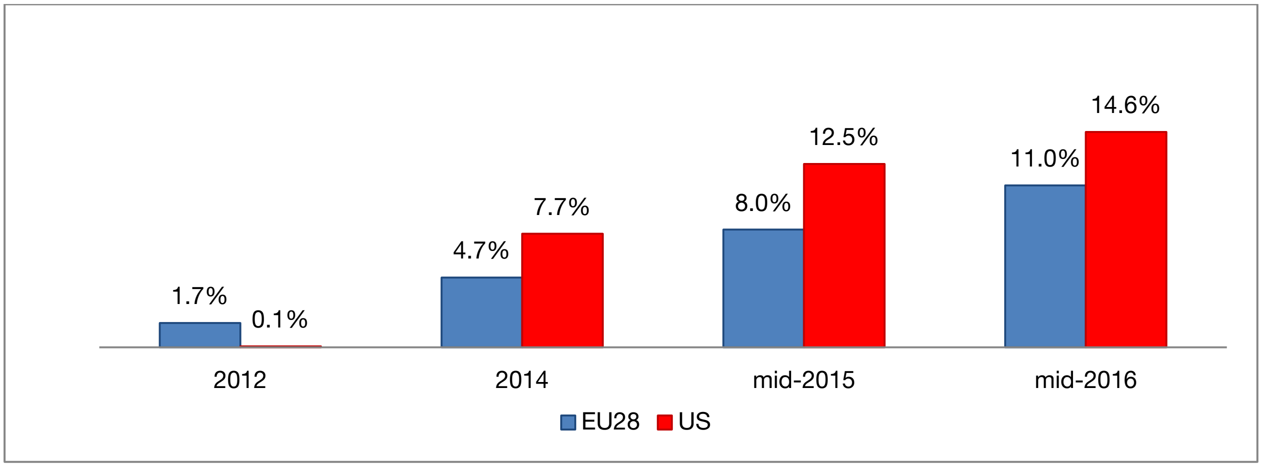


Sources: FCC, US Telecom Association, and European Commission

The penetration rate of very high speed broadband (displaying at least 100 Mbps download speed), as shown in

Figure 14, has increased dramatically in the US between 2012 and 2014, and at lower pace ever since, reaching 14.6% of households in 2016. In the European Union, the adoption rate of very fast broadband (delivering a connection speed of at least 100 Mbps) still remains under the American one, reaching 11% of households in 2016, but enjoys a sustained momentum (the penetration rate has increased from 8% to 11% last year).

Figure 14: Fixed broadband penetration with at least 100 Mbps download speed in the US and EU28



Sources: FCC and European Commission

3. Exponential growth of data traffic consumption in the US; US well ahead of Europe

This section analyses the trends of IP traffic per capita, in terms of aggregate Internet traffic and of fixed and mobile Internet traffic. The intensity of Internet usage is measured by the volume of data traffic per capita. It is acknowledged that sufficiently high bandwidth generates unbridled traffic on the internet. This section analyses the consumption of digital traffic and the volume of usages thus derives a comparison between North America (the US when information is available) and Western and Eastern Europe (depending on the number of Member countries available in the sources). As the US account for more than 93% of total North American IP traffic, it is likely that the evolution of North American Internet and IP traffic in levels is largely attributable to the US trends. The levels of traffic per capita and usage per capita provide valuable information on the intensity of digital consumption in a geographic area. Information on IP traffic and broadband usages are provided by Cisco for the US, Western and Central-Eastern Europe (including Russia). Cisco VNI forecasts statistics for the year 2017 indicate that a greater proportion of population is using internet in the US than in Europe: 89% of total US population against 82% of total Western Europe population (and only 60% of total Central and Eastern Europe population) are internet users. This discrepancy relates to notable geographical differences in data usage. The main findings of Cisco are reported in Appendix 4[9].

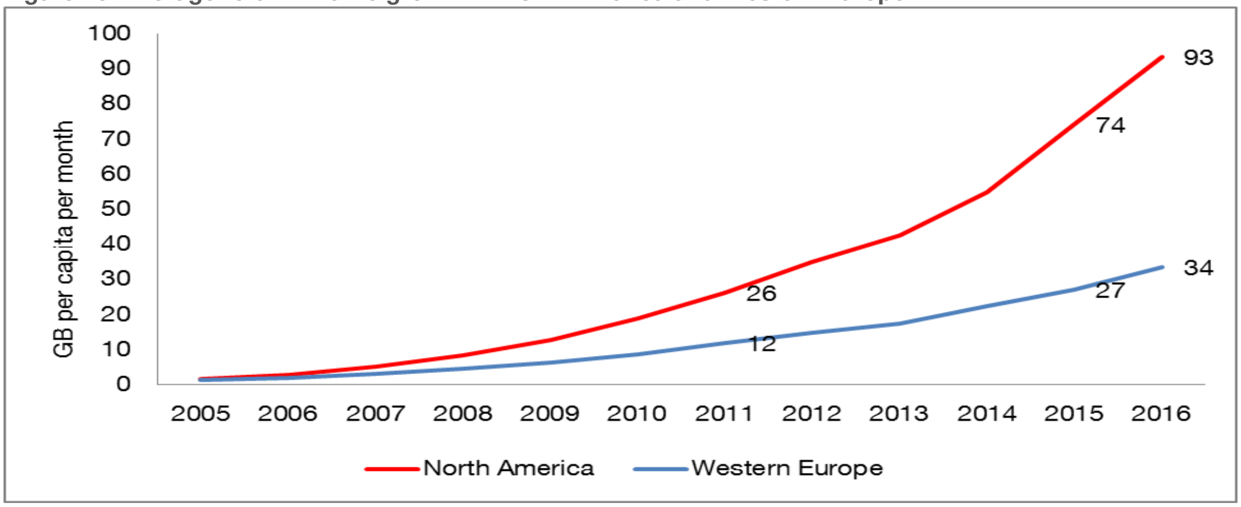
3.1.1. IP Traffic is far more developed in the US than in the EU28

IP traffic is in general far more developed in the North American continent (USA and Canada) than in Europe and IP and Internet traffic per user are increasing faster. The North American continent, with a IP traffic per capita of 93.6 in 2016 is also way ahead of Western Europe, which had only a 33.6 GB per capita traffic level in 2016 and Eastern and Central Europe, with only 12.7. As shown in figure 16, the increase in IP traffic per capita between 2015 and 2016 has been faster in North America (26%) than in Europe (22%). As a matter of fact, in 2016, a Western European internet user was generating the same amount of IP traffic (33.6 GB) as its North American counterpart did in 2012 (35 GB). This four years lag evidences the extent of the gap between America and Europe in terms of individual internet usage. These sharp cross-country differences are partly due to the number

[9] More detailed information on IP traffic provided by Cisco is available on Appendix 4, including traffic forecast until 2020.

of connected devices per capita in each of the regions: the US had 7.8 connected devices per capita in 2016, (7.7 for North America) whereas Western Europe had only 5.3 connected devices per capita (and Central and Eastern Europe had only 2.5 connected devices per capita).

Figure 15: Average total IP traffic growth in North America and Western Europe[10]



Sources: Cisco

The recent update of Cisco VNI indicates that the advance of North America over Europe is largely attributable to the advance of the US. As shown in Table 3, the US are way ahead of Europe in terms of IP traffic and Internet usage. In 2016, the US IP traffic per capita reached 96.7 GB (77.3 in 2015). In 2016, an average US internet user generated 70.8 GB of IP traffic per month (55.6 in 2015), whereas an average internet user only generated 31.1 GB per month in Western Europe (25.7 in 2015) and 15 GB per month in Eastern and Central Europe (12.4 in 2015). These measurements based on the average internet user are also valid in terms of traffic generated by an average connected household. In 2016, an average household generated 135 GB per month in the US, whereas an average Western European household only generated 64.4 GB per month and an average Eastern European household only 39.7 GB per month. In addition, the annual growth rate of IP traffic generated by an internet household between 2016 and 2015 were higher in the US than in (+28% in the US against +21% in Western Europe, and +21% in Eastern and Central Europe). The bulk of all consumer internet traffic is originated by internet video traffic, which accounted for 75% of total IP traffic in the US and 66% of total IP traffic in Western Europe, and 56% of total IP traffic in Eastern and Central Europe in 2016 and for 73%, 60% and 50% in 2015 respectively. More detailed data indicates that Consumer IP VOD traffic was 33% of consumer IP traffic (28% of total IP traffic) in the US 2016, and consumer IP VOD traffic was 20% of Consumer IP traffic (16% of total IP traffic) in Western Europe.

Moreover, the proportion of households generating more than 250 GB per month in 2016 was significantly higher in the US (22%) than in Western Europe (6.1%) and Eastern and Central Europe (2.3%). In addition, the proportion of households generating more than 500 GB per month in 2016 was also significantly higher in the US (10%) than in Western Europe (1.7%) and Eastern and Central Europe (1.1%). This proportion has doubled in the US between 2016 and 2015, while it has hardly increased in both European regions.

[10] Historical data were only available for North America (US + Canada)

On the basis of various indicators of Internet usage intensity, it appears that Internet usage is more intensive in the US and North America than in Europe, and that the share of users generating significant amount of traffic is far larger in the US.

Table 3: IP traffic & usages in the US and in Europe

	US	WE	EEC*
IP traffic per capita in Gigabytes in 2016	96.7	33.6	12.7
IP traffic per capita in Gigabytes in 2015	77.3	27.3	9.9
IP traffic volume evolution 2016 vs 2005	x 51	x 22	x 70
Traffic generated by the average internet user, in gigabytes per month in 2016	70.8	31.1	15.0
Traffic generated by the average internet user, in gigabytes per month in 2015	55.6	25.7	12.4
Growth in traffic generated by the average internet user 2016/2015	+ 27%	+ 21%	+ 20%
Traffic generated by the average internet household, in gigabytes per month in 2016	172.3	64.4	39.7
Traffic generated by the average internet household, in gigabytes per month in 2015	135	53.2	. 32.8
Growth in traffic generated by the average internet household 2016/2015	+ 28%	+ 21%	+ 21%
Proportion of Internet video traffic in all consumer Internet traffic in 2016[11]	75%	66%	56%
Proportion of Internet video traffic in all consumer Internet traffic in 2015	73%	60%	50%
Proportion of internet households generating more than 250 gigabytes per month in 2016	22%	6.1%	2.3%
Proportion of internet households generating more than 500 gigabytes per month in 2016	10%	1.7%	1.1%
Proportion of internet households generating more than 250 gigabytes per month in 2015	19.0%	3.6%	2.1%
Proportion of internet households generating more than 500 gigabytes per month in 2015	5.0%	1.2%.	1.1%

** including Russia; Source: Cisco*

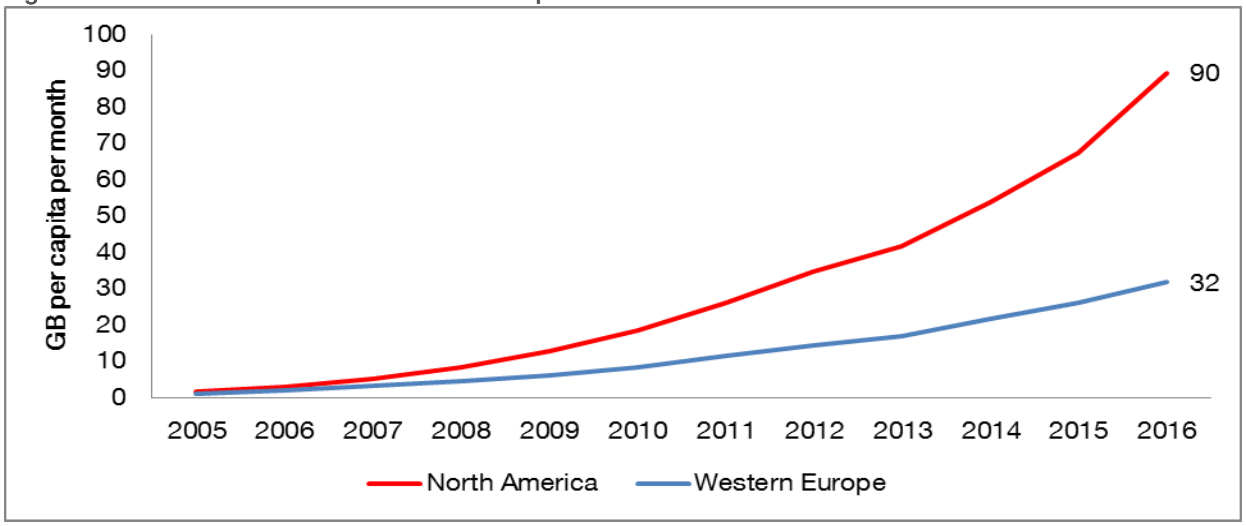
3.1.2. The US account for the bulk of fixed Internet Traffic

As fixed IP traffic accounts for more than 95% of total IP traffic, the discrepancies observed for the cross-country evolutions of total IP traffic are also largely observed for the compared evolutions of fixed IP traffic. As a result, the 2016 level of fixed IP traffic in Western Europe was comparable to the level of fixed IP traffic that North America had in 2012, which relates to a 4 years lag. Indeed, according to calculations on the basis of information provided by Cisco, at the end of the year 2016, the level of monthly fixed IP traffic per capita was 89.6 GB in North America, while it was 31.9 GB in Western Europe, which is equivalent to the fixed IP traffic per capita in North America that was measured in 2012 (35 GB).The evolution of monthly fixed IP traffic per capita in both areas are presented in figure 17, which evidences an increasing gap over the period 2012-2016, and a strengthening of the American advance. The exploration of more detailed information reveals that in 2015, the

[11] https://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html#

fixed IP traffic in North America was allocated between internet (63%) and non-internet managed IP, allocated between IP TV and VOD traffic (34%) and corporate IP WAN traffic (3%). In Western Europe, that same year, internet traffic accounted for 77% of total fixed IP traffic, the remaining part being attributable to IP TV and VOD traffic for 18% and corporate managed WAN traffic for 5%. Furthermore, in the US, fixed/wired IP traffic was 61% of total IP traffic in 2016, while it accounted only for 49% in Western Europe. Besides, in the US, consumer fixed Internet traffic was 64% of consumer IP traffic (55% of total IP traffic in 2016), while it was 75% of consumer IP traffic (60% of total IP traffic) in Western Europe.

Figure 16: Fixed IP traffic in the US and in Europe



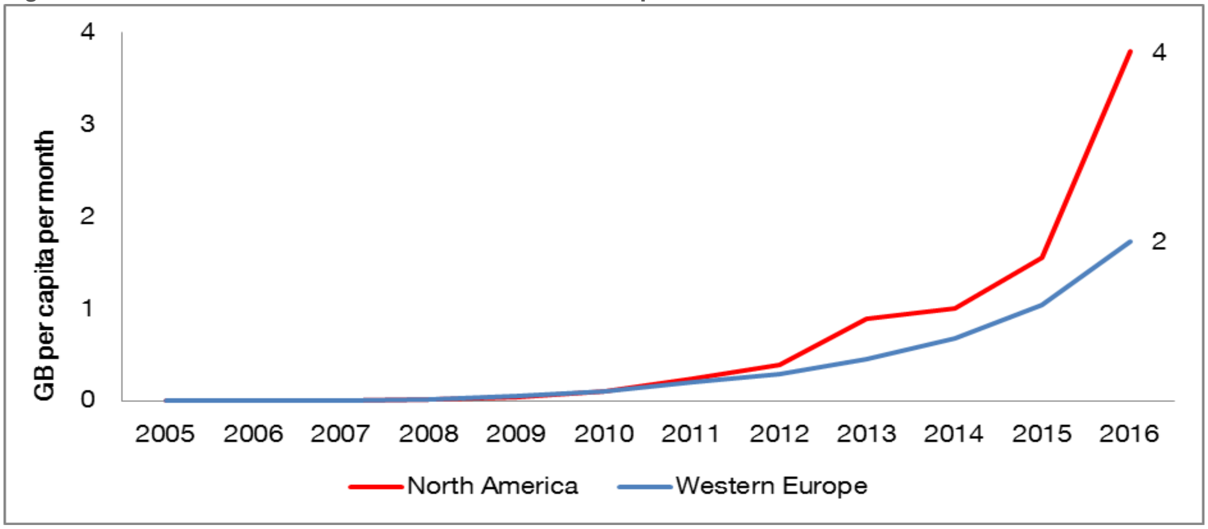
Source: Cisco

Other sources from OFCOM and OVUM reports confirm the ranking evidenced on the basis of Cisco VNI information, even if they rely to other types of measures. OFCOM and OVUM figures of fixed data traffic consumption are reported in Appendix 5.

3.1.3. Mobile Internet traffic also starts diverging between the US and the EU

Mobile internet usage still only represents a very small although fast growing fraction of total IP traffic. Mobile internet is relatively more important in Europe than in North America. North American mobile share of total IP traffic per capita has grown at a 76% average annual rate over 2012-2016, while the Western European share has grown at a 55% rate. In 2016 in North America, 4.1% of total IP traffic was carried over mobile networks (only 2.1% in 2015), whereas 5.2% of total IP traffic was carried over mobile networks in Western Europe (3.8% in 2015). In absolute terms, however, according to calculations from Cisco VNI mobile IP traffic is a year ahead in North America compared to Western Europe, with a level of 3.8 GB against a level of 1.7 GB in 2016. Recent evolution of mobile IP traffic shows evidence of a strengthening in the North America dynamics, while in Western Europe, mobile usage has evolved according to a more linear trend.

Figure 17: Mobile IP traffic in North America and in Europe



Source: Cisco

Just as for fixed traffic, additional analysis of mobile traffic with data provided by OFCOM and OVUM are detailed in Appendix 5, including per country comparison.

4. Higher IP traffic and capacity in the US leads to seemingly similar average speeds than in the EU.

This section analyses the available measures of connection speeds in Europe and the United States. The indicators of broadband coverage by advertised download speed of connections for both the United States and the European Union are provided by the FCC and the European Commission. Additional information is provided by the National Regulatory Authorities or industry representatives. The objective of this section consists in comparing the actual connection speeds experienced by end-users in Europe and in the US.

4.1. Broadband measured average connection speed are similar in the EU28 and the US

The average fixed broadband speed measures for IP traffic provided by Cisco report an advantage for the US over Europe. Broadband connection speeds as measured by Cisco for 2016 and 2015 may challenge the US leadership in advertised download speeds evidenced in the sections on broadband coverage by speed of connections. Based on Cisco's figures, the average connection speed does not seem to be a decisive differentiation factor between both areas, but still, it is higher in the US. In 2016, broadband average connection speed was 36.1 Mbps in the US (26.1 in 2015), 30.2 Mbps in Western Europe (22.8 in 2015), 29.2 Mbps in Central and Eastern Europe (25.3 in 2015). The rate of growth has been higher in the US over 2015-2016, (+38%) against 33% and 15% for both European areas respectively. In addition, the fact that 75% of US internet users could benefit from connections faster than 10 Mbps in 2016 (65% in 2015), against only 61% of Western European users (54% in 2015) and 60% Eastern and Central European (58% in 2015) users could provide an explanatory factor of the US advance in terms of internet traffic per capita and consumption intensity. The increase in the share of Broadband connections faster than 10 Mbps has been faster in the US than in Both European regions, notably Eastern and Central Europe where it hardly progressed between 2015 and 2016. A higher connection speed available to the end-users enables a heavier internet usage and digital services consumption intensity. With heavier digital usages and higher traffic, the US has still a higher average fixed broadband speed.

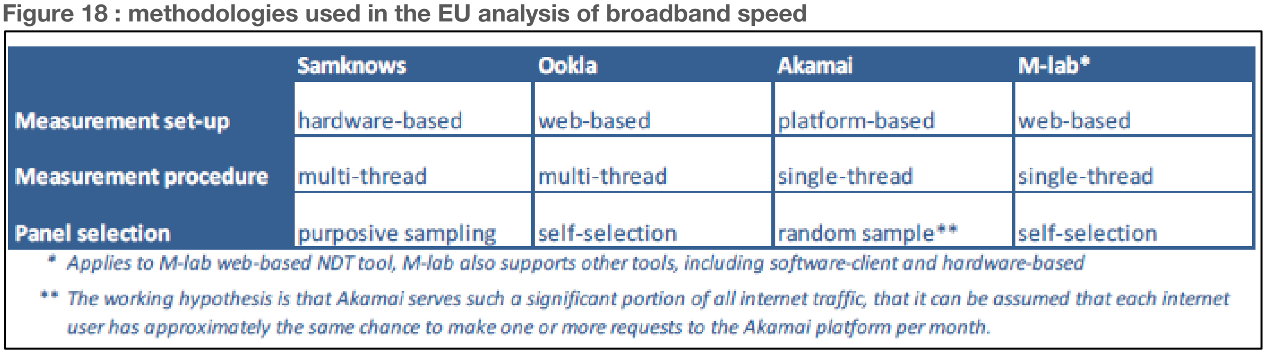
Table 4 : IP traffic speed in the US and in Europe

	United States[12]	Western Europe	Eastern & Central Europe
Average fixed broadband speed in Mbps in 2016	36.1	30.2	29.2
Average fixed broadband speed in Mbps in 2015	26.1	22.8	25.3
Average fixed broadband speed growth 2016/2015	+ 38%	+ 33%	+ 15%
Average fixed broadband speed growth 2015/2014	+ 18%	+ 5%	+ 14%
Broadband connections faster than 5 Mbps in 2015	87%	80%	81%
Broadband connections faster than 10 Mbps in 2015	75%	61%	60%
Broadband connections faster than 5 Mbps in 2015	78%	73%	74%
Broadband connections faster than 10 Mbps in 2015	65%	54%	58%

Source: Cisco

Alternatively, the European Commission published in 2015 an in-depth analysis of Broadband Speed, in a report that reviews global hardware and software/website-based broadband performance measurements from different sources (including M-Lab, Ookla/Speedtest, Akamai and SamKnows)[13]. The report compiles and compares results for the European Union and a range of other countries, including the United States. The data are as of 2007-2014. The Commission's report provides a summary of the different approaches as shown in Figure 18:

Figure 18 : methodologies used in the EU analysis of broadband speed



	Samknows	Ookla	Akamai	M-lab*
Measurement set-up	hardware-based	web-based	platform-based	web-based
Measurement procedure	multi-thread	multi-thread	single-thread	single-thread
Panel selection	purposive sampling	self-selection	random sample**	self-selection

* Applies to M-lab web-based NDT tool, M-lab also supports other tools, including software-client and hardware-based

** The working hypothesis is that Akamai serves such a significant portion of all internet traffic, that it can be assumed that each internet user has approximately the same chance to make one or more requests to the Akamai platform per month.

Source: European Commission: Stratix Report on broadband speed analysis – December 2015

The European Commission has explicitly expressed a preference for Samknows methodology (as measurements are made at the customer premises). Moreover, information produced by other providers has been harmonized to be made as comparable as possible to those of Samknows.

It appears that the growth trends of download speeds are relatively similar over time. However, the variations around the mean and the differences in levels are highly significant. Because of such high volatility, the European Commission concludes that the measurements of actual broadband connection speeds are inadequate to provide a reliable tool for public policy design and technology deployment monitoring.

4.1.1. No clear international ranking in terms of measured average connection speed

This section analyses the trends in quality of service measured as the actual download connection speeds being delivered to end-users, and provides an attempt to draw international comparisons on the basis of available data. According to the most recent information (from Akamai State of connectivity reports), the US have been

[12] https://www.cisco.com/c/m/en_us/solutions/service-provider/vni-forecast-highlights.html#

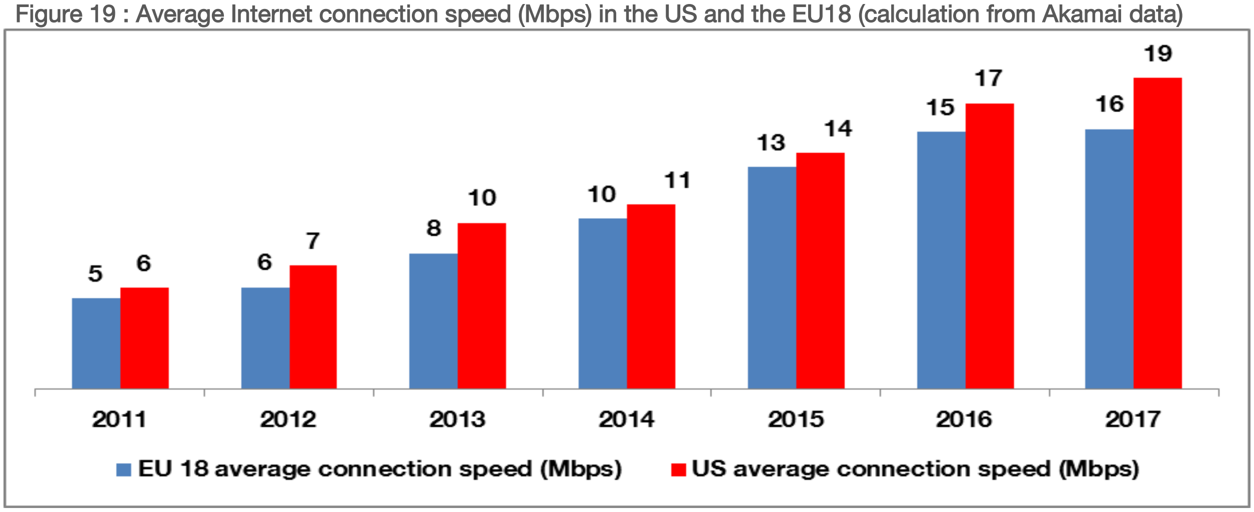
[13] https://ec.europa.eu/digital-single-market/en/news/quality-broadband-services-eu

ahead of Europe in terms of fixed networks connection speed, and the gap has been increasing over late 2016 and early 2017. However, others sources, while less recent, provide different types of measures, leading to opposite ranking over time. As regards mobile networks, available information tends to evidence a higher average connection speed in Europe, however further data would be necessary to draw a sufficiently robust comparison. As a result, available information on quality of services measured by actual connection speeds in Europe and the US is currently sufficient to conclude on a quite similar quality level, but insufficient to be more conclusive on a robust ranking.

The US are leaders in terms of average connection speeds according to Akamai reports

The most recent information on average connection speeds by country has been provided by Akamai, in its reports on the state of connectivity, which allow to compute the mean of connection speeds for the European Union and to compare the results with the US, up to the first quarter of 2017. As shown in Figure 19, which considers a sample of 18 European countries, after a brief process of convergence between 2013 and 2015, the advance of the US has begun to strengthen, to reach a 3.1 Mbps gap in the first quarter of 2017, which is the largest gap ever observed between the US (18.7 Mbps in 2017) and Europe (15.6 Mbps). Considering the whole EU28 sample, which is only possible for the last quarter of 2016 and the first quarter of 2017, the gap is even more important, as the advance of the US over the EU28 amounts to 3.02 Mbps in 2016 and 4.37 Mbps in 2017. The average connection speed for the whole EU28 sample reaches indeed only 14.18 Mbps (instead of 15.44 Mbps for the EU18 sample) in 2016 and 14.33 (instead of 15.63 for the EU18 sample) in 2017. In the Figure 19, the values for the European Union are obtained by computing the mean of member countries for each period.

Figure 19 : Average Internet connection speed (Mbps) in the US and the EU18 (calculation from Akamai data)



Source: Akamai State of connectivity report

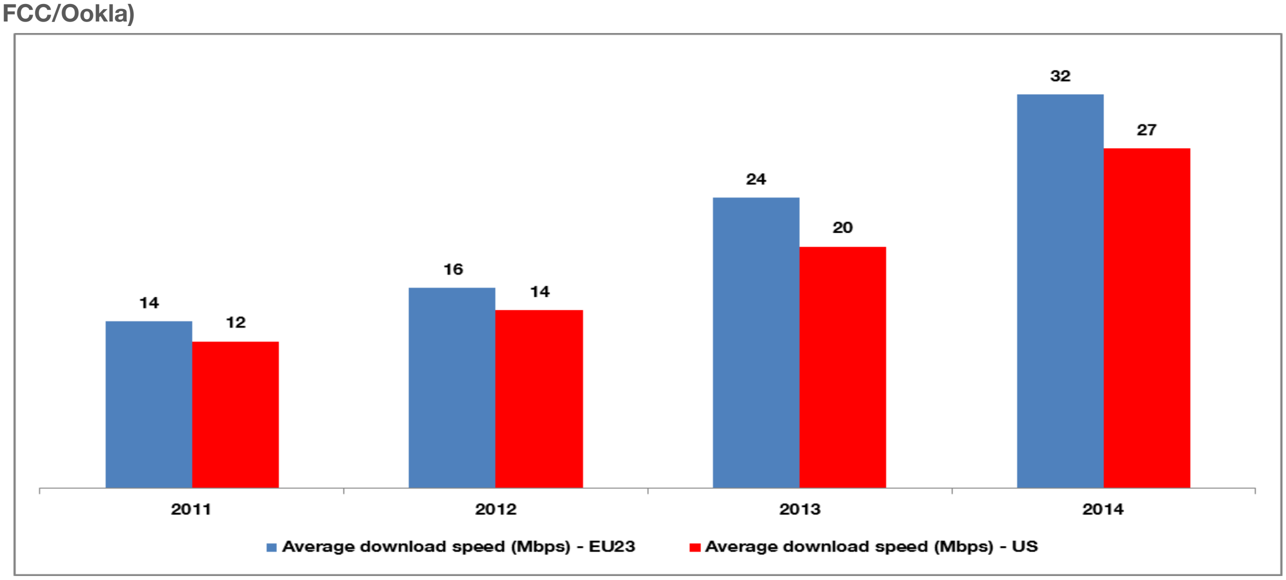
In addition, according to Akamai reports on connectivity, peak connection speeds have been higher in the US since at least 2010, as shown in Appendix 6. The gap has increased since 2014, to reach 13 Mbps in 2017, with an US peak connection speed of 86.5 and a European sample (with 18 Member countries) peak speed of 73.5. Considering the whole EU28 sample, which is only possible for the third quarter of 2016 and the first quarter of 2017, it appears that peak connection speeds have only reached 58 Mbps in the EU28 in Q3 2016 and 68 Mbps in Q1 2017, while it has reached 71 Mbps and 87 Mbps in the US. Hence, both average and peak connection speeds measured for the partial or entire European Union sample indicates that Europe falls behind the US in terms of download speeds delivered by fixed access networks. Though reliable enough to give credible indication on the quality of service delivered to end-users through fixed access network, Akamai's data are not free of bias, and cannot alone provide sufficient information to conclude on international rankings. In particular, Akamai's methodology does not consist in a calibrated approach aimed at measuring broadband speed. It is rather an analysis of Akamai's own operational traffic data.

Other sources challenges Akamai reports and evidence a European advantage over the US

Akamai provides the most up-to-date information on average and peak connection speeds registered in European and American countries. However, alternative sources, even if less recent, point the lack of evidence in terms of leadership of one region over the other with regards to average actual connection speed. For example, a Samknows study for the European Commission has evidenced significantly higher fixed broadband download speeds for the European Union compared to the United States: 8.27 against 7.67 Mbps for xDSL, 53.09 against 41.35 for FTTx, and 66.57 against 25.48 for Cable in 2013. Besides, information the FCC on the basis of Ookla measures provides further evidence of European leadership in average connection speeds for fixed access networks in aggregate. The Ookla measures for internet connection speeds show an increasing gap in favor of the European Union, bearing in mind that the sample tested gathers 23 Member States. Ookla has revised its data for 2013 and 2014 in the last FCC update published in 2016. It appears that the advance of the European sample is even more notable (32 Mbps against 27 Mbps for the US in 2014), as reported in

Figure **20**, which presents the mean calculations on the basis of individual country data from Ookla.

Figure 20: Actual average download speed (Mbps) in the EU (23 countries) and the US (calculation from FCC/Ookla)



Source: FCC from Ookla

Moreover, according to a 2015 European Commission's report, the average levels of download speeds have been relatively similar between the EU15 and the US over the period 2007–2014. They have increased from [3 to 7 Mbps] in the EU15 and from [3.5 to 9 Mbps] in the US in 2007 to [9 to ~40 Mbps] in the EU15 and [12 to ~40 Mbps] in the US at the end of 2014. As a result, the technological advance of the US in terms of network coverage by advertised speed or in terms of NGA coverage is almost cancelled when the comparison is made on the basis of average measured speed. The explanation relates to the fact that the average resource is indeed similar in the EU and the US, as the spread in terms of capacity to the benefit of the US is balanced by a more intense usage (hence higher IP traffic) in the US.

Higher speed per technology in the EU but more favorable technology mix US lead to fairly equivalent outcomes

Additional estimations for actual download speeds of Internet connection (the actual speed measured at peak period) are provided by the FCC on the basis of Ookla information. These estimations are reported according to each fixed technology (DSL, cable and optical fiber), for the year 2013 and the year 2014. The values for the European Union are obtained by computing the mean of member countries for each year. It turns out that the European Union is slightly below the US for DSL, but far above the US for optical fiber technologies, and significantly higher for cable technology (which includes standard cable and Docsis 3.0). The actual speed at peak period for cable in the EU28 was 52.21 Mbps and 66.57 Mbps in 2013 and 2014, while it was only of 28.92 Mbps and 42.14 Mbps in the US. This ranking is consistent with the observation that even if Docsis 3.0 coverage is higher in the US than in Europe, the share of Docsis 3.0 in the total cable technology deployed is largely lower in the US than in Europe (92% in the United States, to be compared with 99% in Europe).

The table 5 shows that, despite the higher speed achieved during peak period for cable and optical fiber in Europe, the actual weighted average download speed is lower in the European Union than in the United States when the average actual connection speed delivered to end-users is weighted by the level of technology adoption. According to the data reported by the FCC on the basis of Ookla measures of actual connection speed. It appears that Europe falls behind by one year, with an average connection speed during peak period of 17.95 Mbps in 2014, to be compared with a 17.83 Mbps peak period connection speed in the US in 2013. This indicates that in aggregate, the actual average peak connection speeds which have been delivered through all available fixed access networks in 2013 and 2014 have been higher in the US.

Table 5 : Actual average connection speed by technology during peak period in the EU-28 and the US

in Mbps	2013		2014	
	EU - 28	US	EU - 28	US
DSL	8.13	9.64	8.27	9.85
cable	52.21	28.92	66.57	42.14
Fiber	47.74	45.17	53.09	47.11
weighted average*	**13.80**	**17.83**	**17.95**	**21.81**

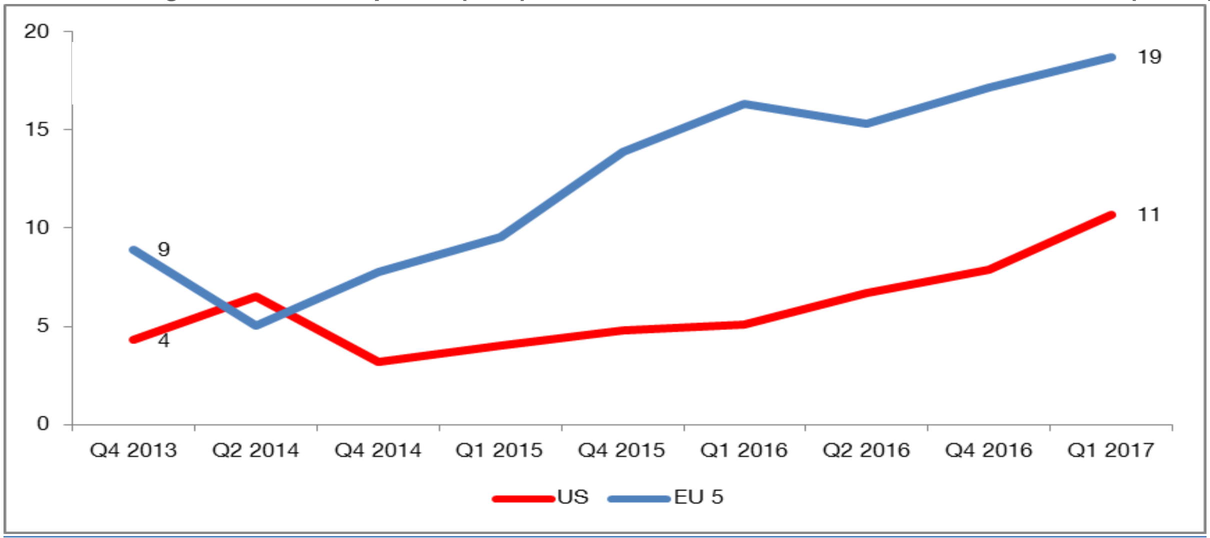
*Source: FCC from Ookla – * calculated weighted average using technology penetration rate reported above*

No sufficient data to compare mobile connections speeds but indications that speeds may be higher at least in part of the EU

On the mobile side, the publicly available data do not allow drawing a sufficiently accurate cross-country comparison, thus the imperfect reliability of data prevents from deriving robust conclusions. However, the information available on mobile broadband allows providing preliminary insights on cross-country discrepancies in terms of download speeds for mobile Internet. According to Akamai data, historical and latest figures available for 2Q 2016 provide evidence of higher speed in the main European countries than in the US since the end of 2014 for both average and peak connection speeds. Average connection speeds are shown below, whereas peak connection speeds are reported in the Appendix 6. According to Akamai, the mobile speed measurements shown below can be influenced by a number of factors, including the use and location of proxies within mobile networks and therefore may not be fully representative of speeds being seen by end users.

Besides, data are not available for all quarters, and 4Q 2013 figures are only related to the main operator network, whereas the following quarters are related to country aggregate traffic. The traffic aggregate for the EU is a computation of the average traffic for France, Italy, Germany, Spain and the UK. Computations from Akamai input data indicate that average connection speeds have not been increasing steadily, as one would have expected as more advanced technologies were being deployed over time. Global trends show however an increase, with average connection speeds higher in the main European countries than in the US since the end of 2014. During 2Q 2016, mobile average connection speed was 6.7 Mbps in the US, while it was of 15.3 Mbps in the EU 5.

Figure 21 : Average Connection Speeds (IPv4) of Mobile Connections for the EU5 and the US (in Mbps)

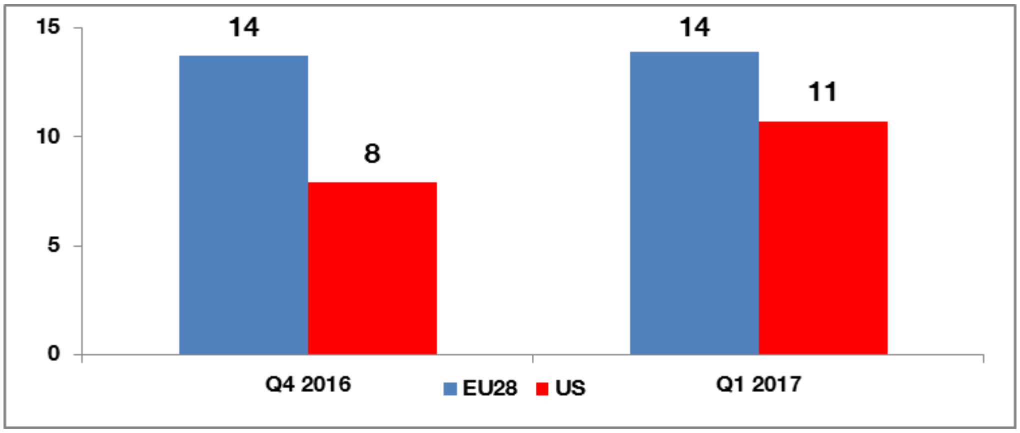


Source: Akamai State of the internet connectivity reports

The selected European countries may not be representative of the average performances reached in the European Union as a whole. Indeed, for instance, the UK and the Nordic countries are known to provide among the highest mobile speeds in Europe (26 Mbps in UK and 22 Mbps in Finland in Q1 2017), while other countries such as Portugal and Bulgaria provide speeds below 10 Mbps. Besides, Ookla provides also some information derived from its speed tests for a selected number of countries, including the US, the UK as well as Nordic European countries (Denmark, Norway, Sweden and Finland), on a monthly basis. In June 2016, the average mobile download speed in the US was 19.6 Mbps, 23.8 Mbps in the UK, and was ranging between 25.8 and 33.6 Mbps in the European Nordic countries. This ranking has proven robust on the latest available monthly data, with an average mobile download speed slightly slower in the US than in the selected European countries. More information would be necessary however to be conclusive.

In that respect, recent information from Akamai reports provides new evidence of a higher average connection speed for the European users. These last two Akamai reports, available for the fourth quarter of 2016 and the first quarter of 2017 allow drawing a comparison between the US and the EU28, thanks to the inclusion of all European Member States.

Figure 22 : Average Connection Speeds (IPv4) of Mobile Connections for the EU28 and the US



Source: Akamai State of the internet connectivity reports

Including all European Member states, it appears that the gap with the US is weaker than considering only the five larger European countries, as shown in **Erreur ! Source du renvoi introuvable.**. Also in those figures, US is behind Europe. However, the strong evolution observed in these figures between Q4 2016 and Q1 2017 for the US, from 7.9 Mbps to 10.7 Mbps is unlikely to reflect actual changes in the field and probably corresponds to methodological effects which may not yet be stabilized. Therefore no definitive conclusions can yet been derived from this source.

Similar US and EU connections speeds despite US higher capacities result from differences in levels of usage and network utilization

Overall, connection speeds in the US and the EU appears to be similar, although network capacity available for end users is clearly higher in the US. This apparent paradox may be explained by the very EU-US gap in traffic and network utilization. Indeed the average connection speed of a user is an increasing function of network capacity, and a decreasing function of the utilization rate of this capacity. If average utilization rates of capacities had been similar in the US compared to EU, the US-EU gap in network capacity should have led to a gap in average download connection speeds. However, as the usage rate is higher (because the gap in traffic is relatively higher than the gap in capacity), the average US user can have a similar download speed than its European counterpart, even if the total available caopacity is higher in the US.

5. Conclusion

The global coverage of fixed and mobile access networks has been higher in the US than in the EU28 during the last five years. The global coverage of NGA (cable, optical fiber and LTE) has also been higher in the US, as well as the NGA coverage in the rural areas. The advance of the US in terms of NGA coverage is notably due to a wider deployment of (Docsis 3.0) cable technology. Despite network coverage being a prerequisite to commercial service adoption, the penetration rate of NGA remains at least 1.86 times lower than coverage in 2016, with notable differences between technologies, which indicates more than a lagging effect in adoption rate. Penetration rate of NGA is higher in the US than in the EU28. Data traffic per capita has been much higher in the US over the period (and since 2008), mainly because of the higher number of connected devices by household, as well as higher internet video viewing time (which implies a more intense usage of highly resource intensive applications and services). This more intensive usage has an implication on the actual download speed available to the end-user. As the median US individual internet user and household internet user have a more intensive usage of highly capacity intensive services, (as the levels of traffic per capita are higher in the US), the actual connection (download) speed available to end-users tends to be similar in Europe and in the US, despite higher NGA penetration in the US. A more intensive usage of more widely deployed NGA networks in the US lowers the actual connection (download) speed available to each end-user down to the level that are observed in Europe.

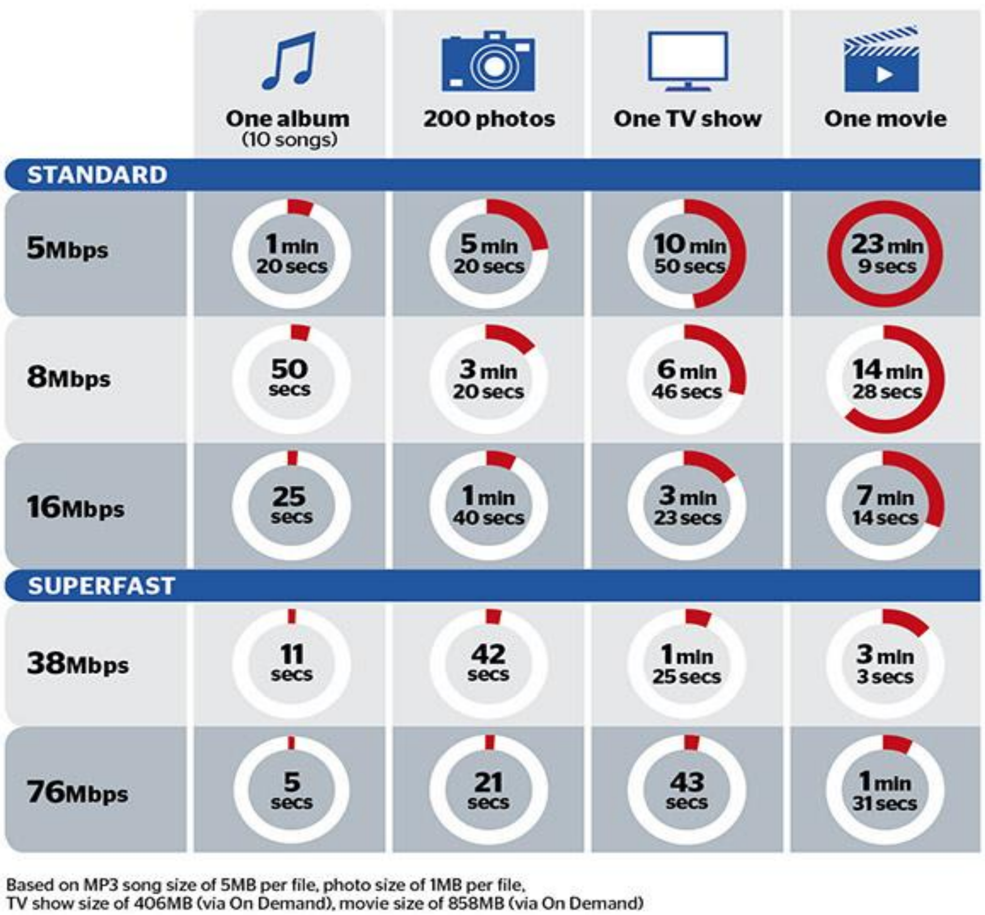
APPENDIX: 1 Definitions of Broadband and NGA

This appendix 1 provides the definitions of indicators used to derive a robust comparison between the European Union and the United States in terms of technology coverage, access network penetration and quality of service delivered to the end-user. Such a comparison requires taking account of the national authorities' definitions of technological performance (notably the definition of "Broadband"). The technological performance is measured by the theoretical levels of download speed associated to each technological norm.

1. Why bandwidth matters?

The main indicators used to assess the quality of access networks are the advertised and the actual download speeds being delivered to the end-user. The range and the quality of digital services that are available to any end-user depend directly on the actual broadband speed delivered by the access network. Figure 23 provides a variety of examples of the usages available according to the download speeds provided.

Figure 23: Downloading speed of a sample of services according to broadband speed



Source: consumer association Which

2. Download speed according to technology

In the European Union, the European Commission provides indications on the download (and upload) speeds associated to a technology. For each type of technologies, the European Commission indicates a maximum download and upload speed in Megabit per Second (Mbps) or Gigabit per Second (Gbps) as well as a maximum efficiency range in km.

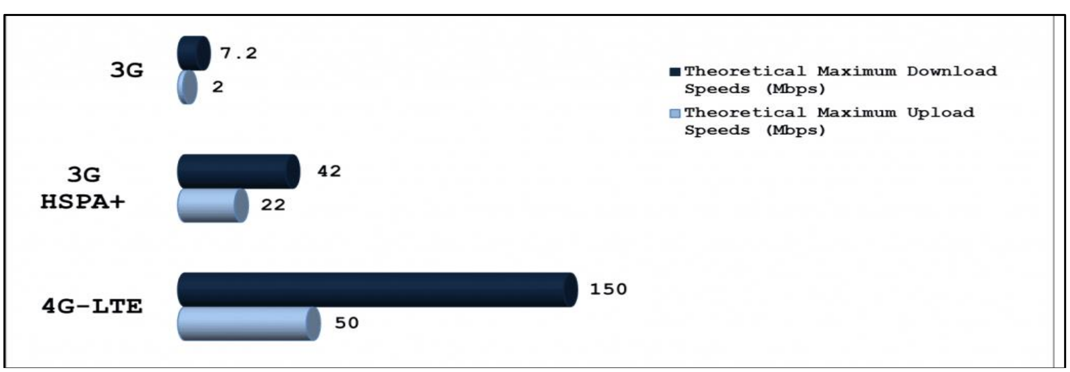
Table 6 : down-upstream maximum rate per technology

	Down-Upstream Rate (technical standard max.)	Efficiency range (technical standard max.)
ADSL, ADSL2, ADSL2+	24/1 Mbps	5 km
VDSL, VDSL2, Vectoring	100 /40 Mbps	1 km
G.Fast	500/500 Mbps	250 m
CATV	200/100 Mbps	2-100 km
Optical Fibre Cable	1/1 Gbps (and more)	10-60 km
LTE (Advanced)	100/30 (1000/30) Mbps	3-6 km
HSPA	42,2 / 5,76 Mbps	3 km
5G	min. 1 Gbps	3-6 km
Satellite	20/6 Mbps	High
Wi-Fi	300/300 Mbps	300 m
WiMAX	4/4 Mbps	60 m

Source: Policy orientations to reach the European Digital Agenda targets, Analysys Mason, May 2012.

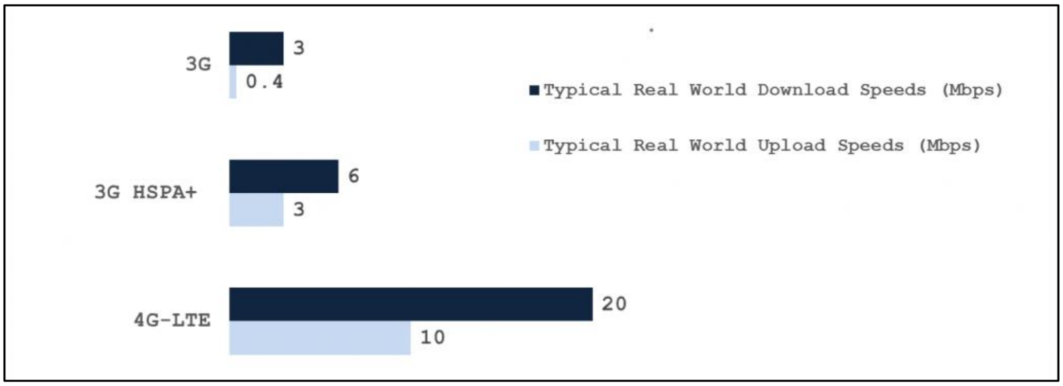
As can be inferred from the Table 6, the advertised speed at which network operators are providing digital services is directly linked to the access technology that is being used. The advertised download speed is a maximum technical standard which highly depends on the architecture of the network. A Higher NGA penetration rate does not imply that a greater proportion of the covered households will always benefit from a greater level of quality: depending on the technology, a defined range of specific parameters will determine the actual download speed. For fixed networks, such parameters relate to the length of the copper line (i.e. the location of subscribers with respect to the access node), while parameters such as the number of simultaneous active end-users, and the rate of maintenance of technical installations apply to both fixed and mobile networks.
The following figures provide information on the theoretical download speeds and on the actual download speed for wireless technologies.

Figure 24 : theoretical download speed per wireless technology



Source: 4G.co.uk

Figure 25 : actual download speed per wireless technology



Source: 4G.co.uk

It appears that the difference between advertised connection speed and actual "real world" connection speed is notable, especially for download speed. As shown in Figure 26 and Figure 25, the actual download speed of mobile broadband is 7.5 times lower than the advertised download speed for LTE ("4G") (20 Mbps in the "real world" against 120 Mbps advertised) and 7 times lower than the advertised download speed for HSPA+ ("3G") (6 Mbps in the "real world" against 42 Mbps advertised). The ratio of advertised to "real world" upload speed amounts to 5 for LTE and to 7.3 for HSPA+.

In its annual Broadband Progress Report, the FCC provides information on the deployment of mobile services on LTE technology, including LTE technology with a minimum advertised speed of 10 Mbps/1 Mbps. The FCC defines broadband for any connection with download speed of above 200 kbps.[14] The 2014 estimates for mobile services are not comparable to the estimates reported in the previous years because the 2014 estimates were based upon a different source. Before 2014, mobile services information referred to the *maximum* advertised speed, whereas 2014 information are based upon the *minimum* advertised speed. The FCC warns about the potential lack of accuracy of its available data with regards to the effective speed, which might lead to overestimate the actual download speed. Indeed, the data do not expressly account for such factors as the signal length, the bit rate, or the in-building coverage. Moreover the consistency of data in terms of speeds across geographic areas and service providers might be affected by bias.

It is therefore necessary, in addition to reporting advertised download speed (as done by the public authorities), to provide measures of actual download speeds of technologies, as in the section 4.

3. Definition of broadband connectivity

The European Commission defines "Broadband" as: Any high speed telecommunications systems, i.e. those capable of simultaneously supporting multiple information formats such as voice, high-speed data services and video services on demand. Because of this definition, broadband has been defined according to download speed only for fixed network. A broadband connection is defined as a fixed connection which delivers download speeds higher than 144 Kbit/s. As of January 2010, the Commission estimates that 1-2 Megabit per Second (Mbps) is the minimum download speed and that only a small share of all retail broadband lines still provide speeds of only 144 Kbit/s. For the European Union, the Digital Agenda Scoreboard provides coverage and

[14] see FCC 477 form : https://transition.fcc.gov/form477/MBD/definitions_mbd.pdf

penetration statistics according to three levels of broadband speeds: 2, 30, and 100 Mbps. Very high broadband refers to broadband download speeds above 30 Mbps[15].

In the United States, the National Telecommunication and Information Association (NTIA) considers that a broadband connection should allow a consumer to "access a basic set of applications that include sending and receiving e-mail, downloading Web pages, photos and video, and using simple video conferencing"[16]. The thresholds for download speed are updated periodically to include "typical household usages". In 2010, when the NTIA began its in-depth analysis, broadband was defined by a combined advertised connection of 3 Mbps downstream and 768 kbps upstream[17], and 4 Mbps downstream and 1 Mbps upstream thereafter. As part of its 2015 Broadband Progress Report, the Federal Communications Commission (FCC) changed the definition of broadband and raised the minimum download speeds needed from 4 Mbps up to 25 Mbps, and also raised the minimum upload speed from 1Mbps up to 3Mbps[18].

The FCC reports assess broadband availability according to seven download speed tiers, as follows:

o ≥ 3 Mbps and < 6 Mbps;
o ≥ 6 Mbps and < 10 Mbps
o ≥ 10 Mbps and < 25 Mbps
o ≥ 25 Mbps and < 50 Mbps
o ≥ 50 Mbps and < 100 Mbps
o ≥ 100 Mbps and < 1 Gbps
o ≥ 1 Gbps

[15] https://ec.europa.eu/digital-single-market/en/download-scoreboard-reports
[16] http://www.broadband.gov/plan/8-availability/
[17] In 2000, broadband definition took into account a download speed of 200 kbps.
[18] https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report

APPENDIX 2: Industrial policy for broadband connectivity

The deployment and the availability of broadband access networks are an important matter for policy makers. They entail an industrial policy objective (more efficient technologies and faster networks encourage stronger productivity and foster higher competitiveness of the global economy), and a public policy objective (reducing digital divide between urban, high-density and rural, low-density areas is a mean to reduce economic inequalities across those regions). In both the United States and the European Union, specific public policies, mainly national broadband plans (notably in the wake of the 2008/2009 macroeconomic downturn) have been designed in order to support or to take over private investment effort in rural areas.

In the United States, the National Broadband Plan ("Broadband Stimulus") was announced by the end of 2009[19]. The Plan aims to enhance Broadband coverage throughout the whole country, with a particular focus on rural areas. The FCC's targets have been expressed in terms of bandwidth coverage. They consisted in achieving coverage of one hundred million US households (i.e. 83% of US households) with 50 Mbps connections by 2015 and 78% of US households with connections of 100 Mbps by 2020. Specific public funds were allocated by the national authorities in support of local deployments. Various organizations are involved, such as the NTIA (National Telecommunications and Information Administration), the NTCA (National Telecommunications Cooperative Association) and the RUS (Rural Utilities Services). Local players, Incumbent Local Exchange Carriers (ILECS), Competitive Local Exchange Carrier (CLECS), and municipalities have already deployed optical fiber (FTTx) networks and/or announced their deployment projects[20]. Specific budgets were granted to such deployment projects in the context of the Stimulus program during 2010. About two-third of the projects were designed to deploy Fiber To The Neighborhood (FTTN) technology solutions and nearly half of them should deploy Fiber to the Home (FTTH), depending on the areas. In January 2013, the FCC announced a new challenge for the country, named the "Gigabit City Challenge"[21]. Its objective was to provide availability of 1 Gbps services in at least one city in each US state by the end of 2015.There is, to our knowledge, currently no publicly available information that this challenge has been won.

In the European Union, the European Commission has designed similar political goals. However, the technological targets are wider than in the US. The European Commission has indeed defined specific objectives for the European Union[22]:

- Access to 30 Mbps connectivity to every European by 2020,
- Access to 100 Mbps connectivity, which can be upgraded to 1 Gbps to every European by 2025 and a 100 Mbps subscriptions for half of the European households by 2020,
- Access to very high - Gigabit - connectivity (allowing users to download/upload 1 Gigabit of data per second) for the main socio-economic drivers such as schools, universities, research centres, transport hubs, and providers of public services such as hospitals, administrations, and firms relying on digital technologies by 2025,
- Uninterrupted 5G coverage for all urban areas, as well as major roads and railways in 2025, with an interim target of 5G commercially available in at least one major city in each EU Member State by 2020[23].

In addition, various Member States have adopted national broadband strategies in order to foster NGA deployment and to bridge the broadband gap between urban and rural underserved areas.

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[19] https://transition.fcc.gov/national-broadband-plan/national-broadband-plan.pdf
[20] http://www2.ntia.doc.gov/files/broadband_fed_funding_guide.pdf
[21] https://apps.fcc.gov/edocs_public/attachmatch/DOC-318489A1.pdf
[22] https://ec.europa.eu/digital-single-market/our-goals/pillar-iv-fast-and-ultra-fast-internet-access
[23] http://europa.eu/rapid/press-release_IP-16-3008_en.htm

APPENDIX 3: NGA connectivity in rural area is better in the US

Fixed and mobile broadband connections in both the EU28 and the US reached respectively 99% and 100% in 2016 in rural areas, according to the European Commission and the US Telecom Association. However, NGA coverage in rural areas are still far from the coverage levels achieved with the legacy networks, with respectively 39% in Europe and 66% in the US fixed NGA broadband coverage. In order to tackle the digital divide, public policies support the provision of high bandwidth broadband to end-users located in the remote, rural areas. In order to do so, policy makers have designed public programs aimed at providing support to private internet access providers and to take over network deployment in areas where deployment would be too costly for private players to recoup their investment.

1. Definition of a rural area: the 20% of population living un the less dense territories

In the United States, rural areas are defined on the basis of the 2010 Census block identification and encompass land areas with a population density under than 1000 people per square mile (or 386 people per square km). Less than 20% of the US population was living in rural areas (according to that definition) at the end of 2013. In the European Union, according to the European Commission, rural areas are defined by areas with a population density under than 100 persons per square kilometer when segmented at the NUTS 5 level (also known as LAU 2 for Local Administrative Unit 2). The NUTS 5 or LAU 2 areas are typically the smallest administrative units in regular use in a EU28 Member State. Less than 20% of the population in Europe is estimated to live in rural areas according this definition. Despite a difference in population density, both Europe and the US have approximately the same percentage of their population living in the defined rural areas. However, the cost for achieving coverage of those areas varies greatly across Europe and America.

2. Political policies regarding rural areas already in place in the US

In the US, one of the four Universal Service Fund programs aims at subsidizing telecommunications services in rural and remote areas[24]. The Program includes both voice and 4 Mbit/s internet connectivity (as of 2014, a 10 Mbit/s internet connectivity)[25]. The Program paid out approximately $4.6 billion per year in subsidies to telecommunications companies, with the aim of making telecommunications affordable to inhabitants of rural and remote areas. In August 2015, the telecommunications carriers were granted over $1.5 billion in annual support for rural broadband deployment (at 25 Mbps/s) from the Connect America Fund, in order to serve over 3.6 million homes and businesses by the end of 2020. This support, along with private carrier investment, is expected to expand broadband coverage to nearly 7.3 million rural consumers in the whole country. The European Union has adopted a different approach, with the European Commission providing guidelines to frame public funding in each State: in 2009 the Commission adopted so-called Broadband Guidelines that outlined how public funding could support the building of broadband networks in the light of European State aid rules. The aim was to provide legal certainty for public and private investors and to facilitate public financial support to projects that would not attract private investment due too high risk or too low demand. These Broadband Guidelines were revised in 2012 to support ultra-fast broadband projects in urban areas, subject to a range of

[24] https://www.fcc.gov/general/universal-service

[25] "High Cost program" now renamed "Connect America Fund" for remote areas, "lifeline program" for people under the poverty line, Rural health care program, Schools & Libraries Program (E-Rate).

strict conditions. Furthermore, a 2013 Regulation on State Aid rules allowed Member States to provide some types of broadband infrastructure support without being obliged to notify the Commission, as long as there was no infrastructure in place or likely to be developed in the near future. These exemptions covered the building of basic broadband infrastructure and additional measures related to NGA networks as well as broadband civil engineering works and passive infrastructure (e.g. towers, poles or underground ducts). The intentions were to speed-up network investment and encourage public support, particularly in rural areas where passive infrastructure is lacking.

In the 2014 guidelines for trans-European networks in the area of telecommunications infrastructure recognised that public funding should be limited to programs which cannot be fully funded by the private sector due to either market failure or sub-optimal investment. This limited public financing should attract additional investment and deliver a multiplier effect. Rural and remote areas and other sparsely populated areas should be targeted primarily. Member States, regional and local authorities are expected to supply part of the financing necessary to build the broadband infrastructure needed to achieve the Digital Agenda targets. However the European Union will continue to contribute to the investment effort, with the European Structural and Investment Funds that are expected to allocate about €6.4 billion for 2014-20 for broadband, either through grants or financing facilities.

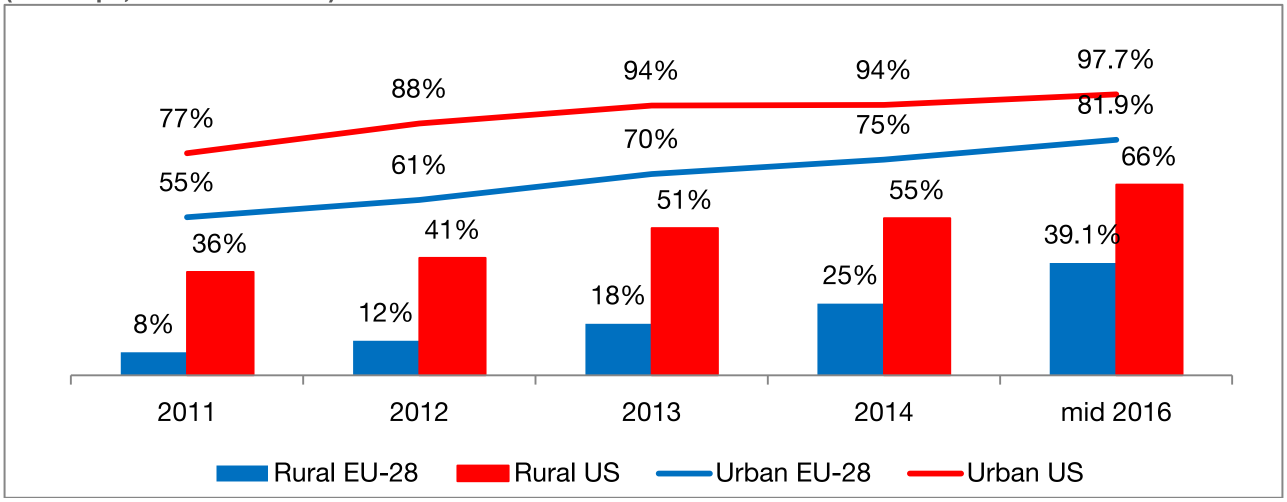
3. NGA coverage divide accentuated in EU28

This section examines the NGA coverage of rural areas in the United States and the European Union, and compares the coverage of high-speed broadband rural areas with the coverage of urban areas. The following chart allows comparing coverage of NGA delivering a download connection speed of more 25 Mbps in the US and a download connection speed of more than 30 Mbps in the EU28, in both the rural and urban areas. For both the European Union and the United States, the FCC provides coverage data in terms of the percentage of rural or urban households living in rural or urban areas accessing to bandwidth above 30 Mbps and using fixed NGA - VDSL, FTTP or Docsis 3.0 technologies.

For example, in June 2016,

- In the EU28, 39.1% of households living in a rural area benefit from high speed broadband coverage, whereas 81.9% of households living in a urban area benefit from high speed broadband coverage.
- In the US, 66.3% of households living in a rural area benefit from high speed broadband coverage, whereas 97.7% of households living in an urban area have access to high speed broadband connection.

Figure 26: High speed broadband rural and urban coverage in the US (>25 Mbps; % of households) and the EU28 (> 30Mbps; % of households)

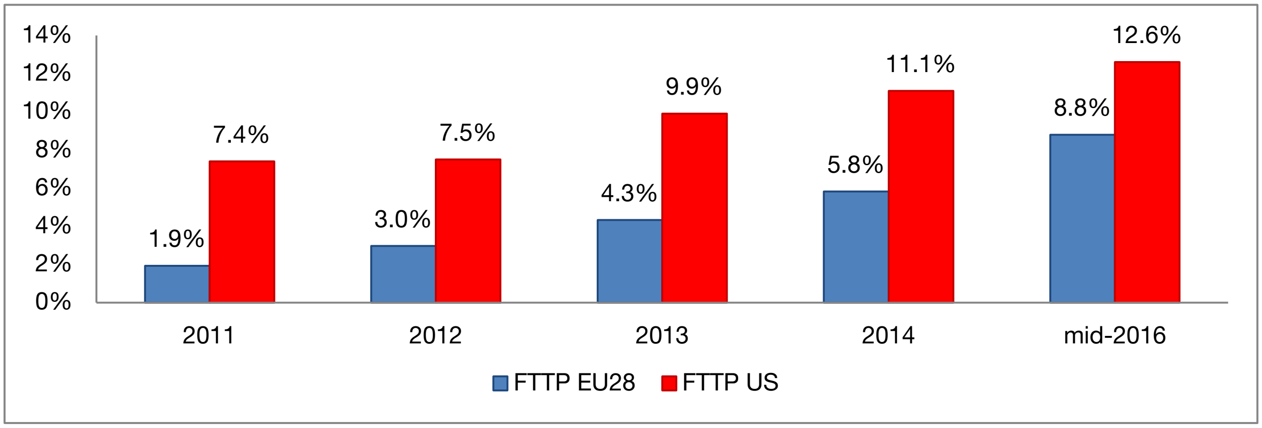


Source: European Commission, FCC & US Telecom Association

The FCC provides information on rural and urban coverage according to download speeds in percentage of population, while the European Commission uses the percentage of homes passed. The following figures show the rural coverage of FTTx and Docsis 3.0 in the US and the EU28. The higher share of household coverage in rural areas in the US relates mainly to a wider rural coverage of Docsis 3.0. In June 2016, 66,3% of rural households were covered with high speed broadband in the US, while Docsis 3.0 cable technology had reached 50,2% of rural coverage (in percentage of population). In addition, 44,6% of US rural households had access to very high speed broadband, with connection speed above 100 Mbps in June 2016.

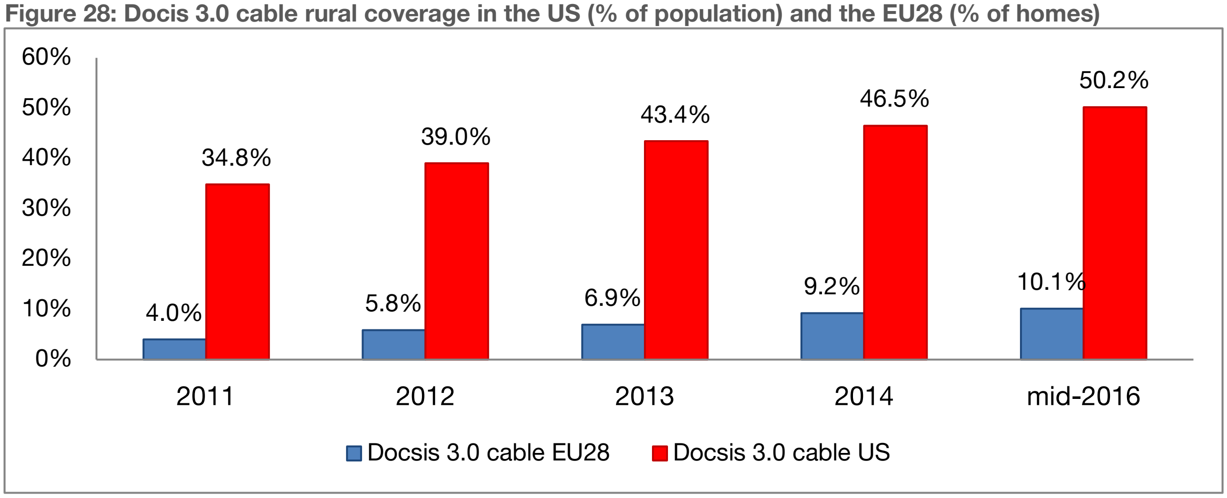
Moreover, the NGA rural coverage is relatively higher in the US than in the EU28, and the ratio of rural to urban NGA coverage is higher in the US (0.68) than in the EU28 (0.48), which illustrate a deeper geographical divide in Europe than in the US. The next two charts represent the rural coverage of FTTP and Docsis 3.0 cable in the US and in the EU28 from 2011 to 2016. They show evidence that the US advance in terms of NGA rural coverage is mainly attributable to a more advanced and faster Docsis 3.0 deployment: rural coverage in the EU28 has only increased from 4% to 9.2% between 2011 and 2014 whereas it has increased from 34.8% to 46.50% in the US. By contrast, the gap in terms of fiber deployment, although important, is of lower magnitude. While the US rural coverage amounted to five time the EU28 rural coverage for Docsis 3.0 in 2014, the US rural coverage amounted to only 2 times the EU28 rural coverage for FTTP. Moreover, the rural FTTP coverage remains low in both the European Union and the United States (it was of only 11.1% in the US and of 5.82% in the EU28 in 2014).

Figure 27 : FTTP rural coverage in the US (% of population) and the EU28 (% of homes)



Source: NTIA, US Telecom Association and European Commission

Figure 28: Docsis 3.0 cable rural coverage in the US (% of population) and the EU28 (% of homes)



Source: NTIA, US Telecom Association and European Commission

APPENDIX 4: Cisco IP traffic and internet traffic

IP Traffic, 2009–2020														
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	CAGR 2009–2015	CAGR 2015–2020
By Type (Petabytes [PB] per Month)														
Fixed Internet	10 942	15 205	23 288	31 339	34 952	42 119	49 494	60 160	73 300	89 012	108 102	130 758	29%	21%
Managed IP	3 652	4 963	6 849	11 346	14 736	17 774	19 342	22 378	25 303	28 155	30 750	33 052	32%	11%
Mobile data	91	228	597	885	1 480	2 582	3 685	6 180	9 931	14 934	21 708	30 564	85%	53%
Internet: Denotes all IP traffic that crosses an Internet backbone														
Managed IP: Includes corporate IP WAN traffic and IP transport of TV and VoD														
Mobile: Includes mobile data and Internet traffic generated by handsets notebook cards and mobile broadband gateways														
By Segment (PB per Month)														
Consumer	11 602	16 534	25 792	35 047	40 905	50 375	58 539	72 320	89 306	109 371	133 521	162 209	31%	23%
Business	3 083	3 862	4 942	8 522	10 263	12 100	13 982	16 399	19 227	22 729	27 040	32 165	29%	18%
Consumer: Includes fixed IP traffic generated by households university populations and Internet cafés														
Business: Includes fixed IP WAN or Internet traffic generated by businesses and governments														
By Geography (PB per Month)														
Asia Pacific	1 460	6 906	10 513	13 906	17 950	22 119	24 827	30 147	36 957	45 357	55 523	67 850	60%	22%
North America	5 115	7 091	10 343	14 439	16 607	20 293	24 759	30 317	36 526	43 482	50 838	59 088	30%	19%
Western Europe	3 495	4 818	7 287	7 722	8 396	9 739	11 299	13 631	16 408	19 535	23 536	27 960	22%	20%
Central and Eastern Europe	493	678	1 162	3 405	3 654	4 416	5 205	6 434	8 116	10 298	13 375	17 020	48%	27%
Latin America	438	680	1 045	3 397	3 488	4 361	4 500	5 491	6 705	8 050	9 625	11 591	47%	21%
Middle East and Africa	157	223	384	701	1 074	1 546	1 930	2 698	3 822	5 380	7 663	10 865	52%	41%
Total (PB per Month)														
Total IP traffic	14 686	20 396	30 734	43 570	51 168	62 476	72 521	88 719	108 533	132 101	160 561	194 374	30%	22%
Source: Cisco VNI 2010 for 2009 and 2010 VNI 2012 for 2011 and 2012 VNI 2014 for 2013 and 2014 & VNI 2016 thereafter														

APPENDIX 5: Data traffic consumption provided by OFCOM and OVUM

1. Fixed data traffic in the US and in main Western European countries

Besides CISCO, the OFCOM provides an alternative source of fixed data traffic consumption in the US and in the main five Western European countries as well. The values are reported in Table 7. In terms of fixed broadband data traffic, the US had a higher average monthly traffic per capita in 2014 (with 18.5 GB per capita per month) than most of the main European countries. This was not the case, however, in 2009, when all countries including the US experienced similar level of data traffic, around a mean of 3 GB per capita per month. The five year annual average growth rate of data volume per capita has been significantly higher in the US (45%) than in the other Western European countries (with the exception of the UK).

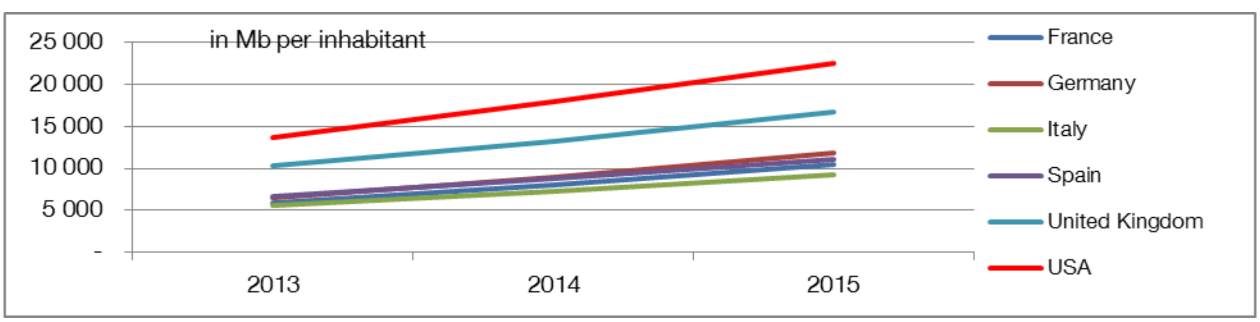
Table 7 : fixed broadband data traffic in main countries

	USA	France	Germany	Spain	UK	Italy
Average monthly fixed broadband data volumes per capita - 2014 (Gigabyte)	18.5	12.6	9.9	9	22.3	7.1
Average monthly fixed broadband data volumes per capita - 2009 (Gigabyte)	2.9	3	2.7	2.1	3.3	2.5
One year percentage change	22%	21%	16%	27%	64%	12%
Five years percentage change(CAGR)	45%	33%	29%	34%	46%	23%

source : OFCOM International Report 2015

The traffic data from the OFCOM, which evidence the gap between the US and some of the largest European countries, are in line with information provided by OVUM figures, as shown in Figure 31. The fixed broadband consumption was well higher in the United-States than in the main Western European countries in 2015 (22.5 GB per capita in the US, 10 GB per capita in France). The gap has been widening over the last three years.

Figure 29 : Fixed data traffic per inhabitant in main countries



source : OVUM – Network Traffic

2. Mobile data traffic in the US and in main Western European countries

As regards mobile broadband traffic, the cross-country differences are significantly sharper than for fixed IP traffic. The indicates that the level of average mobile data volume per capita in the US was approximately 4 times the "Big 5 " Western European levels in 2015 (with 1771 MB per capita in the US against 397 MB in France and 398 in Germany in 2015, and 280 MB, 95 MB and 110 MB in 2009 respectively). Sharp differences between the United States and the largest Western European countries were already observable in 2009.

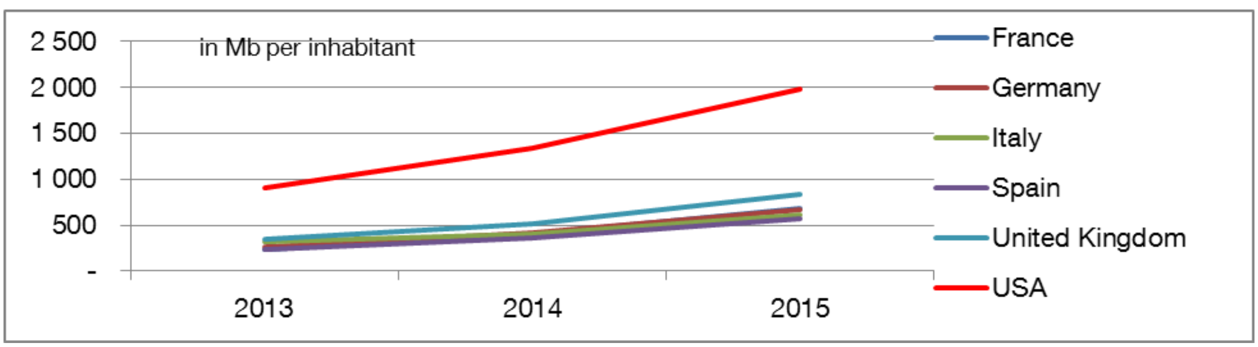
Table 8: mobile broadband data traffic in main countries

	USA	France	Germany	Spain	UK	Italia
Average mobile data volumes per capita in 2014 (Megabytes)	1771	397	398	370	362	684
Average mobile data volumes per capita in 2009 (Megabytes)	280	95	110	85	55	92
One year percentage change	108%	101%	47%	54%	44%	46%
Five years percentage change (CAGR)	107%	87%	66%	44%	58%	49%

source : OFCOM International Report 2015

In addition, information from Ovum, show that mobile data per capita is by far higher in the United States than in some of the largest Western European countries (3 GB per capita in the United States while all of the five European countries are below one GB in 2015), and that the gap with the United States has been increasing over time, as shown in Figure 32.

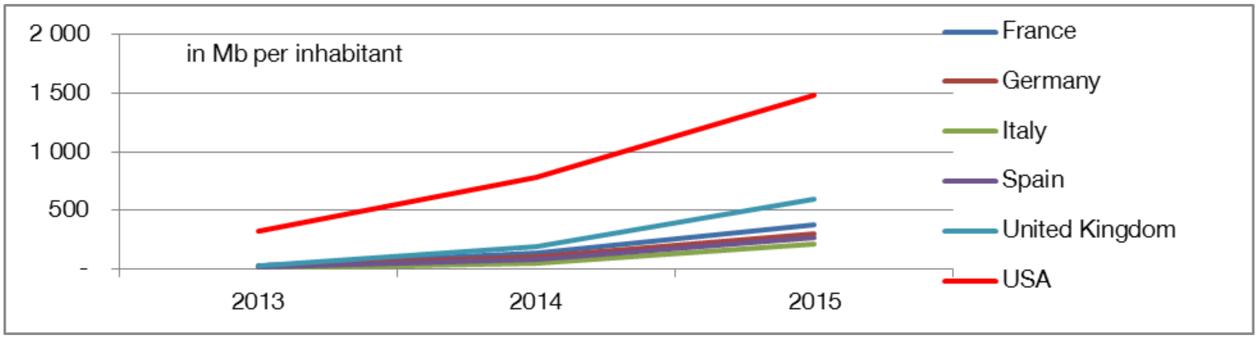
Figure 30: Monthly mobile data traffic per capita



source: OVUM – Network Traffic

The gap between the United States and Europe is even larger when considering only 4G mobile data traffic, as 4G coverage is higher in the United States than in Europe and as data traffic levels from a 4G user are higher than those of 3G customers. In 2015, 4G mobile data traffic per capita has reached 1.5 GB in the United States while it was still below a 500 MB threshold for the main European countries (with the exception of the UK, however not well above the 500 MB threshold), as shown in figure 33. As for the general trend of mobile broadband data traffic intensity, the growth rate of 4G monthly data traffic is accelerating in the United States.

Figure 31: 4G monthly mobile data traffic per capita



Source: OVUM – Network Traffic

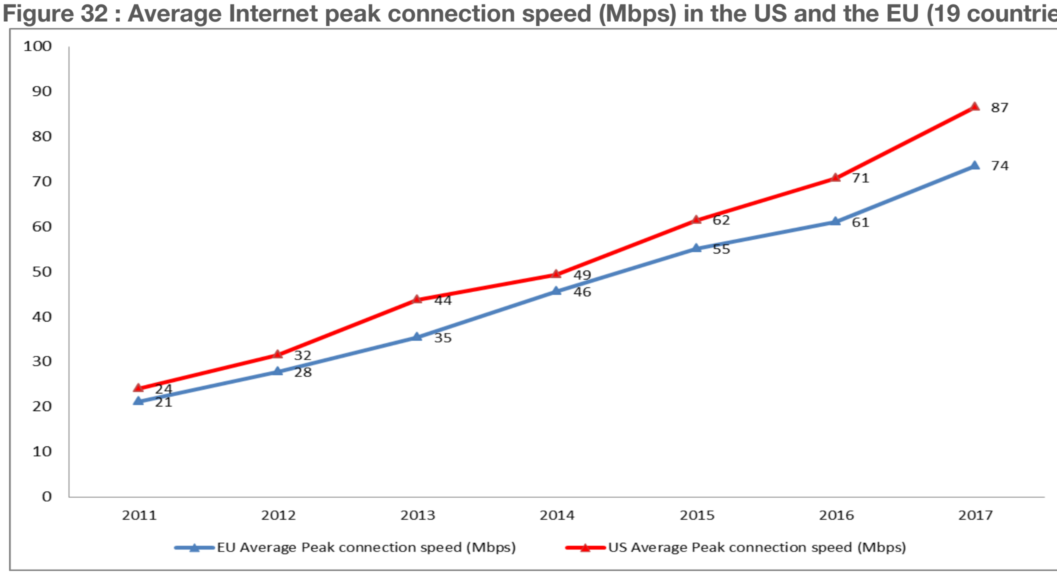
APPENDIX 6: Broadband peak measured speed from Akamai

1. Akamai rates also fixed peak data traffic ahead in the US than in main Western European countries

Aside from the average connection speed, Akamai "State of Internet Reports" provides measures of Internet peak connection speed by country. The result for the European Union is obtained by computing the mean of national connections speeds for the nineteen European countries reported each year by Akamai.

Rather than the absolute values, the relative values provide reliable information on the gap between the United States and the European Union in terms of connection speed. It appears than the average peak connection speeds have been higher in the US during the whole period of observation (2011 to 2017). Indicators of connection speed have been increasing over time in both regions, with only slight variations around the general trend. The increases in the average peak connection speed have been stronger in the US than in Europe between 2012 and 2013, and between 2016 and 2017. However, at the exception of 2012-2013, both indicators follow a similar growth trend in both regions. Moreover, the gap in average peak connection speed has increased over the time.

Figure 32 : Average Internet peak connection speed (Mbps) in the US and the EU (19 countries)



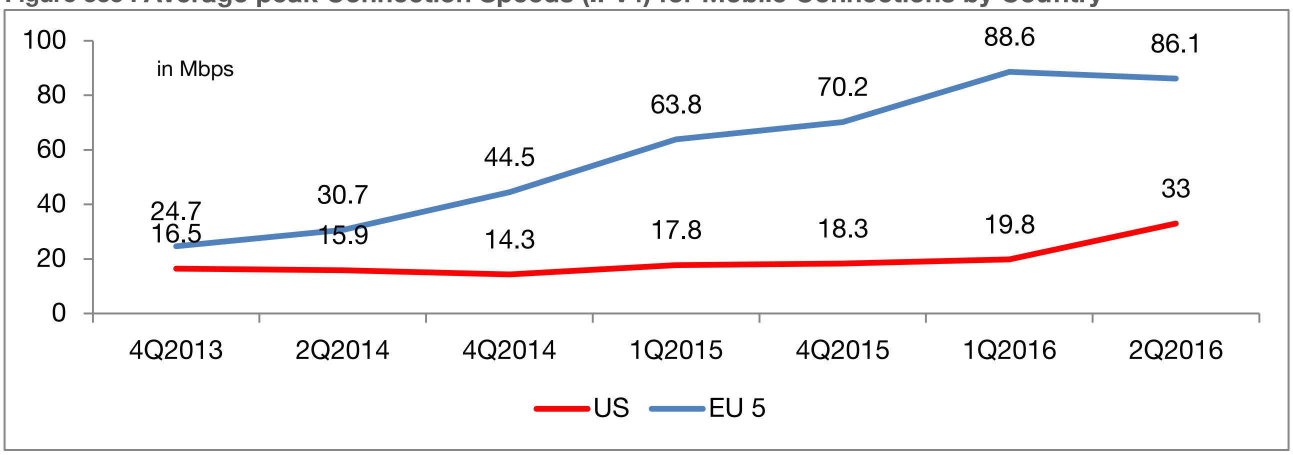
Source: Akamai

2. Akamai rates mobile peak data traffic ahead in main Western European countries

Akamai states that the mobile average peak connection speeds measurements can be influenced by a number of factors, including the use and location of proxies within mobile networks. If a country's major mobile carriers make heavy use of such proxies, peak connection speeds recorded for that country are likely to be influenced by the speeds achieved between Akamai and the proxies (residing in data centers) rather than speeds achieved between Akamai and the mobile devices themselves. Some of the average peak connection speeds recorded below are higher than one might expect given the current state of LTE and LTE-A deployment, so it is likely that these speeds are affected — to differing degrees — by proxies within those countries' mobile provider networks and may not be fully representative of speeds being seen by end users.

Just as per the average connection speed, the peak average connection speeds are neither experiencing a steady increase. Global trends show however an increase, with main European countries average connection speeds above American one since the end of 2014. During 2Q 2016, mobile average peak connection speed was 33.0 Mbps in the US, to be compared with average speed of 86.1Mbps in the EU 5.

Figure 335 : Average peak Connection Speeds (IPv4) for Mobile Connections by Country



Source: Akamai State of the internet connectivity reports

Table: