Section 5

Mobile voice and data services

5.1 Mobile services are playing an increasingly important role in our daily lives. This means consumers increasingly expect their mobile devices to work reliably wherever they are, whether at home, at work, or on the move. In this section we provide an update on the levels of mobile voice and data coverage achieved in different parts of the UK as of June 2016, and the total amount of mobile data being consumed. We also discuss the minimum levels of mobile signal needed to make a good quality voice call and how these relate to the mobile operators' geographic coverage targets for voice call services.

5.2 The key highlights are:

5.2.1 **4G roll-out:** All four operators are in the middle of a major 4G rollout programme, which provides in some locations similar connection speeds to those of fixed networks. To date the rollout of 4G services has primarily focussed on providing higher speed services to users in cities and towns. As they are rolled out more widely, it is likely that 4G landmass coverage will continue to increase to at least match the coverage of earlier generation 2G and 3G services. Some operators have also enabled voice calling on their 4G networks, which together with voice over Wi-Fi, are helping to increase the number of places where consumers can make and receive voice calls.

5.2.2 **Mobile data growth:** In the past year, mobile data consumption per subscriber has grown at a rate of 49%. Although still growing, this is less than last year's growth rate of 64%. It is almost identical to the data growth rate on fixed networks. The volume of data carried over mobile networks remains a small proportion (around 4%) of data carried over all networks.

5.2.3 **More needs to be done to extend mobile coverage to all of the locations consumers want to use their mobile devices**. There are two main reasons why additional steps are likely to be needed to meet future consumer expectations on mobile coverage.

5.2.4 Firstly, the additional coverage improvements resulting from commercial investments by mobile operators in new network infrastructure will reach a plateau.

5.2.5 Secondly, the existing geographic voice call coverage targets in licences, requiring 90% landmass coverage by the end of 2017, are based on lower mobile signal levels than those we have found to be necessary from our field testing work to deliver a good consumer experience. This means that when these targets are met, good geographic landmass coverage is likely to be below 90%.

Our assessment of coverage is representative of how consumers use their mobiles

5.3 In this report, we provide mobile coverage numbers based on the mobile signal levels we have found to be necessary to provide a good consumer mobile experience.

These relate to the areas shown in green on our interactive maps[28]. We also show on these maps areas in amber and red where a mobile signal is available but is likely to provide a less reliable consumer experience.

5.4   In previous years, we have reported on mobile coverage in terms of the number of premises where a signal can be received outdoors. We will continue to report on outdoor coverage in this way but, from this year, our focus will be on reporting on mobile coverage in a way that we believe better reflects how and where consumers use their mobile phones – both indoors and outdoors.

5.5   For **indoor coverage**, we will report on the percentage of premises where a good mobile signal is likely to be available indoors. This metric is useful to describe the coverage that a consumer will experience when using their phone at home, at work or in a shop. It is more challenging to deliver reliable mobile coverage indoors than outdoors, as walls, buildings and doors reduce the strength of, or even block, mobile signals as they pass through.

5.6   We will report on **outdoor coverage** in three ways:

   5.6.1   **Geographic coverage**, which represents the percentage of landmass where good coverage is likely to be available. This metric is useful to describe the coverage that a consumer will experience when using their phone outside or on the move between outdoor locations;

   5.6.2   **Coverage on the transport network**, which focuses this year on roads. This metric represents the percentage of distance covered by the road network where a good mobile signal is likely to be available inside the car. This metric is useful to describe the coverage that a consumer will experience when using their phone while travelling in a vehicle and not using a car kit with an external antenna. Next year we also aim to report on coverage on the rail network;

   5.6.3   **Outdoor premises coverage**, which represents the percentage of premises where a good mobile signal is likely to be available outdoors. This metric is still commonly used by operators and we will continue to report on coverage in this way to aid comparisons.

5.7   The levels of mobile coverage in this report are based on data supplied by the operators which has been scaled to indicate where a good consumer experience is likely to be available. This scaling is based on our own field testing of the minimum mobile signal levels needed for a good consumer experience. These signal levels are generally higher than those used in existing mobile operator licence obligations and, as a result, levels of coverage shown in this report are generally lower than the target coverage levels set out in these obligations.

5.8   While our use of these metrics make it more difficult to compare our coverage figures with those from other sources, we believe that using these metrics is important for two reasons:

   5.8.1   **They offer a more realistic view of current coverage levels.** Figures for coverage expressed in terms of outdoor premises tend to be higher than those for indoor or geographic coverage. Presenting information in terms of

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[28] http://maps.ofcom.org.uk/check-coverage

outdoor premises can be potentially misleading for consumers, who may feel that their actual experience of coverage does not correspond to the relatively high coverage figures presented. Additionally, and as mentioned above, expressing coverage in terms of outdoor premises does not reflect the locations where the majority of consumers use their phones most; and

5.8.2 **They provide an important baseline against which future improvements in coverage can be measured.** Several current public policy initiatives are targeting improvements in coverage by requiring operators to achieve agreed levels of indoor and geographic coverage by certain dates. By reporting on mobile coverage in terms of geographic and indoor coverage, it is easier to identify the progress being made towards meeting these coverage targets. In addition, the use of Ofcom's scaling of the mobile coverage data provided by operators to show where good reliable coverage is available provides a useful benchmark for the actual improvements being delivered by these initiatives, and the improvements any new coverage improvement initiatives should be aiming to achieve.

5.9 In the remainder of this section, we summarise the levels of coverage from all operators for both mobile voice and data networks, i.e. we consider an area or property to be in coverage if a mobile signal can be received from all operators. In addition, we highlight the coverage of 4G networks, given operators' ongoing focus on deploying these networks.

5.10 In order to facilitate year on year comparison, we are using data collected in June 2016 to calculate coverage. We note that since this data was collected, further network deployment is likely to mean that coverage levels have continued to increase. Our coverage checking tools[29] use the most up-to-date mobile coverage data.

Status of mobile coverage across the UK and in the nations

5.11 Figure 17 summarises the mobile coverage available in the UK and constituent nations from all operators, for voice, data and 4G networks.

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[29] https://checker.ofcom.org.uk

Figure 17: Summary of mobile coverage from all UK operators

- Consumers can use their phones for voice calls inside almost 90% of UK premises and data services inside around 80% of UK premises
- Outdoor coverage has improved but remains low, especially in the rural areas of Scotland and Wales
- 4G coverage continues to rise and now covers over 70% of UK premises indoors

UK		2016	2015
Voice	Indoor premises	89%	85%
	Outdoor geographic area	66%	58%
	Outdoor premises	97%	96%
Data	Indoor premises	80%	77%
	Outdoor geographic area	52%	38%
	Outdoor premises	93%	88%
4G	Indoor premises	72%	28%
	Outdoor geographic area	40%	8%
	Outdoor premises	86%	46%

Scotland		2016	2015
Voice	Indoor premises	84%	79%
	Outdoor geographic area	36%	29%
	Outdoor premises	95%	93%
Data	Indoor premises	75%	70%
	Outdoor geographic area	21%	10%
	Outdoor premises	87%	79%
4G	Indoor premises	62%	22%
	Outdoor geographic area	12%	2%
	Outdoor premises	76%	37%

England		2016	2015
Voice	Indoor premises	91%	87%
	Outdoor geographic area	84%	77%
	Outdoor premises	98%	97%
Data	Indoor premises	82%	81%
	Outdoor geographic area	72%	57%
	Outdoor premises	95%	91%
4G	Indoor premises	76%	31%
	Outdoor geographic area	60%	11%
	Outdoor premises	90%	50%

Northern Ireland		2016	2015
Voice	Indoor premises	80%	67%
	Outdoor geographic area	81%	66%
	Outdoor premises	95%	89%
Data	Indoor premises	70%	57%
	Outdoor geographic area	71%	43%
	Outdoor premises	90%	74%
4G	Indoor premises	64%	37%
	Outdoor geographic area	60%	17%
	Outdoor premises	86%	46%

Wales		2016	2015
Voice	Indoor premises	73%	65%
	Outdoor geographic area	52%	46%
	Outdoor premises	90%	88%
Data	Indoor premises	57%	47%
	Outdoor geographic area	27%	17%
	Outdoor premises	76%	67%
4G	Indoor premises	34%	10%
	Outdoor geographic area	13%	2%
	Outdoor premises	53%	20%

Coverage is for all operators, i.e. the percentage of premises or geographic area where there is likely to be a signal from all operators. Coverage levels for individual operators may be higher.

Source: Ofcom analysis of operator data

Mobile delivery technologies

There are currently three generations of technology used to deliver mobile services to consumers in the UK.

2G was the first digital mobile technology, launched in the UK in 1992. It is used to deliver voice, text services and low-speed data services. 2G services are delivered by O_2, Vodafone and EE.

3G is a later generation of digital mobile technology, launched in 2003, and provides typical download speeds of over 5Mbit/s. 3G supports voice, text and data services, and services are operated by O_2, Vodafone, EE and Three.

4G is the latest generation of mobile technology, launched in 2012, and provides typical download speeds of over 10Mbit/s, with some services able to deliver significantly higher. These services are operated by O_2, Vodafone, EE and Three. There has been a significant roll-out of additional 4G services by all operators over

the past year. Three and EE have also upgraded their 4G networks to support voice services. Other operators may introduce similar services over the coming months.

When we report on mobile coverage, we often focus on the services offered by networks, rather than the technologies themselves. This is because the latest generation of mobile phones support all of these technologies and if, for example, a 3G network is unavailable, the phone will automatically switch to a 2G network to make the call. We therefore report on voice and data services.

The coverage of **voice services** is determined by the combined coverage of 2G and 3G networks, plus the 4G voice networks operated by EE and Three. The coverage of **data networks** is determined by the combined coverage of 3G and 4G networks.

5.12 The coverage of voice services has increased over the past 12 months, with 66% of the UK's geographic landmass having coverage from all operators, up from 58% in 2015. Indoors, voice services from all operators are now available within 89% of the UK's premises, up from 85% in 2015. The increase in voice coverage has been driven by both increases in 3G coverage and the deployment of 4G voice services.

5.13 The coverage of mobile data networks has also improved, but remains lower than voice coverage. 52% of the UK's geographic landmass has mobile data coverage from all operators, up from 38% in 2015. Around 82% of UK premises can receive a mobile data network signal from all operators indoors, up from 77% in 2015.

5.14 Geographic coverage of both voice and data networks is lower in Scotland and Wales than other parts of the UK. This is because a greater proportion of their landmass is rural, and mobile coverage is more difficult to provide in these areas than urban areas on a commercial basis due to their lower population density.

5.15 Operators are continuing to increase the coverage of their 4G networks. All operators now provide some 4G coverage to the UK's major cities and coverage is beginning to reach into smaller towns and some rural areas. Around 40% of the UK's landmass is now covered by a 4G signal from all operators, up from just 8% a year ago. In-building 4G coverage has also increased significantly; 72% of UK premises can now receive a 4G service from all operators indoors, compared to just 28% in 2015.

5.16 4G coverage has increased the most in Wales and Scotland, with both countries experiencing a six-fold increase in geographic coverage. However, overall coverage levels are still low, with only 12% and 13% of landmass in Scotland and Wales respectively covered by 4G networks from all operators.

5.17 The information on coverage levels in this chapter is based the mobile signal strength data provided to us by all mobile operators in June 2016. Operators are continuing to upgrade their networks and deploy new base stations. It is therefore possible that coverage levels may have increased since this data was collected. For example, we note that in November EE switched on 700 4G sites[30] which use spectrum at 800MHz. This spectrum is particularly well suited to providing coverage over wide areas and deep into buildings. These and other recent improvements will be reflected

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[30] http://newsroom.ee.co.uk/ee-calls-on-industry-to-get-clear-on-coverage-as-it-covers-5000-square-kilometres-of-4g-not-spots-overnight/

in the next report. In addition, our online coverage checker[31] uses the most up-to-date information provided by operators.

5.18   We explore the coverage of mobile voice and data networks in more detail below.

> **Some 4G networks have been upgraded to support voice calls**
>
> Until recently, the 4G networks deployed in the UK only supported high speed data services; in order to make or receive a voice call, a mobile phone connected to a 4G network needed to automatically switch to a 2G or 3G network, switching back to the 4G network once the call is complete.
>
> However, in the past year EE and Three have upgraded their 4G networks to support voice calls, using a technology known as 4G Voice or VoLTE. Combined with the ability, supported by all operators, to make voice calls over Wi-Fi, this development means that consumers should be able to make and receive phone calls in more places than before.
>
> In calculating voice coverage, we include data from the 2G and 3G networks of all operators, plus the 4G networks of EE and Three. We understand that Vodafone and O_2 are undertaking trials of 4G Voice and could include their networks in the future.

Coverage of mobile voice services

5.19   Operators mostly use their 2G and 3G networks to provide voice services. EE and Three have upgraded their 4G networks to also support voice services and an increasing number of handsets are compatible with this new technology. Figure 18 shows the coverage of mobile voice services for each operator in the UK.

Figure 18: UK coverage for each operator's mobile voice services

	O_2 (2G, 3G)	Vodafone (2G, 3G)	EE (2G, 3G, 4G)	Three (3G, 4G)
Indoor, premises	96%	95%	96%	95%
Outdoor geographic, landmass	78%	82%	80%	76%
Outdoor, premises	99%	99%	99%	99%

Source: Ofcom analysis of operator data

5.20   In the case of EE and Three, the activation of 4G voice services on their networks has helped improve voice coverage[32], but for slightly different reasons. EE's 4G network is the most mature amongst the operators in the UK and enabling 4G voice on this network offers their customers an additional means to make and receive calls. EE provides an indoor mobile voice service to 96% of UK premises, but this falls to 94% of premises if their 4G coverage is disregarded and only their 2G and 3G networks' coverage is included.

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[31] https://checker.ofcom.org.uk
[32] We are currently undertaking further field testing work to more firmly establish the minimum 4G signal level needed to provide reliable 4G voice call coverage.

5.21   For Three, the benefit is mainly derived from their use of lower frequency spectrum at 800MHz for some parts of their 4G network. The characteristics of this frequency band make it good at covering wide areas and, in particular, penetrating deep into buildings. Three's use of their 4G network takes their geographic voice coverage to 76% of UK landmass, as opposed to 70% of landmass if they only used their 3G network. The difference is even more pronounced with indoor coverage, with 95% of UK premises covered if 4G is included, compared to just 86% of premises if only their 3G network is used to deliver voice.

5.22   We can expect some further improvement mobile voice call coverage with the further deployment of voice-enabled 4G networks by all operators, in particular those operating in the 800MHz spectrum band.

Coverage of mobile data services

5.23   Operators mostly use their 3G and 4G networks to provide higher-speed mobile data services to their customers; 2G networks are only capable of supporting lower-speed data connections and we exclude them from this assessment of coverage. Figure 19 shows the coverage of mobile data services for each operator in the UK.

Figure 19: UK coverage for each operators' mobile data services, based on combined 3G and 4G coverage

	O$_2$	Vodafone	EE	Three
Indoor, premises	92%	92%	95%	87%
Outdoor geographic, landmass	63%	66%	76%	70%
Outdoor, premises	96%	97%	99%	97%

Source: Ofcom analysis of operator data

5.24   3G networks have been deployed in the UK since 2003 and their levels of coverage are relatively high, compared to more recently deployed 4G networks. The coverage of mobile data services is, therefore, largely determined by the level of 3G coverage. However, this will change as operators continue their 4G network deployment, especially where those networks make use of spectrum at 800MHz, which is better suited to covering large areas and reaching deep into buildings.

5.25   Coverage of 4G services has increased significantly over the past year as all operators continue to roll out these networks. Each operator now provides indoor coverage to over 80% of the UK's premises, offering levels of coverage similar to their more mature 3G networks. Geographic coverage is lower, with operators' 4G networks covering between a half and two thirds of the UK's landmass.

Figure 20: Coverage of 4G networks has increased over the past year
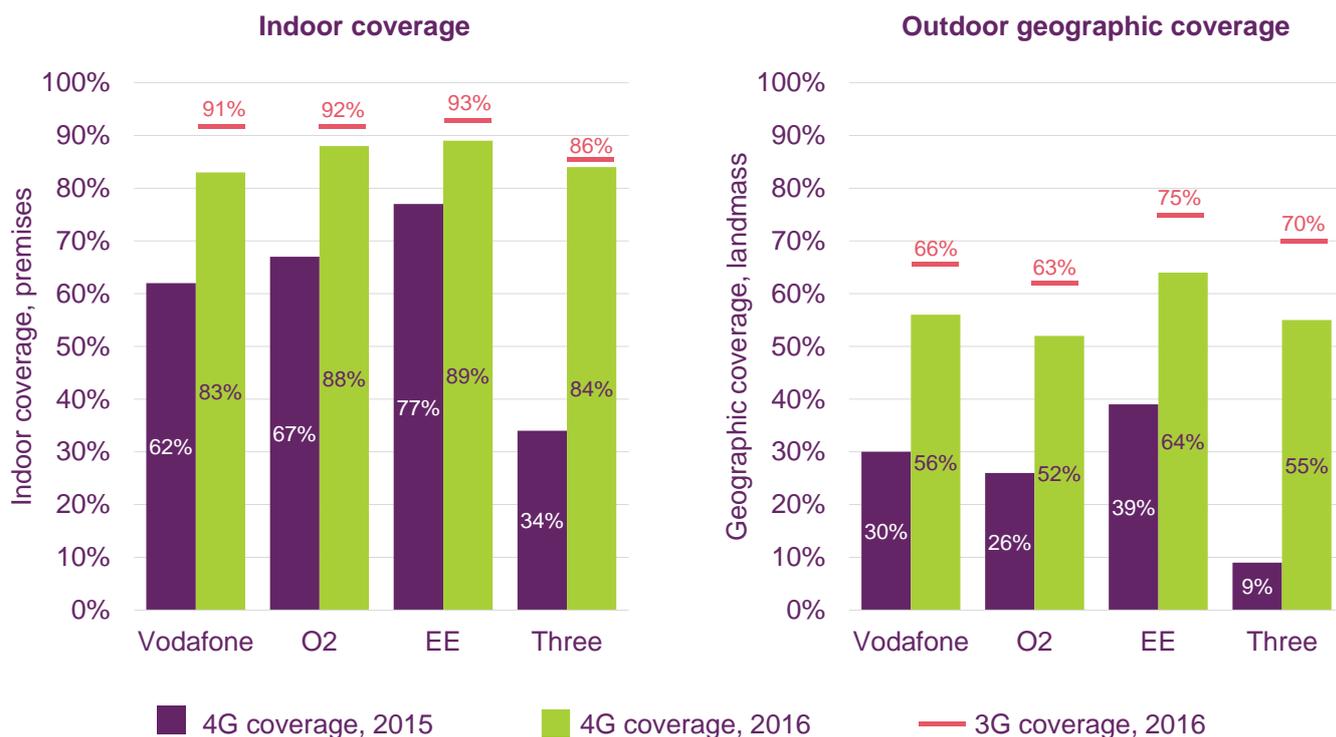
Source: Ofcom analysis of operator data

Coverage of mobile services on the transportation network

5.26   Consumers spend a significant amount of time travelling on the roads or on trains and frequently experience poor coverage. This may be because these roads or railway lines pass through rural areas, tunnels or cuttings, where mobile signals are weak or totally blocked. In urban areas, the problem could be because too many people are trying to use the network at the same time.

5.27   Being able to communicate on the move is important to consumers. Yet providing reliable coverage across the transportation network can be challenging. This year, as in previous years, we report on the coverage of mobile networks across the UK's road network. We have also undertaken some research to understand levels of mobile coverage on key train routes.

Mobile coverage on roads

5.28   Good mobile coverage is important for road users. For workers on the move it provides a vital means to stay in contact with colleagues and customers; it allows drivers or pedestrians to call for help in an emergency; and, increasingly, it will connect vehicles and roadside sensors as part of the emerging Internet of Things.

5.29   As Figure 21 shows, coverage on A and B roads reflects levels of geographic coverage and is relatively low. Just 62% of the UK's network of A and B roads is covered by a voice service from all operators. Data coverage is even lower, at just 45% of the A and B road network. Coverage is worst in Scotland and Wales, which reflects the relatively low levels of geographic coverage in these countries. Voice calls are only possible on around 40% of Scotland and Wales' network of A and B roads.

5.30   Coverage on motorways is better, as these major roads are often targeted by operators at an early stage of network deployment. 97% of the UK's motorway network is covered by voice services from all operators, with motorways in the nations similarly well covered for voice. Data coverage on motorways is lower, but still significantly better than A and B roads; 83% of the UK's motorway network is covered by a data service from all operators.

Figure 21: Mobile coverage on many roads is poor

	A and B roads, % road network		Motorways, % road network	
	Voice coverage	**Data coverage**	**Voice coverage**	**Data coverage**
UK	62%	45%	97%	83%
England	72%	55%	97%	85%
Northern Ireland	59%	43%	92%	74%
Scotland	39%	25%	95%	75%
Wales	40%	22%	97%	89%

Source: Ofcom analysis of operator data
Note: For in-car coverage, we assume that the mobile phone is used within the vehicle. Coverage would be better if a car kit with an external antenna were used.

Mobile coverage on trains

5.31   As explained in the box below, mobile coverage inside train carriages can be poor for a combination of reasons. The apparently obvious approach of simply deploying more base stations to cover all of the rail corridor may not an effective solution in all cases, and would certainly be high cost.

> **Why is mobile coverage on trains often so poor?**
>
> While the coverage of mobile networks continues to improve in many places, many of us still experience the frustration of dropped calls and poor speeds when trying to use our mobile phone on a train. Why is delivering reliable mobile coverage to train passengers so difficult?
>
> One reason is the location of the tracks. Intercity railway tracks often pass through rural areas, where levels of coverage tend to be lower than in urban areas. However, consumers often experience dropped calls and slow data speeds even in dense urban areas, such as around railway stations. This is more likely caused by the mobile networks lacking the capacity to deal with high numbers of users simultaneously. In addition, many railway tracks are laid in deep cuttings and tunnels, which are difficult and costly to cover with standard network base stations.
>
> The construction materials used in some newer trains also contribute to poor coverage. In particular, the train windows are sometimes coated in a metallic film or mesh. While this has the desired effect of helping to regulate the temperature within the train, the coating also weakens or blocks mobile signals from passing through.

5.32 Consequently, the train industry (Network Rail and the Train Operating Companies or TOCs) have been working on a number of different approaches to improving connectivity as the rail travelling public's expectations have risen. Some TOCs have deployed repeater technology, but these have tended only to improve matters for customers of a single mobile operator and do not solve the problem of deep cuttings and tunnels, or lack of coverage.

5.33 More generally, many TOCs, particularly those running the main long distance routes have installed Wi-Fi systems into their rolling stock, providing internet connectivity to the travelling public via on train gateways, provided by specialist service providers, that use either satellite or, now more commonly, mobile coverage. These solutions also do not provide contiguous coverage because of the tunnel and cutting problem and lack of mobile coverage and capacity in some areas. Additionally, these services have typically been provided on a "pay as you go" basis and have not supported voice connectivity. The latter point is becoming less of an issue with increasing adoption of Wi-Fi calling functionality by the operators, and this functionality is likely to be widely available and commonly used by most consumers within a few years.

5.34 Government has taken a keen interest in these developments and recently announced that the Department for Transport is proposing a new set of conditions on TOC franchises that will deliver free Wi-Fi services to travellers on all of the main routes, both long distance and commuter, over the next few years. The aim is to provide uninterrupted coverage along the entire route with sufficient capacity to meet the basic internet access and voice connectivity needs of the normal passenger loads, based on actual route data. The requirement specified per passenger will increase over time to meet increases in expectation and usage.

5.35 The approach taken is technology agnostic as far as "backhaul" solutions providing connectivity to the on train gateways are concerned. Additional operator capacity targeted at the rail corridor is one approach already being deployed on the Chilterns line through an agreement between Arriva and EE. Other radio spectrum, aside from that licensed to mobile network operators, could potentially be used and Ofcom would welcome further dialogue with the TOCs and their service partners on these issues.

5.36 In order to meet the goal of service contiguity, access to facilities close to or on the rail corridor will also be necessary for any backhaul solution deployed. The planned reforms to the Electronic Communications Code contained in the Digital Economy Bill will facilitate this but it is envisaged that Network Rail, as the rail corridor landowner, will also play a key role in providing a range of active and passive services to the service providers, particularly with regard to deploying solutions in tunnels.

5.37 Ofcom is already planning additional service monitoring activity to assess the effectiveness of these measures and will remain in active dialogue with Government, the rail industry and service providers to ensure their success.

Challenges remain in delivering mobile coverage in rural areas and to consumers on the move

5.38 Mobile operators face a number of challenges in delivering high levels of geographic coverage. Many of these result from the challenges associated with installing mobile network equipment in very rural areas, and include:

5.38.1 **Terrain**, e.g. steep mountains make it harder to reliably deliver mobile signal coverage deep into valleys;

5.38.2 **Policy**, e.g. planning restrictions on where mobile base stations can be built, especially in areas of natural beauty; or

5.38.3 **Practical factors**, such as difficulties in securing and maintaining a reliable power supply for the base station.

5.39 As a result of these, and a commercial focus by mobile operators on first deploying networks where population density is highest, levels of mobile coverage in rural areas are significantly lower than in urban areas. Figure 4 below shows the voice service coverage from all operators in rural areas.

Figure 22: Coverage of voice services from all operators in rural areas

Rural areas in	Indoor	Outdoor	
	Premises	Geographic	Premises
UK	50%	64%	84%
England	53%	83%	88%
Northern Ireland	52%	80%	86%
Scotland	41%	35%	71%
Wales	32%	50%	66%

Source: Ofcom analysis of operator data

5.40 The figures in Figure 21 highlight two important themes of rural coverage:

5.40.1 Firstly, indoor coverage of voice services across the all of the UK's rural areas is poor, with only 50% of premises in these areas served by all operators; and

5.40.2 Coverage is particularly poor in Scotland and Wales, both in terms of indoor and geographic coverage.

5.41 We have published alongside this document an update to our Economic Geography report[33], which is a more detailed analysis of the factors that affect the provision of mobile coverage. The decision to offer mobile coverage in a particular area is essentially a commercial judgement by the operators. Profitability will depend on the likely demand for mobile services and the costs of providing these services. Based on actual coverage data provided by operators, we can observe that there are generally more areas in London that have full 3G and 4G coverage than the UK average while the opposite is true for areas within Scotland and Wales.

5.42 This may create the perception that certain parts of the UK are 'under-served' in terms of the level of 3G or 4G coverage that they receive. However, a region may have below-average coverage in part because it is less densely populated or has more challenging terrain than other regions.

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[33] https://www.ofcom.org.uk/research-and-data/multi-sector/economic-geography-2016

5.43   We have used regression techniques to examine how much of the regional variation in 3G and 4G coverage can be explained by differences in the demand and cost factors. Applying this technique, we find that once factors such as population density, population composition, topography and whether the locality is urban or rural are taken into account, the probability of good 3G coverage is relatively similar between different parts of the UK. This indicates that much of the variation that we see in coverage can be explained by these factors. However, there would appear to be other factors that are specific to the East of England, Scotland and Wales that negatively affect coverage. Further work will be needed to understand the reasons for this.

5.44   In the case of 4G, there remains a considerable amount of unexplained regional variation particularly in the West Midlands, East of England, the South West, Wales and Scotland. However, 4G roll-out is ongoing and this only represents a snapshot of a dynamic environment. Over time, as 4G networks mature, we would expect that the amount of unexplained regional variation may become smaller, as it has for 3G.

Mobile coverage obligations

5.45   Licence obligations to meet particular coverage levels are also playing a role in helping extend mobile coverage. In December 2014 the UK Government signed a binding agreement with the four network operators to improve mobile coverage. This agreement, since reflected in a licence obligation, guarantees coverage of a mobile voice service from each operator 90% of the UK's land mass by 2017.

5.46   This agreement uses a different definition of coverage to the one we use in this report. In particular, it is based on a lower mobile signal level requirement. This lower signal level relates to a lower likelihood of reliably being able to make a call when there are localised signal blockages by trees, buildings and other obstructions. Hence when this agreement is met it will correspond to a geographic mobile coverage level of between 80 and 85% based on the definitions used in this report, depending on the frequency bands used by each operator to provide voice services[34]. We intend to report in more detail on the progress being made by mobile operators in meeting their geographic mobile coverage licence obligations in Q1 2017, using more up to date coverage data from the operators[35].

5.47   As with voice services, licence obligations are also playing a role in improving the coverage of data services. O_2 has a coverage obligation in its Wireless Telegraphy Act licence, requiring it to provide indoor coverage to 98% of UK premises by the end of 2017. Other operators have indicated their intention to match this level of coverage over the same timescale.

The increase in 4G coverage is helping to drive consumers' demand for mobile data

5.48   Data consumption on mobile has increased to 106PB per month with the data per active connection per month now over 1GB (Figure 23); this is a ten times increase

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[34] Unless the operators exceed their licence commitments.
[35] We estimate that as of June 2016, based on the lower minimum mobile signal level requirements used in their agreements, the level of geographic mobile voice call coverage achieved by the different operators for the purposes of their agreements are: O_2 – 89%, Vodafone – 93%, EE – 85%, Three – 78%.

over five years. The increase in 4G coverage, as shown in Figure 20 on page 40, has been instrumental in facilitating data consumption growth across the UK.

Figure 23: Mobile data use continues to increase

Traffic Type	June 2016	June 2015	June 2014	June 2013	June 2012	March 2011
Active Connection (millions)	83.6	83.7	83.2*	82.7	82.2	81.1
Total data uploaded/downloaded (GB, millions)	105.5	72.9	44.3	28.9	19.7	9.0
Data per active connection (GB)	1.26	0.87	0.53	0.35	0.24	0.11

Source: Ofcom analysis of Mobile Network Operator data and Connected Nations Report 2015[36]
Note: * figure from March 2014

5.49   Data traffic distribution is roughly in line with population distribution across the UK, as can be seen in Figure 24. England has the highest 4G coverage in the UK and, with just under 93PB, it accounts for 88% of the total data traffic generated in a month. The 2016 data traffic in England has outstripped the total data traffic in the UK for 2015.

5.50   Wales has the lowest 4G coverage in the UK and accounts for 3% of data traffic generated in a month, ahead of Northern Ireland, as a result of higher population. With regards to Northern Ireland, it has the second best 4G coverage in the UK, but only accounts for 2% of the total data traffic generated in a month.

Figure 24: Share of data traffic and population between UK nations

Nation	Data Traffic (GB, millions) (%)		Population (millions) (%)[37]
	2015	**2016**	**Mid-2015**
England	64.0 (88%)	92.7 (88%)	54.8 (84%)
Northern Ireland	0.8 (1%)	1.8 (2%)	1.9 (3%)
Scotland	5.4 (7%)	7.6 (7%)	5.4 (8%)
Wales	2.7 (4%)	3.4 (3%)	3.1 (5%)
UK	72.9	105.5	65.1

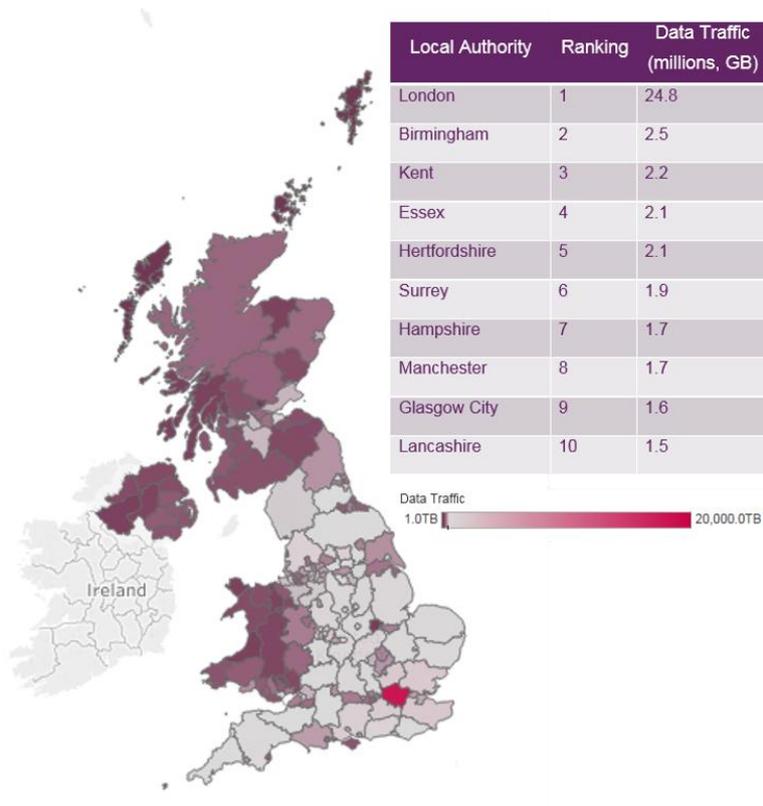[36] https://www.ofcom.org.uk/research-and-data/infrastructure-research/connected-nations-2015
[37] ONS estimates of UK population:
https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2015

Source: Ofcom analysis of Mobile Network Operator data.

5.51   Figure 25 shows the distribution of data traffic by local authority. Data consumption in London is 24.8PB per month, which accounts for almost a quarter (23.5%) of the total UK data consumption. The second highest local authority by data traffic consumption is Birmingham with a tenth of London's data traffic consumption. The least data traffic is consumed in the local authority of the Isles of Scilly.

Figure 25: Data traffic heat map at each local authority[38] and top 10 local authorities by data traffic

Local Authority	Ranking	Data Traffic (millions, GB)
London	1	24.8
Birmingham	2	2.5
Kent	3	2.2
Essex	4	2.1
Hertfordshire	5	2.1
Surrey	6	1.9
Hampshire	7	1.7
Manchester	8	1.7
Glasgow City	9	1.6
Lancashire	10	1.5

Data Traffic
1.0TB — 20,000.0TB

Source: Ofcom analysis of Mobile Network Operator data

5.52   A greater proportion of data is being delivered over 4G networks. Given the faster download speeds of the technology, and its ability to handle high demand applications such as streaming HD video. In 2016, 60.2% of the total data traffic was delivered over 4G networks (63.5PB), in comparison to 39.3% on 3G network (41.5PB). This means that 50% more traffic is carried on 4G than on 3G.

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[38] An interactive version of this map is available: https://www.ofcom.org.uk/research-and-data/infrastructure-research/connected-nations-2016/interactive

Figure 26: UK data traffic by technology type for each nation

	Data Traffic (GB, millions) (%)			
	2G	**3G**	**4G**	**Total**
England	0.4 (76%)	35.7 (86%)	56.4 (89%)	92.7 (88%)
Northern Ireland	0.02 (3%)	0.67 (2%)	1.1 (2%)	1.8 (2%)
Scotland	0.07 (13%)	3.4 (8%)	4.24 (7%)	7.6 (7%)
Wales	0.04 (8%)	1.71 (4%)	1.72 (3%)	3.4 (3%)
UK	0.53 (0.5%)	41.5 (39%)	63.5 (60%)	105.5

Source: Ofcom analysis of Mobile Network Operator data

5.53   The table in Figure 26 highlights the marked difference between 3G and 4G data traffic across nations except Wales, where the data traffic for 3G and 4G are particularly close. Wales has relatively low 4G coverage, compared to the UK as a whole and as shown in Figure 17; as a result, the data traffic delivered over 4G networks is relatively low.

Where and when consumer uses data plays an important role in the experience

5.54   Coverage is perhaps the most important factor in determining the consumer's quality of experience. Despite data traffic and coverage continuing to increase (as shown in Figure 17 and Figure 23), the quality of experience of a single consumer is affected by a range of factors, including whether they are indoors or outdoors, close to or far from a base station and whether they are moving. The service consumers receive will also be influenced by factors outside of their control, such as how many others are trying to use the network at the same time.

5.55   In Figure 27, we analyse data traffic in the busy hour. Each base station has a different busy hour; this is the hour in which the greatest data traffic is downloaded. Consumer quality of experience may be affected in the busy hour, and they may experience slower download speeds as more people are using the network.
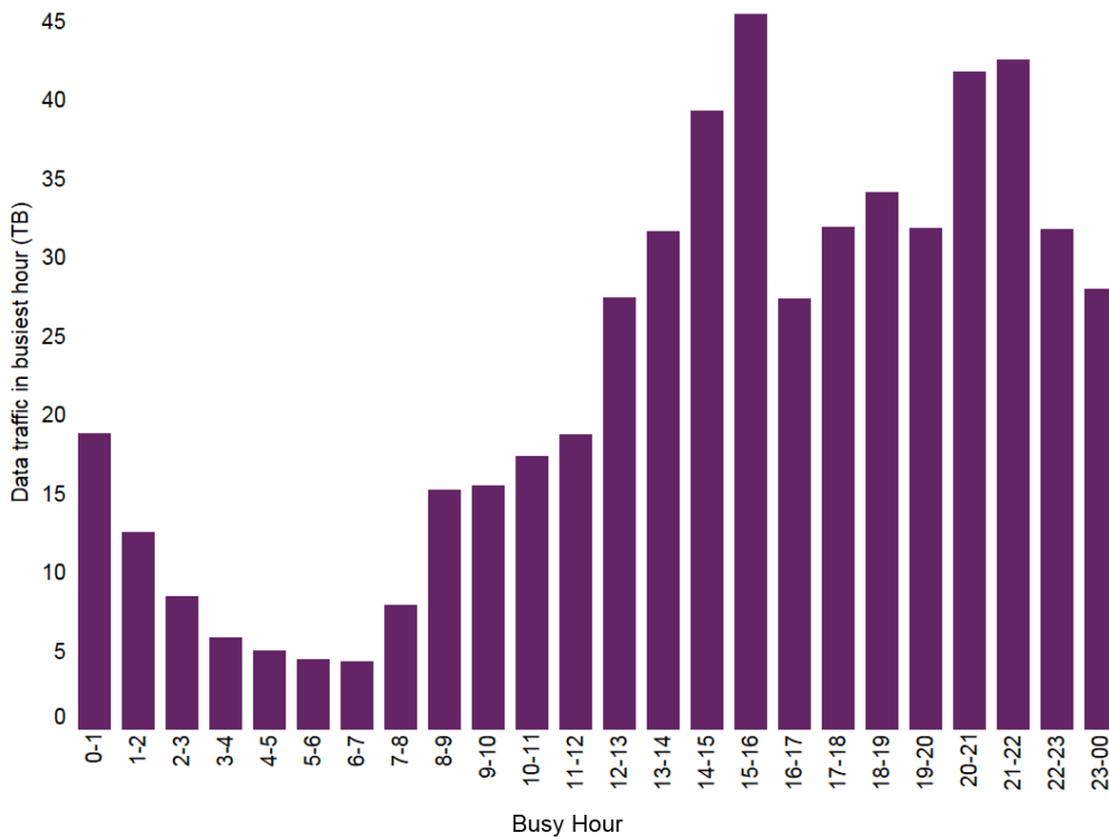
5.56   Our analysis of the data traffic carried in busy hours shows that 15:00 – 16:00, across the month, is the hour in which the most data is downloaded and uploaded across the UK, nevertheless the use of data never switches off. The 15:00 – 16:00 slot coincides with the end of the school day, and analysis of Digital Day data[39] shows a peak for smartphone reach for 11-15 year olds at 3-5pm.

5.57   Consumers at different hours and locations may have a lower quality of experience. Base stations can have their busiest hour across any of the 24 hours of a day. For

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[39] http://www.digitaldayresearch.co.uk/

example, busy hour for some sites surround the O_2 arena in London is between midnight and 01:00 as events finish around that time.

Figure 27: Average busiest hours for data traffic in the UK

Source: Ofcom analysis of Mobile Network Operator data