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Connected Nations 2021

Wales Report

Strong, Secure Networks

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Contents

Overview

This is Ofcom's annual Connected Nations Wales report, which measures progress in the availability and capability of broadband and mobile services in Wales. It also highlights the work we are doing, alongside the UK Government, Welsh Government, local authorities and communications companies to improve these services. We include a case study, focusing on a programme of work underway in Pembrokeshire to improve connectivity.

Alongside this Wales report, we publish separate reports on broadband and mobile availability for the UK as a whole and each of its nations. Our interactive dashboard allows people to easily access data for different areas of the UK and specific types of services. This data is also available at local authority level in Wales, Senedd Cymru and UK Parliament constituency level. We are also releasing the International Broadband Scorecard 2021, which compares the UK's recent position on broadband availability with a number of other European nations.

Given its topography and population distribution, the cost of constructing communications networks in Wales is significantly higher that the UK average. As a result, the availability of superfast broadband and mobile services is typically below the UK average and has been one of the most significant issues for consumers and elected representatives in Wales since Ofcom's creation.

However, as a result of interventions by both the UK and Welsh governments, availability of both mobile and fixed communications services in Wales has improved steadily over recent years. Full fibre availability in Wales is currently 27%, less than one percentage point behind the UK average and many previously unserved communities are at last getting a service that people living in urban areas have taken for granted for many years by now.

However, there will be some areas where the cost of deploying full fibre will be prohibitive. Alternative solutions such as Fixed Wireless Access (FWA) and the latest generation of satellites could provide the next-best connectivity to those relatively small number of premises in rural areas not covered by other network deployments. Around 15,000 premises cannot get a decent broadband service of at least 10Mbit/s download speed and 1Mbit/s upload speed from either fixed or fixed wireless networks. These premises may be eligible to be connected under the universal broadband service.

Consumers need to know what technologies are available and how to go about getting connected. Ofcom's data suggests that there are very many premises that could benefit from alternative delivery technologies, but consumers are unaware of the options. Similarly, there are homes and businesses unaware that full fibre is available in their area or of its potential benefits. Full fibre take-up in Wales is just slightly behind availability and although take up of superfast broadband in Wales has increased by eleven percentage points to 66% in the past year, it remains relatively low compared to superfast broadband availability. Greater awareness of availability might help increase the take up of services in Wales.

In order to help facilitate further roll-out of communications services by fixed broadband providers and mobile network operators the Welsh Government has established a barrier-busting taskforce. We are working closely with the Government and other partners to help ensure that consumers are adequately informed and get the best communications services available to them.

What we have found in Wales[1]

Full-fibre broadband is available to 27% of premises (0.4m) in Wales. This is an increase of 8% percentage points from a year ago and represents the highest year-on-year increase in full fibre coverage to date.

Gigabit-capable coverage is at 36% of premises (0.5m) and we expect this will quickly increase further as Virgin Media O2 has announced it has completed the upgrade of its cable network[2]. This includes full-fibre and upgraded cable networks that are capable of delivering download speeds of 1 Gbit/s or higher. As well as delivering faster download speeds, these services offer faster upload speeds and are more reliable than older broadband technologies.

Superfast broadband availability remains stable at 94% of homes in Wales. But take-up in Wales has increased by eleven percentage points.

We estimate that around 15,000 homes and businesses (1%) in Wales are still without access to a decent broadband service of at least 10Mbit/s download speed and 1Mbit/s upload speed from either fixed or fixed wireless networks. These properties may be eligible for a connection under the broadband Universal Service Obligation (USO). This figure has reduced from 18,000 premises in our 2020 report.

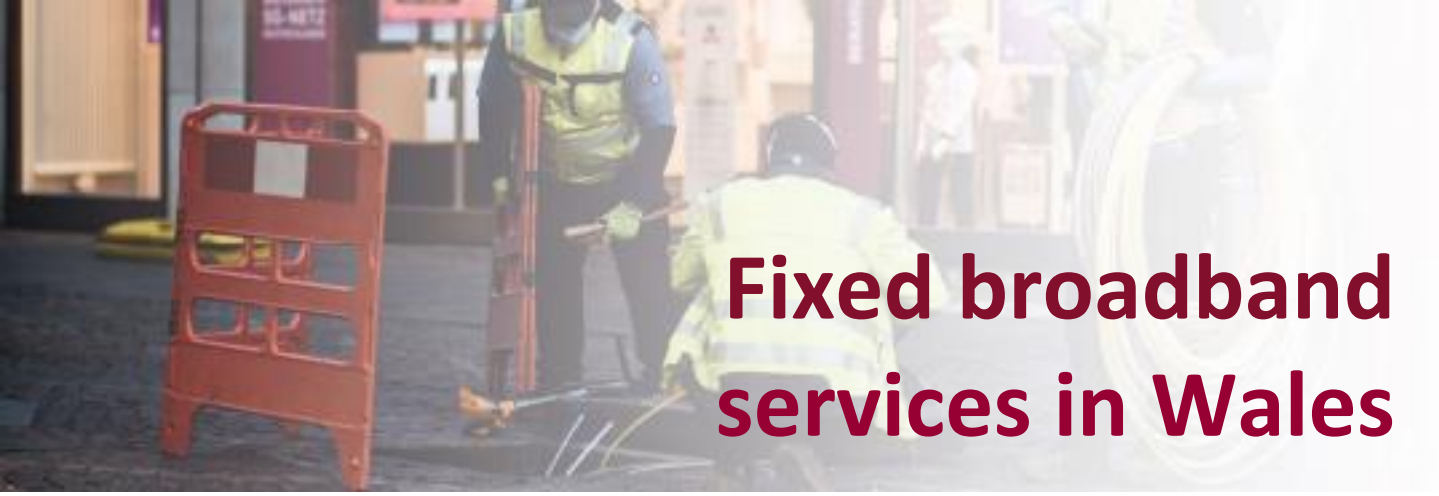
Mobile coverage is generally stable: 90% of Wales has access to good 4G geographic coverage from at least one of the mobile operators and 61% has coverage from all four operators.

Voice and text services from all four operators are available across 78% of Wales' landmass. Voice and text total 'notspots' account for 5% of Wales' landmass. The Shared Rural Network programme agreed in March 2020 will extend coverage beyond this by 2025.

5G rollout has continued at pace, with the number of mobile base stations providing 5G services more than doubling over the last year, to over 6,000 sites across the UK**.** 87% of these are in England, 8% in Scotland,3% in Wales and 2% Northern Ireland.[3]

[1] This analysis is based on network availability data for September 2021.
[2] Our coverage data was collected at September 2021. Virgin Media O2 announced it had completed its upgrade in December. Virgin Media O2 completes gigabit upgrade in boost for Britain's broadband target [accessed 7 December 2021]. We estimate that this raises the gigabit-capable coverage to over 60% for the UK. We shall provide confirmed figures in our Spring update.
[3] Mobile coverage statistics are based on signal strength predictions, and this estimate covers a range from a high to very high confidence of coverage.

Connectivity remains poor in some of the very hard to reach areas in Wales. We estimate that around 7,850 premises in Wales cannot access either a decent fixed broadband service or get good 4G coverage indoors. Almost all these properties are in rural Wales.



Fixed broadband services in Wales

The importance of everyone having access to fast and reliable voice and broadband services, wherever they live and work, has continued to grow in 2021. The Covid-19 pandemic has meant people have continued to rely significantly on these services for work, education, healthcare and entertainment throughout the year.

Connectivity in the UK continues to improve, as existing networks are being upgraded and new fixed infrastructure is being built. We support the investment in gigabit-capable and full fibre networks – as do the UK and devolved governments – which give people fast, reliable and future-proofed connections.

Most homes and businesses benefit from a choice of broadband connections, which deliver superfast or higher speeds. But there are areas in the UK, including in Wales where faster services are not available yet. We remain concerned about the relatively small number of premises that still do not have access to decent broadband given the importance of connectivity to participating in an increasingly digital society. However, we note that this number continues to decline year-on-year.

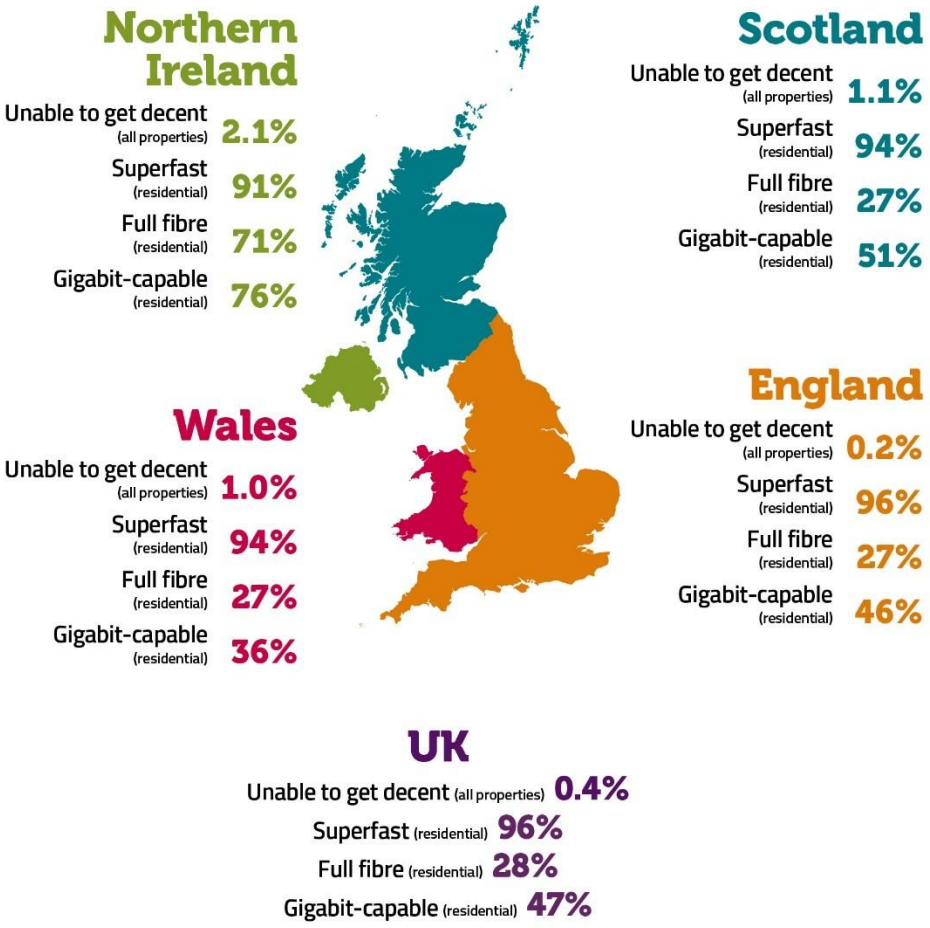
Highlights for Wales

- Coverage of faster networks is increasing rapidly. Full fibre coverage is at 27% (0.4m) premises - an increase of 8 percentage points / 129,000 premises since our 2020 report. Gigabit-capable coverage is at 36% (0.5m) premises and we expect this will quickly increase further as Virgin Media O2 completes the upgrade of its cable network by the end of 2021.[4] Superfast coverage remains at 94%.
- 96% of premises in Wales have access to a decent broadband connection from a fixed connection.[5] Premises without access to decent broadband from a fixed or FWA connection stands at 1% (15,000 premises). Some of these will be connected via publicly funded schemes in the next twelve months. Of the remainder, the Broadband USO will continue to provide connections to some of these premises.
- Superfast broadband availability remains stable at 94% of homes in Wales. But take-up in Wales has increased by eleven percentage points.

[4] Our data on full fibre, gigabit capable and superfast coverage was collected at September 2021. Virgin Media O2 announced it had completed its upgrade in December. Virgin Media O2 completes gigabit upgrade in boost for Britain's broadband target [accessed 7 December 2021]. We estimate that this raises the gigabit capable coverage to over 60% for the UK. We shall provide confirmed figures in our Spring update.

[5] Unless otherwise specified, coverage figures for decent broadband count all UK premises (residential and commercial). Coverage for all other speed tiers counts residential premises only, unless otherwise specified.

Summary of broadband coverage at a fixed location across the UK and Nations



In this section, we report on the following key areas of fixed connectivity:

- the rollout and upgrade of networks across Wales (including, a summary of investment in fixed networks); [6]
- the deployment of fixed wireless and new satellite networks and how these helps provide connectivity to decent broadband services.
- progress of the broadband USO, which launched in March 2020.
- the take-up of services on full fibre, gigabit capable and superfast broadband networks.
- progress in replacing the UK's public switched telephone network.

Throughout this section we generally report data for residential premises unless stated otherwise. However, for reporting of premises not able to get decent broadband which may be eligible for the USO, we report all premises.

[6] Coverage data in this report is from September 2021; further deployments have been made since then.

A variety of fixed broadband networks and services are available in the UK

Fixed broadband in the UK is available at a variety of speeds, delivered over different technologies

Different technologies used to deliver fixed broadband connections

- **Copper (ADSL) –** Copper cables are used to connect from the exchange to the premises (also known as 'standard broadband'). Maximum download speed is up to 24 Mbit/s. Actual speeds delivered by copper connections diminish with distance. Copper can also be affected by poor weather. Since the copper network is old, it can be susceptible to faults.[7]

- **Fibre to the cabinet (FTTC) –** Fibre to the cabinet, with copper cables used to connect from the cabinet to the premises. FTTC uses very high-speed digital subscriber line (VDSL) technology. Maximum download speed is up to 80 Mbit/s (except for G.fast). [8] As with ADSL, actual speeds diminish with distance, and the network can be affected by poor weather and is susceptible to faults.

- **Hybrid fibre coaxial cable (HFC)** – The cable TV network.[9] It uses fibre to a street cabinet and coaxial cable from the street cabinet to the premises. There is decreased signal loss compared to the copper network as described above, which means co-axial cables are capable of delivering much higher speeds. Broadband is supported using the DOCSIS standard, which shares the capacity downstream and upstream between multiple customers. [10] The latest standard of cable technology, DOCSIS 3.1, is capable of delivering download speeds of up to 10Gbit/s and upload speeds of up to 1Gbit/s, although in practice speeds average out significantly below this – and since capacity is shared among users, it may not be the case that each user can simultaneously receive gigabit speeds. Depending on the configuration of the access network in any particular area, this can lead to localised congestion. This may be particularly acute in the upstream direction where total capacity is more limited.[11]

- **Full fibre or 'fibre to the premises' (FTTP) –** The connection from the exchange to the premises is provided entirely over optical fibre. Generally, distance to the premises does not affect the speed delivered. Full fibre is less susceptible to faults and is not usually impacted by poor weather. Most full fibre implementations utilise Passive Optical Network (PON) approaches

[7] ADSL: Asymmetric Digital Subscriber Line.
[8] Openreach deploys G.fast at some cabinets. It uses fibre to the cabinet, and copper from the cabinet to the customer. By using a higher frequency signal on the connection to the customer, G.fast can offer higher speeds than normal FTTC deployment, with Openreach offering wholesale services at up to 330 Mbit/s. But the signal degrades more quickly so the customers able to get ultrafast speeds are limited to those closest to the cabinet.
[9] Most cable broadband in the UK is provided by Virgin Media O2.
[10] DOCSIS: Data Over Cable Service Interface Specification.
[11] Virgin Media O2 has announced its plan is to upgrade its cable network to full fibre to deliver further enhancements to services.

where capacity in the downstream and upstream direction is shared.[12] The number of customers connected to each shared PON is usually 32 or less, which is generally fewer than shared infrastructure on a cable network. This, along with managing the maximum guaranteed throughput provided to each customer, can be used to manage congestion. PON technology has an upgrade path that allows for speed to increase from a shared 2.5 Gbit/s down/1 Gbit/s up to 10 Gbit/s in both directions, and future generations will expand this further.

- F**ixed Wireless Access (FWA) via mobile networks** – Fixed wireless access on mobile networks is offered on licensed 4G and 5G networks, usually to an indoor router. These services share the network capacity with mobile users, meaning that the capacity of the network has to be carefully managed between the demands of existing mobile users and FWA customers. There may be areas of high mobile demand where a reliable FWA service cannot be offered.
- **Fixed Wireless Access via Wireless ISPs (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 premise. These networks generally use license exempt or lightly licensed spectrum. Due to the frequencies where this spectrum is available, performance may be limited by line-of-sight issues.

Figure 1: Summary of characteristics of different types of broadband

Type of broadband[13]	Speed	Use cases	Fixed broadband technologies that can provide this service
Decent[14]	10 Mbit/s download; 1 Mbit/s upload	Making a high definition video call using applications like Zoom, Teams, WhatsApp or Facetime. Downloading a one-hour HD TV episode (1GB) in almost a quarter of an hour.	Copper (ADSL) FTTC (VDSL) HFC cable Full fibre
Superfast	At least 30 Mbit/s download	One person streaming 4K/UHD video. Downloading one-hour HD TV episode in under four-and-a-half minutes. Several devices working simultaneously.	FTTC (VDSL) HFC cable Full fibre

[12] Virgin Media O2 is also deploying some full fibre networks as part of its network expansion. Currently this uses a technology called Radio Frequency Over Glass (RFOG) which allows the DOCSIS signals to be carried over fibre end-to-end. This deployment is capable of also supporting PON technologies and Virgin Media O2 are now trialling the use of XGS-PON with the intention of using this to replace both RFOG and HFC during this decade. See Virgin Media O2 UK Update on Wholesale and FTTP Upgrade Plan, ISP Review UK.

[13] In previous years we have reported on ultrafast broadband as well. Ultrafast is broadband at speeds of 300Mbit/s and above. As network rollout focuses on full fibre and Virgin Media O2 completes its upgrade of its cable network to DOCSIS3.1, we have focused this year on gigabit speeds (and gigabit capable networks). We have removed ultrafast broadband from our main reporting, although the numbers are still available in the interactive report.

[14] The UK government defines a decent broadband service as one that delivers at least 10 Mbit/s download speed and 1 Mbit/s upload speed. This is the level of connection deemed necessary for consumers to participate in a digital society.

Type of broadband[13]	Speed	Use cases	Fixed broadband technologies that can provide this service
Gigabit	1 Gbit/s and above download	It is feasible to download a full 4K film (100GB) in under 15 mins. May be delivered over technologies that give greater reliability and that are future proofed as higher demand services are developed.	HFC cable (when upgraded to DOCSIS3.1) Full fibre

FWA (both that provided by MNOs and by WISPs) can also provide decent, superfast and gigabit speeds, but this will be dependent on the specific deployment, available capacity at the site, and the number and location of users.

Fixed broadband coverage has continued to increase across Wales

Full-fibre broadband is now available to 27% of premises in Wales, with gigabit capable broadband available to 36%

Our data shows that 27% (0.4m) of residential premises in Wales are now served by full fibre connections – an increase of 8 percentage points, in the past year. The increase in coverage in Wales is largely due to the continued investment in the rollout of fibre networks from Openreach and more recently Ogi as well as the continued progress in phase two of the Welsh Government's Superfast Cymru programme. The £56m Welsh Government contract with Openreach will extend its gigabit capable (FTTP) network to 39,000 (extended from the original 26,000 target set) properties by June 2022. The extension to the project targets local authority areas with less than 90% superfast broadband coverage, to strike a better balance of coverage across the local authorities in Wales and provide these additional properties with access to some of the fastest broadband speeds available.

Gigabit-capable broadband is now available at 36% / (0.5m) premises

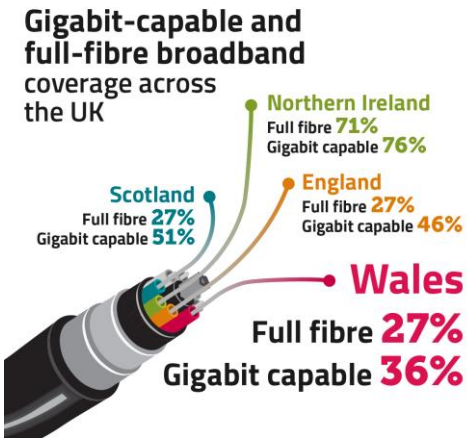
When all technologies are combined, our data shows that 36% / (0.5m) residential premises now have access to gigabit-capable broadband. Some of these premises have access to more than one gigabit-capable network: 6% / 88,000 residential premises have access to a gigabit-capable broadband service over both cable and full fibre technology, and 1% / 14,000 have a choice of two full fibre networks.

Figure 2: Residential full fibre and gigabit-capable coverage

	Full Fibre	Urban	Rural	Gigabit capable	Urban	Rural
England	27% (6.5m)	27% (5.7m)	25% (0.8m)	46% (11.3m)	49% (10.5m)	26% (0.8m)
Northern Ireland	71% (0.5m)	85% (0.5m)	36% (0.1m)	76% (0.6m)	92% (0.5m)	36% (0.1m)
Scotland	27% (0.7m)	30% (0.6m)	17% (0.1m)	51% (1.3m)	58% (1.3m)	18% (0.1m)
Wales	27% (0.4m)	29% (0.3m)	24% (0.1m)	36% (0.5m)	39% (0.4m)	24% (0.1m)
UK	28% (8.2m)	28% (7.2m)	24% (1.0m)	47% (13.7m)	50% (12.7m)	25% (1.0m)

Source: Ofcom analysis of provider data.

In the last year, full fibre rollout has increased by eight percentage points in Wales. There has been rollout in both urban and rural areas, but urban areas continue to have greater access to full fibre. Gigabit capable coverage has increased by seventeen percentage points to 36%. In addition to full fibre, Virgin Media O2's upgrade to DOCSIS3.1 is a key driver of this increase. This means that whilst there has been an increase in gigabit capable coverage in both urban and rural areas, there has been a greater increase in urban areas.



Rollout of full-fibre and gigabit-capable networks

Significant progress has been made over the past year in the roll-out of full fibre and gigabit-capable networks. We expect availability of these networks to continue to increase in the coming years. There are several FTTP service providers in Wales and different providers are taking different approaches to their business models for deploying these networks:

- **Openreach:** has dialled up its Full-Fibre programme and invested heavily to build its Gigabit capable full fibre infrastructure to 25 million properties across the UK by the end of 2026.

More than 500,000 homes and businesses across every single local authority area in Wales can already access full fibre or gigabit capable broadband as a result of Openreach's Full Fibre programme and it continues to roll out its full fibre infrastructure to thousands of properties in market towns and villages up and down the country such as Llwyn-on in the Brecon Beacons, Nolton Haven in Pembrokeshire, Denbigh and Aberconwy.

- **Ogi:** following a £220m investment from Infracapital, Spectrum Internet rebranded itself as Ogi in June of this year and has accelerated its ambitious roll-out plans for a gigabit-capable broadband service in some of Wales' most hard-to-reach areas. It has grown quickly from a business employing just a handful of people, to over 100 employees. Almost 5000 households in the Vale of Glamorgan, Monmouthshire and Pembrokeshire can already access the service and the company's aim is to connect 150,000 homes across south Wales. In order to achieve this Ogi has striven to shorten build times and reduce environmental impact, through the sharing of existing ducts and poles, not just within the historic telecoms infrastructure (PIA), but also through an innovative agreement to share Welsh Government owned ducts alongside Wales' major trunk roads.
- **Virgin Media O2:** Virgin Media O2 has targeted bringing 'gigabit speeds' to over 15 million premises by the end of 2021. Its next-generation Gig1 broadband, providing average download speeds of 1,140Mbps, is now available across its entire network in Cardiff and surrounding areas such as Adamstown, Ely, Grangetown, Lisvane, Pentwyn, Rumney, Saint Mellons, Thornhill and Whitchurch. Cardiff is joined by homes across South Wales in Virgin Media O2's latest gigabit switch-on. Other areas benefiting include Barry, Bridgend, Caerphilly, Glamorgan, Port Talbot and Rhondda Cynon Taf.
- **Voneus:** during 2021 rural fixed wireless and full-fibre broadband ISP Voneus continued its expansion in Wales with the purchase of fixed wireless operators Dyfed Superfast and Reset (IRG Computers). The company has relocated its Welsh office to Carmarthen and has recruited a community engagement team to help grow the business. Voneus is currently delivering network builds across Pembrokeshire, Carmarthenshire, Ceredigion and Powys, which will provide speeds from 100Mbit/s to 1Gbit/s. The company has been chosen by the residents of Maenclochog & Llanycefn as their supplier of Gigabit-capable Broadband. Following an initial investment of £10m from Macquarie Capital the company has continued its growth by acquiring more small fixed wireless access providers in those areas of rural England and Wales where there is no fixed-line access.[15] **T**he agreement could see Macquarie invest a further £20m which could help the company rollout full fibre services. At present Voneus' wireless network spans 25 communities in rural parts of South Wales as well as many counties in England.
- **Broadway Partners:** since 2016, Broadway Partners has been helping communities across Scotland and Wales get connected to high-speed broadband. Its primary offering is full fibre, but the company also uses wireless technology to extend the reach and capability of its network.[16] The company has secured £145 million from Downing LLP to support its plan to deliver full-fibre broadband to rural communities. The funding will support Broadway's

[15] ISP Review UK, Voneus Aim Ultrafast Broadband for More of South West Wales, 9 November 2021.
[16] Broadway Partners, Broadway Partners Secures £145 Million Funding From Downing LLP, 6 October 2021.

aspirations to connect 250,000 homes and businesses by 2025 and to become the natural alternative provider of digital infrastructure wherever it operates. In March 2021 the Pembrokeshire villages of Nevern, Wiston & Slebech, and Herbrandston chose Broadway Partners as the provider of full-fibre services as part of the second phase of Pembrokeshire County Council's Ultrafast Broadband Project. The project aims to connect all of Pembrokeshire to gigabit-capable broadband.

- **Dragon Wi-fi:** established in 2014, Dragon Wi-fi is a provider of Fixed Wireless Access and full-fibre services for both residential and commercial clients throughout Pembrokeshire, West Wales and more recently in North Wales.

Openreach Fibre Community Partnerships (FCP) is a scheme designed to bring fibre broadband to some of the most challenging communities. Its aim is to help people living and working in rural communities that are not included in any current roll-out plans. By working with Openreach to co-fund the installation, communities across Wales have been able to bring fast and reliable broadband to their local area, despite the commercial challenges.

In Wales, the village of Glandwr in Pembrokeshire, Hirwaun near Aberdare and Llanfair PG on Ynys Mon have all benefited from Fibre Community Partnerships. The cost of the FCP is covered by investment from both Openreach and the residents themselves who are often able to fully cover their contribution by accessing the Welsh Government's top-up to the UK Government's Rural Gigabit Voucher scheme. Once Openreach has installed the infrastructure, residents can place an order for the new faster services with an internet service provider of their choice. The Welsh Government has launched a top-up voucher scheme under the UK Government's Gigabit Broadband Voucher Scheme - a programme which normally offers up to £3,500 for small rural businesses and up to £1,500 for homes to get a gigabit-capable connection. This is doubled for applicable residents and small businesses in rural Wales.

Nearly 90 communities across every part of rural Wales have benefitted from Openreach's FCP programme, with more than 11,000 properties now being able to access fibre broadband as a result. In total, more than 260 Welsh communities have been working with Openreach to explore this method of delivering fibre broadband. The rural community of Glandwr in Pembrokeshire is now able to access full-fibre broadband as a result of Openreach's Fibre Community Partnerships.

In order to build this 'full fibre' network, Openreach engineers ran 21km of fibre cable overhead and underground from the telephone exchange in Cardigan to the residents of Glandwr. By working with Openreach to co-fund the installation, around 100 properties in and around Glandwr will benefit from the infrastructure build. The cost of the Glandwr CFP is covered by investment from both Openreach and the residents themselves who were able to access the Welsh Government's top-up to the UK Government's Rural Gigabit Voucher scheme.

Most homes in Wales now have access to a superfast broadband connection

Superfast broadband availability has remained stable in Wales over the year at 94% / 1.4m of premises.

Figure 3: Residential superfast coverage

	Superfast	Urban	Rural
England	96%	98%	85%
Northern Ireland	91%	99%	70%
Scotland	94%	98%	73%
Wales	94%	98%	80%
UK	96%	98%	83%

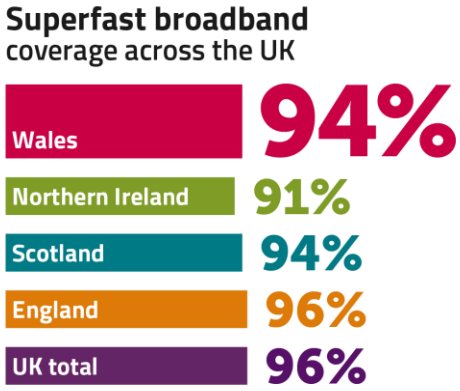
Source: Ofcom analysis of provider data.

There will continue to be investment in superfast broadband networks, mainly due to publicly funded rollout under a number of schemes (described below).

Coverage of superfast broadband in Wales has nearly doubled since 2013 (48%) as a result of the Welsh Government's Superfast Cymru programme. Superfast broadband availability in Wales remains constant at 94% of premises in Wales. Superfast Cymru delivered broadband to around 733,000 homes and businesses in Wales (at >24Mbit/s), of which 717,000 can achieve superfast speeds of at least 30Mbit/s. The project was delivered with a public sector investment of over £220m. The technology rolled out by Openreach was primarily Fibre to the Cabinet with some full fibre. This roll-out finished in 2018.

The Welsh Government awarded its Superfast Cymru successor scheme contract to Openreach which is expected to provide full fibre to 39,000 premises, in three lots across Wales by June 2022, tackling some of those areas in the final 5% of Wales that still cannot access a superfast broadband (30Mbit/s +) connection. This will be achieved with £56m of public subsidy from the Welsh Government and EU funding.

The cost of deployment rises disproportionately as you enter the most remote communities and therefore, the extension costs more, yet does not get to as many premises. To date, Openreach has built its full fibre network to 31,531 premises – of these 8,609 are in the Lot 1 area (North West Wales), 9,785 in Lot 2 (East Wales) and 13,137 are in Lot 3 (South West Wales). At the end of this contract, there will remain in Wales areas that are poorly served but it is hoped that commercial builds from Openreach, Ogi and other relatively new providers will reduce numbers.



The UK Government has set a target of at least 85% gigabit coverage by 2025, alongside an ambition to get as close to 100% as possible. To help achieve this, the Government has committed £5 billion in investment as the UK Gigabit Programme, with at least £1.2bn available by 2025, to provide connectivity for the hardest to reach areas. The first procurement rounds have now commenced, with the first contracts likely to be awarded in 2022 with build commencing thereafter.

Decent broadband over a fixed connection is available to almost all homes and businesses

Taking into account all fixed line connections (but excluding FWA coverage), 96% of homes and businesses in Wales have access to at least decent broadband, the same percentage as in 2020. Around 55,000 premises do not have access to decent broadband via a fixed connection. This shows a slight increase from our report last year. As explained in our spring 2021 update this is due to a small change in our methodology.[17]

Figure 4: Premises unable to receive decent broadband from a fixed line

	Total	Rural	Urban
England	2% (451,000)	7% (234,000)	1% (217,000)
Northern Ireland	6% (45,000)	17% (39,000)	1% (6,000)
Scotland	4% (100,000)	17% (87,000)	1% (13,000)
Wales	4% (55,000)	12% (43,000)	1% (11,000)
UK	2% (651,000)	9% (403,000)	1% (248,000)

Source: Ofcom analysis of operator data.

[17] In Ofcom's Spring 2021 update, we refined the way that these properties are identified and 'address-matched' to operator data to more precisely provide estimated speed data for individual apartments and similar premises. Previously we had included premises in our figures where we had no operator coverage data but they were closely associated with adjacent properties. We have since refined the way that these properties are identified and 'address-matched' to operator data to more precisely provide estimated speed data for individual apartments and similar premises. In doing so, the number of properties for which we have no operator data increases, which results in the higher figure given here. See also footnote 4 in: Connected Nations Spring Update 2021.

Welsh Government initiatives

Access Broadband Cymru Scheme

This scheme provides grants to fund (or part-fund) the installation costs of new broadband connections for homes and businesses in Wales. It does not include monthly rental costs. New connections through this scheme must deliver a step change in speed - with at least double your current download speeds e.g., a current connection of 10Mbit/s must improve to at least 20Mbit/s.

The scheme is open to individuals, businesses and third sectors premises in Wales where the broadband connection (if available) cannot deliver a step change in service provision of at least twice the current download speed. The proposed new service must ensure an absolute minimum download speed of at least 10Mbit/s. Applications requesting step change speeds that result in download speeds lower than 10Mbit/s will not be supported by the scheme.

The Access Broadband Cymru scheme offers two levels of grant funding, that are dependent on the speed of the new connection:

- £400 ABC voucher for 10Mbit/s and 20Mbit/s service.
- £800 ABC voucher for a superfast 30Mbit/s service

Local broadband fund

The Welsh Government has made £10 million available to support local authorities and social enterprises to deliver broadband projects locally. Local authorities and social enterprises can deliver innovative broadband solutions to communities and parts of Wales which do not currently have access to 30Mbit/s broadband speeds with the fund. So far, the fund has approved over £2.3 million of funding. Activities that will be considered for funding include:

- the delivery of fast, reliable broadband to those part of Wales currently without access;
- the creation of new broadband infrastructure including backhaul facilities; and
- upgrading existing broadband infrastructure.

Broadband services are also available across large parts of the UK using wireless networks

Fixed Wireless Access on mobile networks

Of the four MNOs in the UK, only O2 does not currently offer FWA services. Based on the MNOs' claimed coverage, we estimate that 91% have access to an MNO FWA service, in Wales.[18] MNOs claim average download speeds up to 100-200Mbit/s on their 5G FWA services, with lower download speeds on 4G FWA. These services are provided to an indoor router, although EE offers an

[18] Based on coverage data provided by EE and Three, as Vodafone did not submit data at the level of granularity requested. As coverage forecasts are determined by predictive modelling tools, localised issues may mean that particular premises may not be able to receive a service despite being predicted to do so.

external antenna for its FWA services in areas with poor indoor coverage. The end users' experience of the service could be affected by where they place the router, their indoor mobile coverage, the capacity available in the wireless access network and the backhaul network, and the number of users at that location.[19]

Fixed wireless access from WISPs

This year, we have expanded our collection of WISP coverage data; asking operators to provide their own estimate of coverage, factoring in network capacity constraints, interference and other external factors.[20] Based on providers' estimates, around 480,000 homes and businesses in Wales have coverage from a WISP network. As with FWA provided by MNOs, localised issues may mean a particular premise may not be able to receive a service despite being predicted to do so. These services are primarily delivered using licence exempt spectrum in the 5GHz band.

We have carried out some research this year, looking into the speeds that can be delivered to consumers using WISP networks across the UK. We have a long-established programme on home broadband performance research on fixed networks,[21] and using the same approach, we conducted measurements on five WISP networks. Our results show that WISP networks are capable of delivering decent and superfast speeds.[22] Fixed Wireless Access delivered by WISPs can be used to provide gigabit speeds using spectrum in higher frequency bands. Some WISPs are beginning to offer these services, but it has not yet been very widely deployed, due to the high cost of equipment. Over the next year, we will continue to work with FWA providers to understand how they manage the capacity of their networks and the performance of these services.

Figure 5: Coverage of MNO and WISP FWA networks with at least decent broadband

	MNO FWA	WISP FWA
England	94%	6%
Northern Ireland	82%	3%
Scotland	93%	2%
Wales	91%	31%
UK	94%	7%

Source: Ofcom analysis of provider data.

[19] Backhaul here refers to the connection between the cell site and the mobile network core.
[20] Previously, we have rolled over coverage data where WISPs have not provided updates. This year we have issued a new request to WISPs for an updated set of information about their network and have not rolled over submissions based on our previous requests. Therefore our coverage estimates are not comparable to those reported in previous years. For more information, see our methodology.
[21] This research uses a panel of consumers, who have a monitoring unit connected to their broadband router. This measures the performance of the home broadband services, including metrics such as download and upload speeds, latency, jitter and packet loss.
[22] More information is available in our interactive report.

FWA and the impact on the availability of decent broadband

As shown in our research, both MNOs and WISPs networks can deliver a decent broadband service and can be an alternative network technology for consumers who cannot receive a decent broadband connection from their fixed network.

Based on the coverage estimates provided by FWA providers, we estimate that around 40,000 premises in Wales that do not have access to a decent broadband service from a fixed network could have access via a FWA network. This provides an additional 2.6% of decent broadband service coverage in Wales. Some premises that can get decent broadband on a WISP network may also be covered by an MNO FWA service. The figure below shows, by nation, premises without access to decent broadband from a fixed network, of these, which have access to decent broadband from only an FWA network, and, as a result, those remaining with no access to decent broadband from either fixed or FWA.

Figure 6: Access to a decent broadband service by different types of technology

	Has no access to decent broadband from a fixed network	Has access to decent broadband from an FWA network	Remaining premises without access to decent broadband
England	451,000	390,000	61,000
Northern Ireland	45,000	28,000	17,000
Scotland	100,000	70,000	30,000
Wales	55,000	40,000	15,000
UK	651,000	528,000	123,000

Source: Ofcom analysis of operator data.

A small – but nevertheless important – subset of premises in Wales still cannot access decent broadband

Our latest estimate is that 15,000 (1%) premises in Wales still do not have access to a decent broadband service via either a fixed or fixed wireless network. This figure has reduced from around 18,000 last year, which we believe is due to a combination of factors, including that we have gathered data from more small fibre networks and FWA providers and because of some providers using more up to date premises data to report their coverage.[23] Some of the 15,000 premises will be due to receive a decent broadband service under a publicly funded scheme within the next 12 months.

[23] We have gathered data from more networks; whilst these are small networks their footprint may sit in more remote areas where larger networks have not been deployed and so may help reduce the number of premises. In addition, we have worked with providers to improve reporting. In particular, BT has updated its reporting of its fixed wireless network coverage which has had a large impact on the reduction we have reported.

The remaining premises may be able to have a new connection built under the broadband Universal Service Obligation (USO).[24]

The Broadband Universal Service Obligation (USO)

The broadband USO provides everybody with the right to request a broadband connection with the following technical characteristics:

- a download sync speed of at least 10 Mbit/s;
- an upload sync speed of at least 1 Mbit/s;
- a contention ratio of no more than 50:1;
- latency which is capable of allowing the end user to make and receive voice calls effectively; and
- the capability to allow data usage of at least 100GB per month.

Where an affordable service with the above characteristics is not available, or due to become available in twelve months under a publicly funded scheme, the customer is eligible for the USO if the costs of providing the connection are below £3,400 or, where the costs are above £3,400, the customer agrees to pay the excess.[25] In calculating whether the costs are below or above £3,400, the Universal Service Provider (USP) must take into account where costs could be shared by several USO eligible premises. BT is the USP for the UK (excluding Hull), and KCOM for the Hull Area. They are required to provide the USO and to report at six monthly intervals on delivery.

BT's delivery of the broadband USO

So far, BT has received just under 1350 orders,[26] 108 of which are in Wales. Each order may require network build that can serve multiple premises, and therefore these orders will lead to full fibre connections being built that can serve just under 6,500 premises (689 premises in Wales) that do not currently have access to decent broadband. These breakdown by Nation as follows:

[24] The Electronic Communications (Universal Service) (Broadband) Order 2018
[25] In our statement of 6 June 2019 (para 5.1), we decided that an affordable service was one that cost £45 per month, rising annually by CPI. When the USO launched, this figure was £46.10.
[26] Data provided by BT to Ofcom includes orders up to 14 October 2021. BT's public reporting, up to 30 September 2021, indicates 1288 orders.

Figure 7: USO orders and number of premises being built

	Number of USO orders	Total homes passed by resulting build
England	1100	5000
Northern Ireland	57	439
Scotland	84	288
Wales	108	689

BT published its latest delivery report in October 2021.[27] These reports show that to date:

- It has received just over 20,000 requests to its USO Helpdesk;
- Of these, around two-thirds were ineligible as a decent broadband product already existed from BT or another provider, or one would be made available within 12 months by a publicly funded scheme; and
- BT has connected just under 200 premises under the USO scheme. As stated above, network build may serve more than 1 premises. The build that has been completed may serve many more than these 200 premises. However, a connection is only provided once a customer places an order.

Shortly after the USO launched, we were concerned that BT may not be complying with the USO conditions correctly when it was calculating the excess costs for a given connection. This was potentially resulting in some customers receiving a quote for a connection that was higher than it should have been, leading to fewer people taking advantage of the USO. We opened an investigation into BT's approach to calculating quotes for excess costs in October 2020.[28] In November 2021, we closed the investigation and amended the conditions imposed on BT so that:[29]

- BT would have to share costs appropriately amongst premises where the cost per premises was below £8,400 (£5,000 above the reasonable cost threshold), and would have to start build immediately after the first customer placed an order; and
- BT could wait until it had agreement to recover all the shared network costs of a build for all customers, where the cost per premises was higher than £8400, to ensure that where excess costs are high BT will recover these costs given fewer customers might be prepared to pay these higher amounts.

[27] BT, BT report on progress against the Broadband USO, [accessed 29 October 2021].
[28] Ofcom, Investigation into BT's compliance with its obligations as a broadband universal service provider, October 2020.
[29] Ofcom, Statement: Approach to high excess costs under the broadband universal service, 11 November 2021.

Some premises may not get connected under the USO

Data analysis by BT indicates that in many cases, the costs to connect these remaining premises will be high so that many customers are likely to receive excess cost quotes above the £3,400 threshold. Those premises that are the most expensive to connect may need alternative solutions.

Satellite services may be an option for customers in poorly served areas

Satellite remains an option for a fixed broadband connection, particularly for premises without the alternative of a fixed provider. However, the number of customers accessing satellite services remains low in comparison with traditional broadband provision.

Geostationary (GSO) satellites orbit the earth at around 36,000km, and can be used to provide satellite broadband to premises across the UK, including the most remote premises, but the connection's performance can be limited by its latency, and by data caps that are commonly imposed on satellite broadband connections. But newer GSO services may offer improved services for consumers. For example, Konnect states that its satellite covers around 75% of the UK and offers commercial services on a 24/7 basis direct to consumers with download speeds between 30Mbit/s and 100Mbit/s, with upload speeds averaging 3Mbit/s.

We are beginning to see the introduction and deployment of Low Earth Orbit (LEO) satellite constellations that offer residential and business broadband to UK consumers. These services will have lower latency, because the satellites are closer to Earth, so they are more likely to provide better broadband services. However, the throughput that a customer receives will also depend on the number and capacity of satellites and available spectrum, which will be shared between users of the service.

SpaceX's Starlink service has been launched and is currently in beta trial. It offers direct to consumer services on a 24/7 basis in most of the UK with future coverage for the whole of the UK planned. Starlink indicates that users can currently expect to see 100 to 200 Mbit/s or greater download speeds and upload speeds of 10 to 20 Mbit/s with latency of 20ms or lower in most locations.

Other LEO services include OneWeb, which aims to provide 24/7 coverage of the entire UK by the end of 2021, with services available via distribution partners in 2022. We understand it will have a focus on backhaul and services for businesses initially.

We plan to conduct broadband performance measurements on satellite connections to understand in more detail the performance that can be delivered on these networks.

Premises without a decent connection from any means

Premises are considered to have access to a decent fixed connection if it has 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.

Our latest analysis estimates that at least 65% of premises in Wales can receive both decent fixed and 4G mobile broadband services, with 7,850 (0.5%) of premises in Wales unable to access either of these or a WISP provide broadband service.

It is not surprising that nine of the ten local authorities in Wales with the highest number of premises unable to receive a decent broadband service of any kind are predominantly rural with Powys (just over 2,500 premises), Carmarthenshire (1,050 premises) and Ceredigion (just under 950 premises) respectively. The one exception is Wrexham, which despite being predominantly urban, has 137 properties without decent broadband from any means as shown in the following table.

Figure 8: Ten local authorities in Wales with the highest (in descending order) number of premises which are unable to receive decent broadband from either 4G, Fixed connection or WISP

Local authority	Premises without Mobile – Fixed – WISP	
Powys	2,529	3.6%
Carmarthenshire	1,050	1%
Ceredigion	947	2.5%
Gwynedd	850	1%
Monmouthshire	753	2%
Pembrokeshire	548	1%
Conwy	390	1%
Denbighshire	310	1%
Wrexham	137	0.2%
Anglesey	103	0.3%

Improving connectivity in Pembrokeshire

"A fo ben, bid bont" is an old Welsh proverb translated as "If you want to be a leader, be a bridge". It has been adopted by Pembrokshire County Council as it tries to bridge the gap between infrastructure builders and its many rural communities.

Pembrokeshire has a population of around 130,000 people and 65,000 domestic and commercial premises, many of which are scattered across a highly rural geography. According to the 2011 census, over 80% of the county's population lives in rural areas with fewer than 10,000 inhabitants, compared with 17% in England.

POPULATION:
130,000

65,000
DOMESTIC AND COMMERCIAL PREMISES

POPULATION:
OVER 80% RURAL

Pembrokeshire County Council is of the view that the problem will not fix itself and is not willing to wait and see what suppliers may or may not do. It has adopted a proactive approach to encourage and facilitate roll-out. The Council has identified digital connectivity as central to its plans for economic recovery, regeneration, and growth, and for supporting its community development, education and health and well-being strategies.

The increase in home working and home education associated with the pandemic has highlighted what needs to be done for households and businesses in Pembrokeshire to be able to cope and thrive digitally. It has created a dedicated broadband team of six engagement officers with a wealth of local insight and strong links into the community. They are working in partnership with providers such as Ogi, Broadway Partners and Openreach to stimulate demand and facilitate roll-out.

Connectivity in Pembrokeshire

Rural areas in Pembrokeshire are characterised by dispersed settlements. Distances between premises are typically greater and many premises are far from existing infrastructure. The cost of reaching these premises is correspondingly high. The topography of the county makes the cost of infrastructure construction significantly higher than in urban areas.

The rate of return on infrastructure investment for many suppliers might be below their minimum investment criteria and as things stand only **88%** of households and businesses have access to broadband speeds of at least **30Mbit/s** with **8%** of premises having access to **gigabit capable broadband** and nearly **2%** of premises that could be eligible for the **broadband USO**.

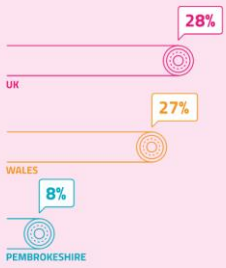
88%
OF HOUSEHOLDS AND BUSINESSES HAVE ACCESS TO BROADBAND SPEEDS OF AT LEAST 30Mbit/s

8%
HAVE ACCESS TO GIGABIT CAPABLE BROADBAND (>1000Mbit/s)

2%
PREMISES COULD BE ELIGIBLE FOR THE BROADBAND USO

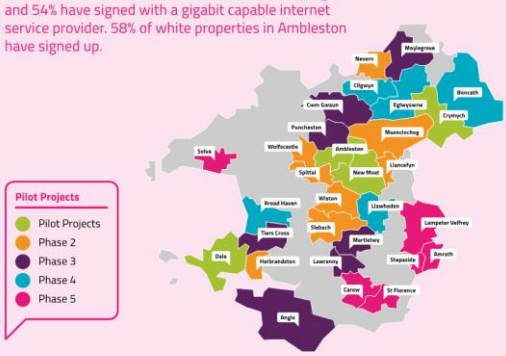
Full fibre availabilty

The number of properties in the county with access to full fibre is significantly less that both the UK and Wales average of 28% and 27% respectively at 8%.



FTTP project areas
Pembrokeshire County Council

Following a survey of homes and businesses the council received 6,438 expressions of interest to date. In the first pilot project area of Ambleston 65% of residents expressed initial interest to be part of the Pembrokeshire programme and 54% have signed with a gigabit capable internet service provider. 58% of white properties in Ambleston have signed up.



More consumers are upgrading to higher speed packages

Having discussed coverage, and the investment in improving the availability of network above, we now report on take-up. The benefits of increased coverage of broadband networks able to support higher speed services cannot be realised if consumers do not take advantage of these services when they are available.

We estimate that the take up of full-fibre services in Wales, where they are available, is around 24%. [30] Our reporting of full-fibre take-up may appear lower than expected because, whilst networks are being deployed at pace, take-up is likely to lag coverage. This occurs because the new fibre services may not be advertised until the network is available so that there is a lag in awareness of availability, and consumers may need to wait until their existing service contract ends before they can migrate to a new fibre service.

Figure 9: Estimated full fibre take-up as a percentage of premises where full fibre services are available: 2020 and 2021

	2021	2020
UK	24%	25%
England	25%	27%
Northern Ireland	19%	11%
Scotland	22%	25%
Wales	24%	22%

Take-up of superfast broadband has increased to over two-thirds

Overall, we estimate that for those premises that are able to take superfast broadband or a higher speed (94% of all premises in Wales), around 66% of them do so. This is an increase from around 55% last year.

Figure 10: Estimated superfast take-up as a percentage of premises where superfast services are available: 2020 and 2021

Nation	2021	2020
UK	69%	60%
England	69%	61%
Northern Ireland	73%	65%
Scotland	68%	57%

[30] This take-up figure refers to the underlying technology; customers can often choose a range of speed tiers over full fibre technology.

Wales	66%	55%

The UK's traditional telephone network is also being replaced

It is not only the UK's fixed broadband networks that are changing – traditional landline services are also undergoing a substantial transition. Network providers such as BT, Virgin Media O2 and KCOM, that offer traditional telephony services, are in the process of retiring their legacy systems (referred to as the Public Switched Telephone Network, or 'PSTN') and replacing them with modern systems.[31] In particular, BT and Openreach plan to retire BT's PSTN network and the Openreach wholesale services that deliver that capability by the end of 2025. To make sure that landline services continue in future, providers which currently use the legacy telephony networks will deliver landline calls over a digital technology called Voice over Broadband (VoBB), which uses Voice over Internet Protocol (VoIP) over a broadband connection.

Analysis of provider data shows that around 15% of landline services in the UK are now delivered over broadband, up from 8% last year. Increasingly, customers have their landline service moved to VoBB when they change provider or upgrade their phone and broadband package. In addition, BT and Virgin Media O2 have started to migrate existing customers. We are monitoring the migration and continue to engage with providers to help ensure consumers are protected and disruption is minimised.

At the same time, broadband customers can choose a 'broadband-only' package, where they are no longer required to take a phone service. Broadband-only packages – with or without the option to add a landline service – are offered by most full fibre providers and are increasingly being offered for copper-based broadband as well. With landline usage falling, we anticipate that adoption of these packages will grow significantly in the coming years, with a corresponding decrease in the number of landlines. [32] We also note consumers are using mobile phones to replace or complement fixed connections.

The migration from the legacy telephone network also brings certain challenges. We discuss these challenges in more detail in the Security and Resilience chapter in the UK report.

[31] In the case of BT, PSTN services are provided by Openreach in terms of access connectivity and BT for calls services. Openreach's WLR withdrawal site gives more information.
[32] Ofcom's Communications Market Report 2021.

Mobile, data and voice in Wales

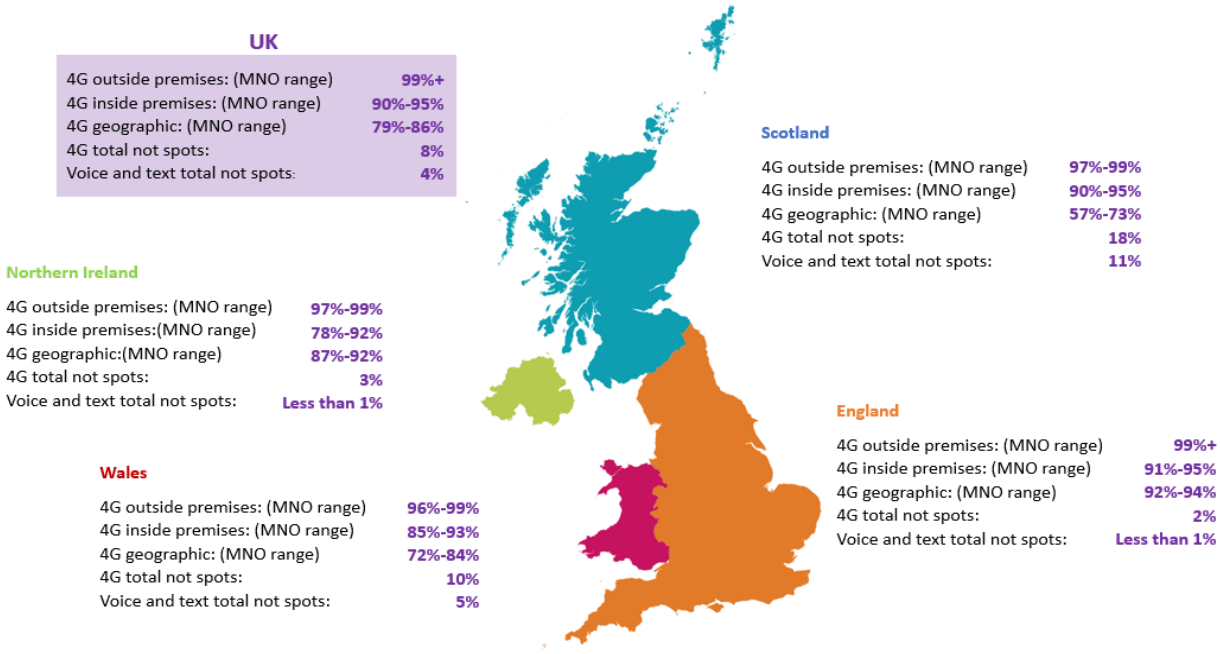
Introduction

Mobile services play an ever-increasing role in people's lives. In this chapter, we report on the availability of mobile coverage, outside and inside premises, across Wales' landmass. We provide an update on developments in the rollout of 5G over the last year, and for the first time provide a view of how extensively 5G is available.

Key highlights for Wales:

- There has been a slight increase in 4G geographic coverage (landmass) outdoor in Wales with coverage from all operators increasing to 61%; Voice coverage from all four operators is available to 78% of Wales' landmass (outdoor).
- Gwynedd (46%), Conwy (46%) and Powys (49%) are the three local authorities in Wales with the lowest 4G coverage (outdoors) from all four operators. This remains the same as last year.
- 4G indoor coverage from all operators in Wales has increased to 74% with coverage in rural areas having increased to 44% compared to 83% in urban areas. Voice services from all four operators are predicted to be available in 90% of premises in Wales.
- All four mobile network operators (MNOs) have continued to rollout 5G services with initial deployments in urban areas to provide additional capacity. Locations in Wales include Cardiff, Swansea, Newport, Porthcawl and Llandudno.

Summary of mobile coverage across the UK Nations



5G rollout and adoption is evolving

5G deployment has continued at pace in 2021, and now stands at more than c6,500 5G mobile sites across the UK, up from c3,000 in 2020. 87% of these sites are in England, 8% in Scotland, 3% in Wales and 2% in Northern Ireland.

Consumer take up remains relatively modest but has increased substantially, with around 800,000 active 5G devices across all mobile operator networks in the UK in 2020 rising to more than 6 million handsets in September 2021. This represents c10% of all active devices.

5G in the UK has been commercially rolled out initially in Non Stand-Alone mode, relying on a 4G core network, and using 4G for signalling and network control functions. This means that user services can be delivered over 5G, or a combination of 4G and 5G, and can place constraints on some of the full capabilities of 5G.

5G rollout is well underway in Wales, predominantly in Cardiff, Newport, and Swansea with coverage from at least one operator available outside between 23% and 34% of premises. This range extends from high to very high confidence of coverage.[33] We are not yet in a position to provide a breakdown by operator, as we discuss further in the main report. The majority of consumers continue to rely on 4G, 3G and 2G for their daily mobile service.

The Welsh Government has established '5G Wales Unlocked' - a consortium that combines the knowledge and resources of some of the world's leading technology, security, academic and mobility organisations, including Cisco, BT, Cardiff University, UtterBerry, Jam Creative and AppyWay working

[33] Please see our methodology for a more detailed explanation of how we have associated confidence levels with signal strength predictions from the mobile operators.

in partnership with Monmouthshire County Council and Blaenau Gwent County Borough Council. Its aim is to unlock the potential of next-generation networks in order to improve public services, boost tourism and accelerate social change in the country's rural and valley areas. The project will focus on four key areas – security, transport, tourism and education – that present the most compelling case for increased investment in 5G.

Availability of mobile calls and data services

In this section, we continue to report on the availability of voice calls and data services across a range of metrics, as we have done in the past. This year, we are placing a particular focus on the range of 4G coverage available from individual MNOs, as this most closely matches the experience of consumers. We continue to report on other metrics, including where all operators, or any one operator have coverage, both here but also in more detail in our online datasets.

The mobile coverage figures provided are based on predictions which the MNOs supply to Ofcom, with Ofcom undertaking regular testing to ensure the predictions provided are suitable for national and regional reporting. We take the accuracy of the data supplied to us seriously and we continue to monitor, through drive testing, the accuracy of all operators' coverage predictions. We note that operators continue to update and improve their prediction models and we continue to work with them to ensure appropriate validation is undertaken. [34]

Coverage outside premises

Individual operators provide good 4G coverage outside between 96-99% of premises in Wales (with this range covering different individual MNO coverage levels).[35] Individual MNOs each provide voice calls outside more than 99% of premises in Wales, while 98% of premises are predicted to have voice calls available from all four MNOs.

Differences remain between coverage in urban and rural areas. Individual operators' 4G coverage outside of rural premises ranges between 88-95% whereas each MNO serves between 98-99% of urban premises. Outdoor voice coverage around premises is predicted to be at least 100% for each MNO in urban areas, falling to a range of 96-97%, across the MNOs in rural areas.

[34] In last year's report, we noted that new predictions had been received from O2 and that validation was ongoing. O2 has shared further data with Ofcom over the last year and is continuing to undertake work in this area.

[35] By coverage outside a premise, we mean coverage is predicted in a 100x100m area in which a dwelling is located.

Coverage inside premises in Wales

The coverage people receive indoors depends on a range of factors including: the thickness of walls, building materials used in construction and where in a building people are using their phone.[36] Consequently there may be differences between operators predicted indoor coverage data and the actual coverage available in some premises.[37]

For indoor 4G coverage, we find that the percentage of premises served ranges from 85-93% across the MNOs. The availability of indoor voice calls ranges from 94-98% across the MNOs. As with coverage outside premises, we continue to see a significant (and unchanged) difference between rural and urban areas for indoor coverage. Individual MNOs provide indoor 4G coverage to 67-80% of premises in rural Wales, compared with 91-97% of urban premises. Indoor voice coverage is somewhat higher, ranging from 83-91% across the MNOs for rural premises, compared to a range of 97-99% for urban premises. Only 44% of premises in rural Wales have indoor 4G coverage from all operators.

Where indoor coverage remains poor, a number of alternative options are available to improve the experience. Tools include broadband-based calls on services such as Skype/WhatsApp, femtocells and Wi-Fi calling (the ability to make and receive a call and texts/ SMS over a Wi-Fi network).[38]All UK MNOs offer Wi-Fi calling[39] to consumers (though not all mobile phones are configured to support this feature).

Differences across the UK nations

There continues to be significant differences in coverage across the UK nations, although progress is also observable in each. As of September 2021, MNOs provided 4G geographic coverage ranging from: 92-94% in England; 87-92% in Northern Ireland; 57-73% in Scotland; and 72-84% in Wales. Coverage increases from BT EE mean that the top end of these ranges increased by one percentage point for England and Wales, and two percentage points in Scotland, alongside a one-percentage-point increase to the lower bound for Northern Ireland compared with last year.

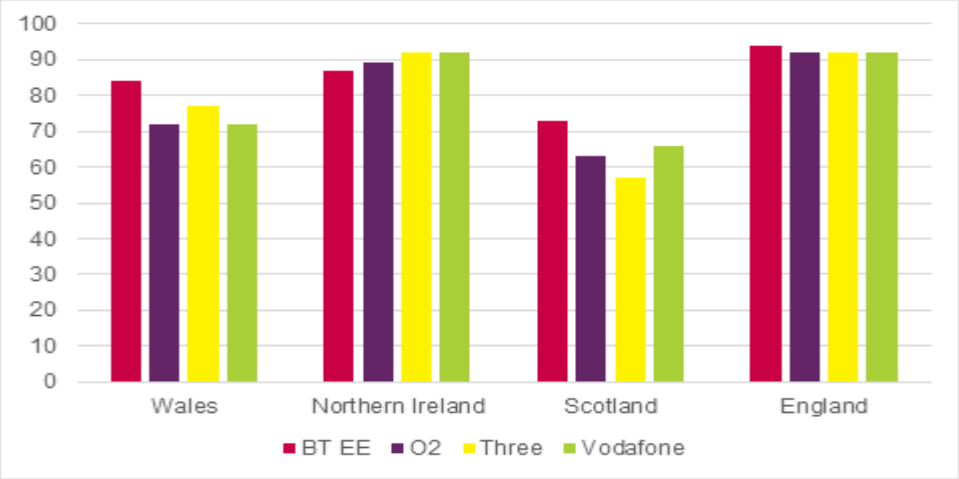
[36] Our online coverage checker provides additional information on the likelihood of there being indoor coverage in buildings at different locations and some of the factors that can affect a mobile signal

[37] We determine indoor coverage by applying an average building entry loss of 10dB across buildings. We acknowledge that this approach provides only a simplified view of what levels of indoor coverage might be, with the real experience in a building depending heavily on the types of building material and insulation in a given premises.

[38] We note that many of today's femtocells rely on 3G, and consequently some MNOs are placing less emphasis on this as a tool for improving indoor coverage.

[39] 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. This year, we have seen some of the UK MNOs move or revert to a "Wi-Fi preferred" solution.

Figure 11: Differences in 4G geographic coverage in Wales, Scotland, Northern Ireland and England



Source: Ofcom analysis of MNO predictions, September 2021.

The mobile coverage for each operator in Wales is further broken down shown below for four major metrics discussed above (indoor premises voice, indoor premises 4G, geographic 4G coverage and geographic voice) in figure 12 below.

Figure 12: Coverage of mobile services in Wales by network operator September 2021

	O2	Vodafone	EE	Three
Premises (indoor) voice	98%	97%	95%	94%
Premises (Indoor) 4G	91%	89%	93%	85%
Geographic voice	91%	88%	86%	87%
Geographic 4G	72%	72%	84%	77%

This coverage from individual MNOs reflects the coverage that is available to consumers, although areas where All MNOs are present represent areas of maximum choice. Only 61% of Wales and 45% of Scotland can receive 4G geographic coverage from all MNOs. In comparison, these services are available from all MNOs in 79% of geographic areas in Northern Ireland and 84% in England.

Figure 13: Change in 4G geographic coverage from all operators by UK nation

	% of landmass served with 4G by all operators (2020)	% of landmass served with 4G by all operators (2021)	Percentage point coverage change
Wales	60%	61%	+1
Scotland	44%	45%	+1
Northern Ireland	79%	79%	0
England	84%	84%	0
UK	69%	69%	0

Differences across local authorities and Senedd Cymru constituencies in Wales

4G geographic coverage in local authorities and Senedd constituencies varies considerably between those in urban and rural parts of Wales. Gwynedd and Conwy have the lowest levels of coverage from all operators with 46%, followed by Powys (49%) and Ceredigion (53%). Likewise, the Senedd constituencies of Dwyfor Meirionnydd has the lowest availability with 42% and is followed by Clwyd West (46%), Brecon and Radnorshire and Montgomeryshire (49%). But even predominantly urban constituencies such as Cynon Valley and Neath are included in the 10 constituencies with the lowest levels of availability.

Figures 14 and 15: difference in 4G geographic coverage by Welsh local authority and devolved constituency

Local authority	Coverage % (all operators)
Gwynedd	46
Conwy	46
Powys	49
Ceredigion	53
Monmouthshire	59
Carmarthenshire	63
Denbighshire	68
Neath Port Talbot	69
Anglesey	71
Pembrokeshire	74

Devolved constituency	Coverage %
Dwyfor Meirionnydd	42
Clwyd West	46
Brecon and Radnorshire	49
Montgomeryshire	49
Ceredigion	53
Aberconwy	54
Monmouth	57
Carmarthen East & Dinefwr	59
Cynon Valley	64
Neath	66

Update on the Shared Rural Network (SRN)

The Shared Rural Network project was agreed between the UK Government and the UK mobile operators in March 2020, as a key plank in improving UK mobile coverage and to support the Government's ambition of achieving 95% coverage of UK landmass by 2025. Under the agreement, each MNO is committed to reaching 88% coverage of UK landmass by 2024, and 90% of the landmass within six years from 2020 (subject to certain conditions), with an expectation that this will see the 'at least one operator' footprint reach 95% of the UK landmass by 2025.[40]Ofcom is responsible for assessing operators against these 88% and 90% targets, which have been added to spectrum licences to make them binding.

It is expected that 4G coverage in Wales from all MNOs will increase from 79% to 88% and that 4G coverage from at least one MNO will increase from 97% to 99%. The biggest increases in coverage will occur in those Senedd Regions with the highest percentages of rural areas, Mid and West Wales, and North Wales where the 4G coverage from all MNOs will increase from 51% to 78% and 63% to 83% respectively.

Figure 16: Forecast for 4G coverage pre and post-SRN by local authority

	4G coverage from all MNOs		4G coverage from at least one MNO	
Senedd Cymru Region	**Pre-SRN**	**Forecast post-SRN**	**Pre-SRN**	**Forecast post-SRN**
Mid and West	51%	78%	86%	97%
North	63%	83%	93%	98%
South Wales Central	83%	90%	98%	99%
South Wales East	71%	89%	98%	99%
South Wales West	79%	88%	97%	99%

Source: The SRN programme.

2021 has seen MNOs begin to make progress towards the 88% target, which they are delivering through their own investment. A key objective of the programme when it was announced in March 2020 was a reduction in the number of partial not spots consumers experienced, where service was available from one MNO but not others. As noted above, we have seen a percentage point increase in the area of landmass covered by all four MNOs in Wales. 46 fresh sites have so far been deployed to deliver on SRN commitments across all MNOs[41] which includes 5 sites in Wales.

Work to deliver the additional elements of the SRN that will secure the 90% and 95% coverage outcomes remains at an earlier stage. Component parts include deployment on the Extended Area

[40] We note that MNO licences were amended in July 2021 to change the subsequent coverage deadline (relating to the 90% target) to January 2027. This reflects changes made to the Grant Agreement between the four mobile operators and Government in light of the current process for subsidy control.

[41] Other sites have been built over this period, which were in planning at the time of the SRN agreement and are not included in this figure, although they will provide significant coverage towards final SRN outcomes.

Service (EAS) sites being built by the Home Office as part of the Emergency Services Network (ESN)[42], and the delivery of an additional 1% coverage in Total Not Spots (TNS) from sites shared by the 4 MNOs. In July, the Government completed its consultation on the target areas for investment, whilst the MNOs collectively published updated and more localised plans for highlighting areas likely to benefit from the programme. [43]Work to deliver this TNS commitment is continuing and remains focused on more detailed planning and procurement activities. We expect that the year ahead will see an increase in on the ground activity, although the planning and build lifecycle may mean more time is needed for coverage benefits to flow through.

Complete 4G not spots across the nations

Urban areas of Wales are relatively well served by 4G networks but those in rural areas continue to experience poor levels of 4G geographic coverage. 10% of Wales' landmass remains without 4G coverage compared with 8% of the UK as a whole.

Figure 17: Complete 4G not-spots by UK nation

Nation	Percentage not-spots
Scotland	18%
Wales	10%
Northern Ireland	3%
England	2%
UK	8%

Source: Ofcom analysis of operator data.

Switch off of 3G and (eventually) 2G services is on the horizon, and will need careful management

Over time, as 4G and 5G services reach an increasing number of households and businesses across the UK, we expect mobile operators to consider switching off their older 2G and 3G networks.

2G and 3G services first launched in the 1990s and 2000s respectively and while they continue to be important mobile services now, in coming years factors such as increasing operating costs and less efficient utilisation of spectrum and energy compared with newer generation technologies, are likely to result in the reduced use and eventual switch off of these networks.

Switching off these networks affects a number of applications such as availability of mobile telephone calls, which rely either on these legacy services. In addition to emergency voice calls, other applications such as smart meters and e-call services, could be impacted without careful implementation.

[42] The Emergency Services Network (ESN) is a cross-government programme to replace the current Airwave service used by the emergency services in Great Britain and transmit voice, video and data across a 4G network.

[43] Shared Rural Network, Forecast coverage improvements [accessed 7 December 2021].

As things stand, the number of mobile sites where 2G and 3G is carried remains stable, with only a small reduction in the number of 3G sectors compared with 2020, as a result of spectrum being refarmed to other technologies.[44] This is line with our expectation that typically 3G networks will be switched-off ahead of 2G networks. This is due to 4G services now being at a level of maturity where it can outstrip the data carrying capability of 3G in most places. However, based on data provided to use by the MNOs, we estimate that more than 4m active devices continue to rely on 2G and 3G communications.[45] 2G will remain important, particularly for making voice calls, until customers upgrade to 4G handsets.

Some MNOs are beginning to announce plans to switch off their 3G networks. For example, BT announced in July that it plans to phase customers off 3G by 2023-The UK Government also announced on 8 December that mobile operators have confirmed that they do not intend to offer 2G and 3G mobile networks past 2033 at the latest.[46] Some operators will switch off their networks earlier than this date, and will announce their own plans, as BT have done.

We welcome the Government's commitment to safeguard consumers and other network users of 2G and 3G services. It is important that as MNOs start to switch off these networks, adequate mitigation is in place to minimise the impact on consumers, including both customers with handsets and business users and systems reliant on 2G and 3G SIMs for IoT type communications.

Internet of Things

There has been a significant increase in the number of Internet of Things devices

The Internet of Things (IoT) refers to a network of devices and sensors capable of collecting and sharing data with humans or with other devices, and taking actions based on this data. Operators use IoT and Machine-to-Machine (M2M) networks for a range of applications for customers, including smart meters for utilities[47], travel and transport, environmental sensors and energy management solutions for smart buildings, car telemetry, video surveillance and pipeline monitoring for oil and gas companies. This year's report continues to provide qualitative and quantitative insights into public and private wide-area IoT networks.[48]

IoT Connectivity available from Mobile Network Operators

Low-power wide area networks (LPWAN)

- Wide area IoT connectivity can be delivered via several technologies: traditional cellular (2G, 3G, 4G and 5G) and Low-Power Wide Area (LPWA) networks such as Narrowband IoT (NB-IoT), Long

[44] Each technology on a mobile site may operator on several frequencies, and these can be divided into sectors (often three, but sometimes more) so there are many more sectors than sites.
[45] Based on aggregation of operator data supplied for June 2020-21.
[46] DCMS, A joint statement on the sunsetting of 2G and 3G networks and public ambition for Open RAN rollout as part of the Telecoms Supply Chain Diversification Strategy, 8 December 2021.
[47] Arqiva Limited provides radio communications links between the smart meters and the energy suppliers in Scotland and the north of England while O2 provides the radio links in the rest of England and Wales.
[48] IoT can be delivered via other tech such as Wi-Fi, Zigbee, Bluetooth and several others. In this report, we focus only on IoT services delivered through traditional cellular technologies by MNOs and LPWAN technologies such as NB-IoT, LTE-M, Sigfox and LoRa.

Term Evolution for Machines (LTE-M), Long Range Wide Area Networks (LoRaWAN) and Sigfox. NB-IoT and LTE-M have been standardised by 3GPP and they are now part of the 4G standard.

- 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.

Today, IoT connectivity is delivered by UK MNOs using a mix of cellular technologies (2G, 3G, 4G and 5G) and Low Power Wide Area Networks (LPWANs) such as NB-IoT and LTE-M. Vodafone continues to provide NB-IoT coverage across the UK. While Virgin Media O2's LTE-M coverage remains available only in the eastern parts of the UK, it has now started offering commercial services on the network. EE is exploring proof-of-concept deployments using LoraWAN.

This year, the number of active IoT connections on MNO networks increased by 63% (more than double the year-on-year growth from last year) to 10.3 million. Although the overall volume of IoT data traffic across all UK MNOs increased by 55% to 1.26PB, it remains significantly less than 1% of overall data traffic.

LoRaWANs in Wales new gateways to increase overall coverage

Evometric is a professional services and software company based in North Wales, specialising in long range wireless sensor networks, data applications and bespoke solutions. The company has developed an on Farm and Forestry asset tracking application, as well as site monitoring for remote renewable generation installations using the LoRaWAN protocol.

Morgan Walsh of Penffordd, Pembrokeshire has developed a real time monitoring system for dairy farms. The system monitors the milk in the tank to ensure its quality, and alerts the farmer of issues, for example if the tank has not been cleaned properly. The company has also developed an anti-social behaviour detection device, that uses LoRaWAN that has been trialled in Cardigan, and has also generated interest in other parts of Wales.

Both companies have capitalised on the LoRaWAN coverage in Enterprise Zones provided by the Welsh Government, along with Ofcom's free radio spectrum, that has created an environment to pilot, innovate and take new products to market. Many other organisations such Menter Mon, Barcud and Adra Housing associations, are also piloting innovative approaches, and are encouraging innovation from the development of the Internet of Things.

In the public sector, both Ceredigion and Carmarthenshire County Councils are at the final stages of beginning to deploy county wide LoRaWAN networks, which will enable innovation, and allow both the public and private sector to deploy IoT sensors such as road surface temperature monitoring, salt bin level monitoring, flood monitoring, coastal erosion monitoring and an almost unlimited amount of applications now possible through low power, long range, sensors which can be deployed for years at a time with no intervention.

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.

IoT Connectivity available from non-mobile network operators

Sigfox

Within the past year, WND UK, the sole Sigfox network operator in the UK has focused on developing a cost-optimised network that supports very low bandwidth applications with infrequent transmissions such as telemetry, metering, asset tracking, gas and water leak detection. Its network includes more than 1,500 base stations with a population and landmass coverage of 83% and 54% respectively.

Public LoRaWANs

Public community LoRaWAN networks, which are open-source and largely free to use, allow users to connect devices to existing gateways (base station) or add new gateways to increase overall coverage.[49] [50] They support developers, small/medium businesses and enterprises (particularly for Proof-of-Concept), government and public initiatives across the UK. Today, The Things Network (TTN), one of the leading (global) providers of public LoRaWANs has about 950 gateways in the UK serving 100 communities.

Private LoRaWANs

Private networks offer managed carrier-grade services with guaranteed availability, on a paid basis.

We are aware of several private LoRaWAN providers operating in the UK, such as Comms365, Connexion, The Things Industries (TTI) and North limited. We estimate that these networks have at least 580 gateways (a 66% increase from the past year) between them serving about 37,000 devices (a 50% increase from the past year). Some of the services provided by these networks include intelligent lighting, smart building, flood and air quality monitoring, waste management solutions, soil moisture sensing and asset tracking.

IoT has the potential to play a growing role across a range of services

The increase in IoT devices and traffic suggests that businesses are increasingly utilising the services IoT can deliver.

As the Covid-19 pandemic has evolved, businesses are relying on a range of IoT devices to support the safe and secure return of employees to work. For example, some of these devices measure body temperature, building occupancy and social distance, with both Vodafone and Virgin Media O2 having launched suites of solutions for the delivery of such services.

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

The on-going PSTN switch-off planned for completion in 2025 has implications for a range of sectors which include domestic and business customers, with the potential for IoT to support enduring solutions in services such as security devices, telecare and utility network monitoring.

Businesses across various sectors and industries are also increasingly relying on IoT applications in the attainment of their sustainability goals. Remote monitoring and control of devices, for example, can enable businesses to reduce the need for human travel, thereby reducing their carbon footprint. Smart technology in cities (e.g., smart lights, smart bins, traffic management systems, etc) could also minimise wastage and drive efficient use of resources and infrastructure.

There is an enabling environment for IoT to thrive in the UK

The increasing availability of 3GPP standardised technologies such as 5G (Massive Machine-Type Communications, MMTC), NB-IoT and LTE-M which are optimised for IoT applications together with non-3GPP standardised technologies such as Sigfox and LoRaWan support the continued adoption of IoT services.

One historic obstacle has been the potential security limitations in certain consumer IOT devices, which in many cases have universal default passwords and are not updated against known security threats. However, in the UK, government has set out its intentions for proposed legislation to regulate the cyber security of such products with the overall objective of ensuring a 'secure by design' approach in the future.[51]

Furthermore, Ofcom recently introduced regulations which harmonise conditions for spectrum use by Short-Range Devices (SRDs) within the 870 to 874.4 MHz frequency bands.[52] These changes will make the band more suitable for IoT type applications such as smart metering and industrial automation. The decision also means the UK can benefit from economies of scale for IoT type devices which already operate in these bands in other territories.

[51] DCMS, Government response to the call for views on consumer connected product cyber security legislation, 21 April 2021.
[52] Ofcom, Decision on changes to the licence exemption for wireless telegraphy devices and on licensing equipment in 57 to 71 GHz, 29 April 2021.