# **Connected** Nations **2019**

## UK report

# Overview

This annual report measures progress in broadband and mobile services in the UK and highlights the work Ofcom is doing, alongside UK and devolved governments and communications companies, to improve the availability of these services. Ofcom wants people in the UK to be able to easily access good broadband and mobile connections wherever they live, work and travel.

Alongside this report, we publish reports on broadband and mobile availability in each of the UK's nations. We also provide an interactive dashboard, allowing people to see data for different areas, services and coverage levels. We are also making it easier for people to access our data, so they can create their own interactive services. We have two application programming interfaces (APIs), which allow others to use our data creatively to develop services, such as apps and widgets to benefit consumers and businesses.[1]

Ofcom is also releasing the International Broadband Scorecard 2019 . This compares the UK's recent position on broadband availability with a number of other European nations.

Over the last few years, the availability and take-up of superfast and ultrafast broadband, and the coverage and take-up of 4G mobile services have dramatically increased. As the Scorecard shows, the UK leads other large European countries for the highest availability of superfast services. The UK also holds a leading position on current 4G mobile network coverage. This demonstrates that policy and regulatory decisions made in the past few years have supported investment in new networks and technology and delivered a good outcome for consumers. Emphasis must now turn to the initiatives needed to ensure that the next wave of network deployment can meet future needs as quickly as possible by further extending the reach of full fibre and mobile networks.

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[1] More than 50 organisations are now looking to exploit this capability.

## What we have found:

- Three million homes and businesses (10%) now have access to full-fibre broadband connections; over 1.5million more premises than last year. These connections can deliver much higher download speeds, of up to 1 Gbit/s and are also much more reliable than older, copper-based broadband.

- The number of homes with access to superfast (at least 30 Mbit/s) broadband has increased by over 500,000 since last year, although the pace of rollout has slowed from a few years ago as the overall superfast coverage is now around 95%. In areas where at least superfast broadband is available, over half (57%) of those properties use superfast or ultrafast (at least 300 Mbit/s) services.

- The deployment of wireless home broadband from BT/EE on its mobile network further reduces the number of premises that cannot get a decent broadband service. We now estimate that as few as 189,000 homes should be unable to access a decent fixed broadband service, subject to confirmation of individual premises coverage. From March, those homes unable to get a decent connection will be able to request one from BT[2][3].

- 5G services have been launched by all four mobile network operators over the past year and are now operating in over 40 towns and cities across the UK.

- 4G coverage remains largely unchanged over the year. Individual operator coverage of the UK landmass varies, with the highest (EE) being 84% and the lowest (O2) 76%.

- 91% of the UK has access to good 4G outdoor mobile coverage from at least one of the operators. This leaves 9% of the UK that does not have good outdoor 4G coverage from any operator, predominantly in rural areas. Some 66% of the UK has coverage from all four operators. The proposed Shared Rural Network programme being negotiated between the operators and Government, with support from Ofcom, will aim to extend coverage for all operators well beyond this.

- Although 80% of homes and businesses should be able to get good 4G indoor coverage from all operators, this leaves one in five premises unable to do so.

- We estimate that 53,000 premises cannot access either a decent fixed broadband service or get good 4G coverage indoors (from any operator).

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[2] Or KCOM in the Kingston-upon-Hull area.
[3] Subject to eligibility criteria

## Work continues to improve service availability

### Ofcom initiatives

Ofcom supports investment in full fibre networks to make sure the needs of consumers and businesses continue to be met both now and in the future. We support this through measures designed to encourage investment from Openreach and make it cheaper and easier for other providers to build their own networks. This has helped to support faster growth in full fibre over the past year. We will publish proposals on this as part of our forthcoming consultation on the Telecoms Access Review, which will also include a number of other regulatory measures to encourage new network investments.

We have also worked to encourage early investment in 5G mobile networks, and this is already bearing fruit.

### Working with the UK and devolved governments

Alongside the work we do as a regulator, there will continue to be a role for government to help improve access to mobile and broadband, including by investing public money in networks in areas which are unlikely to be covered commercially. We will work closely with the new UK Government as it develops plans to invest £5bn in full fibre and gigabit capable broadband and as it works towards an agreement with the mobile operators on a Shared Rural Network (SRN). We will also continue to work closely with the devolved governments as the implementation date for the Broadband Universal Service Obligation approaches. More detailed information about publicly funded schemes in Scotland, Wales and Northern Ireland can be found in the individual nations reports.

## Fixed broadband services

In this report, we also focus on the availability of services for decent (10 Mbit/s and above), superfast (30 Mbit/s and above), ultrafast (300 Mbit/s and above) and full-fibre broadband, which can offer speeds of 1 Gbit/s. Our report shows that coverage of faster broadband networks, particularly full-fibre networks, is increasing, and consumers are increasingly taking up the faster broadband services.

### Decent broadband coverage is improving but more remains to be done

In March 2018, the UK Government introduced legislation for a Broadband Universal Service Obligation (USO), which will give eligible homes and businesses the right to request a broadband connection that delivers a decent broadband service of at least 10 Mbit/s download speed and 1 Mbit/s upload speed. Ofcom is implementing this, and it will come into force in March 2020.

Coverage from conventional fixed line networks continues to improve but around 610,000 homes and businesses are still unable to receive a decent broadband service. However, factoring in the coverage from fixed wireless networks, including those of the mobile operators, we estimate that around 189,000 homes and businesses are unable to access a decent broadband service.  This number is expected to fall further by the time the USO comes into force.

### Superfast and ultrafast broadband rollout continues

In addition to full-fibre rollout, investment in superfast and ultrafast coverage continues, but at a generally lower pace than previously reported. This is because most of the country now has access to superfast broadband. The total number of premises able to get superfast broadband has risen by around 500,000 and stands at 95% of residential premises (94% for all properties)[4]. Coverage for all business premises, both large and small, is at 86%[5]. Coverage of ultrafast broadband has increased from 50% to 53% of homes over the year.

# Mobile services

Mobile coverage across the UK is gradually improving but some parts of the country still struggle to get a good mobile connection. Good reception is easier to achieve outdoors than inside because mobile signals are weakened by obstacles such as walls and the glass used in cars and trains. Because of this, we report separately on outdoor and indoor coverage. We also report on in-car and out-of-car coverage on roads.

### Mobile coverage

91% of the UK landmass now has good outdoor 4G coverage from at least one mobile operator, and almost all UK premises are contained within this area. Only 66% of the UK landmass has good outdoor 4G coverage from all four operators, but this area includes 96% of UK premises. The proposed SRN should further reduce the areas without good 4G coverage.

As with last year, indoor call coverage from all four operators is available to 93% of UK premises. Indoor 4G coverage from all four operators has increased from 77% of premises last year to 80%. The operator with the highest coverage, O2, provides good 4G indoor coverage to 95% of premises, six percentage points more than Three, which has the lowest indoor coverage. Good indoor coverage is available to 42% of rural[6] premises, comparable to last year.

Outdoors, voice coverage is available from all four operators to 79% of the UK, up from 78% a year ago. Vodafone and O2 continue to have the highest voice call coverage covering 91% of the UK's landmass (an improvement of one percentage point), around five percentage points above Three and EE. 97% of UK premises outdoor are covered by 4G data services from all operators (the same as last year). Almost all UK premises have 4G data coverage from at least one operator (the same as last year).

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[4] In this report and the associated data and interactive charts, we are improving the way we identify, include and categorise properties in our analysis. This is explained in more detail in our methodology annex.
[5] This may be due in part to lower availability in business parks, due to the costs involved in rolling out the relevant technology to these areas and the alternative use of "leased lines" for data networking, particularly by larger enterprises.
[6] Definitions of 'rural' and 'urban' are given in our Methodology annex.

### Coverage is lower in rural areas

The areas with limited or no mobile coverage tend to be sparsely populated rural areas where the commercial incentives to provide coverage are lower.

Coverage can vary a lot between operators. Ofcom's online coverage checker and app enables people to identify which operators predict a good connection in the locations that matter most to them. People can then choose the operator that best meets their needs.

### There are a small number of premises that do not have a decent fixed line or good 4G mobile network connection

As with last year this report looks at those premises unable to get a decent fixed (at least 10 Mbit/s download speed) *or* a good 4G mobile broadband service. We estimate that 97% of premises can receive both decent fixed and good mobile broadband services, while 53,000 (0.2% of UK premises) are unable to access either. As with last year, more premises currently have good indoor 4G coverage from at least one operator than a decent fixed broadband service.

The broadband USO, which we are implementing, and the proposed SRN for improved mobile coverage should reduce the number of premises that are unable to receive either a decent fixed or good mobile service. However, there might be some premises that will require an alternative technology solution.

### 5G

As of October 2019 EE, O2, Three and Vodafone were offering mobile and/or fixed 5G services. They have launched 5G in more than 40 cities and towns in the UK. Initial offerings are focused on densely populated areas.

As well as providing improved broadband services for consumers via public networks, future 5G networks could provide specialist services to organisations and businesses. We expect our new spectrum sharing framework announced in July to provide support for organisations and businesses to deploy such private wireless networks.

## Network security and resilience

As people and businesses become more reliant on fixed and mobile networks, and the threat from cybersecurity risks increase, companies must manage security risks and safeguard the availability of their services. We are working closely with the UK Government and its agencies to improve security and resilience, for example by contributing to the work initiated by the Supply Chain Review being led by DCMS.

In previous Connected Nations, we reported on the significant incidents that we have been informed about by fixed and mobile phone companies. This year, we have found:

- Network problems and outages continue to occur with roughly the same frequency, root causes and level of impact.
- Fixed telephone networks tend to be the most reliable, with the worst being unavailable for five hours during the year. Fixed broadband networks reported up to 24 hours of unavailability. Mobile networks tended to perform somewhat worse with reported unavailability ranging from seven hours to two days.
- The few large-scale outages that do occur can have a major impact on users.

Ofcom is increasingly focused on how networks could be designed and operated to minimise the risk of widespread failures and mitigate their impact. We are working with industry and Government to achieve this. We are also continuing with our increased focus on cyber security through our Security and Resilience Assurance Scheme, with initiatives such as a penetration testing programme. We continue to work closely with Government and the National Cyber Security Centre (NCSC) on a set of technical security requirements for the telecoms sector.

# Contents

# Fixed broadband and voice

## Introduction

A key priority for Ofcom is to encourage investment in full-fibre, which provides greater speed and reliability than copper-based telecoms networks. The UK and devolved governments are also supporting the move to improved connectivity for the country.

For this report, we have expanded the number of companies contributing data to our analysis, incorporating coverage information from fixed wireless access providers and smaller full-fibre network providers.

We also highlight some of the developments in the preparation for migrating voice services to be delivered over fibre broadband connections.
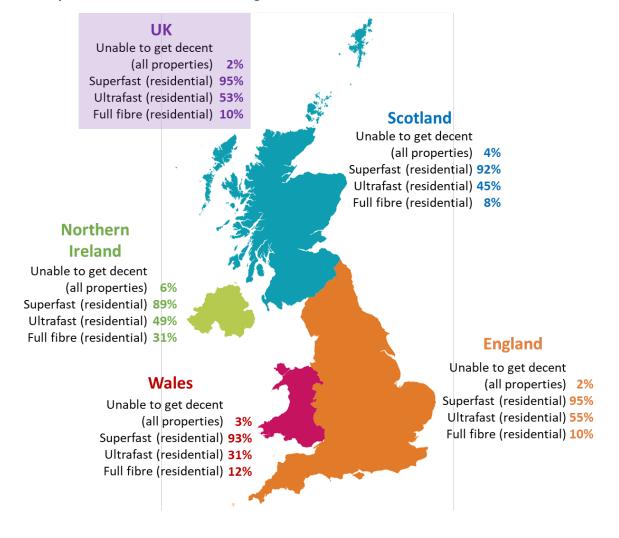
### Key highlights:

- Superfast broadband coverage to residential properties stands at 95%. This relates to the availability of fixed broadband with a download speed of at least 30 Mbit/s.

- Three million premises now have access to a full-fibre connection, capable of delivering much higher download and upload speeds.

- Around 610,000 UK homes and businesses are still unable to access a fixed broadband service that delivers a decent broadband connection, that is one that delivers a download speed of at least 10 Mbit/s and an upload speed of at least 1 Mbit/s.

- Factoring in the coverage from fixed wireless providers, we now estimate that as few as 189,000 homes should be unable to access a decent fixed broadband service, subject to confirmation of individual premises coverage. From March, those homes unable to get a decent connection will be able to request one from BT.[7,8]

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[7] Subject to eligibility criteria

[8] Or KCOM in the Kingston-upon-Hull area.

**Summary of fixed line broadband coverage across the UK and Nations**

**UK**
Unable to get decent
(all properties) **2%**
Superfast (residential) **95%**
Ultrafast (residential) **53%**
Full fibre (residential) **10%**

**Scotland**
Unable to get decent
(all properties) **4%**
Superfast (residential) **92%**
Ultrafast (residential) **45%**
Full fibre (residential) **8%**

**Northern Ireland**
Unable to get decent
(all properties) **6%**
Superfast (residential) **89%**
Ultrafast (residential) **49%**
Full fibre (residential) **31%**

**England**
Unable to get decent
(all properties) **2%**
Superfast (residential) **95%**
Ultrafast (residential) **55%**
Full fibre (residential) **10%**

**Wales**
Unable to get decent
(all properties) **3%**
Superfast (residential) **93%**
Ultrafast (residential) **31%**
Full fibre (residential) **12%**

# Fixed broadband coverage has increased across the UK

There has been continued investment in fixed networks resulting in improvements in the availability of superfast, ultrafast and full-fibre broadband. Consequently, the number of premises that do not receive decent broadband has also declined.

## Access to a superfast broadband service continues to increase although at a slower pace than for previous years

Ofcom defines superfast broadband as a service which delivers a minimum download speed of at least 30 Mbit/s. The Scottish Government and Welsh Government also use this definition in their schemes to extend broadband coverage.

**Over the past year the coverage of superfast broadband to residential homes across the UK stands at 95%, broadly similar to last year.**

| Nation | Residential superfast coverage |
|---|---|
| Scotland | 92% |
| Wales | 93% |
| Northern Ireland | 89% |
| England | 95% |

Superfast availability for UK business or commercial properties is somewhat lower (86%) than for residential premises. This may be due in part to lower availability in business parks, due to the costs involved in rolling out technology in these areas and the higher use of business broadband services to such areas (such as private lines).

There is also a significant difference between the availability of superfast broadband in urban and rural areas, with 97% of residential premises in urban areas having access to superfast broadband compared to 79% in rural areas.

We expect superfast broadband coverage to continue to increase as a number of public sector interventions are currently underway:

- As part of the Autumn 2018 Budget, the Chancellor announced that £200m would be made available to pilot innovative approaches to the deployment of full-fibre via the Rural Gigabit Connectivity Programme. The programme aims to deliver gigabit capable connections to key public and business buildings, including schools, as well as encouraging broadband providers to create additional connections to local homes.

- Building Digital UK (BDUK) has extended 24 Mbit/s coverage to 95% of the UK, and estimates that by 2020 this coverage will be extended to at least a further 2% of UK homes and businesses. "As part of this, the Digital Scotland Superfast Broadband Programme (DSSB) will also continue to deploy into 2020.

- The Local Full Fibre Networks Programme ('LFFN') is allocating £200m to local projects to incentivise and accelerate commercial investment in full-fibre broadband. As part of the LFFN programme, a £67m Gigabit Broadband Voucher Scheme was launched to help small businesses and the local communities around them to contribute to the installation cost of faster connections using gigabit-capable infrastructure.

- The Scottish Government has committed to extending superfast broadband access to 100% of premises in Scotland as part of its 'Reaching 100%' (R100) programme. Contracts for the £600m programme are being finalised, with BT Group plc named as the preferred bidder for all three geographical lots across Scotland.
- The Welsh Government has announced that BT has won all three lots of the new Phase 2 Superfast Cymru programme. This will initially provide access to fast broadband to 26,000 premises by March 2021 with the majority of these premises being served by FTTP connections.
- In Northern Ireland, the Department for the Economy has identified 97,000 premises that will be eligible for a broadband boost under *Project Stratum*. The £165m project seeks to improve connectivity for those unable to access broadband services of 30 Mbit/s or greater. Procurement was launched in July 2019 and contract award is anticipated in mid-2020[9].

## Ultrafast broadband deployment continues to increase

Ultrafast services are defined as being able to deliver broadband speeds that are greater than or equal to 300 Mbit/s. This definition includes G.fast[10], cable networks and full-fibre technologies. G.fast services deliver very high speeds over very short telephone lines, so only premises close to the serving cabinet will be able to receive ultrafast broadband from this technology.

**Ultrafast broadband coverage stands at 53%.** Virgin Media has continued to upgrade its network, increasing its fastest residential broadband service to 300 Mbit/s for the majority of its network. In addition, Openreach has deployed G.fast technology in many areas. We also expect ultrafast coverage to increase as a result of growth in full-fibre networks. Although we have observed in increase in ultrafast coverage due to these factors, this figure is lower than the one quoted in our summer update due to changes in the way that we identify premises, which is discussed further in our Methodology Annex.

## Full-fibre investment and roll out continues to increase

In a 'Full-fibre' or Fibre-to-the-Premises network, fibre optic cables are connected all the way from the local exchange to the home or small business, and can reliably deliver speeds of 1 Gbit/s or more.[11]  This contrasts with technologies that are a combination of fibre and copper, like Fibre-to-the-Cabinet, where the quality and distance of the copper to the premises can impact on both the reliability and speed of the service.

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[9] https://www.economy-ni.gov.uk/news/review-identifies-97000-premises-eligible-broadband-boost
[10] G.fast is a fixed line technology that reuses the existing copper connection to a cabinet, and makes use of a greater frequency range to deliver

faster services than current fibre to the cabinet services that use VDSL technology.
[11] We define full-fibre coverage as where the network has been rolled out to a "lead-in" that will serve the consumer end premise and where the customer would expect to pay a standard installation charge for that connection.

**Over 3 million premises now have access to a full-fibre connection.** This is an increase of 1.5 million premises compared to last year and represents over 10% of UK premises. Coverage of commercial properties with "full-fibre" broadband access services[12] stands at around 12% which is likely to be the result of operators selecting areas for deployment that contain a larger number of businesses to maximise take-up.

## Capability for access networks to meet consumer demands for service.

In addition to physical coverage, to ensure that consumers can access the services that they want, the networks need to be able to meet new demand. This capability varies from location to location and from time to time as demand emerges and operators upgrade equipment and install new capacity to meet this demand. We have examined the capacity of fixed access networks to meet additional demand and estimate that across the UK for 99% of the time access networks can meet additional demand. We shall use this as a baseline to monitor how operators are ensuring that networks remain open and available to new customers as network coverage expands.

A full list of the providers who contributed coverage data can be found in our Methodology Annex.

To encourage investment in building full-fibre networks and to provide investors and companies with long term regulatory certainty, Ofcom has proposed several changes in our regulatory and policy approach. They include:

- Allowing competing companies to use Openreach's ducts and poles for both people and businesses. In June this year, we set out our decision on regulation to allow all telecoms providers to access the ducts and poles operated by Openreach to promote competition and make it easier to build high-capacity connections to homes and businesses.
- A flexible approach to regulation by deregulating in areas where there are competing fibre providers.
- Increasing the periods between major reviews of the telecoms market from 3 to 5 years.

Ofcom collected data from telecoms providers relating to their full-fibre network roll-out from 1 April 2019 using both Openreach's PIA (Physical Infrastructure Access) product and their own-build deployments. Opening up Openreach's ducts and poles to other telecoms providers was a remedy put forward in Ofcom's Digital Communications Review (2016) to promote competition in the telecoms access network. We found that telecoms providers were beginning to use this product, however, at the time of data collection (September 2019) volumes were low as this was a relatively new product and responses were provided in a way that we were unable to report take-up in a comparable manner. We expect these issues to be resolved allowing us to report on total

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[12] "Full-fibre" broadband access services are those delivered to the mass market primarily to deliver internet connectivity and have some degree of contention in the network. Uncontended "leased line" services over fibre are also available at higher price points for corporate networks and other applications.

full-fibre network and PIA volumes in the Connected Nations 2020 report.

## The number of premises unable to access decent broadband has fallen

While superfast coverage continues to improve, there remain premises that do not have access to decent broadband. In March 2018 the UK Government finalised the terms of a new Universal Service Obligation (USO) by issuing secondary legislation to introduce a USO for broadband connections and services. The Order states that affordable broadband connections and services must be provided throughout the UK with a download speed of at least 10 Mbit/s and other specified technical characteristics. The technical specification in the Order aims to ensure that consumers can use the digital communications they need today, but it may have to increase over time to meet rising consumer expectations and demands. The Digital Economy Act 2017 includes an automatic review of the USO to ensure it remains relevant.

The USO will apply to the whole of the UK and is intended to help fill the gap left by existing broadband rollout programmes. It will act as an important digital safety net for people who might otherwise get left behind by ensuring every household and business will have the right to request a decent broadband connection and service. The USO aims to improve broadband coverage to households and businesses in hard to reach areas and it is an important building block to improving access to broadband services across the whole of the UK.

Ofcom is responsible for implementing the Broadband Universal Service Obligation (USO). We have designated BT and KCOM as the broadband Universal Service Providers and from March 2020 consumers can start to request USO connections.

We will be working with the Universal Service Providers and public bodies to raise consumer awareness of the USO in time for consumers to start requesting connections in March.

## The number of UK premises (homes and businesses) that were unable to access a decent fixed-line broadband service fell again

Around 610,000 premises (2% of all premises) cannot get decent broadband from a fixed line connection. Of these, we estimate that around 189,000 (0.6% of the total) could be potentially eligible for the broadband USO[13]. This is because the launch and substantial expansion of 4G fixed wireless services has meant that a decent broadband service can be delivered over a wireless connection (see further detail below). Ofcom will continue to analyse the coverage and performance of these providers to ensure that they are robust and likely to give homes and businesses the connections they need.

Coverage of decent broadband also varies across the nations in both rural and urban areas. The following table highlights the differences between the nations and the urban/rural divide. Premises with no access to a decent broadband connection would be considered eligible for the UK Government's USO[14].

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[13] Subject to eligibility criteria

[14] Note that eligibility for broadband USO will depend on a number of factors of which download speed <10 Mbit/s is just one.

## Figure 1: Premises unable to receive decent broadband from a fixed line

| Nations | All | Rural | Urban |
|---|---|---|---|
| England | 2% (412,000) | 8% (273,000) | 1% (138,000) |
| Northern Ireland | 6% (50,000) | 19% (44,000) | 1% (6,000) |
| Scotland | 4% (98,000) | 19% (89,000) | 0% (9,000) |
| Wales | 3% (50,000) | 12% (42,000) | 1% (8,000) |
| Total | 2% (610,000) | 10% (449,000) | 1% (161,000) |

*Source: Ofcom analysis of operator data*

Direct comparison with previous years' figures is not possible given the changes in address matching.

# Fixed Wireless Access as a means of delivering broadband

Fixed Wireless Access (FWA) networks use a wireless link for the final connection to a home or business, avoiding the installation of a line into the building. The capacity in the wireless access network is shared between multiple users. The service needs to be managed appropriately to ensure there is sufficient capacity to meet user needs, especially in areas with capacity constraints.

FWA services can be delivered on networks that only serve customers at a fixed location, by Wireless Internet Service Providers (WISPs). In the UK, these networks most commonly use licence exempt or light licensed spectrum such as the 5 GHz band. They can also be delivered on mobile networks, where the capacity of the network is shared with mobile users, using 4G and 5G technologies.

This section initially focuses on the FWA services provided by licence exempt or light licensed systems offered by WISPs and then considers the FWA service delivered by mobile networks.

## Fixed Wireless Access by WISPs

The majority of these services are delivered over wireless networks that communicate via a wireless link between a provider's mast site and an external antenna fixed to a customer's premises. The speeds and services delivered will depend on a number of factors including, but not limited to: the number of premises being served from the same transmitter, the location of the premises, line-of-sight issues, consumer equipment and available network capacity.

## Figure 2: Schematic of Fixed Wireless Access network

### Ofcom's work with WISPs

We have applied a modelling method to data we have received from a number of providers in order to predict the number of premises that have coverage from these providers via existing infrastructure. The modelling method provides an estimate only and does not account for network capacity constraints, interference or other external factors.[15] We would note that, for all coverage estimates based on such predictive modelling tools, localised issues may mean that particular premises may not be able to receive an adequate service despite being predicted to do so. We intend to work with FWA providers to better understand the performance of these services.

### We estimate that up to 1.6 million premises could receive decent wireless broadband on licence exempt or light licensed spectrum.

The results of our modelling show that, in principle, as many as 1.6 million[16] homes and businesses in the UK could have a medium or high chance of being able to receive a decent broadband service from a WISP.[17] Of these, 53,000 currently do not have access to a decent fixed broadband service. This provides an additional 0.17% of decent broadband service coverage to the UK. Around 1% of premises that have coverage from a WISP have taken up a service from one of these networks.

Figure 3 shows the total number of premises covered by one or more WISP networks. It also shows the number of premises which are unable to access a decent broadband service but can be covered by a WISP. This is labelled WISP USO in the table below.

### Figure 3: Number of premises which can receive decent broadband from WISP by nation

| Nation | WISP coverage | WISP USO |
|---|---|---|
| UK | 1,588,000 | 53,000[18] |
| England | 1,126,000 | 39,000 |
| Northern Ireland | 26,000 | 6,000 |
| Scotland | 33,000 | 3,000 |
| Wales | 403,000 | 6,000 |

*Source: Ofcom analysis of operator data*

There are many more WISPs who have not given us their coverage data, so coverage from these providers could be higher. We intend to continue to collate and analyse data from these providers and monitor changes to the sector.

In July this year, we announced our decision to introduce a new local licensing approach to provide localised access to spectrum bands. We have already issued a licence for access to licensed mobile spectrum and we have recently opened up access to the shared spectrum bands. We expect this could help extend the provision of FWA networks in hard to reach places.

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[15] More detail on the methodology used to determine WISP coverage can be found in Annex A.

[16] The network infrastructure that is currently deployed by the providers we have obtained information from would need to be extended significantly to support any larger proportion of this total nominal capability beyond the current level

[17] This consists of data from 13 providers, of which 5 provided updated data for this year. The increase in the number of premises compared to last year is due to data from one additional provider.

[18] Many of these are likely also to be covered by the mobile network FWA services described in the next section so we estimate that only around 10,000 of this total could be uniquely served by WISPs.

## Fixed Wireless Access via mobile technologies

Over the past year, mobile network operators (MNOs) have launched new FWA services, in some cases making use of the increased capacity of their 5G networks. Some MNOs have also continued to offer FWA services on their 4G networks. Of the four MNOs, only Telefonica does not currently offer 4G or 5G FWA services.

Mobile FWA services are mainly delivered directly to an indoor router. For areas with poor indoor coverage, EE offers an external antenna for its 4G FWA service. Three offers an external antenna to customers of its 4G FWA service in parts of Swindon. There are currently no providers offering an external antenna for their 5G FWA service.

In the majority of cases, these services share the network capacity with mobile users and MNOs do not market the services based on speed. We intend to carry out more research into the performance of these services.

We estimate that EE has FWA coverage over 401,000 premises that do not currently have access to a decent broadband service from a fixed line or a WISP. Our research has shown that the 4G EE service is capable of delivering USO level broadband.[19] Taking this and the WISP coverage into consideration means that we estimate that there are currently only around 189,000 premises that could be eligible for the Broadband USO.[20]

**Figure 4: Breakdown of the number of premises unable to get decent broadband from fixed, WISP or mobile FWA connection**

| Nation | No decent broadband from a fixed line | No decent broadband (no fixed, WISP or mobile) |
|---|---|---|
| UK | 610,000 | 189,000 |
| England | 412,000 | 111,000 |
| Northern Ireland | 50,000 | 20,000 |
| Scotland | 98,000 | 40,000 |
| Wales | 50,000 | 18,000 |

*Source: Ofcom analysis of operator data*

We are in discussions with Vodafone and Three about collecting information about the performance of their services and understanding how they plan to manage the capacity of their network for FWA customers.

As we explain in the next section, the initial rollout of 5G has been focussed in areas of higher population density, where capacity demands are likely to be the greatest. In the near term, operators are likely to continue to rollout in areas where 5G will deliver significant quality of service improvements. As roll out continues, MNOs might consider whether to offer 5G FWA; this could help extend the reach of broadband services.

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[19] In 2018 we conducted research into the performance of the EE FWA service. We found high levels of variation in the performance of FWA connections. Overall, five of the 58 panellists did not receive our benchmark 9.5Mbit/s downstream

speed and 0.95Mbit/s upstream speed during peak hours.
[20] Subject to the individual premise network coverage variations noted earlier.

## Satellite

There remain 6% of premises that are unable to access superfast broadband coverage from a fixed network, of which 2% are unable to access decent broadband. For the most remote premises, which do not have suitable coverage from a mobile network, broadband services may be provided using satellite broadband. Like with mobile networks, capacity is shared between premises served by the same spot beam.

Until now, the most common of these are services from geostationary satellites. These offer broadband packages with speeds up to 30 Mbit/s but, unlike fixed broadband services, have data caps to manage the demand on the network. In addition, broadband services from geostationary satellites have higher latency than fixed broadband services, due to the round-trip time for data packets to travel between the earth and the geostationary orbit (some 36,000 km above the Earth's surface).

In the past few years, there has been a renewed interest in Low Earth Orbit (LEO) satellite constellations. These satellites are deployed at an orbit much closer to the Earth. This means that they can provide lower latency services. However, the closer to Earth they orbit, the greater the number of satellites required to ensure a continuous connection.

Two constellations have started to deploy satellites:

**SpaceX's Starlink** constellation will operate at around 500km and will comprise at least 4,425 satellites. At the time of writing, 120 satellites have been launched into orbit. SpaceX has announced that an initial broadband service is to be offered over Canada and the US by mid-2020 and this service will be available in other countries from 2021.

**OneWeb** will operate at an altitude of between 900 and 1100 km, deploying an initial constellation of between 650 and 900 satellites. It has already launched four satellites and plans to launch 30 satellites a month in 2020. Oneweb has announced that an initial service will be available from 2021.

Not all constellations will provide direct-to-home broadband services. Some operators may opt to provide backhaul for more traditional mobile or broadband providers. The types of services offered may partly depend on the final cost of satellite receivers for LEO constellations, which are currently more expensive compared to customer premise equipment for fixed and other wireless services. Despite this, they could still be less costly than the total costs of installing a fixed or wireless connection in hard-to-reach premises, and therefore could help to connect those premises.

## Take-up of fixed services

The benefits of increased coverage of high-speed broadband networks cannot be realised if consumers do not take advantage of these services when they are available. So alongside reporting on the extent of coverage of broadband networks we also examine the take-up of services over them.

Coverage is used to refer to the maximum broadband speed available at a property, e.g. if the building can receive a decent broadband service (10 Mbit/s) and a superfast (30 Mbit/s) broadband service from BT, and an ultrafast broadband service (300 Mbit/s) from Virgin Media, the coverage at that premises would be 300 Mbit/s as it is the maximum speed available at the property.

Take-up is defined based on the package the customer subscribes to and the measured speed that is delivered on that line, e.g. if the customer receives a broadband service at the premises above, they have the option of selecting either a decent broadband or superfast service from BT or ultrafast service from Virgin Media.
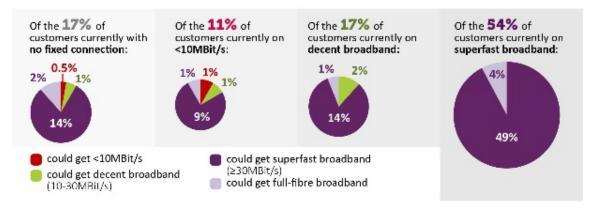
Figure 5 shows that, although 94% of premises have access to superfast broadband, only 54% of premises have signed up to them (or 57% of those able to take superfast services have done so). However, this has increased 9 percentage points from 45% last year. Similarly, although 98% of premises have access to a decent broadband service,

only 70% of premises have an active broadband service that delivers a download speed higher than 10 Mbit/s. This also represents an improvement of broadband service take-up over the past year (from 65%).

Take up of full-fibre services varies between providers. Those that target specific buildings with pre-existing interest tend to have high take-up rates whereas others that build to wider areas, sometimes to cater for business services tend to have much lower take-up rates. On average we estimate that the percentage of premises taking full-fibre services where they are available is around 30%[21].

**Figure 5: Take up of available services**



*Source: Ofcom analysis of operator data*

**Figure 6: Many consumers on an existing package could sign up to faster services**



*Source: Ofcom analysis of operator data*

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[21] We collect line performance/speed data from a subset of those operators that provide coverage data. See Methodology Annex for more details.

## Data use on fixed networks continues to increase

Consumers are also consuming more data over their fixed connections. Data use on fixed networks has increased to an average of 315GB per connection per month, from 240GB in 2018. The median value of data use on fixed lines has increased by 30% to 164GB from 124GB last year and those with superfast packages use 368GB per month suggesting that users with faster connections are using a lot more data. Putting this in perspective, 315GB per month is roughly equivalent to watching three to four hours of HD content (films, sports, video clips) per day. As user needs and expectations evolve, we will keep the level and specification of the broadband safety net under review.

# Future of voice

As companies move away from deploying copper-based to fibre broadband technologies, the traditional telephone network will also have to change. Traditionally most landline services are delivered to people over the Public Switched Telephone Network (PSTN), using copper. With a reduction of technical knowledge on such copper dependent systems and the unavailability of spare parts, companies are already preparing to move to an all IP world where telephone services will be delivered over the broadband connection, often referred to as Voice over IP (VoIP).

Openreach and Virgin Media are planning to migrate voice services to VoIP. Sky and TalkTalk already carry voice calls as IP traffic within their core network.

We are gathering information about the technology used by companies to provide voice services so that we can track the migration to VoIP in the coming years. The majority of services are still being supported by the traditional PSTN network, with around a fifth of them being supported by a modern IP-based network that imitates the characteristics of the traditional PSTN (known as 'emulation').

Managed voice services over broadband or fibre to replace the PSTN completely still constitute a very small part of the total number of lines (around 1%), but we expect this to increase rapidly in the coming years as part of the PSTN migration. We will continue to monitor this in future Connected Nations reports.

Some services that rely on the analogue characteristics of the current PSTN may be affected by the migration to IP, for example some types of fire alarms and telecare services and monitoring equipment used in the energy, water and transport sectors. As a part of their plan for migration, BT and Virgin Media[22] are offering a test facility for providers of such services to test the impact of this transition. Ofcom has also engaged with the UK and devolved governments and other regulators to help raise awareness about the migration and potential impact for services they or their stakeholders use so that they can make sure appropriate measures are being taken to protect critical services.

**There are a number of other regulatory and operational implications of the change to VoIP that Ofcom is addressing through a work programme that will continue through 2020 and beyond.**

The technology change brings new challenges – for example, it has become easier to hide or change callers' identity information presented through phone numbers, and therefore more difficult to trace and prevent nuisance or scam calls.

We work closely with the Information Commissioner's Office (ICO) which is the organisation with lead responsibility for tackling unsolicited sales and marketing calls. Together with the ICO, we have published a Joint Action Plan which sets out a number of initiatives on dealing with the problem of nuisance calls and how to prevent them occurring in the first place.

Ultimately, we believe that addressing nuisance or scam calls will require a

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[22] For further information email:
IPvoice@virginmedia.co.uk

mechanism for providers to authenticate callers' identity for each call. We are working with industry to understand the significant changes to communications systems that will be necessary and to implement a common numbering database that can be used for authentication. We believe a common database could be in place by 2022, which could then be progressively used to verify that the identity of a calling number is genuine for calls made on these networks.

A common database could also support more efficient processes for porting numbers and routing calls to these numbers when customers switch between competing providers, as well as support improvements and efficiencies in number management.

The move to IP will also need changes to how calls are passed between networks. Our main regulation in this area is in setting the maximum charge that operators can levy for calls handed over to them. With PSTN on BT

this means calls that are handed over to BT at each of its 800 local exchanges. IP calls will be handed over centrally with the number of different points of connection largely determined by the need for resilience. Our regulation will also shift to focus on the charges for calls handed over using IP.

**We are also continuing to explore how blockchain and distributed ledger technology could improve the management of UK landline numbers.**

In October 2018, Ofcom secured funds from the Department of Business, Energy and Industrial Strategy to explore how blockchain[23] or distributed ledger technology could improve how UK landline telephone numbers are managed.  This work is on schedule to be completed during early 2020, with a pilot system currently undergoing trials by communications providers, using transaction volumes that would typically be expected in practice.

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[23] Blockchain allows for the transfer of digital assets between two parties, that creates a trusted record of transactions and ownership.

# Mobile voice and data

## Introduction

People expect to be able to make calls and get online where they live, work and travel. In this chapter we provide an update on coverage both outside and inside premises, across the UK's landmass and on roads. We also describe the measurements we are making available to policy makers, train operators and others to improve their understanding of the coverage available along selected railways in England, Wales and Scotland. 'Internet-of-Things' services are also becoming increasingly important, and in this chapter, we are reporting on their availability in the UK.

## Key highlights:

- All four Mobile Network Operators (MNOs) have launched 5G services.

- The commercial rollout of 4G is approaching completion and MNOs are focusing further investment to deliver improvements where demand is concentrated. As a result, both UK premises coverage and outdoor geographic coverage show small improvements. Outdoor coverage is now available in the majority of places where people live and work.

- However, coverage of the UK landmass remains patchy, especially in rural areas. The UK Government has announced its in-principle support for the network operators' proposed Shared Rural Network, which would deliver new coverage in many rural areas.

**Summary of mobile coverage across the UK and Nations**



**UK**

| | |
|---|---|
| 4G indoor all operators | **80%** |
| 4G geographic all operators | **66%** |
| 4G geographic not spots | **9%** |
| Voice and text geographic all operators | **79%** |
| Voice and text not spots | **5%** |

**Scotland**

| | |
|---|---|
| 4G indoor all operators | **79%** |
| 4G geographic all operators | **42%** |
| 4G geographic not spots | **20%** |
| Voice and text geographic all operators | **58%** |
| Voice and text not spots | **12%** |

**Northern Ireland**

| | |
|---|---|
| 4G indoor all operators | **61%** |
| 4G geographic all operators | **75%** |
| 4G geographic not spots | **3%** |
| Voice and text geographic all operators | **86%** |
| Voice and text not spots | **1%** |

**Wales**

| | |
|---|---|
| 4G indoor all operators | **73%** |
| 4G geographic all operators | **58%** |
| 4G geographic not spots | **11%** |
| Voice and text geographic all operators | **77%** |
| Voice and text not spots | **5%** |

**England**

| | |
|---|---|
| 4G indoor all operators | **81%** |
| 4G geographic all operators | **81%** |
| 4G geographic not spots | **3%** |
| Voice and text geographic all operators | **91%** |
| Voice and text not spots | **1%** |

# 5G is here

This year marked the launch of 5G in the UK. The UK is a 5G leader in Europe, because it is one of the first countries where all the Mobile Network Operators (MNOs) have started 5G deployment.

These initial 5G networks target mobile broadband services, providing several enhancements over 4G networks, including higher speeds and the capability to deliver extra capacity where needed, such as in urban areas or sports stadiums. Future evolutions of these initial 5G networks will enable additional services that rely on a near instantaneous network response (a latency of the order of only a few milliseconds) and need high reliability, with applications in sectors such as manufacturing, logistics, agriculture, transport/automotive, energy, media & entertainment, and healthcare. Examples of applications include controlling vehicles at distance, e.g. in mines, or enabling robots in automated factories to communicate with each other.

## All UK MNOs have launched 5G this year

EE, O2, Three and Vodafone are offering 5G in some form in more than 40 UK cities and towns in the UK, from Plymouth to Edinburgh and from Lisburn to Norwich. Rollout has so far focused on areas with higher populations, where capacity demands are likely to be greatest. In the near term, operators are likely to continue rollout in areas where 5G will deliver significant quality of service improvements needed to meet consumer demand.

### 5G will also benefit organisations and businesses

Public mobile networks, in addition to providing broadband services for consumers, could also be used to provide specialist services to organisations and businesses.

Organisations and businesses could also decide to access 5G services via a local private 5G network, either self-deployed or deployed by a third party. This option guarantees a high level of security and full control on data ownership. In February 2019 we outlined a range of technological approaches and business models to support organisations and businesses in developing their digital infrastructure. We expect the new spectrum sharing framework to provide support for organisations and businesses interested in deploying wireless services via private solutions using 4G or 5G. From December 2019, it has been possible to apply for a local licence.

## 4G coverage growth has been slowing but the SRN is designed to change this

### Introduction

During 2017 and 2018 we saw significant growth in 4G rollout as MNOs deployed 4G by upgrading existing infrastructure, spurred on by the coverage obligations that fell in December 2018. Since then, 4G coverage has continued to improve, but at a lower rate than in previous years. Generally, the MNOs' focus has more recently been on targeted rollout and capacity enhancement to deliver key improvements to meet consumer demand.

However, in October 2019, the UK Government announced that it had reached an in-principle agreement with industry to fund a 'Shared Rural Network.' The Shared Rural Network proposal would see mobile operators sharing existing and new infrastructure to provide significantly improved and extended coverage in rural areas, as is explained later in this section.

### Additional public investments

The Scottish Government is investing up to £25 million in the Scottish 4G Infill Programme (S4GI) to provide future proofed 4G infrastructure and services in selected notspots. However, S4GI will not resolve every notspot in Scotland. S4GI aims to deliver to up to 49 sites currently in the programme but, crucially, no site will go into build unless the programme has firm commitment from at least one MNO to use the mast.

In parallel, the Scottish Government has welcomed the UK Government's in-principle announcement regarding the Shared Rural Network (SRN) which could, if final agreement is reached, deliver an improvement to the availability of 4G across Scotland's rural and island communities. The Scottish Government has said it will look for opportunities for alignment of S4GI with SRN and that it intends to work with the UK Government and the MNOs on its implementation plans.

### Methodology

In this section we report on coverage both outside and inside premises, on geographic coverage and on coverage along roads. We report on the availability of voice services, via either 2G, 3G or 4G, and on the availability of 4G data connections. Our definition of 4G coverage reflects a level of service that supports nearly all 90-second telephone calls being completed without interruption and data connections that deliver a connection speed of at least 2 Mbit/s (fast enough to browse the internet and watch glitch-free mobile video).

The mobile coverage figures provided in this report rely on the accuracy of coverage prediction data supplied by the mobile operators. We note that operators continue to update and improve their prediction models, which is welcome. The data used in this report includes predictions provided to us by EE using a newly developed coverage prediction model, which has seen some changes in the coverage it predicts for landmass and premises. EE has provided us with information on the validation work it has undertaken to date.

We take the accuracy of the data supplied to us seriously given its importance to policy making and to ensuring people are well informed about available coverage. We will continue to monitor, through drive testing, the accuracy of all operators' coverage predictions.

## Coverage outside premises

People expect good mobile coverage inside and outside their home, and coverage that is only present outside a home does not provide consumers with a comprehensive experience. Coverage outside premises, however, provides a good indication of the availability of coverage in the kinds of places where people typically live, work and travel.

Mobile telephone calls outside premises are available from all operators at 99% of UK premises (to the same as last year), while almost all premises have telephone call services from at least one operator (the same as last year).

97% of UK premises outdoors are covered by 4G data services from all operators (the same as last year). Almost all UK premises have 4G data coverage from at least one operator (the same as last year).

There are substantial differences between urban and rural areas. For example, almost all premises in urban areas have outdoor mobile telephone services from all operators (in line with last year) while in rural areas these services are available only outside 94% of premises (up 1 percentage point from last year). However, we note that in rural areas mobile services from at least one operator are available outside almost all premises (in line with last year). The difference between the MNO with best outdoor coverage and the MNO with the worst is about 2 percentage points.

Moreover, in urban areas 4G data services are available from all operators outside 99% of premises (the same as last year) while in rural areas 4G services from all operators are available outside only 85% of premises (up 1 percentage point from last year). In rural areas 4G data services from at least one operator are available directly outside 99% of premises (the same as last year). In Figure 7 we show a comparison of the 4G data coverage outside UK premises by the four MNOs in both urban and rural areas.
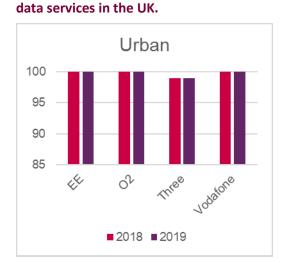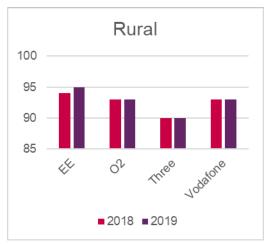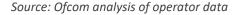
**Figure 7 - Outdoor premises coverage of 4G data services in the UK.**



Source: Ofcom analysis of operator data

### Indoor coverage

The coverage people receive indoors will depends on a range of factors including: the thickness of walls, building materials used in construction and where in the building you are. Due to these factors, in some premises there may be differences between our predicted indoor coverage data and the actual coverage available. Our online coverage checker provides additional information on the likelihood of there being indoor coverage in buildings in different locations, which takes

into account some of the factors that can affect a mobile signal.

Based on an average building loss model[24] (i.e. the model we use to estimate the amount of signal loss from outside to inside the building), indoor mobile calls are predicted to be available from all operators in 93% of premises (up 1 percentage point from last year), while in almost all premises mobile call services are available from at least one operator (the same as last year), with a maximum difference of about 3 percentage points between operators. The operators with the highest coverage levels are O2 and Vodafone, who provide coverage to 99% of premises, with EE and Three providing coverage to around 96% of premises.

80% of UK premises now receive 4G data services indoors from all operators (up 3 percentage points from last year), while in 99% of premises 4G data services are available indoors from at least one operator. Nationwide, the difference between operators is less significant than last year. We note that there is an increase of 4 percentage points in EE's 4G indoor premises coverage with respect to last year. We explained above that this year EE is using a newly developed coverage prediction model, and the apparent difference in its indoor coverage could be related to this, rather than to any significant network expansion.

Indoor coverage remains poor in many rural areas. For example, in urban areas mobile call services are available from all operators in 97% of premises (as last year) while in rural areas services are available from all operators in only 68% of premises (up 2 percentage

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[24] We determine indoor coverage by applying an average building entry loss of 10dB across all buildings.
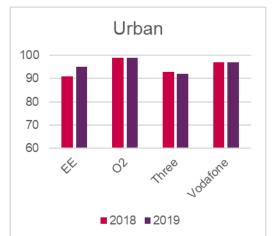
points from last year). However, we note that in rural areas mobile call services by at least one operator are available in 98% of all premises (in line with last year), with a difference of about 15 percentage points between operators.[25]
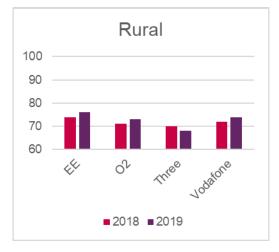
Moreover, in urban areas 4G data services are available from all operators within 86% of premises (up 3 percentage points from last year) while in rural areas 4G services are available from all operators in only 42% of premises (up 1 percentage point from last year). In rural areas good 4G data services by at least one operator are available inside 95% of premises (as last year). In Figure 8 we provide a comparison of the 4G data coverage inside UK premises by the four MNOs in both urban and rural areas.

There are a number of alternative options for people who struggle to get reliable indoor mobile coverage, such as broadband-based calls on services such as Skype, femtocells[26] and mobile repeaters. Moreover, all the MNOs in the UK make Wi-Fi calling services (the ability to make and receive a call over a Wi-Fi network) available to their customers (although not all the mobile phones support them).

There are two types of Wi-Fi calling solutions: "cellular preferred", where the devices use Wi-Fi calling only if there is poor cellular coverage, and "Wi-Fi preferred" where all the calls are made via Wi-Fi, when Wi-Fi is available. The percentage of calls made using voice over Wi-Fi by the MNOs ranges from 0.22% to 12%. We note that this percentage is

usually higher for MNOs using "Wi-Fi preferred solutions".

**Figure 8 - Indoor premises coverage of 4G data services in the UK**



*Source: Ofcom analysis of operator data*

### Geographic coverage

4G geographic outdoor coverage growth is slowing, with small increases in individual operator coverage, but no substantial change to coverage overall. There is still considerable difference between the coverage offered by individual operators, with good consumer

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[25] Reductions in indoor coverage can be the result of re-use of 3G spectrum for 4G services and the in-building penetration losses that apply to signals at these frequencies.

[26] Femtocells are small base stations that can be plugged to a home broadband connection.

experience limited by the presence of enduring 'partial not spots' (i.e. areas not covered by all operators). These partial not spots are predominantly located in rural areas.

79% per cent of the UK's geographic area is now covered by all four operators for mobile calls (up from 78% in September 2018[27]). As last year, the area covered by at least one operator for mobile calls is 95% of the UK's landmass, with a maximum difference of about 6 percentage points between operators. Vodafone and O2 continue to have the highest voice call coverage covering 91% of the UK's landmass (an improvement of one percentage point), around 5 percentage points above Three and EE.

66% of the UK's geographic area is covered by all four operators for 4G data services (no change over the last year). As last year, the area covered by at least one operator for 4G data services is 91% of the UK's landmass, with a maximum difference of about 8 percentage points between operators.

As with last year, there are significant differences between the operators. EE has the highest good 4G coverage, at 84%, largely unchanged from last year, with O2 having the lowest at 76%, an improvement of around 2 percentage points from 2018. 9% of the landmass does not have good outdoor 4G coverage from any operator, again, largely unchanged from last year.

There continue to be differences in coverage between urban and rural areas. Mobile calls are available in 99% of urban areas (in line with last year) and in 77% of rural areas (up 2 percentage points from last year). In 95% of

the rural areas voice calls are available from at least one operator, with a maximum difference of 6 percentage points between operators.

In urban areas 4G data services are available from all operators in 96% of the landmass (1 percentage point down from last year), while in rural areas 4G data services are available in only 62% of the landmass (in line with last year). 4G data services from at least one operator are available in 90% of rural landmass. In Figure 9 we provide a comparison of the 4G data geographic coverage by the four MNOs, in both urban and rural areas.

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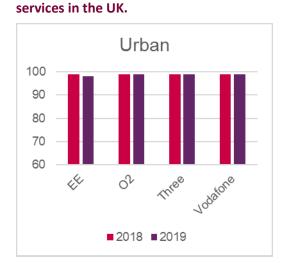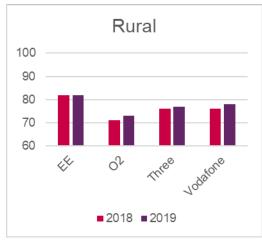[27] These figures include voice calls over 4G LTE services.

**Figure 9 - Outdoor area coverage of 4G data services in the UK.**





*Source: Ofcom analysis of operator data*

## The Shared Rural Network proposal aims to improve rural coverage

Following detailed discussions between the MNOs and the UK Government (supported by Ofcom), in October 2019 the UK Government announced in-principle support for the MNOs' proposed 'Shared Rural Network'. The Shared Rural Network would expand each operator's outdoor 4G coverage to 92% of the UK landmass by 2025, with specified increases in each of the UK nations. 4G outdoor coverage from at least one MNO is expected to increase to 95% by the same date. The Shared Rural Network proposal is subject to final agreement by the mobile operators and the UK Government. The UK Government's intention is to reach a formal agreement in early 2020.

Should final agreement be reached, these promised improvements will make a real difference to mobile customers across the UK, enabling consumers to get a continuous coverage experience in areas where there is at least one provider, but, as of today, not their provider of choice. Operators have committed to entering into legally binding licence variations which will allow Ofcom to hold them to these commitments. We will monitor and report on the MNOs' progress in achieving better coverage via our Connected Nations reports.

## The key elements of the shared rural network agreement

The proposal has three key elements:

- Existing masts would be shared by all four MNOs, at their own cost, in areas where some, but not all, MNOs have coverage.

- Up to 292 mobile infrastructure sites built as part of the Government-owned Emergency Services Network would be made available to all four operators, delivering additional coverage in some of the most remote, rural locations.

- New sites would be built in a number of areas where there is no coverage from any operator. These sites would host all MNOs and would be funded by Government.

### Emergency calls

Mobile phones can use signals from other mobile networks to make emergency calls. As the mobile networks have slightly different coverage footprints this means that 95% of the UK geographic area, and almost all premises indoors, are covered for mobile emergency calls. This is in line with last year.

## Premises that do not have a decent fixed or a 4G mobile network connection

As with last year this report examines those premises unable to get a decent fixed or a 4G mobile broadband service. Premises are considered to have access to a decent fixed connection if the broadband speed is above a download speed of at least 10 Mbit/s and an upload speed of at least 1 Mbit/s and to have access to an indoor 4G mobile service if a connection speed of at least 2 Mbit/s is available. We estimate that 97% of premises can receive both decent fixed and 4G mobile broadband services, while 53,000 (0.2% of UK premises) are unable to access either. As with last year, more premises currently have indoor 4G coverage from at least one operator than a decent fixed broadband service.

As with last year, it is rural areas in Scotland (3%) and Wales (3%) that have the highest percentage of properties that have neither decent fixed nor (indoor) 4G mobile services. Premises in the Scottish Highlands and Islands and rural areas of Wales are most likely to be unable to access either a decent fixed or 4G mobile service.
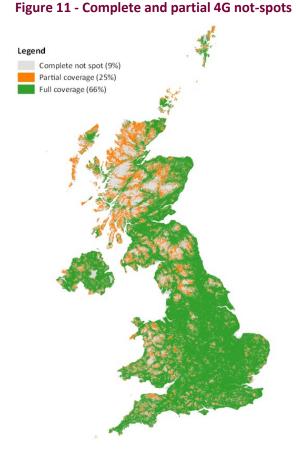
## Differences across the Nations

Mobile coverage is still worse in Northern Ireland, Scotland and Wales than it is in England. Geographic coverage varies considerably among mobile operators and remains poor in many places, with only 58% of Wales (up from 57% last year) and 42% of Scotland (up from 38% last year) able to receive 4G data services from all operators. This is in comparison with 75% geographic coverage in Northern Ireland (down from 79% last year) and 81% (down from 82% last year) in England, and 66% UK-wide. At least one operator provides 4G data services in 89% of geographic areas in Wales (compared to 90% last year), compared to 80% in Scotland (78%

last year), 97% in Northern Ireland (98% last year), 97% in England (98% last year) and 91% nationwide (as last year). Figure 10 shows the differences in geographic 4G data coverage in Wales, Scotland, Northern Ireland and England.

**Figure 10 – Differences in 4G data geographic coverage in Wales, Scotland, Northern Ireland and England.**



*Source: Ofcom analysis of operator data*

Figure 11 shows the areas of the UK that have outdoor 4G coverage from all operators, the areas that have coverage from some operators (partial not spots) and the areas that have no coverage at all (not spots).

**Figure 11 - Complete and partial 4G not-spots**



Legend
- ▢ Complete not spot (9%)
- ▢ Partial coverage (25%)
- ▢ Full coverage (66%)

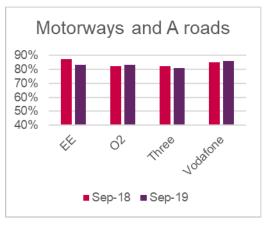*Source: Ofcom analysis of operator data*

## Coverage on the roads

Mobile coverage on roads has remained stable over the last year.
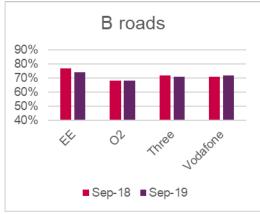
Within vehicles, mobile voice services from all operators are available on 81% of motorways and A roads and on 68% of B roads. Mobile voice services (outside vehicles) are available on 95% of motorways and A roads and on 90% of B roads. For emergency calls, where mobile calls can be made on any network, voice coverage within vehicles increases to 99% of motorways and A roads and 96% of B roads. Outside vehicles there is coverage for

emergency calls across almost 100% of motorways and A roads and in 99% of B roads.

Within vehicles, 62% of motorways and A roads and 46% of B roads have 4G data coverage from all four operators. We note that there is a decrease in coverage with respect to last year and this might be in part due to EE's new coverage model. Outside the vehicle, 88% of motorways and A roads and 80% of B roads have good 4G data coverage from all operators.

**Figure 12 – Motorways and A road coverage of in-car 4G mobile services[28].**



*Source: Ofcom analysis of operator data*

## 4G continues to carry most of the data traffic

Mobile traffic has increased by 38% with respect to last year (compared to 36% growth the previous year). 4G carries 90% of data traffic (compared to 85% last year) but only carries 21% of voice traffic[29], with 3G and 2G carrying 73% and 6% of voice traffic respectively.

**Figure 13** - Mobile data traffic (GB, Millions)



*Source: Ofcom analysis of operator data*

The vast majority of traffic (82%) is generated in urban areas, and data growth in these urban areas is continuing rapidly, up 35% on 2018, (a marginal acceleration against the 2017-18 growth rate of 34%).

**Table 2** - **Traffic consumption in urban and rural areas.**

| Year | Rurality | Percentage of year's total | Total traffic (Petabytes) |
|------|----------|---------------------------|---------------------------|
| 2017 | Urban | 85.2% | 133 |
| 2018 | Urban | 83.3% | 177 |
| 2019 | Urban | 82.2% | 240 |
| 2017 | Rural | 14.8% | 23 |
| 2018 | Rural | 16.7% | 36 |
| 2019 | Rural | 17.8% | 52 |

*Source: Ofcom analysis of operator data*

Rural data consumption has also expanded significantly, and has more than doubled since 2017, although this reflects growth from a relatively low base. While rural growth has been significant, rural data traffic accounts for only 18% of the total data traffic. All the 100 busiest locations are in urban areas.

# Connectivity on the railways

Most rail passengers want to be able to make calls, text, email and use other data services while travelling, but the services available on trains are not meeting consumers' expectations.

## Ofcom is making available data on coverage on the UK's rail network

Ofcom has been collecting mobile network signal measurements at the carriage rooftop level of Network Rail Engineering Trains since October 2017. The data represents the strongest 2G, 3G and/or 4G mobile signals received by a rooftop antenna along selected rail corridors in England, Wales and Scotland. While these measurements do not provide us with information about passengers' experience of connectivity on these routes, they can help the rail and telecoms industry – and policy makers – to better understand mobile signal availability along rail corridors and the solutions that may improve connectivity. These measurements are directly relevant to the connectivity via the Wi-Fi "gateways" that are now deployed on most major routes and typically use carriage rooftop antennae to access mobile networks to provide "backhaul".

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[29] In terms of the proportion of total minutes of originated calls.

## Improving rail connectivity

Different challenges can result in mobile coverage on the railways being patchy and sometimes non-existent, particularly in rural areas. In the areas along the rail corridors where coverage is generally available, mobile reception inside the train carriage can suffer as a result of the signal having to travel through carriage walls and/or being obstructed by the use of window anti-glare coatings. Also, the rail corridors are inevitably difficult to serve, as terrain variations and the presence of tunnels present a physical barrier. The historically limited access to railway property leaves the MNOs largely reliant on infrastructure outside the rail network estate, limiting their ability to deploy rail corridor network enhancements cost effectively.

In October 2018, following a request from the UK Government as part of its ongoing work to improve mobile connectivity on the rail network, we published a document advising the UK Government on current and future demand for data services from passengers on the UK's mainline railways, and the spectrum bands that have the potential to meet these data requirements. Our advice recognised that, while spectrum solutions are available, delivering new coverage is complex and requires different parties to work together.

Since providing this advice, Ofcom has been working closely with the Department for Transport, the Department for Digital, Culture, Media & Sport, Network Rail and a number of other stakeholders on the issue of rail connectivity. Our current focus is on gaining insight into passenger and operator requirements for connectivity to trains, and to understand the quality-of-experience passengers currently receive.

## Internet of Things

The Internet of Things (IoT) is a term used to describe the aggregate network of devices and sensors, which is able to collect and share data with people or with other devices, and to take actions based on this data. IoT has applications in different sectors, such as healthcare, utilities, manufacturing, consumer electronics, and smart cities among others.

This year's report provides some qualitative and quantitative insights into public and private wide-area IoT networks in the UK.

### Low-power wide area networks

Wide area IoT connectivity can be delivered via several technologies: traditional cellular (2G, 3G and 4G) and Low-Power Wide Area (LPWA)[30] networks such as Narrowband IoT (NB-IoT), Long Term Evolution for Machines (LTE-M), Long Range Wide Area Networks (LoRaWAN) and Sigfox. NB-IoT and LTE-M have been standardised by 3GPP[31] and they are now part of the 4G standard. 3GPP is further evolving these technologies as a part of 5G.

LPWA technologies are designed for IoT applications and services that have low data rates, require long battery lives and can operate in remote and hard to reach locations. Furthermore, their extended range makes them better suited for in-building applications such as smart meters and smart car parks which may be located underground or in basements.

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[30] We have introduced and discussed LPWA technologies in detail in previous Connected Nations Reports:

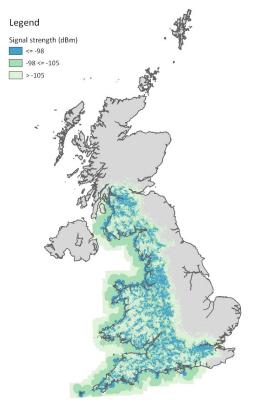[31] 3GPP is the global standardisation body for mobile technologies.

## IoT Connectivity available from Mobile Network Operators

Today all four UK MNOs have commercial IoT deployments using traditional 2G, 3G and 4G cellular technologies. IoT traffic is a very small portion of the total MNO data traffic: less than 1% of the total.

Vodafone has commercially deployed NB-IoT using the 800 MHz band in the UK, and has a network covering the west part of the UK (see Figure 14).

### Figure 14 - Vodafone's NB-IoT Coverage map



*Source: Vodafone*

BT is currently deploying a LoRaWAN proof-of-concept in Newcastle and Sunderland as part of a collaboration with Northumbrian Water to analyse network information to reduce costs and improve overall network performance.

Three UK recently launched its LPWA network pilot network based on LTE-M and NB-IoT. The pilot is a collaboration between Three UK, Northern Gas Networks, Newcastle University, Northern Powergrid, Northumbrian Water and Siemens. It aims to help utilities to improve service reliability, detect faults and reduce emissions.
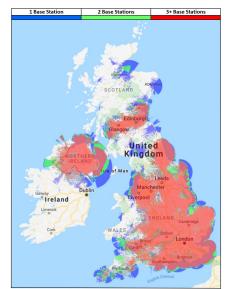
## IoT Connectivity available from non-mobile network operators

### SIGFOX

Sigfox is a global network[32] deploying the technology in various countries or territories. In the UK, WND UK is the sole Sigfox network operator. Its network includes 1900 base stations with a population and landmass coverage of 90% and 60% respectively. Figure 15 below shows the coverage of WND UK's network. The figure also shows areas with more than one base station for increased reliability.

The network supports very low bandwidth applications with infrequent transmissions. Examples of applications utilising this technology include smart metering (where usage data is sent once a day), gas and water leakage detection and asset tracking.

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[32] Several partners may be affiliated to Sigfox but it generally has one operator in each country/territory. https://partners.sigfox.com/

**Figure 15 - Map of WND UK's Sigfox coverage**



*Source: WND UK*

## LoRaWAN

There are several LoRaWANs in the UK, supporting both public community and/or private deployments. The public community networks are open-source and free to use[33,34]. They allow users to connect devices to existing gateways (base stations) within the network or add new gateways to increase coverage. In essence they are decentralised and collaborative networks driven by the user community. The private networks offer service level agreements and guaranteed availability on a paid basis to organisations.

## Public community LoRaWANs

Providers of public community LoRaWANs allow users to connect to their open network. In this capacity, they support developers, businesses (particularly where prototypes are being tested), government and public initiatives across the UK Local Authorities.[35,36]

Table 3 provides a list of public community LoRaWANs in the UK. The Things Network (TTN), that recently partnered with the Digital Catapult's Things Connected network, is the major LoRaWAN in the UK. It has over 600 base stations (gateways) and about 90 communities (cities, counties or groups of hobbyists with deployments in close proximity). Applications include smart irrigation, smart parking, cattle tracking among others. The TTN Mapper provides a crowd sourced coverage map of the network.

## Private LoRaWANs

We are aware of several private LoRaWAN providers operating in the UK, such as Comms365, Connexion, The Things Industries (TTI), Boston Networks and Pinacl Solutions Limited. These private networks provide services such as smart metering, flood detection, street lighting and air quality detection.

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[33] They are usually bound by fair use policies which restrict data rates, packet sizes, transmit time, number of gateways/devices, etc.
[34] The network servers are hosted by not for profit institutions like the Digital Catapult (UK) or companies which also offer private networks.

[35] https://www.suffolk.gov.uk/business/suffolk-norfolk-long-range-wide-area-network/
[36] https://thingitude.com/2018/11/digital-playground-in-wales/

**Table 3 An estimate of the number of LoRa gateways across the UK[37].**

| City/Region | Estimate | Lead organisation |
|---|---|---|
| UK Wide | 660 | The Things Network (including Digital Catapult and Community) |
| Norfolk | 29 | Norfolk Council |
| Reading | 25 | Reading city Council |
| Hull | 10 | Connexin |
| Scotland | 120 | Boston Networks |
| Scotland School Network | 20 | Edinburgh University |
| Universities | 10 | JISC |
| Aberdeen | 8 | Pinacl Solutions |
| York | 4 | Pinacl Solutions |
| Newport | 4 | Pinacl Solutions |
| UK Wide | 35 | Comms365 |

*Source: LoRA Alliance & Ofcom*

[37] These estimates are based on public announcements and have not been verified with the lead organisations.

# Security and resilience

## Introduction

Much of this report is about the latest capabilities offered by telecoms services, and how many people in the UK are able to benefit from them, where they live and work. In this chapter, we look at two other important aspects of these services – can they be relied upon to be secure and to be working properly most of the time?

As we were writing last year's report, one of the mobile operators suffered a major problem with its network, which caused an unusually large interruption to the services it normally provides to its customers. We decided to conduct a detailed investigation into this event and have now published our conclusions. Thankfully, problems of this size are rare, but when they do occur, the amount and tone of social and news media reaction is a reminder of how much people, and businesses, rely on the services provided by the telecoms sector. This fact, and the resulting need to further strengthen the security and resilience of our networks, was a key finding in a report published by the UK Government in July.

In September, we announced that we have opened an investigation into an outage on EE's network which occurred in May. During the investigation, we will consider the processes that BT (the owner of EE) had in place to manage network changes, and

whether these comply with its obligation to take all appropriate steps to protect, so far as possible, the availability of its network.

It is an unfortunate reality that networks providing complex telecoms services for so many customers do sometimes experience problems. Most of these problems only affect one customer and can be rectified reasonably quickly. When the problems are larger and affect lots of customers, possibly for extended periods, operators are required to report them to us. This chapter summarises the reports we have received and looks at what typically causes them. This year, we have also asked the telecoms operators for additional information about the how much of the time their services are working properly, and how well protected they are against power cuts. We also examine this information here.

Over the last year we have increased the number of people we have working on understanding and improving the levels of security and service reliability among the companies Ofcom regulates. This report includes an update on our work with operators to understand their current arrangements to ensure their services are secure and reliable, and to test how well they can withstand sophisticated cyber attackers.

# Reported security incidents

### Network incidents continue to occur with roughly the same frequency, root causes and level of impact

Both telecoms providers, and some internet infrastructure companies, are required to tell us about incidents which significantly affect the security or availability of the services they provide. We publish guidance for these companies, explaining their regulatory obligations in relation to security and availability. This includes information about the types and sizes of incident we expect them to report to us. The following charts summarise the incident reports we have received since last year's Connected Nations report.

Of the 410 reports we have received, 284 related to fixed services, such as landline telephone and broadband, and 126 relate to mobile services. This is a reduction compared to last year, where Figure 16 shows the reported incidents, plotted against the number of customers that lost service and the period of time between the start of the incident and service being restored. Multiplied together, these give a single figure for the total number of "customer hours" of service that was lost due to the incident. This is a useful single metric for gauging the overall significance of an incident. The line on the chart shows 1,000,000 customer hours, with incidents falling above this line being particularly significant. This is also the threshold we use to determine which incidents to include in the annual summary report that we are required to send to the European Commission[38].

As we have seen in previous years, mobile incidents tend to have a bigger customer hours figure than fixed incidents. There are a several reasons for this, which we discussed in last year's report[39].

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[38] This requirement is derived from European Directives. The European Networks and Information Security Agency (ENISA) publishes an annual EU-level summary report based on the information received from each Member State.

[39] Page 32, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf
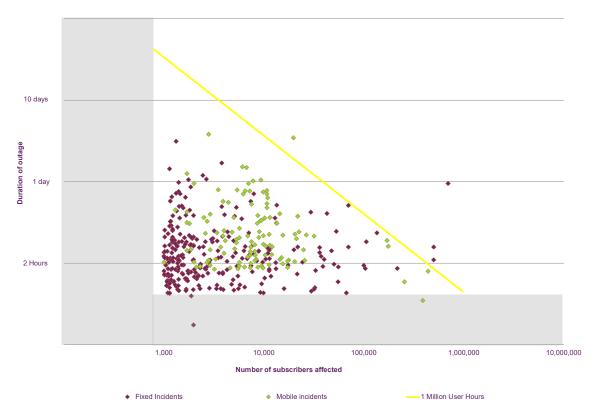
**Figure 16: The impact of incidents reported to Ofcom, between September 2018 and August 2019**



*Source: Ofcom analysis of operator data*

**Figure 17: Monthly number of incidents reported between September 2018 and August 2019**



*Source: Ofcom analysis of operator data*

Figure 17 shows the distribution of reported incidents by month. This shows quite a large variation, with the busiest month, July, having nearly three times as many as the quietest, December. However, this variation appears to be random year on year, with no consistent seasonal variations emerging.

**Figure 18: Heat map showing the distribution of incidents throughout the UK**



Figure 18 shows a heatmap, reflecting how the reported incidents are spread across the country. As we have seen in previous years, this pattern generally follows population density.

We ask telecoms operators to include in their incident reports an indication of the type of problem which caused the incident. This can often be somewhat complicated and subjective, as incidents can result from a combination of factors, or a series of unfolding events. Nevertheless, the categories shown in this chart represent the best estimate of the single root cause behind each incident.

This year hardware failure was the main root cause, accounting for two thirds of all incidents. Power cuts were next (around one quarter of all incidents) and then cuts or breaks in cables. The order of these causes in the ranking does shift slightly year on year, but typically all will feature in the top four most common causes.

Some causes are rare, perhaps most interestingly cyber attacks. This year, none of the incidents reported to us were attributed to cyber attack as their root cause. This is not to say that cyber attacks are not a significant and increasing issue for the telecoms sector, as they are for many others. However, according to the reports we receive, cyber attacks are not often the cause of incidents resulting in a significant customer service outages. This may be because the typical motivations behind the cyber attacks that do occur are often more associated with stealing customer data, or committing fraud, rather than switching off services. As such, most cyber incidents would not be reported to us.
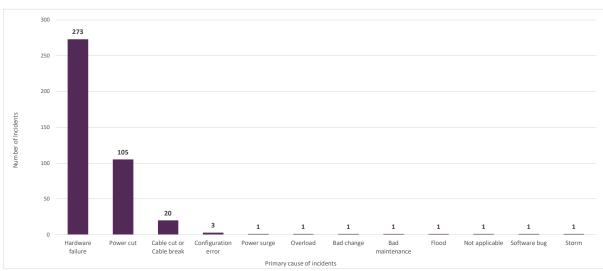
**Figure 19: Primary cause of incidents reported to Ofcom, September 2018 to August 2019**



*Source: Ofcom analysis of operator data*

# How often are telecoms services working properly?

We have collected data from operators about the percentage of the time their services have been available for use by their customers over the last year. The operators do not all collect this availability data in the same way currently, which means we are unable to directly compare the results between them, nor to conclude which operators are "best". Despite this, there are some interesting conclusions that we can draw from the data.

A monthly availability figure is calculated by each operator, as a percentage. This figure represents the proportion of the total time in the month that the service was working for all customers. A figure of 100% would mean it was working for all customers, all of the time. A figure of 50% could show the service was working for all customers for half the month and out of action for the other half of the month, or that half the customers could use it all month, but the other half had no service at all. Fortunately, this illustrative example is a long way from the reality where availability figures are usually well above 99%.

We asked operators to consider only service interruptions that were "unplanned" – interruptions that happened as a result of some unexpected fault or failure somewhere in the network. However, some operators do not distinguish between unplanned and planned interruptions in the figures they record. Planned interruptions occur when an operator deliberately turns off services to some customers in order to undertake maintenance or upgrades. This work is usually undertaken overnight during the network's quietest time, and is limited to short periods, in order to minimise the effect on customers. This inconsistency between operators as to whether or not planned work is included in their availability figures, is one of the reasons why we cannot directly compare the data we have received.

Another source of inconsistency is the types of network faults which are included in the availability calculations undertaken by each operator. All operators monitor central network components carefully, and log any problems automatically, which can then be included in the availability figures we receive. This close monitoring is because faults with these components can affect service for

thousands or millions of customers at once. Operators take a range of steps to minimise any faults and their effects, often including having back-up systems which can take over the main component's functions very quickly. Generally, operators do not monitor faults affecting single customers as closely, and most do not include them in their availability figures. For example, a fault with the cable connecting a house to a street cabinet may not be included. Exactly which type of faults are, and are not, included in the figures varies between operators.

The service problems that people experience may not be caused by a network fault at all. For example, your telecoms service could be interrupted due to problems with your mobile handset or computer, a broadband hub that needs rebooting, being in an area with poor mobile coverage, or simply being in a busy railway station at rush hour. These sorts of problems will not generally be included in any network availability figures, so customers may well feel like the service they receive is interrupted more often than reported figures would suggest.

We received availability figures for fixed voice and broadband services, and mobile services, split by technology generation, i.e. 2G, 3G and 4G. Of these services, fixed line voice services have, by some margin, the highest reported availability. Looking at the annual average, the worst reported figure for this service, 99.94%, equates to around 5 hours of service interruption per year for the average customer. The best report was of no interruption at all during the period.

Fixed broadband services varied from 99.67% to 99.9999%. or from about one day down to

just half a minute of annual interruption for the average customer.

Mobile services tended to perform less well than fixed, with there being no significant difference between 2G, 3G and 4G when averaged across the operators. The worst annual figure was 99.50%, equating to about 2 days of interruption. The best was 99.92%, or around 7 hours of interruption.

## How are telecoms services likely to be affected by power cuts?

In our last report, we examined the possible effects of power cuts on different types of telecoms services and the general arrangements that operators have in place to minimise them[40]. All operators reported that they have robust arrangements in place to ensure the central elements of their networks can continue to function, even during power cuts that continue for several days. The picture became more mixed as we moved from the centre out towards parts of the network that connect directly to customers – often known as the "access" network.

This year, we asked the operators for additional information about the back-up power arrangements they have in place at each of their access network sites – telephone exchanges, street cabinet and mobile basestation sites. This information allows us to better understand what the experience for users of telecoms services is likely to be during different types of power cut. However, as we discussed last time, it is almost impossible to predict the implications of a

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[40] Connected Nations 2018, Page 36,

power cut for any specific user as there are so many variables.

For fixed networks, there are several elements that need to continue to be powered for services to continue operating. Under the operator's control is the equipment in nearby buildings such as the telephone exchange, and additional equipment in the street, usually housed in cabinets or in manholes. Most services also require your domestic mains electricity to be available, in order to keep powering devices such as your broadband router and Wi-Fi access point, desktop computers and smart TVs. Although domestic generators and uninterruptable power supplies (UPS) are available to provide mains during a power cut, most people do not have them. Without them, your broadband service and wireless telephones will stop working during a power cut which affects your home.

One exception to this is fixed telephone services where you are using a traditional wired phone, the type that uses a single cable connection plugged straight into a phone socket. These phones receive the small amount of electrical power they need from the phone socket, and this in turn comes from the local telephone exchange, rather than from your own mains supply.

If, during a nearby power cut, you continue to have mains electricity in your house, or you are trying to use a simple wired telephone, whether your telecoms service will work depends on the back-up arrangements that your network operator has in place.

For fixed services delivered using the Openreach network, e.g. those sold by BT, Sky and TalkTalk, all the telephone exchanges involved have back-up power supplies designed to allow continued operation for at least five days. All of BT's services are connected to these supplies. For Sky and TalkTalk, in somewhere between 7% and 13% of exchanges, their equipment is not connected to this supply and relies instead on alternative back-up power, which typically offers around an hour of protection.

Most fibre broadband services using Openreach's network also need power at street cabinets, and these all contain batteries designed to offer at least four hours of operation. For customers of KCOM's network in Hull, the situation is similar, although around 10 % of its broadband cabinets do not have any back-up power.

Virgin Media's network uses a different technology and is therefore structured somewhat differently, in particular in having far fewer of its equivalent to telephone exchange buildings. These sites are all protected with between one and three days of back-up power, with some other sites required for its phone and broadband services having four hours and 90 minutes respectively. Its street cabinets do not have any power resilience.

In some ways, the situation for mobile networks is simpler, because there is no reliance on mains power in your home for continued service, with the exception of customers using in-home signal boosters. Provided that your mobile handset is charged, or that you can charge it from a power pack or your car, your service will only depend on whether your service provider's mobile network has power.

The mobile basestation site that your phone is connected to requires power in order for your service to continue operating. These sites then connect traffic back into the operator's central sites, often via other, larger, transmitter sites known as "hub sites". Some operators have greater levels of back-up

power at these hub sites, because not only the site itself, but also all the sites connected via it, will stop providing service when it fails.

Both EE and Three have 6 hours or more of back-up power at around 3% of their sites. EE has a further 4% of sites which can continue operating for five days or more during a power cut. The vast majority have no back-up power.

Vodafone and O2 use a shared network, with each providing around half the total sites used for UK coverage. Of the sites which Vodafone provides, which broadly speaking cover the west of England and Wales, around half have four hours of back-up power. The remaining Vodafone sites have between 1 and 2 hours. O2 protects its hub sites, which account for about 5% of its total sites, with 4 hours of back-up power. Most of its remaining sites have no protection, with an unspecified number of larger coverage sites having 10 minutes.

We will also be proactively collaborating with the wider digital industry and other relevant regulatory organisations to understand how Ofcom can promote energy efficiency and carbon footprint reduction.

## Improving the security and resilience of telecoms services

In February 2019, we launched our Security and Resilience Assurance Scheme. A foundational activity has been an information gathering exercise to build a more detailed understanding of the current security and resilience arrangements in each of the major telecoms operators. This work started with a

detailed questionnaire, followed up by evidence gathering sessions and analysis work, which is still underway. The areas we have explored with each operator include their processes and procedures for identifying and managing security risks, the technical security controls that are in place or planned, and the measures used to minimise the effect of network failures on their services.

Cyber security is a particularly important part of our work, as this is an area of increasing risk. This year we have started running TBEST; a threat intelligence-led penetration testing scheme which assesses how well a company stands up to a concerted attack. It is based on the techniques known to be used by cyber criminals and hostile nation states. We expect TBEST to identify specific areas in which telecoms operators' security can be improved. We will work with the operators to ensure they implement appropriate changes as quickly as possible.

We are also continuing to expand our work with operators to improve how resilient their networks are to interruptions. This will be particularly important in the next few years, because the technology powering the networks is changing in fundamental ways, such a virtualisation[41].

The information that we currently receive from operators when they report incidents allows us to assess these incidents individually, but has limited value in understanding underlying root causes, and any connections between incidents. Addressing these weaknesses will help us, working together with operators, to develop

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[41] Virtualisation is the migration away from telecoms networks being built from a combination of software and dedicated hardware components, to software running on general purpose computing hardware.

better guidance about the best practices to improve network availability.

The telecoms industry has an existing resilience best practice document, produced by the Electronic Communications Resilience and Response Group (EC-RRG). This group, formed of the major network operators, the UK and devolved Governments, and Ofcom, is a focal point for cooperation on telecoms network resilience issues. We are establishing a new working group for EC-RRG members, to review and develop the existing best practice document. Some of the topics we wish to examine are:

- data collection;
- virtualisation;
- control of recovery phases from mass-outage events;
- greater levels of redundancy in the elements that control the network and its functions; and
- how the network will function when it is operating in a degraded state, for example due to a fault.

The UK Government published the conclusions of its Telecoms Supply Chain Review in July. We contributed to the Review, which was established to conduct a comprehensive assessment of the supply arrangements for the UK's telecoms networks. Among its conclusions, the report identified a need to "strengthen policy and regulation to ensure better telecoms cyber security" and recommended a new framework to ensure telecoms networks are secure and resilient. Since the report's publication, we have continued to work closely with the Government and NCSC (National Cyber Security Agency) as this framework has been developed. We will continue to contribute to whatever activity the UK Government wishes to take forward in this regard.

# Glossary

**2G** Second generation of mobile telephony systems. Uses digital transmission to deliver: voice, text services and very low-speed data services.

**3G** Third generation of mobile systems. It can be used to deliver: voice, text and lower speed data services. It supports multi-media applications such as video, audio and internet access, alongside conventional voice services.

**4G** Fourth generation of mobile systems. It can provide download speeds of over 10 Mbit/s, and is used to deliver: voice, text and higher speed data services.

**5G** will be the fifth generation of mobile technology. It is expected to deliver faster, lower latency mobile broadband, and to enable more revolutionary uses in sectors such as manufacturing, transport and healthcare.

**Access network** An electronic communications network which connects end-users to a service provider; running from the end-user's premises to a local access node and supporting the provision of access-based services. It is sometimes referred to as the 'local loop' or the 'last mile'.

**ADSL** Asymmetric Digital Subscriber Line. A digital technology that allows the use of a standard telephone line to provide high-speed data communications. Allows higher speeds in one direction ('downstream' towards the customer) than the other.

**Backhaul** The part of the communications network which connects the local exchange to the ISP's core network

**Base station** This is the active equipment installed at a mobile transmitter site. The equipment installed determines the types of access technology that are used at that site.

**Decent Broadband** A data service that provides download speeds of at least 10 Mbit/s and upload speeds of at least 1 Mbit/s.

**Broadband** A data service or connection generally defined as being 'always on' and providing a bandwidth greater than narrowband connections.

**Broadband USO** Broadband Universal Service Obligation. This will give consumers and businesses the right to request a broadband connection capable of delivering a download sync speed of 10Mbit/s and an upload sync speed of 1Mbit/s.

**Core network** The central part of any network aggregating traffic from multiple backhaul and access networks.

**DOCSIS** Data Over Cable Service Interface Specification. It is a standard for the high-speed transmission of data over cable networks.

**DSL** Digital Subscriber Line. A family of technologies generally referred to as DSL, or xDSL, capable of transforming ordinary phone lines (also known as 'twisted copper pairs') into high-speed digital lines, capable of supporting advanced services such as fast internet access and video on demand. ADSL and VDSL (very high-speed digital subscriber line) are variants of xDSL).

**FTTC** Fibre to the Cabinet. Access network consisting of optical fibre extending from the access node to the street cabinet. The street cabinet is usually located only a few hundred metres from the subscribers' premises. The remaining segment of the access network from the cabinet to the customer is usually a copper pair.

**FTTP** Fibre to the Premises. A form of fibre optic communication delivery in which the optical signal reaches the end user's home or office. Also known as full-fibre broadband.

**FTIR** Future Telecoms Infrastructure Review. This document sets out the government's ambition for digital connectivity published in July 2018.

**Full-fibre coverage** Where the network has been rolled out to a "lead-in" that will serve the consumer end premise and where the customer would expect to pay a standard installation charge for that connection

**HD** or **HDTV** High-definition television. A technology that provides viewers with better quality, high resolution pictures.

**IP** Internet Protocol. This is the packet data protocol used for routing and carrying data across the internet and similar networks.

**IoT** Internet of Things. Embedded connectivity in everyday things, enabling them to send and receive data.

**LTE** Long Term Evolution. This is 4G technology which is designed to provide faster upload and download speeds for data on mobile networks.

**M2M** Machine to Machine. Wired and wireless technologies that allow systems to communicate with each other.

**MNO** Mobile Network Operator, a provider who owns a cellular mobile network.

**Not-spot** An area which is not covered by fixed or mobile networks.

**PSTN** Public Switched Telephone Network. The network that manages circuit switched fixed line telephone systems.

**SIM** Subscriber Identity Module. A SIM is a small flat electronic chip that identifies a mobile customer and the mobile operator. A mobile phone must have a SIM before it can be used.

**Smartphone** A mobile phone that offers more advanced computing ability and connectivity than a contemporary basic 'feature' phone.

**Superfast broadband** A data service that delivers download speeds of at least 30 Mbit/s.

**UHD** Ultra High Definition television, providing a resolution of 3840 x 2160 pixels (4K).

**Ultrafast broadband** A data service that delivers download speeds of greater than 300 Mbit/s.

**Usage cap** Monthly limit on the amount of data that users can download, imposed by fixed and mobile operators for some of their packages.

**VDSL** Very High-Speed DSL. A high-speed variant of DSL technology, which provides a high headline speed through reducing the length of the access line copper by connecting to fibre at the cabinet.

**VoIP** Voice over Internet Protocol. A technology that allows users to send calls using internet protocol, using either the public internet or private IP networks.

**wifi** A short range wireless access technology that allows devices to connect to a network through using any of the 802.11 standards. These technologies allow an over-the-air connection between a wireless client and a base station or between two wireless clients.

**xDSL** The generic term for the Digital Subscriber Line (DSL) family of technologies used to provide broadband services over a copper telephone line.