

## Section 4

# Fixed broadband networks and services

- 4.1 The quality and reach of fixed broadband infrastructure in the UK has advanced considerably over the last few years, both in terms of technology and services offered. Superfast broadband is now available to almost 90% of homes and small businesses across the UK and continuing investment by industry and Government will ensure further increases in coverage over the next few years.
- 4.2 This section explores the coverage and performance of fixed broadband services in the UK and highlights how consumers are using their broadband connections to send and receive more data than ever before. We note, however, that many consumers still cannot access adequate broadband speeds and highlight ongoing Government and industry initiatives aimed at improving the quality of broadband services for all.
- 4.3 The most important messages are:
- 4.3.1 **Superfast broadband coverage in the UK has improved significantly over the last few years.** The coverage of superfast broadband has extended to over 25 million (or 89% of) UK premises, up from 83% in 2015. This creates the potential for better speeds and improved quality of service for both residential and SME consumers.
- 4.3.2 **There are still gaps in broadband coverage.** Progress has been made in reducing the number of premises that cannot get acceptable speeds. However, around 1.4 million, or 5% of, homes and small businesses in the UK are still unable to receive download speeds greater than 10Mbit/s. This represents the lowest number of premises that would fall within the UK Government's proposed broadband Universal Service Obligation (USO), depending in its specification;
- 4.3.3 **The growth in the number of premises taking up superfast broadband appears to be slowing.** Over 9 million, or 31% of, UK premises now subscribe to superfast services, up from 27% in 2015 and 21% in 2014. While this latest year-on-year increase is a reasonable improvement, these figures suggest that growth in superfast take-up might be reaching a plateau. Given the relatively high levels of superfast coverage, it is unclear why more consumers are not actively taking up faster services.
- 4.3.4 **Faster speeds mean that more data is being consumed.** The average download speed of all broadband products in the UK is now 37Mbit/s, up from 29Mbit/s in 2015. Average monthly data volumes per household have increased by 36% over the past year, from 97GB to 132GB. The total volume of data transferred over fixed broadband networks in June 2016 was 2,750PB<sup>11</sup>.

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<sup>11</sup> A petabyte, or PB, is equivalent to one million gigabytes.

### **What is superfast broadband and how is it delivered to homes and small businesses?**

We define superfast broadband as supporting download speeds of at least 30Mbit/s. In order to deliver these speeds, service providers typically need to install fibre optic cabling, which supports higher speeds than the copper cables used in traditional networks.

The current generation of superfast broadband is typically delivered by replacing the copper cable between the local exchange and the street cabinet with optical fibre. The cable between the street cabinet and the consumer's home or business is still made of copper. The replacement of copper with fibre in the connection enables higher speeds for the consumer. It is also possible to use fibre optic from the exchange all the way to the consumer's premises. This offers speeds that are even higher than superfast, which we call ultrafast broadband.

Note that the UK Government uses a slightly different definition of superfast. They define superfast as supporting download speeds of at least 24Mbit/s.

Some common terms used to describe broadband services include:

*Fibre to the cabinet (FTTC):* This describes a superfast broadband connection that uses optical fibre from the exchange to the street cabinet and a copper cable to connect the cabinet to the home or office, as described above. Providers such as BT, Sky and TalkTalk offer FTTC services.

*Cable:* This is a similar concept to FTTC, but the connection between the cabinet and the home or office is made of a particular type of copper cable that can support very high speeds. Virgin Media offers this kind of service, delivering superfast broadband and television services over its cable network.

*Fibre to the premises (FTTP):* This describes a service that uses fibre from the exchange directly to the consumer's home or office. FTTP, or "full fibre" networks can deliver very high speeds and is offered to different extents by BT, KCOM in and around Kingston Upon Hull, and several smaller providers such as B4RN in rural Lancashire, Hyperoptic and Gigaclear.

*Wireless:* This describes a service that uses a wireless connection between the consumer's home or office and the provider's network. This kind of service is often based on similar technologies to those used in mobile networks, and can deliver superfast speeds. These services are offered by providers such as Relish and Quickline.

## **Coverage of superfast broadband has increased to almost 90% of UK premises**

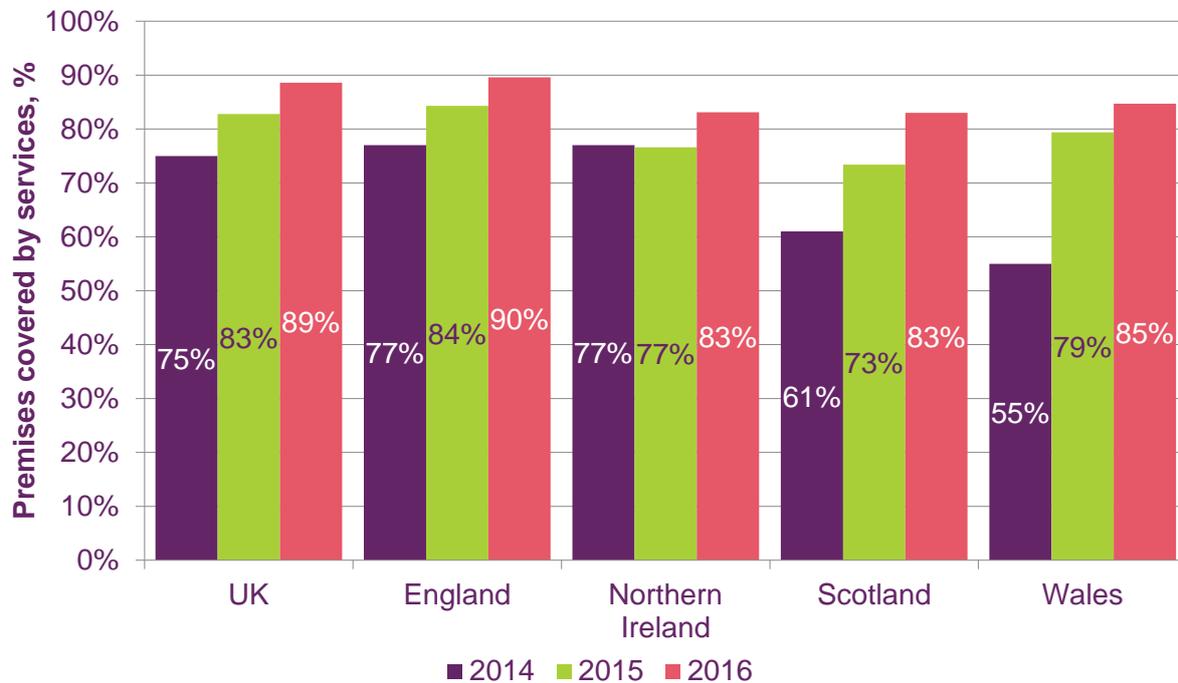
- 4.4 Around 25.5 million, or 89%, of premises across the UK can now access networks offering at least 30Mbit/s. The average download speed<sup>12</sup> of these superfast connections is now 74Mbit/s, a 14% increase on last year's speeds. The average

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<sup>12</sup> This is the average of actual measured speeds of active superfast or ultrafast lines, where known. The sync speed of a connection is the maximum speed achievable between a consumer's premises and their internet service provider's (ISP's) network.

upload speed for superfast services in the UK is unchanged from last year, at 8Mbit/s.

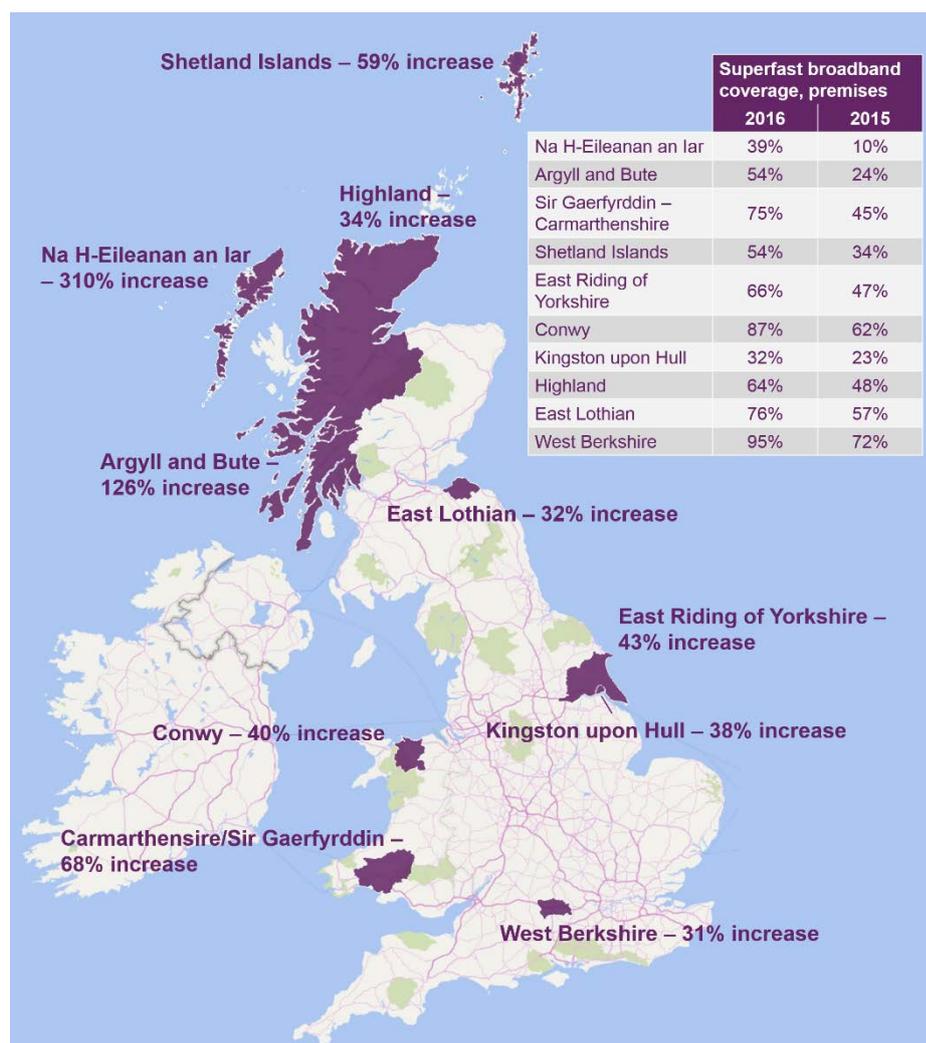
**Figure 3: The number of properties that can access broadband services with superfast speeds or higher continues to increase**



Source: Ofcom analysis of operator data

- 4.5 As Figure 3 shows, coverage of services offering superfast speeds of 30Mbit/s or higher has increased across all of the UK's nations. The greatest increase was in Scotland, with a year-on-year rise of almost 14%, compared to an average of around 7% for the other nations. However, superfast coverage in Scotland and Northern Ireland still remains lower than in other nations.
- 4.6 Targeted investment by industry and Government has led to some areas of the UK experiencing significant increases in superfast broadband coverage over the past year, as shown in Figure 4. In many cases, these areas previously had very low levels of coverage and, even with recent increases, the availability of superfast broadband remains low compared with the UK as a whole. Nonetheless, these improvements will be welcomed by consumers in these areas, many of whom will be experiencing significant improvements in the quality and speed of their broadband services.
- 4.7 Although the coverage of broadband services remains better in urban areas, there has been significant increase in the availability of superfast in rural areas. As Figure 5 shows, around 60% of UK rural premises can now access speeds of over 30Mbit/s, up from 44% in 2015.

**Figure 4: Areas of the UK have seen a significant increase in the availability of superfast broadband**



Source: Ofcom analysis of operator data

**Figure 5: Superfast broadband coverage in rural areas has increased by around 35%**

	Availability of superfast broadband in rural areas, premises		
	2016	2015	Approximate year-on-year increase
<b>UK</b>	59%	44%	35%
<b>England</b>	62%	45%	38%
<b>Northern Ireland</b>	52%	40%	29%
<b>Scotland</b>	46%	31%	46%
<b>Wales</b>	57%	54%	5%

Source: Ofcom analysis of operator data

## The coverage of ultrafast services is largely unchanged

- 4.8 Alongside the continuing roll-out of superfast services, a new range of broadband services are now increasingly available that offer download speeds of several hundred Mbit/s or higher. These services are enabled via upgrades to the capacity of existing networks or by new technologies such as FTTP (see the box above).
- 4.9 As we noted last year, there is not a consensus on a definition for these ultrafast services, with views on the minimum download speed ranging from 100Mbit/s to 1Gbit/s. Figure 6 shows the coverage of broadband services for this range of speeds<sup>13</sup>.

**Figure 6: Coverage of faster broadband services with download speeds of 100Mbit/s or higher**

	Coverage of premises, %		
	Download speed of at least 100Mbit/s	Download speed of at least 300Mbit/s	Download speed of at least 1Gbit/s
<b>UK</b>	46%	1.7%	0.8%
<b>England</b>	49%	1.9%	1.0%
<b>Northern Ireland</b>	27%	0.2%	0%
<b>Scotland</b>	36%	0.2%	0.2%
<b>Wales</b>	22%	0.7%	0.2%

Source: Ofcom analysis of operator data

- 4.10 The coverage of these services is broadly unchanged from 2015. Around 13 million, or 46% of, UK premises have access to broadband services with download speeds of 100Mbit/s or more; and download speeds of 300Mbit/s and above are available to around 2% of UK premises (480,000).
- 4.11 Since supplying us with their network coverage data in June, Virgin Media has started to offer services with download speeds of 300Mbit/s. The availability of these services is not reflected in this year's data but we would expect to see a significant increase in the number of premises that can receive download speeds of 300Mbit/s or more in subsequent reports. We would also expect to see these figures increase as a result of Virgin Media's ongoing Project Lightning activity, which is seeking to extend their network coverage to around 17 million premises by 2020.
- 4.12 As with last year, for this report we have defined ultrafast services as those delivering a download speed of 300Mbit/s or more. We will continue to monitor the coverage of these faster services and may, if appropriate, refine our definition as the market evolves.

<sup>13</sup> Last year we reported that the coverage of services with download speeds of at least 300Mbit/s in Scotland and Wales was 2% and 5% respectively. This year we are reporting lower levels of coverage; however, this is likely a result of this year's more accurate data set, which is based on address-level granularity, rather than any real reduction in coverage.

## Almost half a million homes and small businesses have access to "full fibre" broadband

- 4.13 In addition to the ongoing deployment of fibre to the cabinet (FTTC) services to support superfast speeds, some operators are also in the process of rolling out fibre to the premises (FTTP) or "full fibre" networks. These are networks where the entire connection, from the operator's core network to the customer's premise, is based on fibre optic links.
- 4.14 One important benefit of full fibre networks is that they are able to support very high speeds, ranging from several hundred Mbit/s to 1Gbit/s or more. In addition, full fibre networks can be more reliable and experience fewer faults than services based fully or partially on the traditional telephone networks, as they are less susceptible to damage from water ingress. The increased capacity of full fibre networks also can mean that the speeds actually experienced by consumers will be more stable and less likely to degrade at peak times.
- 4.15 Coverage of full fibre services is low, reflecting what is currently an immature market. Around 1.7% of homes and small businesses (500,000) have access to full fibre services across the UK and, as Figure 7 shows, most (over 90%) of these premises are in England.

**Figure 7: Percentage of premises that receive full fibre services**

	Premises covered, number (%)
UK	500,000 (1.7%)
England	480,000 (2.0%)
Northern Ireland	1,600 (0.2%)
Scotland	6,000 (0.2%)
Wales	11,000 (0.7%)

Source: Ofcom analysis of operator data

- 4.16 A range of providers, both large and small, are beginning to offer full fibre services:
- 4.16.1 Openreach is a national provider of full fibre services, with the largest coverage footprint in the UK. In addition to its commercial roll-out, Openreach has been deploying full fibre services to some parts of the country as part of its agreement with the UK Government to improve broadband speeds as part of the BDUK Superfast Broadband Programme<sup>14</sup>;
- 4.16.2 Virgin Media is also starting to offer full fibre services across the country. The company intends to add around four million premises to its coverage

<sup>14</sup> The UK Government's Broadband Delivery UK (BDUK) Superfast Broadband Programme is seeking to deliver download speeds of 24Mbit/s or more to 95% of the UK by the end of 2017.

footprint by 2020 as part of its Project Lightning expansion plans, around half of which will be full fibre connections<sup>15</sup>;

- 4.16.3 KCOM, who are responsible for operating the network in and around the city of Kingston upon Hull; and
  - 4.16.4 A number of smaller providers, such as Gigaclear, Hyperoptic and B4RN that often target areas that would otherwise remain unserved by other, larger operators.
- 4.17 While levels of superfast coverage are relatively high, the UK has a low level of full fibre coverage compared to other countries, as we describe in our International Communications Market Report<sup>16</sup>. For example, Germany, France and Portugal have full fibre coverage levels of 7%, 16% and 75% respectively. Further afield, 95% of premises in Singapore, and 97% in Japan, have access to full fibre broadband.
- 4.18 The next two sections look in more detail at deployments of full fibre networks in Kingston upon Hull and by smaller providers throughout the country.

### **Kingston upon Hull has a relatively high availability of full fibre services**

- 4.19 The English city of Kingston upon Hull is the only city in the UK that is not served by BT. Telecommunications services are instead provided by KCOM, which is the incumbent operator in the city and the neighbouring areas in East Yorkshire.
- 4.20 KCOM has followed a different approach to upgrading its broadband network, compared to BT in other parts of the country. KCOM is pursuing a strategy of upgrading its network to offer mainly full fibre services, rather than the fibre to the cabinet (FTTC) services that underpin most of BT's superfast services<sup>17</sup>.
- 4.21 KCOM's focus on the deployment of full fibre networks means that around 35% of homes and small businesses in the Hull area<sup>18</sup> can now benefit from download speeds of at least 250Mbit/s, more predictable performance at peak times and a more reliable service. The network is also more future-proofed than fully or partially copper-based networks, meaning that the speeds delivered to consumers can continue to grow.
- 4.22 KCOM have more recently announced<sup>19</sup> that they are accelerating their FTTP plans with the aim of passing 150,000 properties by the end of 2017. This would represent a significant increase in FTTP availability in the area where they are the incumbent.
- 4.23 However, the shorter term price of this revolutionary approach, as opposed to the evolutionary approach of upgrading to FTTC services, is that it runs the risk of creating a two-tier online community. Where these full fibre services are not available, the relative lack of FTTC deployment in the Hull area means that consumers in the city rely on slower, all copper-based services. As a result, based on

<sup>15</sup> Virgin Media Q3 2016 results, <http://www.virginmedia.com/corporate/media-centre/press-releases/virgin-media-q3-2016-results.html>

<sup>16</sup> <https://www.ofcom.org.uk/research-and-data/cmr/cmr16/international>

<sup>17</sup> KCOM has deployed some FTTC and will continue to do so but FTTP will provide the main NGA connectivity solution.

<sup>18</sup> The "Hull area" refers to the area where KCOM operates as the incumbent and consists of the Kingston upon Hull City Council area and some parts of the East Riding of Yorkshire Council area.

<sup>19</sup> <http://www.kcomplc.com/business-insight/news-and-media/kcom-announces-major-milestone-in-ultrafast-broadband-rollout/>

the June 2016 data used in this report, around 24% of premises in the Hull area are unable to get more than 10Mbit/s.

### Smaller providers are playing an important role in delivering high speed broadband services throughout the country

- 4.24 As we reported in previous years, a number of smaller providers are continuing to invest in the infrastructure required to deliver high speed broadband services. These providers sometimes target areas with little or no superfast coverage and, without their deployments, consumers in these areas would continue to experience poor broadband performance.
- 4.25 Recognising the important role that these smaller providers play in improving the coverage of broadband services, we collected data from a sample of five providers operating throughout the UK. The combined coverage of these providers is around 570,000 premises, or 2% of all premises in the UK. As a result of this coverage, around 185,000 premises that previously were unable to get superfast speeds or higher are now connected.

**Figure 8: Number of premises that are served by superfast services, or faster, from smaller providers**

	Number of premises served
England	563,000
Scotland	4,540
Wales	2,430

Source: Ofcom analysis of operator data

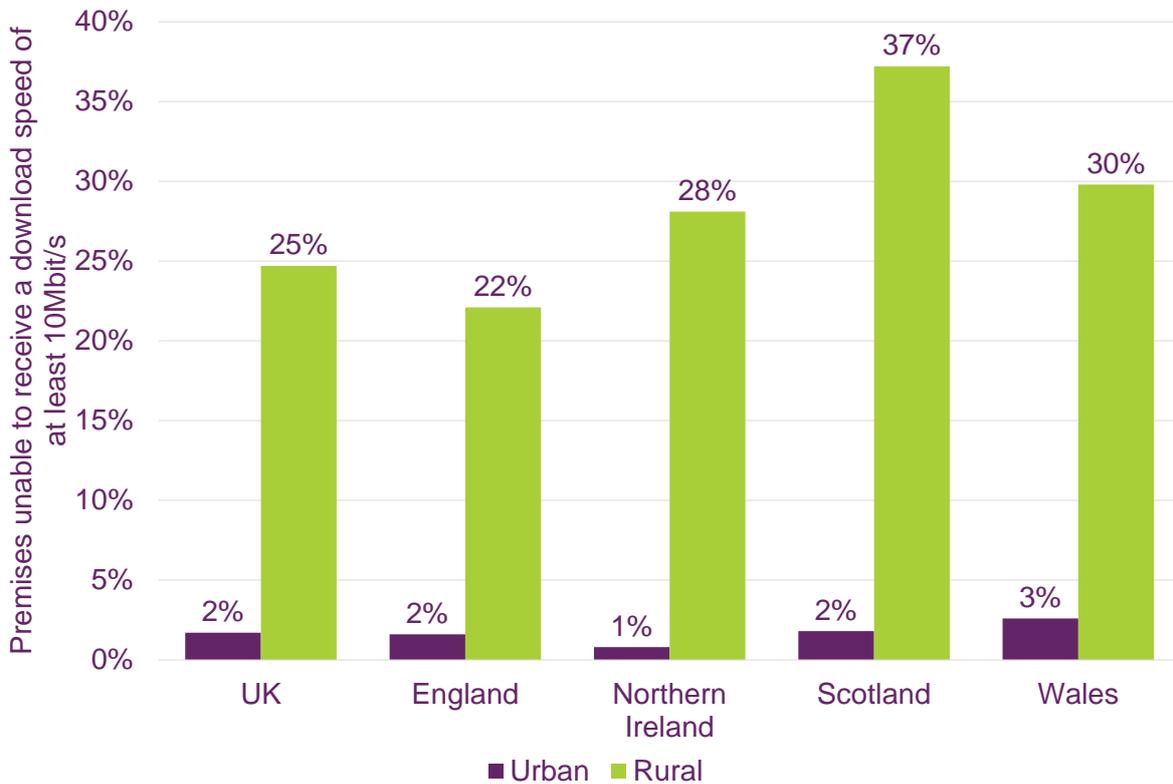
- 4.26 As Figure 8 shows, the majority of the premises served by smaller providers are in England. The majority of these premises are in London, where coverage is provided by a mix of full fibre and fixed wireless services. Outside of larger cities there are also targeted deployments of full fibre services in rural areas, such as the counties of Lancashire, Cumbria and North Yorkshire. In these cases, smaller providers are playing a vital role in delivering superfast, or even ultrafast, services to consumers who had previously lacked acceptable broadband.
- 4.27 In Scotland and Wales, coverage is focused in the cities of Glasgow and Cardiff respectively. We do not currently hold data on the coverage of smaller providers in Northern Ireland. We aim to include coverage from a greater number of smaller providers in next year's report.

### Many consumers remain unable to access broadband with acceptable speeds

- 4.28 Despite the increase in coverage of superfast services, many homes and small businesses still are unable to receive broadband speeds that are adequate to reliably perform a range of common online activities. Almost a quarter of a million UK premises, around 1% of the total, cannot get a download speed of more than 2Mbit/s and over 600,000 premises cannot get 5Mbit/s.

- 4.29 As Figure 9 shows, the problem is particularly bad in rural areas. One of the main reasons for poor broadband speeds in rural areas is the length of the connection to the property. Rural properties are often further from the exchange or street cabinet than in urban areas and, for copper-based telephony networks, the longer the connection, the slower the speeds are likely to be due to attenuation of the broadband signal.
- 4.30 Around 1.4 million, or 5%, of UK premises are unable to receive a download speed greater than 10Mbit/s. We continue to regard this as the minimum download speed required to fulfil the basic needs of the average UK household. As Figure 9 shows, a much higher proportion of premises unable to access a connection speed of at least 10Mbit/s are in rural areas, and across the UK 25% of rural premises (approximately 960,000 premises) are unable to receive download speeds greater than 10Mbit/s. Government programmes, such as those administered by Broadband Delivery UK (BDUK), are helping to address the problem of poor broadband coverage, in particular in rural areas. We expect to see improvements in the coverage of faster services over the coming 12 months.

**Figure 9: Many premises are unable to receive a download speed greater than 10Mbit/s, especially in rural areas**



Source: Ofcom analysis of operators' data

**Why are broadband speeds lower in rural areas?**

The distance between the premises and the exchange has an impact on the quality of service received, and in particular the speed of a consumer's connection. Consumers who live in less densely populated parts of the UK are more likely to live further from the exchange, and therefore achieve lower broadband speeds.

The resistance of copper wire increases with the length of the wire, so speeds decay as the distance between the premises and the exchange increases. Speeds typically start to decrease between 1 and 2km from the exchange and are reduced considerably at distances more than 3.5km.

FTTC-based broadband uses optical fibre to the cabinet and therefore the length of copper wire is reduced. It can currently support superfast speeds up to 80Mbit/s. However, as some copper wire remains between the cabinet and the premises, there can be some decay in speeds for customers located a long way from a cabinet. Customers further than 300m from a cabinet can expect their speeds to be less than half the maximum possible.

However, most consumers who live too far from the cabinet to receive superfast broadband may still benefit from the upgrade at the cabinet, as the reduction in the length of the copper access line will improve their broadband speeds.

- 4.31 There are some consumers that are connected to FTTC networks but do not currently receive superfast speeds. Many of these premises are found in rural areas, where the distance between properties and street cabinets can be higher than those in urban areas. Despite the cabinet being upgraded to fibre, the long copper lines between the cabinet and the premise results in reduced speeds.
- 4.32 We estimate that around 3%, or 780,000, premises in the UK are connected to FTTC networks but cannot receive superfast speeds. The situation is broadly similar in England, Scotland and Wales, where around 3% of premises are affected in this way. However, Northern Ireland has a much higher proportion of such lines; around 7% of premises in the nation as a whole and 16% of rural premises are connected to FTTC networks but do not receive superfast speeds. This is because Northern Ireland has a relatively large number of dispersed rural properties, needing longer lines to connect them to street cabinets.

### **Broadband coverage remains relatively poor for many small businesses**

- 4.33 The UK's 5.5 million small and medium enterprises (SMEs)<sup>20</sup> constitute 99.3% of all UK private businesses, account for 60% of private sector employment and 47% of business revenue<sup>21</sup>. Providing all SMEs with access to superfast broadband services is vital for improving efficiencies of business and providing equal opportunities to participate and utilise the benefits of a digital economy.
- 4.34 We have analysed the availability of superfast broadband delivered to 2.4 million SMEs with at least one employee (i.e. not including sole traders)<sup>22</sup>. We have compared coverage of SMEs against the average, split by geography, shown in Figure 10.

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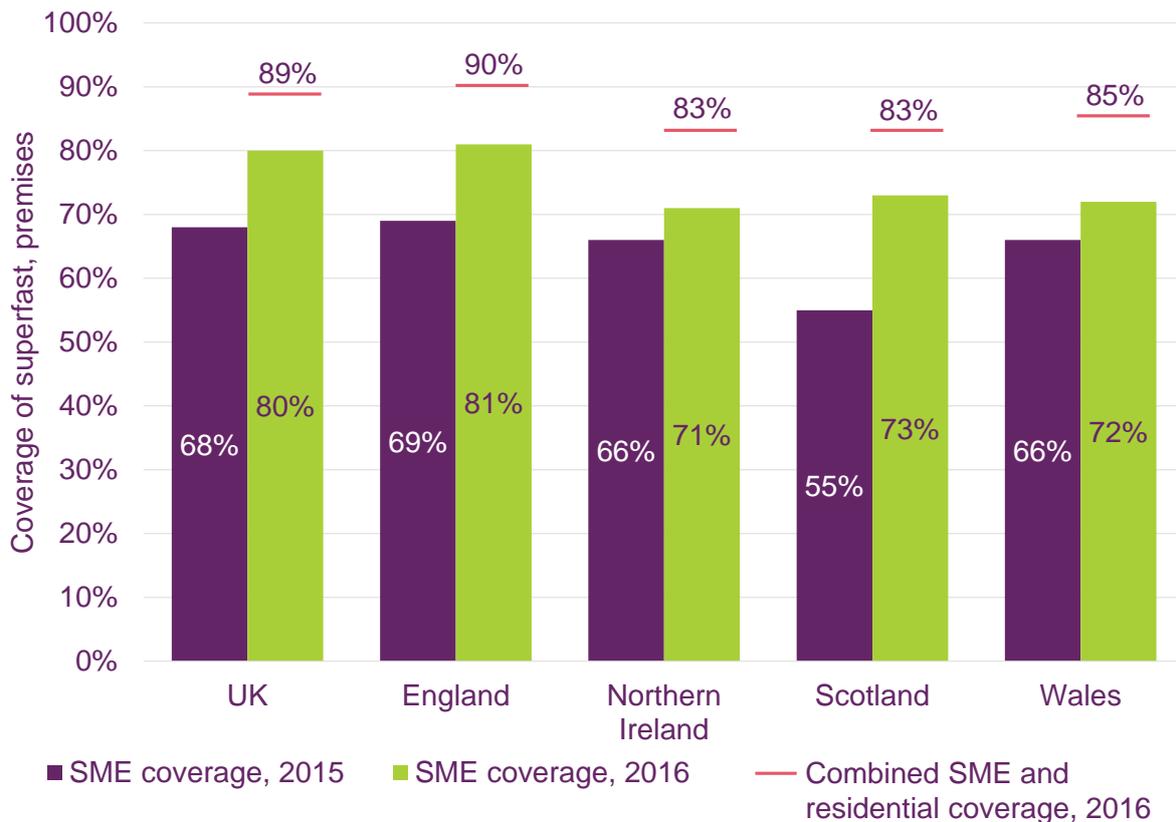
<sup>20</sup> Defined as businesses with fewer than 250 employees. In this report we use the terms "SME" and "small business" interchangeably.

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[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/559219/bpe\\_2016\\_statistical\\_release.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/559219/bpe_2016_statistical_release.pdf)

<sup>22</sup> This year we have used a more detailed dataset that identifies more active SMEs (around 2.4 million) than the dataset we used last year (that identified around 1.3 million). As a result, accurate year-on-year comparisons cannot be made and should be considered an indication of broad changes in coverage.

**Figure 10: Superfast coverage for SMEs has increased but still lags the population as a whole**



Source: Ofcom analysis of operators' data

- 4.35 Superfast coverage for SMEs has increased to around 81% of premises (1.9 million), up from 68% in equivalent analysis last year. Across the UK, SMEs still experience lower coverage of superfast services than the population as a whole. For example, only 82% of SMEs in England have access to superfast services, compared to 90% of all premises in the country. We note, however, that some SMEs may have access to alternative sources of connectivity, such as within *incubator centres*, i.e. shared facilities intended to help SMEs become established.
- 4.36 SMEs in Northern Ireland, Scotland and Wales experience relatively low levels of superfast coverage, compared to the UK as a whole. This reflects the lower availability of superfast broadband in these areas overall. More generally, many SMEs are based in rural areas or in business parks, areas that to date have not been targeted for network upgrades.
- 4.37 Overall, around 8% of SMEs (190,000) in the UK are unable to access broadband services with download speeds of 10Mbit/s or higher, compared to around 5% of all premises. Most of these SMEs are in rural areas, where over 130,000 SMEs receive less than 10Mbit/s.
- 4.38 Operators are continuing to upgrade, or to deploy entirely new, networks and we expect the availability of superfast broadband to further increase for SMEs, and for all consumers more generally. Looking ahead to the coming year, we estimate that additional, planned network deployments will reduce the number of UK SMEs that are unable to receive superfast services from around 20% today to 10% (around 240,000 businesses) by the end of 2017.

### Superfast coverage in business parks is lower than in the rest of the country

- 4.39 We estimate that around 15%, or 340,000, of the 2.4 million SMEs that we have analysed are located within areas, typically business parks that include no residential premises. As the deployment of superfast broadband services has, to date, been driven by demand from residential customers, many of these areas currently have little or no coverage of these services.
- 4.40 Across the UK as a whole, around 67% of SMEs in business parks (230,000) have access to superfast broadband. This compares to 80% of SMEs throughout the country and 89% of the wider population. Coverage in the individual nations' business parks is broadly similar to the UK average, apart from in Northern Ireland, where 83% of SMEs in business parks have access to superfast services.
- 4.41 Given the lower availability of superfast services in business parks, the actual speeds delivered to SMEs in these areas is lower than in the country as a whole. We estimate that the average speed of broadband connections in business parks is 24Mbit/s, compared to 38Mbit/s for SMEs as a whole.

### **Improving the coverage of broadband services for all**

- 4.42 While the coverage and speed of broadband services across the UK have continued to increase, many consumers and small businesses are still unable to get online with acceptable speeds and quality of service. A quarter (25%, or 960,000) of premises in the UK's rural areas cannot get download speeds greater than 10Mbit/s. Even in the UK's towns and cities, where coverage is typically high, there are still some consumers that cannot get fast speeds; almost 1.7 million urban premises cannot receive superfast services and over 410,000 cannot receive download speeds greater than 10Mbit/s.
- 4.43 We expect the situation to improve over the coming years as operators, both large and small, continue to invest in their networks to both improve the reach and speed of broadband services. There are also a number of ongoing public policy initiatives that are intended to improve superfast broadband availability in areas that may otherwise not be covered by commercial deployments.
- 4.44 The largest of these programmes is the UK Government's intervention under the Broadband Delivery UK (BDUK) initiative, which aims to deliver download speeds of 24Mbit/s or more to 95% of the UK by the end of 2017. Based on our analysis, we estimate that, as of June 2016, 90% of UK premises (almost 26 million) are covered by broadband services at this speed.
- 4.45 Even with these current commercial deployments and public policy initiatives, there will still be some UK premises that will lack access to superfast services at the end of 2017. Below we examine a proposal from the UK Government for a broadband Universal Service Obligation (USO), intended to extend the availability of a broadband service to all homes and businesses. We also summarise some recent or emerging technology developments that could improve broadband speeds for all consumers.

## Between 1.4 and 3.5 million premises may fall within the broadband Universal Service Obligation

- 4.46 Ofcom has been asked<sup>23</sup> by the Department for Culture, Media and Sport to provide technical analysis and recommendations to support the design of the broadband Universal Service Obligation (USO).
- 4.47 The Government has said that its ambition is for a download speed of 10Mbit/s to be available to all on reasonable request. We have published a detailed report<sup>24</sup> on the USO which examines how the provision of USO could work in practice. It also considers how the specification of the USO could affect both the number of premises that are eligible and the costs that could result in meeting the specification if the Government makes a decision to implement it.
- 4.48 Currently around 5% of premises cannot receive a download speed of 10Mbit/s, a figure which has come down significantly over time - it was 15% in 2014. While small in percentage terms, it should be remembered that 5% represents around 1.4m premises that are currently unable to receive a download speed of 10Mbit/s. Furthermore, as we showed in Figure 9 on page 19, a far greater proportion of rural premises are unable to receive a speed of 10Mbit/s than urban premises, and Wales, Scotland and Northern Ireland have a greater proportion of premises unable to do so.
- 4.49 However, the number of premises could rise if, for example, the threshold also took upload speeds and other factors into account. One option would be to extend the specification above to include properties that *can* get a download speed of greater than 10Mbit/s, but have an upload speed of less than 1Mbit/s, as well as other technical measurements that can affect a consumer's broadband experience. In this scenario, we estimate that around 2.6 million premises may fall within the USO's technical specification. If Government were to choose a superfast option (30Mbit/s), we estimate that around 3.5 million premises could be in scope.

## Technology continues to evolve to meet the demand for higher speeds

- 4.50 The physical characteristics of full fibre networks mean that they are best placed to deliver reliable, ultrafast speeds both now and for the foreseeable future. Other technologies are emerging, however, that could play a complementary role in delivering broadband where full fibre networks are not available. They include:
- 4.50.1 **G.fast:** Openreach is partnering with Huawei and Nokia to support its planned rollout of this technology to over 10 million homes and businesses across the UK by 2020. The technology has been trialled in two areas of the UK, and a trial extension to more areas has been announced for early 2017<sup>25</sup>. G.fast has the potential to deliver download speeds up to 330Mbit/s over Openreach's existing copper-based network.
- 4.50.2 **Long range VDSL:** This emerging technology, also currently being trialled, has the potential to deliver superfast speeds over longer distances than can be achieved using current fibre to the cabinet (FTTC) technologies. In theory, download speeds of up to 40Mbit/s and upload speeds of up to

<sup>23</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0027/53676/dcms\\_letter.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0027/53676/dcms_letter.pdf)

<sup>24</sup> <https://www.ofcom.org.uk/consultations-and-statements/category-1/broadband-uso-cfi>

<sup>25</sup>

<https://www.openreach.co.uk/orpg/home/updates/briefings/ultrafastfibreaccessbriefings/ultrafastfibreaccessbriefingarticles/nga200216.do>

10Mbit/s could be delivered using this technology to premises that currently receive much lower speeds due to the distance to their serving VDSL cabinet.

- 4.50.3 **Next generation cable:** Virgin Media is in the process of upgrading its network and is beginning to offer services with download speeds of 300Mbit/s. Later versions of the technology used could support, in theory, download speeds of up to 10Gbit/s and upload speeds of up to 1Gbit/s<sup>26</sup>.
- 4.51 The above technologies are all related to the evolution of fixed broadband networks. However, wireless networks can also play an important role in delivering broadband services. In London and Swindon, for example, Relish provides a fixed wireless broadband service based on 4G technology that is capable of delivering superfast speeds. The Swindon project is part of a BDUK programme to evaluate “fixed wireless” solutions for superfast and the programme also includes equivalent projects involving Airwave and Quickline elsewhere in the country.
- 4.52 Satellite broadband is another wireless approach that is currently being used to deliver broadband to some parts of the country that are hard to reach with the above terrestrial technologies. Current satellite broadband services use geostationary satellites (which, like those used for satellite TV, stay at a fixed point in the sky) and can offer near universal coverage. A number of companies operate satellites that are used to provide broadband services to users in the UK including Avanti Communications, Eutelsat and SES. These offer download speeds of up to 20Mbit/s, depending on the satellite and package selected. Services are usually offered to consumers via a service provider rather than directly by the satellite operator.
- 4.53 The next generation of satellite broadband services are expected to provide superfast speeds and better overall performance than existing geostationary satellite broadband services. These services are likely to be available from 2020.

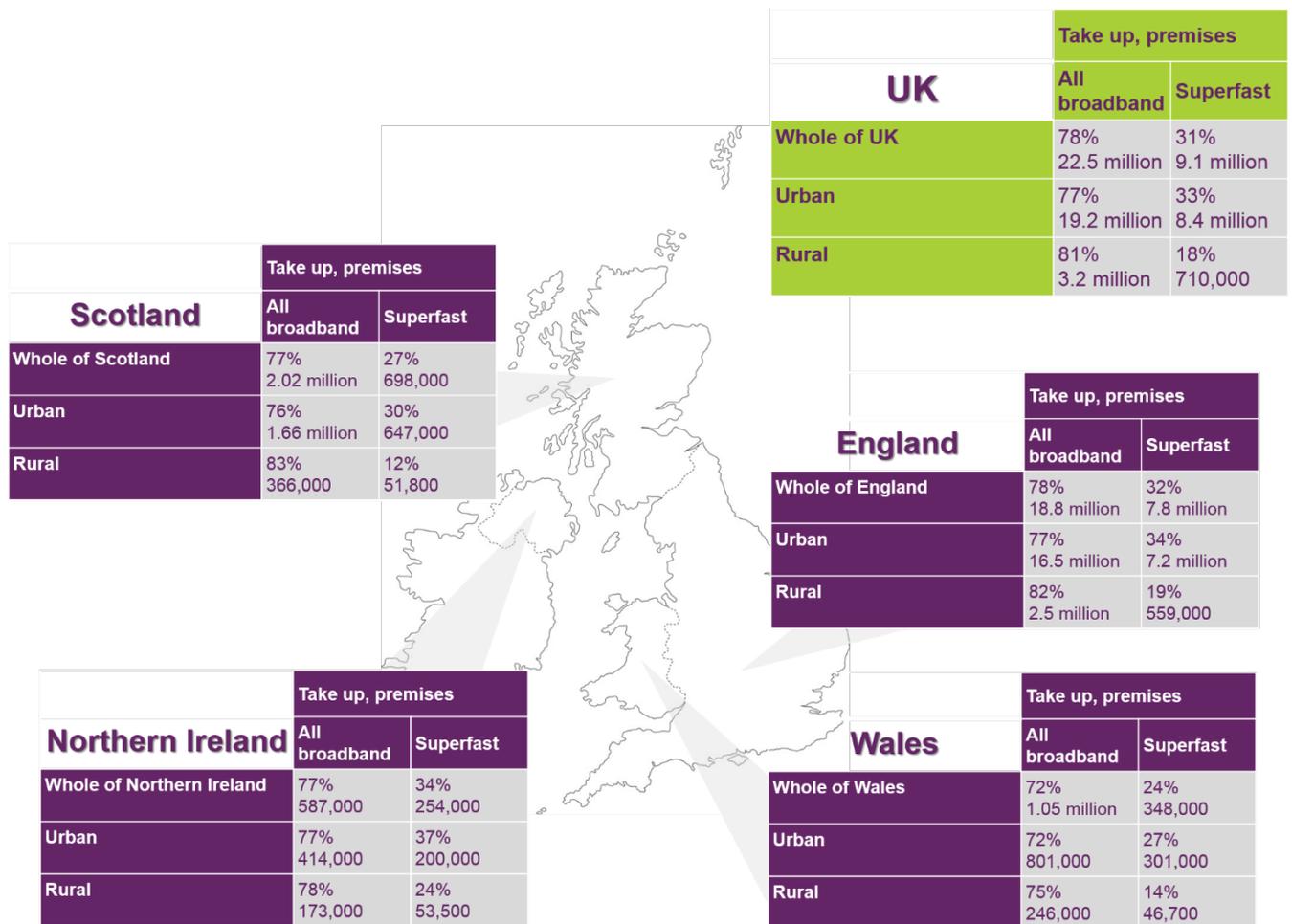
### **Increased coverage and take up of superfast services means that consumers are using more data**

- 4.54 In the UK, 31% of premises (9.1 million) now have an active superfast broadband connection. This is an increase from 27% in 2015. Nine out of 10 of these properties are in urban areas, which reflects the higher levels of superfast coverage in towns and cities.
- 4.55 Around 22% of UK premises (6.5 million) have not taken up any fixed broadband product at all, down slightly from 24% in 2015. Take up of broadband is lowest in Wales where almost 28% of the population have not subscribed to broadband services.

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<sup>26</sup> See the commentary on DOCSIS3.1 and other cable futures in <http://www.libertyglobal.com/pdf/public-policy/Liberty-Global-Policy-Series-Connectivity-for-the-Gigabit-Society.pdf>

Figure 11: Take-up of broadband services across the UK

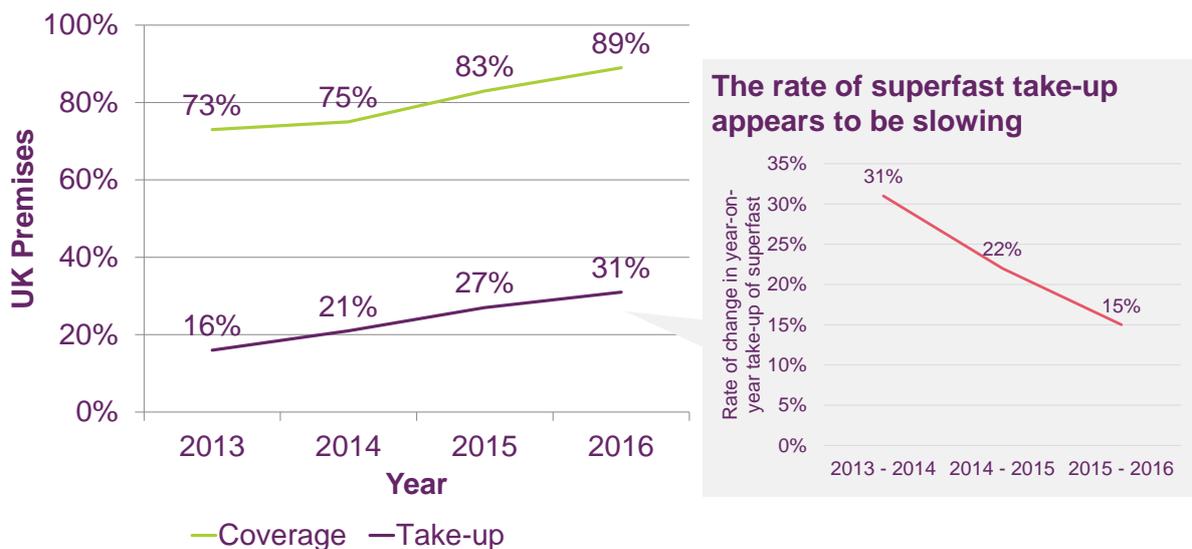


Source: Ofcom analysis of operators' data

### Take up of superfast broadband remains lower than availability

- 4.56 While take up of superfast broadband services has continued to increase, it remains relatively low; 89% of UK premises are able to receive superfast services, but only 31% have active superfast broadband connections.
- 4.57 Figure 12 shows how coverage and take up of superfast broadband has increased over the past three years. The rate that new subscribers are migrating from basic broadband services and adopting superfast services appears to be slowing, dropping from 31% in the year to 2014, to 15% over the past year.

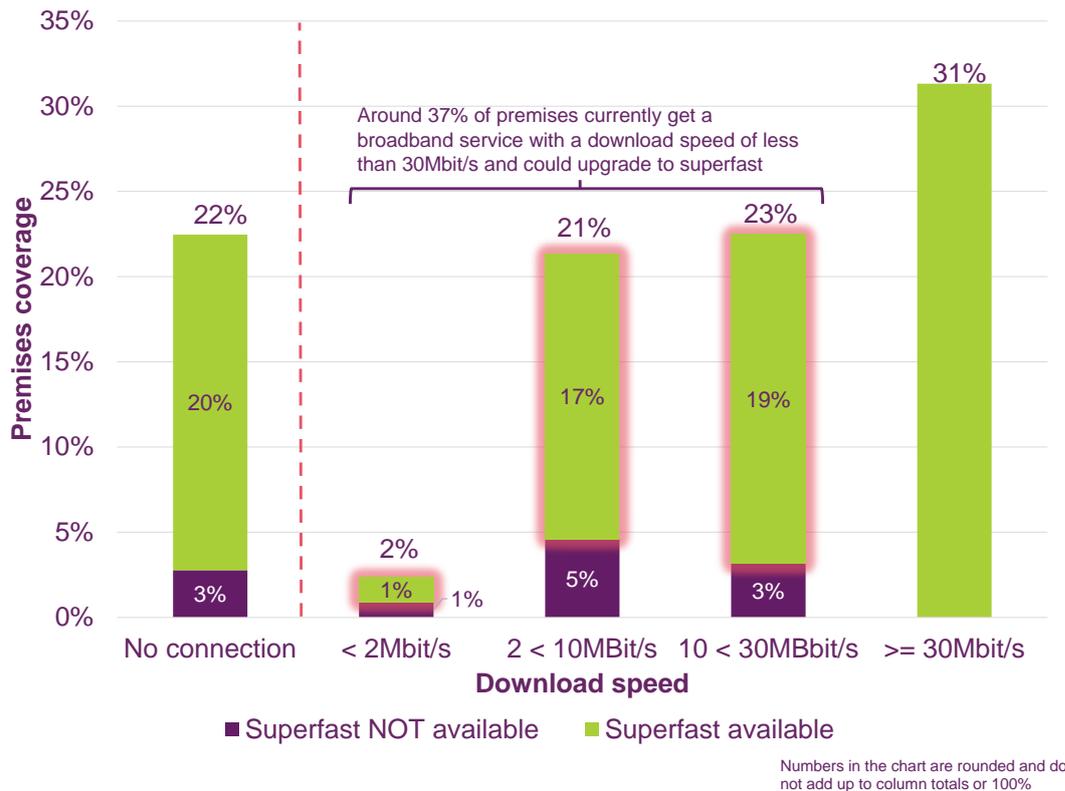
**Figure 12: Take up of superfast broadband has tracked the increase in coverage, but remains significantly lower**



Source: Ofcom analysis of operators' data

- 4.58 Some consumers may be unable to take up superfast broadband because these services are not yet available at their property. On the other hand, some consumers with slow broadband could upgrade to superfast, but have not yet done so.
- 4.59 Figure 13 shows the take up of broadband services grouped by download speed and indicates the extent to which superfast services are available to consumers with those broadband speeds. It shows that around 37% of premises currently get a broadband service with a download speed of less than 30Mbit/s and could upgrade to superfast.
- 4.60 It is not clear from this data why some consumers are choosing not to take superfast services where they are available and further market research is needed. In order for superfast broadband take up to continue growing at the same rate as it has in the past, providers may need to consider new approaches for attracting customers, including articulating its benefits more clearly and lowering prices further.
- 4.61 Just less than 0.1% of UK premises (27,000) have taken up a service offering download speeds of 300Mbit/s or more. This relatively low level of take up is understandable, given current low levels of coverage. However, take up has increased significantly since 2015, when we reported that just 0.003% of UK premises had subscribed to these services.

**Figure 13: Over three quarters of premises with standard broadband could get superfast broadband**



Source: Ofcom analysis of operators' data

**The average download speed of active connections has increased, but upload speeds have remained static**

- 4.62 The growth in take up of superfast broadband has led to an increase in average speeds across the UK. The average download speed of all active connections in the UK is now 37Mbit/s, an increase of 28% from 29Mbit/s in 2015. Speeds are lower in rural areas, where there is a lower availability of superfast services. The average download speed in the UK's rural areas is just 21Mbit/s, although this still represents an increase on the speed last year, which was 13Mbit/s.
- 4.63 Download speeds have also risen for those consumers that subscribe to superfast services. The average download speed of superfast services in the UK is now 74Mbit/s, up from 65Mbit/s in 2015. We do not yet have sufficient data to estimate the average speeds of ultrafast or full fibre services, but will explore ways to calculate this in future reports.
- 4.64 While download speeds have increased, upload speeds have remained static. This may restrict the quality of experience for some popular online services that require good upload, as well as download, speeds, such as social media sites and cloud backup services. The average upload speed of all broadband services has increased

by just 7% to 4Mbit/s over the past year, while the average upload speed of superfast services has remained the same at 8Mbit/s.<sup>27</sup>

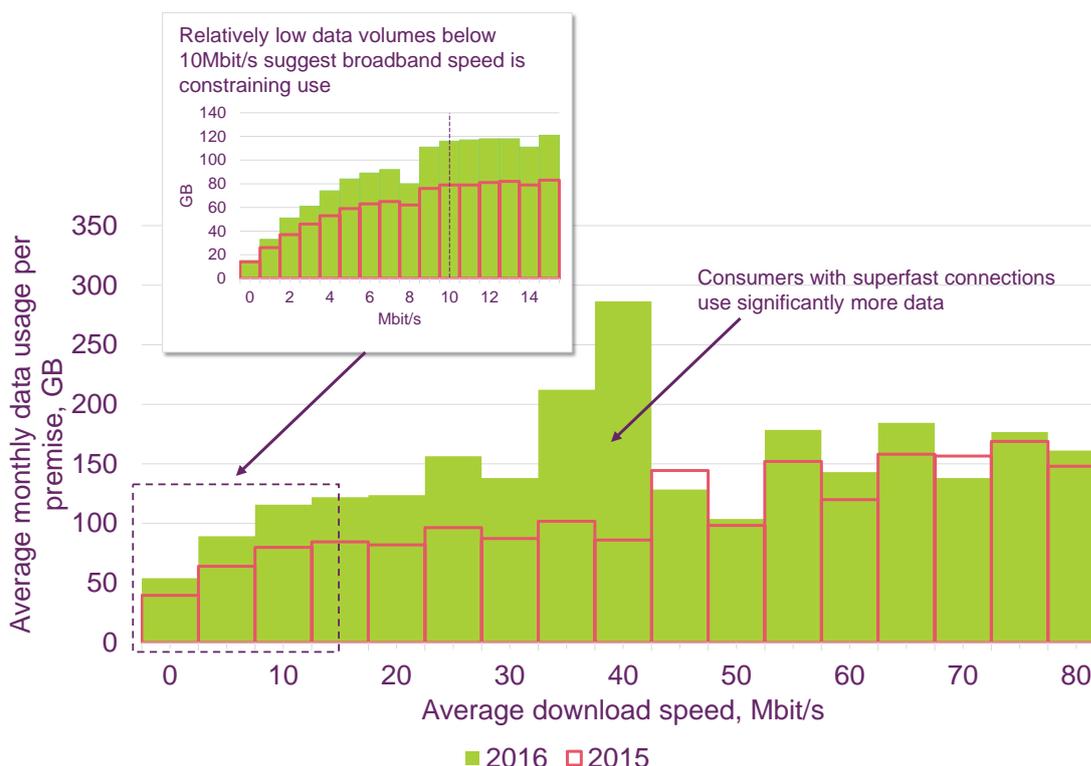
4.65 The average download speed of 37Mbit/s reflects both the speeds available to consumers and their choice of package; if consumers were to choose faster packages, the average speed would rise. We estimate that the average download speed would rise to around 132Mbit/s if all consumers subscribed to the fastest available broadband service at their property.

### Faster broadband speeds lead to more data being consumed

4.66 Consumers who take up superfast broadband will find that the faster download and upload speeds will enable them to use a much wider range of multimedia applications than they could with slower connections. They include:

- 4.66.1 Online video services, such as You Tube, iPlayer and Netflix. These services offer video for download or streaming in standard, high and, increasingly, ultra-high definition formats;
- 4.66.2 Video calling services, such as Skype or Apple’s FaceTime; and
- 4.66.3 Cloud-based services for back-up of data or sharing content with friends or colleagues.

**Figure 14: Users with faster broadband connections tend to use more data**



Source: Ofcom analysis of operator data

<sup>27</sup> This asymmetry of download and upload is a feature of both DSL and DOCSIS technology implementations currently. The degree of asymmetry can be reduced but this is normally at the expense of reducing download speeds. Future technologies may suffer less from this problem.

- 4.67 On average UK households consumed 132GB of data per month over the past year, up from 97GB in 2015. Figure 14 shows that, on average, more data per household is being consumed for all broadband speeds. As in previous years, there is evidence that households with higher speed connections are consuming significantly more data, especially those with superfast speeds.
- 4.68 Users with broadband speeds of around 40Mbit/s appear to be consuming very high volumes of data. We believe that this is evidence of an increase in the consumption of online video. Services such as the BBC's iPlayer, Sky's Now TV and Netflix are increasingly popular and are integrated into smart TVs and set-top boxes. Consumers are often unaware that content they access via these services is delivered over their broadband connection as they are intended to deliver a seamless viewing experience.
- 4.69 In addition, many video services are also available on smartphones and tablets. This means that content could be streamed to multiple devices within a home simultaneously, adding to the overall volume of data consumed.
- 4.70 We might also expect the impact of video on demand services to be reflected in higher average data volumes for broadband connections faster than 40Mbit/s. This is not apparent from Figure 14. In the case of Virgin Media's customers, many of whom are on a package with a download speed of 50Mbit/s or higher, this could be explained by some on demand video services being delivered over the cable TV connection, rather than the broadband connection.
- 4.71 Figure 14 also shows that the average usage per household drops notably for connections with speed less than 10Mbit/s. This may be evidence that users would use more data if their connections were faster.

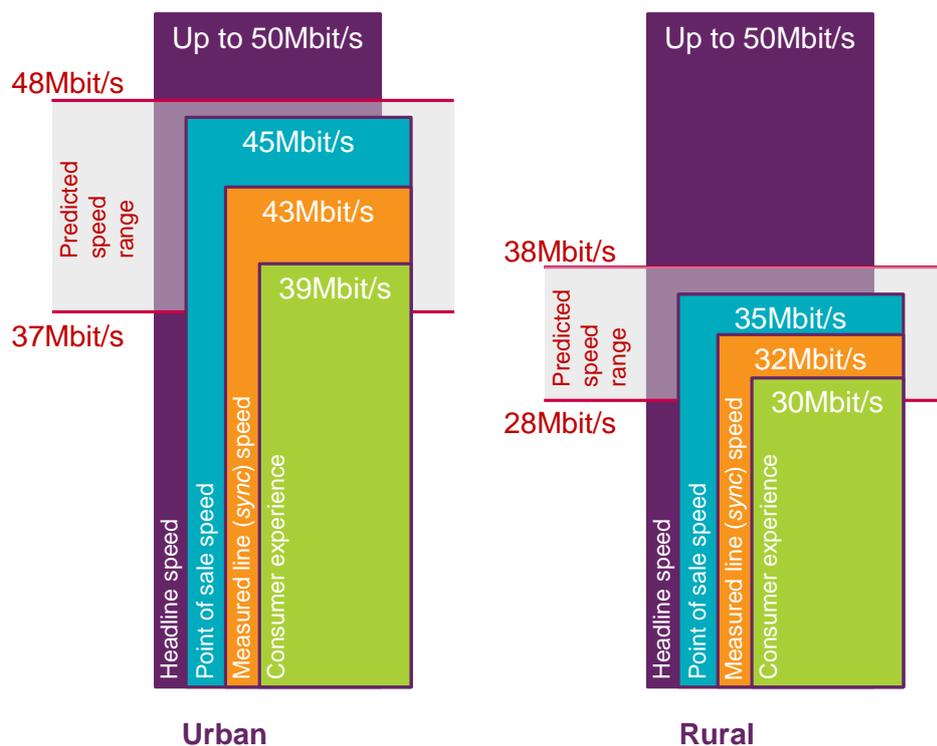
## Measuring the broadband speeds consumers actually receive

- 4.72 One of the most commonly used ways to describe the performance of broadband connections is speed and, in particular, download speed. However, there are a number of ways to express broadband speed, as shown in Figure 15:
- 4.72.1 **Headline speed** is the speed at which a particular broadband service is the maximum speed available by at least 10% of the customer base. It is normally preceded by the words "up to".
- 4.72.2 **Point of sale speed** is the estimated speed that a customer is quoted before they purchase the broadband service for the first time. Signatories of the Broadband speeds Code of Practice undertake to give this estimated speed, normally in the form of a range, although it can also sometimes be a point estimate. Specifically, this constitutes an estimate of the max speed a customer will be able to experience on his or her individual line. The speed is based on a technical assessment of factors such as the length of the line to the customer's property, which could affect the performance of the line. As a result, the point of sale speed is often lower than the headline speed
- 4.72.3 **Measured line, or sync, speed** is the maximum rate at which the line connecting the customer's property to the street cabinet or exchange can operate. In many cases, ISPs are able to measure this speed and this data is provided to us as part of preparing this report. Sync speeds can be lower than the point of sale speeds as a result of local technical factors, such as

interference on the line, which are difficult to predict when calculating the point of sale speed; and

- 4.72.4 **Consumer experience speed** is the measured speed that the consumer actually experiences during the course of using the broadband service. This is measured through a panel based methodology using SamKnows “Whiteboxes” that are connected to panellists’ routers. This does not include any Wi-Fi measurements, and indicates the speeds that may be experienced if a consumer was to connect their device to the router with an Ethernet cable. The consumer experience speed is likely to be lower than the sync speed because it is an end-to-end measure of performance, i.e. it also takes into account the speed of the ISPs backhaul and core network.

**Figure 15: Illustration of different ways to express broadband speed**



Speeds are illustrative only and are not based on actual measurements

Source: Ofcom

- 4.73 Consumers may receive slower speeds than they expect, because of the factors described above. In addition, the difference between headline and consumer experience speeds may be greater in rural areas than in urban areas because factors such as longer line lengths.

### Investigating broadband performance using physical measurement units

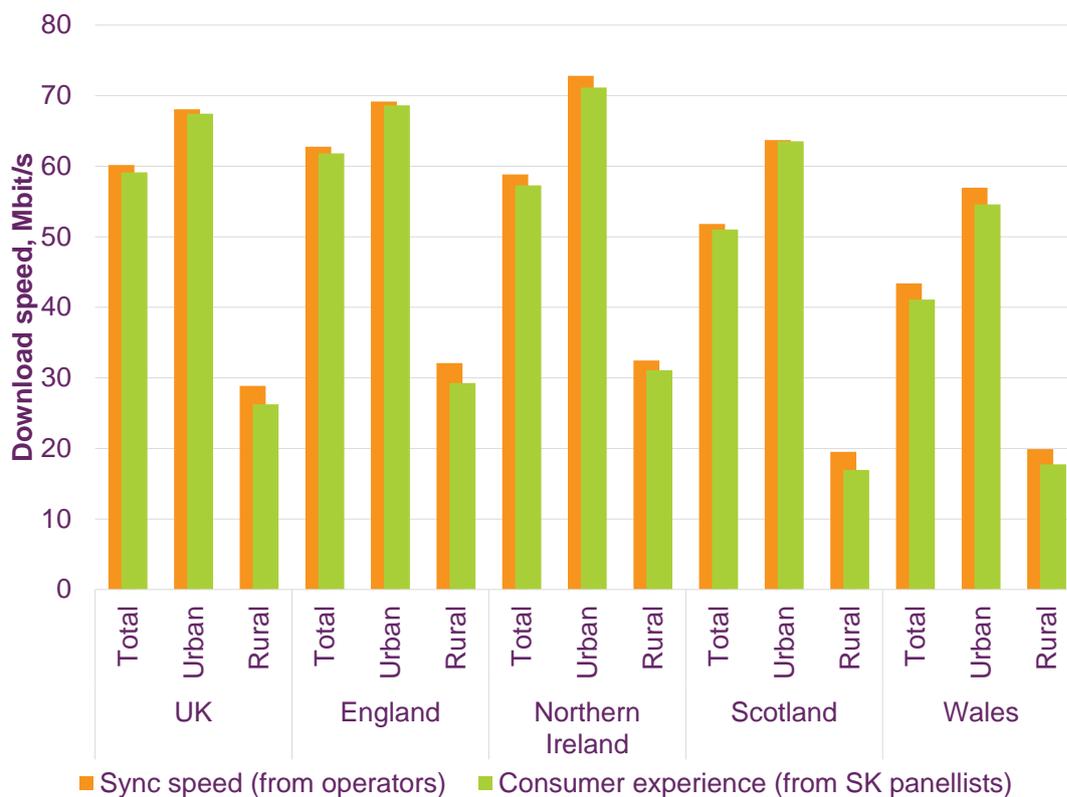
- 4.74 Each year we publish a report on the performance of residential fixed broadband services<sup>28</sup> as part of our work to monitor the UK communications industry. The objective of this research is to provide better information about the *actual performance* (i.e. the measure of consumer experience described above) of UK

<sup>28</sup> <https://www.ofcom.org.uk/research-and-data/broadband-research/home-broadband-performance>

residential fixed broadband connections to inform Ofcom's policy making and help consumers make better-informed purchasing decisions.

- 4.75 This section of the Connected Nations report uses data collected by our research partner, SamKnows Limited (SK), in September, from a panel of volunteers. The panel is selected to be representative in terms of a number of factors, including geographic location, broadband connection technology, internet service provider (ISP) and broadband package.
- 4.76 Volunteers are required to connect a hardware measurement unit (a “whitebox”) to their broadband router. These units run tests that measure various metrics that help determine the user experience of various online activities. The software is configured to identify other network activity and not to run tests when such activity was detected. This avoids compromising results by running tests at a time when bandwidth was being used by other internet-connected devices in the household (including those using a Wi-Fi connection).
- 4.77 We carried out analysis to match the sync speed data collected from fixed network operators for the purposes of preparing this report, to the data collected from SK panellists across the month of September 2016. This matching process has allowed us to compare the two data sets across download and upload speed metrics.
- 4.78 We would not expect the results of the two data sets to match exactly, given the differing timescales of the data and that one data set contains sync speed data and the other consumer experience data. However, comparing the values will highlight the extent of any systemic difference between sync and consumer experience speeds, and whether this difference varies between urban and rural properties.
- 4.79 Figure 16 shows a comparison of the download speeds of each data set, split by nation and rurality. As we illustrated in Figure 15, when comparing consumer experience speeds to sync speeds there is some disparity between the two measures. Across all panellists, measured consumer experience speeds were around 2% lower than the sync speeds, rising to a 5% difference for those panellists in Wales.
- 4.80 This disparity is more pronounced in rural areas, which could suggest that speeds in these areas are lower than they could be under ideal conditions due to the amount of available backhaul, impeding optimal performance. For example, consumer experience speeds for panellists in the UK's urban areas were just 1% lower than sync speeds; whereas, in rural areas, the difference was 9%. For panellists in the rural areas Wales and Scotland the difference was greater, 11% and 13% respectively.

**Figure 16: Comparison of sync and average consumer experience speeds, for only those premises with a SK measurement unit**



Source: Ofcom analysis of operator data / SamKnows

4.81 We are aiming to continue analysis between these joined data sets and will endeavour to include further analysis in the UK home broadband performance report planned for publication in H1 2017.