

5. Mobile voice and data services

- 5.1 Our expectation of mobile services is changing as we become more dependent on mobile services and need to access them wherever we are – indoors, outdoors or on the move. At the same time the devices we use to access mobile services have changed, with increasing take-up of smartphones and tablets, which require stronger signals than older, simpler phones.
- 5.2 We have therefore carried out an extensive programme of practical tests to ensure mobile coverage information reflects the actual experience of today’s mobile users. This has resulted in a new approach for defining mobile coverage that we set out in the box below.
- 5.3 The Government and the National Infrastructure Commission (NIC) have supported this approach. In December 2016, the National Infrastructure Commission recommended that common measures are developed to reflect the actual consumer experience of using mobile services.⁵¹ In March 2017, the UK Government published ‘Next Generation Mobile Technologies: A 5G strategy for the UK’.⁵² This report asked Ofcom to set out, by the end of 2017, how reporting of mobile coverage might provide ‘a genuine and meaningful reflection of the services experienced by customers’.

A new approach for defining coverage that reflects consumer experience

We start by defining mobile coverage in a way that will likely deliver a decent experience to smartphone users:

- **Telephone calls:** Nearly all 90-second telephone calls should be completed without interruption;
- **Data services:** Nearly all connections should deliver a speed of at least 2Mbit/s. This is fast enough to allow users to browse the internet and watch glitch-free mobile video.

We then link these user-facing definitions of coverage to technical definitions that can be used by our engineers to measure coverage. We do so using crowdsourced data from consumer handsets to identify the signal levels needed to meet these targets at least 95% of the time. This shows, for example, that 4G telephone call and data coverage requires a higher signal level than previously estimated⁵³.

Finally, we apply these signal level thresholds to the actual signal level predicted in different geographic locations to determine whether there is coverage at that location.

- 5.4 The actual signal levels we use to estimate coverage are based on those predicted by each operators’ theoretical model of their own coverage, validated using our own extensive on-the-ground measurement programme. Our own measurements suggest that the operator’s

⁵¹ <https://www.gov.uk/government/publications/connected-future>

⁵² <https://www.gov.uk/government/publications/next-generation-mobile-technologies-a-5g-strategy-for-the-uk>

⁵³ To provide comparable year-on-year figures, we have re-calculated 4G coverage for June 2016 using these higher signal levels.

predictions largely reflect the signal strengths actually available. However, there are some differences between some of our measurements and the predicted signal strengths provided by EE⁵⁴.

- 5.5 As well as allowing us to derive the mobile coverage statistics which are presented in this report, our approach makes it possible to provide more accurate data to individual consumers. Our coverage checker app is available on tablets and smartphones and allows consumers to identify the operators who are most likely to provide a good mobile experience in the locations that matter most to them. This also helps promote competition between operators to improve coverage.
- 5.6 We have established an industry working group to provide more consistent cross-industry messages and information on mobile coverage. This will involve agreeing a common means of measuring coverage, building on and refining the principles set out here. We expect this to require further testing, using both traditional test equipment and crowdsourcing. The working group will also consider how coverage information should be presented to consumers to make it easy to understand.
- 5.7 While the speed of a mobile data connection is important, there are other factors that can affect the quality of the service a person receives on their mobile phone, such as contention, which happens when many users try to use the network at the same time. We will continue to work on metrics that measure the impact of these factors.

Mobile coverage in the UK

- 5.8 Over the past year, indoor and outdoor mobile coverage has continued to generally improve in the UK, as shown in Figure 22⁵⁵. However, many consumers still experience poor coverage, especially in rural areas and while on the move.

Figure 22: Summary of UK coverage from all operators, June 2017

	Indoor coverage, % premises	Outdoor geographic coverage, % landmass	A&B roads, % road network	Motorways, % road network
Telephone calls	90% (↑ 5pp)	70% (↑ 7pp)	68% (↑ 12pp)	97% (↑ 4pp)
Data	85% (↑ 5pp)	63% (↑ 11pp)	58% (↑ 13pp)	91% (↑ 8pp)

Figures in brackets are percentage point (PP) changes since 2016

Source: Ofcom analysis of operator data

⁵⁴ To date, we have been unable to fully explain these differences to our satisfaction. We are undertaking further measurements and have decided to include in this report the predicted coverage data as provided by EE. We will continue to work with EE and expect to reflect the outcome of these discussions in our next update.

⁵⁵ The coverage information provided in this chapter is based on predicted mobile signal strength data provided to us by MNOs in June 2017. Operators are continuing to deploy base stations and to optimise the performance of existing ones. It is therefore likely that coverage levels have increased since this data was collected, especially for 4G networks.

Coverage is calculated using a combination of different mobile delivery technologies

Three types of mobile delivery technology are used to deliver mobile services to consumers. Most mobile handsets support all three, and we report on the combined coverage of these technologies.

Combined voice call coverage includes: 2G, 3G, and more recent 4G **VoLTE** (Voice over LTE) services. Mobile data coverage includes 3G and 4G services.

2G: this 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 O₂, Vodafone and EE.

3G: this is a later generation of digital mobile technology, launched in 2003. It provides download speeds of over 5Mbit/s, and is used to deliver: voice, text and data services. 3G services are operated by O₂, Vodafone, EE and Three.

4G: this is the latest generation of mobile technology, launched in 2012. It provides download speeds of over 10Mbit/s, and is used to deliver: voice, text and data services. 4G services are operated by O₂, Vodafone, EE and Three.

Indoor premises coverage

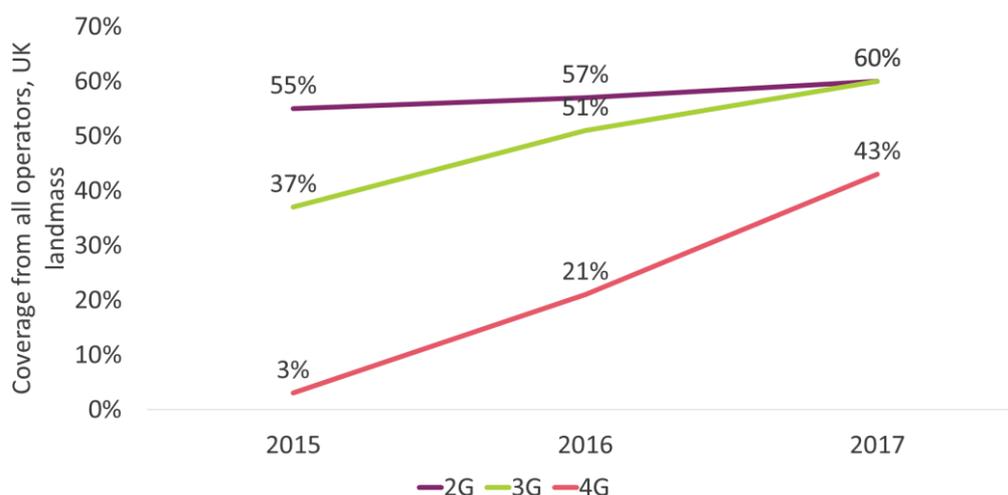
- 5.9 Most, but not all, people have coverage in their home or office. Indoor telephone call coverage by all four operators is available to 90% of UK premises, up from 85% in 2016. Coverage for data services stands at 85% of UK premises, up from 80% last year.
- 5.10 Our coverage figures account for the reduction in mobile signals caused by different buildings. This reduction is higher for premises with thermally efficient building materials. The wider use of these materials is increasing the challenge of providing reliable indoor coverage from mobile networks. Two developments are helping meet this challenge:
- People in premises that do not have indoor coverage from a mobile network may still be able to access data over wifi, and are increasingly able to make telephone calls over wifi; and
 - 4G services are using lower frequency spectrum bands to carry telephone calls and data services over longer distances and deeper into buildings. These are making an increasingly important contribution to outdoor and indoor mobile coverage.

Outdoor geographic and road coverage

- 5.11 Coverage away from home has also improved, but it is still relatively poor. The proportion of the UK's geographic landmass where reliable telephone calls can be made on all four mobile networks has reached 70%, up from 63% in 2016. Coverage of data services is lower, with 63% of UK landmass covered by all operators, an increase from 52% last year.

5.12 Figure 23 shows that increases in coverage of earlier generation 2G and 3G networks are levelling off alongside more significant growth in coverage from newer 4G networks.

Figure 23: Increases in geographic coverage from all operators since 2015



Source: Ofcom analysis of operator data, latest data is June 2017

5.13 While the UK’s motorways are well covered by both telephone and data networks, coverage on A and B roads is quite poor. It is possible to make a telephone call from all four networks while inside a vehicle on just 68% of A and B roads, while 58% of A and B roads have in-vehicle data coverage. These figures are up from 56% and 45% respectively last year. Our coverage figures take into account the reduction of mobile signal levels as they travel through the metal frame of a typical vehicle.

5.14 Motorists increasingly rely on mobile connectivity for a wide range of services, from entertainment to navigation, and we expect this reliance to increase as ‘connected cars’ become more popular. Coverage on roads will need to improve significantly to adequately support these service

5.15 To help improve our future road coverage predictions Ofcom has commissioned measurements of the mobile signal loss inside a range of popular vehicles⁵⁶.

Coverage in the nations and rural areas

5.16 There are some significant variations in coverage across the nations of the UK. As Figure 24 shows, coverage is generally higher in England than in the other nations.

- a) Northern Ireland is particularly poor for indoor coverage, which is around 10 percentage points lower than for the UK as a whole. This is likely because there is a greater proportion of properties in Northern Ireland that are dispersed throughout the countryside, compared to other nations.

⁵⁶ <https://www.ofcom.org.uk/research-and-data/technology/general/in-car-attenuation/>

- b) Scotland is particularly poor for outdoor coverage. Just 40% of the landmass in Scotland is covered by mobile telephone services from all operators, compared to 70% in the UK as a whole. Data coverage is even lower, at just 31% of geographic area. Consequently, coverage on A and B roads is also the lowest of the nations. This is due to the challenges in delivering coverage across the large and often mountainous areas of Scotland with low population densities.
- c) There are similar challenges in delivering coverage in Wales, which also has a large proportion of rural and mountainous areas. Both indoor and outdoor geographic coverage is lower in Wales than in the UK as a whole by around 10 percentage points.

Figure 24: Coverage of telephone call and data services across the UK and nations

	Indoor coverage, % premises		Outdoor geographic coverage, % landmass		A&B roads, % road network		Motorways, % road network	
	Telephone calls	Data	Telephone calls	Data	Telephone calls	Data	Telephone calls	Data
UK	90%	85%	70%	63%	68%	58%	97%	91%
England	91%	87%	88%	82%	78%	66%	97%	91%
Northern Ireland	78%	75%	83%	76%	62%	54%	91%	81%
Scotland	87%	82%	40%	31%	46%	38%	96%	88%
Wales	80%	73%	62%	52%	53%	41%	99%	96%

Source: Ofcom analysis of operator data

5.17 In the rural areas of all nations, including England, consumers continue to experience levels of coverage that are substantially lower than those in towns and cities. As Figure 25 shows, just 18% of rural premises can receive an indoor 4G service from all operators, compared to 64% of premises in urban areas.

Figure 25: Indoor 4G coverage from all operators in urban and rural areas



Source: Ofcom analysis of operator data

- 5.18 There are number of practical challenges associated with installing mobile network infrastructure rural areas:
- a) **Planning restrictions:** especially in areas of natural beauty there can be planning restrictions on where mobile base stations can be built;
 - b) **Terrain:** steep and hilly topography make it harder to deliver mobile signals over a wide area;
 - c) **Practical factors:** such as challenges in securing and maintaining a reliable power supply for the base station and a backhaul connection.
- 5.19 In addition to practical difficulties of installing and maintaining network equipment in these locations, the commercial business case for operators to provide coverage in areas of low population density can be challenging.
- 5.20 Alongside this report we published an update to our Economic Geography report⁵⁷, providing a detailed analysis of the factors that influence the decisions of MNOs to provide mobile coverage. This uses a regression approach 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 and composition, topography, distance to mobile backhaul and whether the locality is urban or rural are considered, 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.
- 5.21 In the case of 4G, there remains a considerable amount of unexplained regional variation particularly in the East of England, Northern Ireland, Wales and Scotland. However, 4G rollout 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.

Rail coverage

- 5.22 The train industry (Network Rail and the Train Operating Companies or TOCs) are taking steps to improve mobile connections inside train carriages. These are aiming to overcome the reduction in mobile signal levels as they enter into trains.
- 5.23 Some TOCs are using *repeaters*, to boost mobile signals inside the carriages. Whilst others (especially those running the main long-distance routes) have installed wifi systems in their carriages. Whilst these are providing some improvements they rely only on a good outdoor mobile signal connection to the train, which is often not available in many tunnels, deep cuttings and rural areas.
- 5.24 Other approaches for improving mobile coverage inside rail carriages are also being explored to better meet the future needs of travellers. One approach being considered

⁵⁷ <https://www.ofcom.org.uk/research-and-data/multi-sector-research/availability-of-communication-services/economic-geography-2017>

would use trackside bases stations interconnected by optical fibre. This could provide a high speed high capacity connection to trains, enabling more passengers to access high speed data services such as video at the same time.

Coverage levels by operator

5.25 The mobile coverage levels set out above relate to places where coverage is available from all four operators. Figure 26 below shows the level voice call coverage provided by each mobile operator.

Figure 26: Coverage of mobile voice services by operator, June 2017

	Indoor voice coverage, % premises	Outdoor geographic voice coverage, % landmass
EE	95%	79%
O2	98%	84%
Vodafone	97%	86%
Three	95%	78%

Source: Ofcom analysis of operator data

5.26 Some operators are now supporting voice services on their 4G networks. We expect these to contribute more to overall voice coverage over the next few years.

5.27 Similarly, Figure 27 shows the level of mobile data coverage provided by each operator.

Figure 27: Coverage of mobile data services by operator, June 2017

	Indoor data coverage, % premises	Outdoor geographic data coverage, % landmass
EE	95%	77%
O2	97%	77%
Vodafone	96%	77%
Three	89%	72%

Source: Ofcom analysis of operator data

Using coverage obligations to improve mobile coverage

- 5.28 Coverage obligations are the main means by which we can improve mobile coverage. There are currently two coverage obligations which reflect the consumer expectations and devices in use at the time that they were drafted:
- a) In February 2015, Ofcom varied the licences of the UK's four mobile network operators, with their consent, to commit them to provide telephone call coverage across 90% of the UK's landmass by the end of 2017; and
 - b) O2 is subject to an obligation to provide indoor coverage of a mobile data service capable of 2Mbit/s or more, to 98% of UK premises by the end of 2017. The other operators have indicated that they will match this commitment.
- 5.29 We can use the data presented in this report to assess progress against the first of these obligations, which requires each operator to provide 90% outdoor coverage. We estimate that the mobile coverage provided by each operator in June 2017, based on the signal strength thresholds agreed for the original 90% coverage obligation, was 87% for EE, 91% for O2, 83% for Three and 93% for Vodafone. We cannot use the data presented in this report to make a meaningful assessment of O2's progress against its obligation to provide 98% coverage for indoor data coverage.
- 5.30 We will assess formal compliance with the mobile operators' coverage obligations as early as possible in 2018.
- 5.31 When these coverage obligations were established they adopted the approach to measurement that had historically been used by the mobile industry. Since then, consumers have come to expect better coverage and the increased use of smartphones to access mobile services means that the levels of coverage actually achieved will be lower - by approximately 10 percentage points. Based on how we now measure coverage to reflect modern smartphone use, and assuming the operators meet their obligations, the historic coverage obligations would in practice mean that all operators would provide outdoor coverage to 80% of the UK landmass (rather than 90%), and O2 would deliver an indoor data service to 88% of UK premises (rather than 98%).
- 5.32 As set out in our Strategic Review of Digital Communications⁵⁸, the award of the mobile airwaves in the 700MHz band provides an important opportunity to improve coverage. We intend that these new obligations will be defined to reflect the actual experience of today's mobile users. We also believe that they should focus on rural areas, where the current experience is poorest and is least likely to be addressed by operators' commercial deployments. We are planning to consult early in 2018 on specific proposals.

⁵⁸ <https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/policy/digital-comms-review/conclusions-strategic-review-digital-Communications>

Mobile data use in the UK

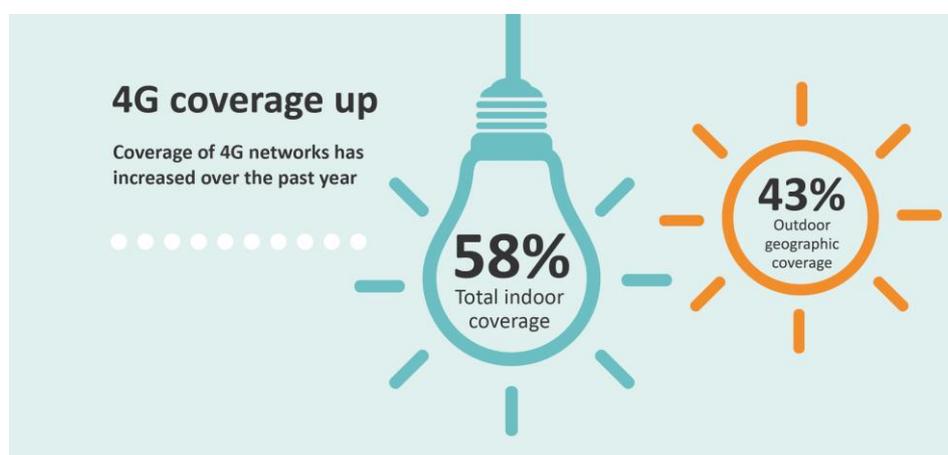
Increasing 4G coverage is driving data use

5.33 The amount of data consumed by mobile users continues to increase. As shown in Figure 28, this has been supported by the wider rollout of higher speed 4G services which now deliver 74% of all mobile data traffic.

Figure 28: UK data traffic by technology type for each nation, June 2017

Nation	Data Traffic (GB, millions) (%)			Total
	2G	3G	4G	
England	0.4 (80%)	35.2 (86%)	100.2 (87%)	135.8 (87%)
Northern Ireland	0.01 (2%)	0.8 (2%)	2.4 (2%)	3.1 (2%)
Scotland	0.05 (11%)	3.0 (7%)	8.3 (7%)	11.3 (7%)
Wales	0.03 (7%)	1.8 (4%)	3.9 (3%)	5.7 (4%)
UK	0.4 (0.3%)	40.8 (26%)	114.6 (74%)	155.9

Source: Ofcom analysis of operator data



5.34 Data use per subscriber has increased to 1.86GB in the year to June 2017, an increase of 48% compared to 2016.

5.35 A total of 156PB was sent over all mobile networks in June 2017, a 47% increase on the year before. Even so, this represents less than 4% of the volume of data sent over fixed broadband networks

Figure 29: Mobile data use continues to increase

Mobile data use	June 17	June 16	June 15	June 14	June 13	June 12
Active Connections (millions)	83.8	83.7	84.8	81.9	82.3	81.6
Total data uploaded/downloaded (GB, millions)	155.9	105.5	72.9	44.3	28.9	19.7
Data per active connection (GB)	1.86	1.26	0.86	0.54	0.35	0.24

Source: Ofcom analysis of mobile network operator data

Note: "Active connections" data excludes M2M connections and is as at end of June

Mobile data consumption varies throughout the day

- 5.36 In Figure 30 we show the times of day when the mobile data consumption is highest. During these times it is more likely that the consumer experience will be affected by network congestion. If this occurs, consumers may experience slower data speeds caused by more people drawing on the mobile networks finite capacity.
- 5.37 Across the month of June 2017, 21:00 - 21:59 was the hour during which most data were uploaded and downloaded across the UK.

Figure 30: Average busiest hours for data traffic in the UK, June 2017



Source: Ofcom analysis of operator data