Connected Nations 2020

Annex A: Methodology section

About this document

This is the methodology section of the Connected Nations report explaining the process, data sets and assumptions used in compiling and presenting data.

Methodology

This annex explains our approach to obtaining and analyzing information from operators for the purposes of our Connected Nations report.

The report uses data gathered from the communication operators in each sector, as well as information already held by Ofcom.

Calculating the 'premise base'

This section explains how we identify, include and categorise properties. In summary:

- We use property information from the Ordnance Survey's AddressBase® database including both Royal Mail postal addresses and additional property details from Local Authority sources. This ensures our 'premises base' is comprehensive and allows us to measure how network expansion is affecting all sections of the UK
- We consider the sub-properties within a building regardless of the number of postal delivery points serving them. This ensures our overall report, as well as our published maps and apps, better reflect coverage at individual premises across the UK and are consistent with coverage information provided by operators
- In the report we will normally focus on coverage figures for residential properties. We will also highlight distinctions between residential and commercial premises where appropriate.

The addressing products used in the annual Connected Nations include:

- Ordnance Survey AddressBase Premium Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-release-note-aug-20.pdf)
- Ordnance Survey AddressBase Islands Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-islands-release-note-aug-20.pdf)

Both products were released in August 2020 and contain address information valid up to July 2020.

Since the last full Connected Nations report in December 2019 we have provided two additional updates which used:

- OS AddressBase® Premium and Islands September 2019, Epoch 73 for the Spring Update (https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-update-spring-2019)
- OS AddressBase® Premium and Islands April 2020, Epoch 75 for the Summer Update (https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-update-summer-2020)

Ofcom uses the Ordnance Survey AddressBase® Premium product to provide the base dataset used to assess broadband coverage for residential and commercial premises.

AddressBase® includes information about 44million addresses, properties and land areas where services are provided, by combining 3 datasets:

- Local Government National Land and Property Gazetteer (NLPG),
- Ordnance Survey MasterMap address layer, and
- Royal Mail Postal Address File (PAF).

Each record in AddressBase® refers to a Basic Land and Property Unit (BLPU) and is defined in the British Standard for Addressing (BS7666) as an:

- Area of land in uniform property rights or, in the absence of such ownership evidence or where required for administration purposes, inferred from physical features, occupation or use

Each BLPU has a Unique Property Reference Number (UPRN), a spatial reference and one or more Land and Property Identifiers (LPI).

Method

Our approach to identifying the 'premise base' includes three stages:

- Identifying 'Service delivery addresses'; the address locations that are indicative of where a service would be provided
- Data cleansing; for use in reporting, the premise list is linked to other attributes to identify statistical or administrative geographic units, or rurality categories. Timing of data may impact on how many records may be linked
- Reporting definition; the inclusion of all records based on property classification or status may change dependent on the specific focus of a report

A Service delivery address can be defined as a premise that is:

- able to receive mail either directly or indirectly (via a parent, sibling or holding address)
- is not a "parent-shell" address
- does not have a parent address OR parent address is classified as a "parent-shell".

For the identification of all UPRNs that are considered valid for analysis the following source tables are used:

- [AB BLPU Table] AddressBase® Basic Land and Parcel Unit (BLPU) Table
- [AB Classification Table] AddressBase® Classification Table
- [NSPL Postcode Table] National Statistics Postcode Lookup table (https://geoportal.statistics.gov.uk/search?collection=Dataset&sort=name&tags=PRD_NSPL)

The following SQL code is used to construct the 'premise base'. A separate process is undertaken to link operator data to individual addresses.
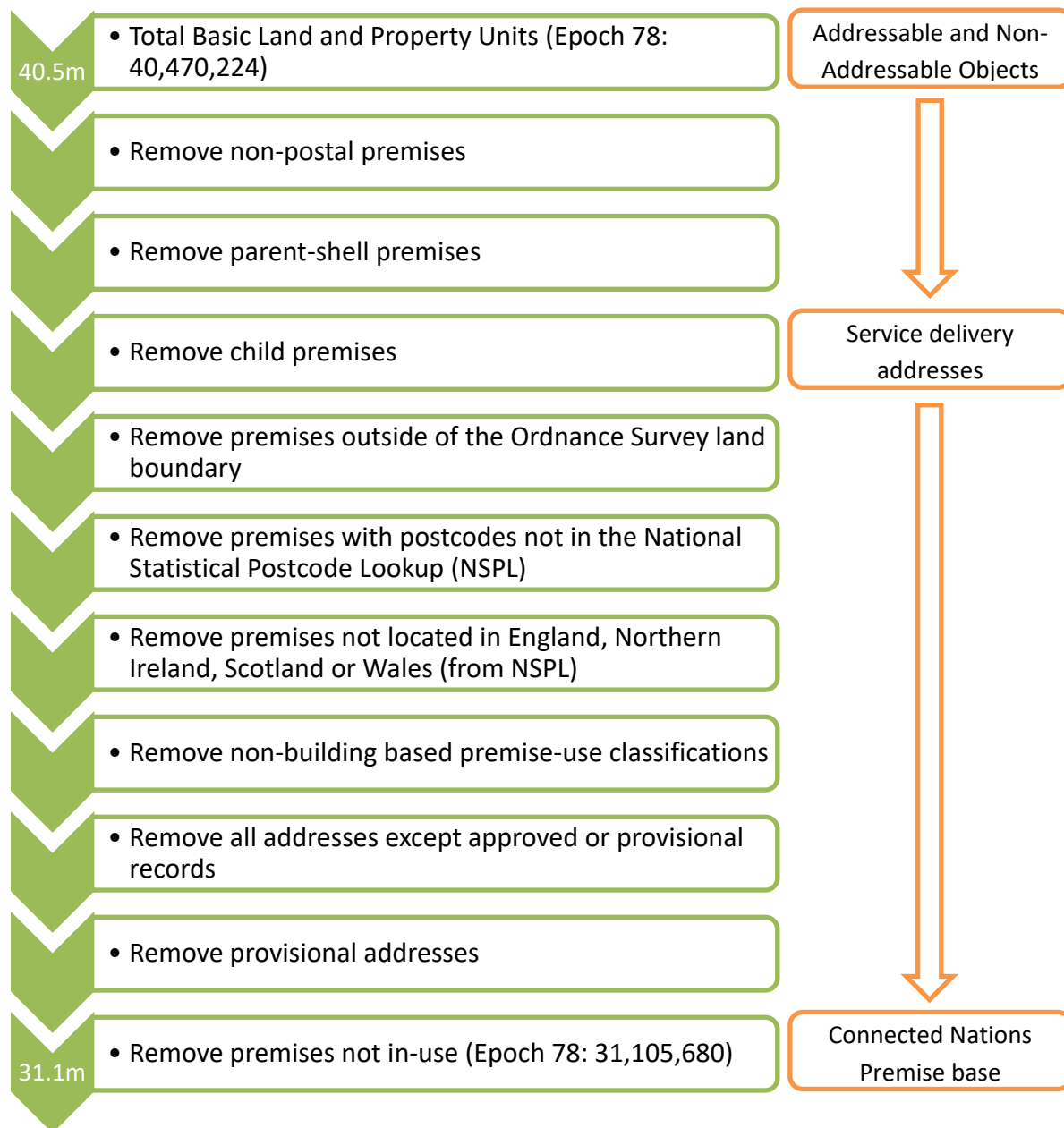
```
SELECT
      count (*)
FROM
```

```
    [AB BLPU Table] b
    LEFT JOIN [NSPL Postcode Table]  n ON UPPER(replace(b.postcode_locator,' ','')) =
UPPER(n.postcode) -- join to NSPL on postcode
    LEFT JOIN [NSPL Country Table]  nc using (ctry) -- join to the country lookup
    LEFT JOIN [AB Classification Table] c ON b.uprn = c.uprn --join to classifications on
uprn
    LEFT JOIN [AB Classification Table] cp ON b.parent_uprn = cp.uprn --join to
classifications on parent_uprn
WHERE
    b.addressbase_postal IN ('D','C','L') -- is an addressable object (postal address)
AND
    left(c.classification_code,1) != 'P' --not a parent shell
AND
    (
    b.parent_uprn is null --does not have a parent
    OR
    left(cp.classification_code,1) = 'P' --has a parent, but that parent is a parent-shell
    )
AND
    b.country !='J' --uprn is within Ordnance Survey Land Boundary
AND
    n.postcode is not null --postcode exists in nspl
AND
    UPPER(nc.country_name) IN ('ENGLAND', 'NI', 'SCOTLAND', 'WALES') --UPRN in
Eng,Sco,NI,Wal (excludes Channel Isl, IoM)
AND
    (
    left(c.classification_code,1)='C' -- Commercial
    OR left(c.classification_code,1)='R' -- Residential
    OR left(c.classification_code,1)='X' -- Dual Use
    OR left(c.classification_code,2)='ZS' -- Object of Interest->Stately Home
    OR left(c.classification_code,2)='ZW' -- Object of Interest->Place of Worship
    OR c.classification_code = 'OR04' -- Additional Mail / Packet Addressee
    )
AND
    b.logical_status IN ( 1, 6) --approved or provisional addresses only
AND
    b.logical_status = 1 --approved addresses only
AND
    (
    b.blpu_state IS NULL
    OR
    b.blpu_state = 2
```

) --in use premises

Figure 1. Conceptual steps to calculating the premise base

40.5m	• Total Basic Land and Property Units (Epoch 78: 40,470,224)
	• Remove non-postal premises
	• Remove parent-shell premises
	• Remove child premises
	• Remove premises outside of the Ordnance Survey land boundary
	• Remove premises with postcodes not in the National Statistical Postcode Lookup (NSPL)
	• Remove premises not located in England, Northern Ireland, Scotland or Wales (from NSPL)
	• Remove non-building based premise-use classifications
	• Remove all addresses except approved or provisional records
	• Remove provisional addresses
31.1m	• Remove premises not in-use (Epoch 78: 31,105,680)

Addressable and Non-Addressable Objects

Service delivery addresses

Connected Nations Premise base

Comparison to previous approaches

In our December 2019 Connected Nations report (https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2019) we provided further information and comparison to previous approaches on the calculation of the 'premise base'.

Data matching

The availability of address-level data allows us to create a comprehensive data set describing the characteristics of all available services and operators present at premises across the UK. Many operators provided a unique property reference number (UPRN), a common identifier available for use in the UK. Other operators provided address information that would need to be processed and linked to our premise base. Over 90 million records were received from operators and 99.7% of our uniquely identified 'premise base' was matched to at least one operator using the UPRN or building address reference.

Our approach to address matching involves comparing records using:

- Direct matches based on the UPRN hierarchy
- Confident matches using addresses that have an identified building number or name, a street address and postcode
- Approximate matches using addresses that have a street address and postcode

Figure 3 shows that the 30.4m premises (97.8%) were matched to operators using the UPRN. Some premises were matched using different methods for each operator, but the UPRN was the basis for matching 30.9m premises overall. Only 14,700 premises (0.05%) were matched using address information only. Whilst this represents an increase compared to the December 2019 analysis, this is due to the increased number of operators providing data resulting in additional address matching analysis being undertaken.

Figure 2. Address match results to the premise base from all operators
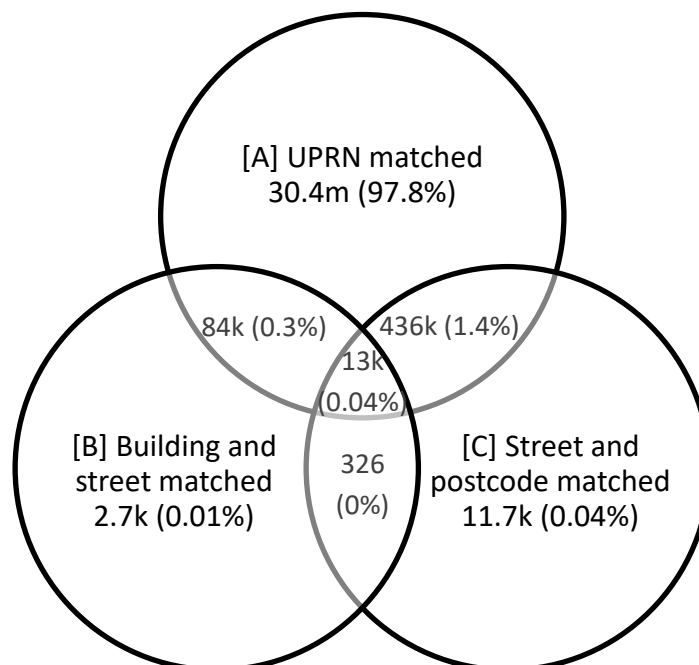
Of the remaining 149,000 (0.5%) of premises not initially matched by UPRN or building address information, at least 51,000 could be subsequently linked to a premise via the UPRN parent-child relationship, leaving a net total of 98,000 premises where no confident match could be used.

Across the 94m records received from all operators, just over 50,000 (0.05%) could not be assigned to a geographic location and 141,000 records (0.15%) could only be matched to a postcode.

As the number of non-used records is a small volume, and operator overlaps reduce the number of premises for which no information is available, for this report we have removed all postcode estimate results to ensure that we are reporting as accurately as possible at the address level.

Fixed broadband networks

Coverage

Our data on coverage of fixed broadband services is collected from a number of operators (see A3 fixed network providers). In 2020 operators were asked to provide data for each address where a service was provided. This was provided with a reference date of 1 September 2020.

For the overall coverage of fixed broadband we have identified the number of UK properties, our 'premise base'. For September 2020 we have used a premise base of 31.1 million.

We use premises data from Ordnance Survey AddressBase Premium Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-release-note-aug-20.pdf) and the Ordnance Survey AddressBase Islands Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-islands-release-note-aug-20.pdf). This is combined with additional geographic classifications from the ONS National Statistics Postcode Lookup table (https://geoportal.statistics.gov.uk/search?collection=Dataset&sort=name&tags=PRD_NSPL) and (August 2020) and Urban and Rural categories derived from the Locale classification (http://www.bluewavegeographics.com/images/LOCALE_Classification.pdf).

Calculating availability

Each operator provides information on the technology available together with predictions of download and upload speeds. After the address matching process these characteristics are assigned to each premise to enable further detailed analysis to be undertaken. We apply thresholds in our analysis to investigate different patterns of provision. For coverage we have used the maximum predicted download speed available at a premise to determine in which broadband category a premise is represented.

- Since the first Connected Nations report in 2011, we have tracked the progress of superfast broadband roll-out. We use 30 Mbit/s download speeds as the threshold for defining superfast services. We use the term 'Ultrafast' for services offering download speeds of 300Mbit/s or higher.
- We also monitor the proportion of premises that do not have access to a decent broadband service, defined as a service capable of delivering a download speed of at least 10Mbit/s and an upload speed of 1Mbit/s. In this report we include all unmatched and unclassified premises when assessing their access to a broadband service.

Performance metrics, speeds and data use

We gathered data from many of the fixed broadband internet service providers (see A3 fixed network providers) on both their retail services and the services they provide to other ISPs as a wholesale service. This was provided with a collection date of 1st to 30th June 2020. This is one month later than in previous reports due to managing stakeholder workload demands this year.

Our analysis of broadband speeds is based on the information provided by these ISPs regarding the sync speed of each active line. This gives a measure of the maximum possible connection speed achievable between the ISP's access network and the consumer premises. Line speed measurements are typically a few Mbit/s lower than sync speed measurement, and they typically vary throughout the day depending on the level of congestion in the ISP's network.

This data was collected at the address-level and by line identifier and involves a more complex matching process. In addition to matching records via the UPRN or address to our 'premise base', we also need to match wholesale providers including BT Group, Sky, TalkTalk and Vodafone) to the Openreach infrastructure using either a line identifier (where these are common) or via address matching.

A premise is also considered in our analysis if any line associated with that premise has a measured speed greater than zero. A total of 24.5m records met this criterion and were used in line performance and data usage calculations. Of these records 23.4 million (95%) could be assigned to a geographic location using a UPRN address or postcode matching process. Due to changes in data systems across providers a proportion of lines could not be matched accounting for 1.1m records (5% of all records), although this has improved since last year. Overall UK figures include all 24.5m records, whilst geographic analyses by rurality and region use the 23.4m records.

We also gathered supplemental data from fixed broadband providers in relation to: consumer demand, and network data traffic, during the Covid-19 period (defined as 1 February 2020 and 31 January 2020); take up of full fibre and gigabit-capable services; capacity to meet consumer demands for service; voice services; and FTTP connection time (the latter with a collection date chosen by providers in the period 17 August 2020 – 17 September 2020).

Estimating take-up

Take-up is estimated from the lines reported as discussed above (as of June 2020) as well as the total premises as of May 2020 to ensure consistency.

For the year on year changes, only addresses were included for which we accurate address matching and usage information in both 2019 and 2020. This limited the analysis to 21 million premises.

Data use

Our analysis of data use is calculated from the amount of data downloaded and uploaded on each line as reported by operators. We also collected data on the total data use between the hours of 6pm and midnight, to assess data use at 'peak times'. Our analysis considers all lines where the amount of data downloaded was greater than zero.

Our analysis of patterns of data use during the period of Covid-19 restrictions is based on providers' reports of what they observed on their networks, aggregated across providers.

Access capacity

We asked fixed communications providers to state the percentage of access network equipment or infrastructure that were, at the time of submission, unable to meet customer orders for new service using the highest speed technology or to provide service at the maximum speed advertised. The network equipment included those in the exchange and cabinet (or equivalent).

As operators use different technologies (e.g. full-fibre, telephone line xDSL, DOCSIS etc.), data cannot be directly compared, so data from all submission were aggregated to provide an overall figure.

PSTN migration

We asked the providers of fixed broadband communications to provide a breakdown of the technology used to delivery voice services over the access network. Some broadband providers do not offer voice services, and many internet voice service providers do not deploy fixed broadband networks and were therefore not approached to provide data to us, so the results obtained are indicative only.

Mobile

Coverage

Our data on the coverage of mobile networks were collected from the four mobile network operators, EE, O2, Three and Vodafone (see A3 mobile network operators) as 100m x 100m pixels referenced against the Ordnance Survey Great Britain (OSGB) grid system, for their coverage as at 1st September 2020 for 2G, 3G and 4G networks. Premises coverage is calculated from the base of 31.1 million premises derived from the Ordnance Survey AddressBase Premium Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-release-note-aug-20.pdf) and the Ordnance Survey AddressBase Islands Epoch 78 (https://www.ordnancesurvey.co.uk/documents/product-support/release-notes/addressbase-islands-release-note-aug-20.pdf).

In addition, geographic identifiers are added from the ONS National Statistics Postcode Lookup table (https://geoportal.statistics.gov.uk/search?collection=Dataset&sort=name&tags=PRD_NSPL) and (August 2020) and Urban and Rural categories derived from the Locale classification (http://www.bluewavegeographics.com/images/LOCALE_Classification.pdf). Roads data is taken from Ordnance Survey (https://www.ordnancesurvey.co.uk/business-and-government/products/os-open-roads.html) and Northern Ireland Land & Property Services (https://www.opendatani.gov.uk/dataset/osni-open-data-50k-transport-line1) open data sources.

We apply the technology-specific thresholds to each of 100m x 100m pixels to determine whether a sufficiently strong signal is available to successfully make a phone call or send or receive data. These

pixels are aggregated to provide an estimate of either the landmass or the number of premises that are covered by the corresponding mobile technology.

In 2018 measurement work to identify the minimum coverage level (the technology-specific threshold) required to deliver a good quality of experience to consumers on the 4G network has been undertaken. We have identified minimum coverage levels for 2G and 3G networks, which allows us to present a consistent view of coverage on all these networks to consumers.

For 2G, 3G and, now, 4G networks, we define coverage based on the minimum signal strength required to deliver a 98% probability of making a 90 second telephone call successfully. In the case of 4G specifically, our definition also delivers a 95% chance of getting a download speed of at least 2Mbit/s.

We use the signal strength thresholds shown in Figure 6 when estimating coverage.

Figure 3. Mobile strength thresholds

Service		Metric	Outdoor	Indoor and in-car
2G		RxLev	-81dBm	-71dBm
3G		RSCP CPiCH	-100dBm	-90dBm
4G / Enhanced data		RSRP	-105dBm	-95dBm
Voice:	2G	RxLev	-81dBm	-71dBm
	3G	RSCP CPiCH	-100dBm	-90dBm
	4G	RSRP	-105dBm	-95dBm
Basic data:	3G	RSCP CPiCH	-100dBm	-90dBm
	4G	RSRP	-115dBm	-105dBm

Mobile prediction models

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.

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.

Data use

This data was collected in June 2020 and included information on the amount of data uploaded and downloaded on each mobile cell in these networks. The geography of data traffic is defined by the location of the associated mobile cell base station.

Fixed Wireless Access

Fixed Wireless Access services can be provided on a mobile network by Mobile Network Operators (MNOs) or on a dedicated wireless network by Wireless Internet Service Providers (WISPs).

Fixed Wireless Access coverage from WISPs

Our analysis of Fixed Wireless Access by WISP coverage includes data from 18 providers. Of these, 6 providers provided new data relating to their network as of October 2020. The remaining 11 providers did not provide us with new data, and therefore we have reused coverage estimates from Connected Nations 2019.

Providers who submitted new coverage data provided this data using our new guidance (https://www.ofcom.org.uk/__data/assets/pdf_file/0013/204061/technical-guidance-wisps.pdf) on coverage reporting, submitting their own estimate of coverage at a premise level. We then matched these against our 'premise base' in the same way as fixed broadband coverage. We plan to do further work next year to validate operators' coverage modelling.

Where we have reused older coverage estimates, this was based on data reported by WISPs relating to the location and technical characteristics of their network infrastructure and details their service provision to customers. This approach is summarised in A1.59-A1.64 in the methodology annex of the 2019 Connected Nations Report (https://www.ofcom.org.uk/__data/assets/pdf_file/0021/186411/connected-nations-2019-methodology.pdf).

Fixed Wireless Access coverage from MNOs

FWA services are also available on mobile networks, where the capacity is shared with mobile users. We asked MNOs for a list of the properties that could be served with FWA by their network without the installation of new access points, and to specify whether this service is at least a decent broadband service. An explanation of the use of FWA to deliver a decent broadband service is available in our statement on Delivering the Broadband Universal Service (https://www.ofcom.org.uk/consultations-and-statements/category-1/delivering-broadband-universal-service).

We encourage all FWA providers to submit updated data and invite any provider which has not yet submitted data or are not listed in the table to contact us at connectednationsreport@ofcom.org.uk.

Figure 4: FWA data included in our analysis this year

WISPs	
Air Broadband	Airband
Borderlink	Boundless Networks
Country Broadband	Cromarty Firth Wireless Networks
Kencomp	Loop Scorpio
Lothian Broadband (including Highland Wireless)	Mycomms
Net1	Quickline Communications
ResQNet	Rural Comms
Secure Web Services	Signa Technologies
Wessex Internet	
Mobile networks	
EE	Three

Urban and rural classifications

We have used the Locale classification
(http://www.bluewavegeographics.com/images/LOCALE_Classification.pdf) to identify premises as
being in an urban or rural area. Locale is a third-party data source based on the analysis of 2011
census output areas (OAs). Each OA is assigned to one of seven Locale Groups using a combination
of Government conurbation definitions, population density at the OA- and postcode sector-levels,
urban sprawl boundaries, OS roadmaps and additional visual inspection.

We assign the Locale classifications to either Urban or Rural based on the following:

- Urban: Codes A to C relate to settlements with populations over 10,000 and codes D to
  E relate to settlements with populations over 2,000
- Rural: F to G relate to settlements with populations under 2,000

For fixed broadband analysis each premise is assigned to a census output area via its postcode. For
mobile analysis, each pixel is assigned to a census output area through a spatial comparison of the
pixel OSGB coordinate to the corresponding census output area polygon. The Locale urban and rural
classification is then matched to these records via the census output area.

Geographic boundary changes

The table below identifies changes for local authorities across the United Kingdom, effective as at 1
April 2020.

Figure 5 Geographic changes in the United Kingdom

Authority in 2020	Previously	Type of change
Buckinghamshire (Unitary Authority)	Aylesbury Vale Chiltern South Bucks and Wycombe	Merger of authorities

	Buckinghamshire county	

These changes result in the number of Lower Tier authorities decreasing from 317 to 314 in England.

The number of Lower Tier authorities in Northern Ireland (11), Wales (22) and Scotland (32) is unchanged.

In total there are 379 Lower Tier authorities in the United Kingdom.

Comparisons to previously published reports should take note of these changes.

Glossary

2G Second generation of mobile telephony systems, launched in the UK in 1992. Uses digital transmission to support voice, very low-speed data communications, and short messaging services.

3G Third generation of mobile systems, launched in the UK in 2003. Provides low-speed data transmission and supports multi-media applications such as video, audio and internet access, alongside conventional voice services.

4G Fourth generation of mobile systems, launched in the UK in 2012. It is designed to provide faster data download and upload speeds on mobile networks and can also support VoIP services

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'.

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.

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

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

Full Fibre coverage Services that provide a fibre optic cable from the exchange to the end user's home or office. In 2018 we have modified this definition to: where the network has been rolled out to a "lead-in" that will serve the consumer end premise and where the consumer would expect to pay a standard installation charge for that connection.

Gigabit coverage Services that provide a fibre optic cable from the exchange to the end user's home or office and coaxial cable services delivering DOCSIS 3.1 services.

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

ITU-R International Telecommunications Union Radiocommunication Sector. One of the three sectors of the ITU, responsible for radio communication.

ITU-T International Telecommunications Union Telecommunication Standardization Sector. One of the three sectors of the ITU, responsible standards in telecommunications.

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

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

Ultrafast broadband A data service that can deliver download speeds of at least 300 Mbit/s.

Voice (Mobile) Mobile voice services where nearly all 90-second calls are completed without interruption from any of 2G, 3G or 4G mobile services.

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.

WISP Wireless Internet Service Provider. Broadband service providers using a wireless link between a provider's mast site and an external antenna fixed to a customer's premise. These are dedicated networks for broadband customers only. They commonly use license exempt or light licensed spectrum such as the 5GHz band

Obtaining information from providers

Ofcom requested data from communication providers using our powers under section 135 of the Communications Act 2003 and Regulation 17 of the Statutory Instrument 2016/607.

Under section 134A and 134B of the Act[1] Ofcom is required to prepare a report for "each relevant period", as defined in section 134A(4) of the Act, that deals with the electronic communications networks matters listed in section 134B(1), and the electronic communications services matters listed in section 134B(2), of the Act.

Fixed network providers

The data for use in this report was obtained, or continued to be used, from the following fixed network providers:

- Ask4
- B4RN
- Bridge Fibre (from Sept 2018)
- BT Group
- Cablecom Glide
- Call Flow
- CityFibre
- Community Fibre
- Country Broadband
- Fibrespeed
- Fibrus
- Full Fibre
- FW Networks
- Gigaclear
- G.Network
- Hampshire Broadband
- Hutchinson 3G UK Limited ("Three")
- Hyperoptic
- IFNL
- ITS
- KCOM
- MiFi Wales
- Openreach
- Sky
- Spectrum Internet (from Sept 2018)
- TalkTalk

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[1] Sections 134A and 134B of the Act, as amended by Section 1 of the Digital Economy Act 2010, can be found here: https://www.legislation.gov.uk/ukpga/2010/24/section/1

- Technological Services
- Telcom Infrastructure
- Truespeed (from Sept 2018)
- Velocity1
- Virgin Media
- Vision Fibre
- Vodafone
- VX Fibre (from Sept 2018)
- Wessex Internet
- Wight Fibre
- Zzoomm

Mobile network operators

The following mobile network operators supplied data for use in this report:

- Everything Everywhere ("EE")
- Hutchinson 3G UK ("Three")
- Telefónica UK ("O2")
- Vodafone.