TECHNICAL GUIDANCE FOR WISPS

OFCOM CONNECTED NATIONS REPORTING

Version: 1.5

Revision Date: 28 September 2020

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INTRODUCTION

Ofcom has a statutory duty to collect and publish data about fixed and mobile connectivity across the UK. This is reported annually and updated more frequently.

This document sets out technical guidance to help Fixed Wireless Operators (WISPs) when responding to Information Requests from Ofcom. This guidance has been prepared in consultation with members of the UK Wireless Internet Service Providers Association (UKWISPA) and Ofcom.

The objectives of this guidance are: -

1. Help WISPs to prepare data that can be relied upon by Ofcom and the users of their collected data
2. Provide specific guidance about the observed performance characteristics of commonly used FWA products
3. Help WISPs to consider Quality of Experience within their coverage reports
4. Help WISPs to calculate fixed wireless link performance in a point to multipoint network
5. Provide guidance on the impact of obstructions and the importance of the type of height data used when modelling coverage

As new equipment becomes available and new frequency bands become popular, this guidance may be updated and therefore the information included should only be used as a guide.

DATA COLLECTION AND REPORTING

PURPOSE OF CONNECTED NATIONS

Ofcom tracks coverage progress across fixed and mobile services, by Nation and by access technology. This information is published in reporting and interactive formats and is used by a range of consumers and industry stakeholders.

Until recently, Ofcom did not include data from many WISPs as the industry was maturing and growing. Since 2018, Ofcom has actively sought to engage with the Fixed Wireless Market to collect more data to understand the range of communications networks that are available to consumers across the UK. Accordingly, various consultations regarding spectrum and policy have been conducted to help the Fixed Wireless Market to develop. These consultations have resulted in several policy and spectrum license changes that have been beneficial to the industry such as: -

- Removal of 20 MHz 'notch' in the 5.8 GHz Band C, making more contiguous spectrum available
- Changes to the V-Band (60 GHz band) license restrictions to permit use of Point to Multi Point equipment.
- Introduction of Local Access Licenses which provide low cost licensed access to bands that are allocated to Mobile Network Operators where they are not in use by the MNO. These bands include 800 MHz, 900 MHz, 1400 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2600 MHz and 3.4 GHz bands.
- Introduction of Shared Access Licenses which provide low cost access to new bands in rural locations in the 1800 MHz, 2300 MHz, 3.8-4.2 GHz and lower 26 GHz (indoor) band.

It is Ofcom's expectation that the general increase in demand for high speed connectivity across the Nations, along with the maturing UK Fixed Wireless Industry that the Fixed Wireless Access market will continue to grow and should therefore be reported more comprehensively.

DATA COLLECTED

At the simplest level, Ofcom would like to know at a premises level, which services are available from what operators, regardless of the access technology. In the case of broadband access, this would include the access speeds that can be delivered to each individual property from each operator.

In a perfect world, Ofcom would have access to real-time data for every individual premises across the Nations. However, this is a moving target as both the number of premises is changing (new developments and re-developments) and operators continue to build or grow their networks. In relation to Fixed Wireless, the changing landscape can also affect coverage (e.g. changes to the built and natural world landscape).

It is also accepted that all access equipment has finite constraints and capacity and Ofcom does consider such constraints when it receives coverage data from each type of operator. It is therefore important that Fixed Wireless Access coverage reports recognize such constraints and that each operator can provide evidence about how they deal with growth and capacity constraints. As an example, locating an omni-directional access point at a high site in the middle of a city would not provide credible coverage for the entire city, as the amount of capacity on a single access point would not allow the connection of thousands of premises. However, if the operator has a policy of introducing more capacity to meet local demand, this could be acceptable in certain circumstances.

IMPORTANCE OF COMPLIANCE

Ofcom requests data to be submitted by fixed and mobile operators by way of a Statutory Notice under section 135 of the Communications Act 2003 in order to comply with its own obligations as a statutory body. A

Statutory Notice is one that carries the full legal weight of enforcement and can result in sanctions being placed on operators who do not comply. . These Statutory Notices are enforceable by a Court and non-compliance includes a fines of up to £2 million and the suspension of operator licences. Ofcom does engage with operators in order to help ensure that information requests are reasonable and proportionate and does engage with industry to help ensure that requests are manageable.

OBSERVED EQUIPMENT PERFORMANCE

In order to help WISPs prepare meaningful coverage data, the following tables have been prepared to act as good practice guidelines.

Whilst manufacturers have been consulted on the performance characteristics of their equipment, the performance and contention details in these tables may in some cases be lower than the manufacturer claims.

In preparing this information, we have assumed that an individual base station will have a minimum of 10 subscribers connected. These observations are for guidance purposes only and are not a specification of maximum or minimum performance unless stated. The absolute performance of equipment will be determined by a number of factors that have not been considered, including quality of subscriber installation, local noise floor and wireless conditions, quality of cabling, stability of mounts, link distance and the line of sight.

UBIQUITI

UBIQUITI M5 SERIES THROUGHPUT

Product (Base Station)	Max Subscribers (warning threshold for >10 Mbps services)	Max Total Download Throughput (warning threshold) at 20MHz	Max Total Download Throughput (warning threshold) at 30MHz	Max Total Download Throughput (warning threshold) at 40MHz	Max Individual Subscriber Download Throughput (warning threshold) at 20MHz	Max Individual Subscriber Download Throughput (warning threshold) at 30MHz	Max Individual Subscriber Download Throughput (warning threshold) at 40MHz
Rocket AirMax M5 *	22	70 Mbps	80 Mbps	85 Mbps	50 Mbps	60 Mbps	65 Mbps

*includes Rocket M5, PowerBridge M5, Rocket M5 Titanium, Rocket M5 GPS. Where GPS sync is active, throughput figures should be reduced by approximately 30%.

UBIQUITI M5 AC SERIES THROUGHPUT

Product (Base Station)	Max Subscribers (warning threshold for >10 Mbps services)	Max Total Download Throughput (warning threshold) at 20MHz	Max Total Download Throughput (warning threshold) at 30MHz	Max Total Download Throughput (warning threshold) at 40MHz	Max Individual Subscriber Download Throughput (warning threshold) at 20MHz	Max Individual Subscriber Download Throughput (warning threshold) at 30MHz	Max Individual Subscriber Download Throughput (warning threshold) at 40MHz
Rocket AC	28	130 Mbps	N/A	200 Mbps	120 Mbps	N/A	200 Mbps
AirMax LiteAP AC/GPS	28	130 Mbps	N/A	200 Mbps	120 Mbps	N/A	200 Mbps
Rocket Prism AC	32	130 Mbps	N/A	200 Mbps	120 Mbps	N/A	200 Mbps
Rocket Prism AC Gen2	32	155 Mbps	N/A	240 Mbps	155 Mbps	N/A	240 Mbps
PrismStation AC	28	130 Mbps	N/A	200 Mbps	120 Mbps	N/A	200 Mbps

UBIQUITI LTU SERIES

No data available at the time of publication.

CAMBIUM NETWORKS

CAMBIUM EPMP SERIES

Product (Base Station)	Max Subscribers (warning threshold for >10 Mbps services)	Max Total Download Throughput (warning threshold) at 20MHz	Max Total Download Throughput (warning threshold) at 30MHz	Max Total Download Throughput (warning threshold) at 40MHz	Max Individual Subscriber Download Throughput (warning threshold) at 20MHz	Max Individual Subscriber Download Throughput (warning threshold) at 30MHz	Max Individual Subscriber Download Throughput (warning threshold) at 40MHz
ePMP 2000	112	75 Mbps	N/A	150 Mbps	75 Mbps	N/A	150 Mbps
ePMP 3000L	64	225 Mbps	N/A	450 Mbps	225 Mbps	N/A	450 Mbps
ePMP 3000	112	450 Mbps	N/A	750 Mbps	450 Mbps	N/A	450 Mbps

CAMBIUM PMP450 SERIES

Product (Base Station)	Max Subscribers (warning threshold for >10 Mbps services)	Max Total Download Throughput (warning threshold) at 20MHz	Max Total Download Throughput (warning threshold) at 30MHz	Max Total Download Throughput (warning threshold) at 40MHz	Max Individual Subscriber Download Throughput (warning threshold) at 20MHz	Max Individual Subscriber Download Throughput (warning threshold) at 30MHz	Max Individual Subscriber Download Throughput (warning threshold) at 40MHz
PMP450i	238	127 Mbps	195 Mbps	263 Mbps	127 Mbps	195 Mbps	239 Mbps
PMP450M	238	640 Mbps	997 Mbps	1,204 Mbps	127 Mbps	195 Mbps	239 Mbps

RADWIN

RADWIN JET SERIES

Product (Base Station)	Max Subscribers (warning threshold for >10 Mbps services)	Max Total Download Throughput (warning threshold) at 20MHz	Max Total Download Throughput (warning threshold) at 30MHz	Max Total Download Throughput (warning threshold) at 40MHz	Max Individual Subscriber Download Throughput (warning threshold) at 20MHz	Max Individual Subscriber Download Throughput (warning threshold) at 30MHz	Max Individual Subscriber Download Throughput (warning threshold) at 40MHz
Jet Air	48	130	N/A	250	110	N/A	220
Jet Pro	48	130	N/A	250	110	N/A	220

MIKROTIK

No data available at the time of publication.

QUALITY OF EXPERIENCE

When publishing coverage information about premises, Ofcom needs to be comfortable that the end users' broadband experience is adequate for a range of common services and applications for a reasonable price.

At present, Ofcom regards a reasonable price for broadband connections to be £46.10 per month (Ofcom, 2020) without low data caps. This should be capable of delivering at least 10 Mbps download speed and 1 Mbps upload speed. However, it is recognised that lower speed services as low as 2 Mbps download can be provided and offered and these should also be reported as part of the Connected Nations data collection. This information is valuable for reporting to policymakers and infrastructure planning.

Quality of Experience (QoE) can also be influenced by a range of factors that include network dimensioning and policies regarding contention. A highly contended network may be capable of delivering high speeds at certain times, but apparent QoE could be negatively impacted during busy periods. In Annex 1 of Ofcom's 2019 Connected Nations Report, there is a good indication of the types of testing that Ofcom has used to help measure QoE.

It is recommended that operators dimension and test their network performance around their busy-hour, which may be between 8pm and 10pm to ensure decent broadband at key times for users. UKWISPA recommends that all operators use effective and comprehensive network monitoring systems to track the performance and loading of key network components.

OPERATOR POLICIES

It is recommended that operators define (and demonstrate if required), clear policies regarding the following elements of their networks: -

1. Backhaul capacity, load and contention
2. Access Point capacity and load, including maximum subscriber numbers
3. Minimum expected busy hour bandwidth
4. Policy relating to customer enquiries that would breach the above related thresholds
5. Network monitoring systems and upgrade threshold policies
6. Mitigation of interference

These policies, where implemented, should be in line with general good practice and should be appropriate to the access technology and specific products in use.

LINK PERFORMANCE CALCULATIONS

Access speeds on Fixed Wireless point-to-multipoint networks are governed by several key factors including: -

- Radio System characteristics (modulation rates and efficiency etc)
- Channel size
- Signal quality
- RF noise and interference
- System load and scheduler efficiency (sharing capacity across multiple subscribers)
- TDD Framing ratio (download vs upload speeds)

In general, estimating the Signal to Noise Ratio (SNR) for a link can be a good guide to the modulation rates that will be achieved by a given Radio System in one direction. The MAC Efficiency of the Radio System will determine the maximum speeds that can be delivered assuming all other system variables are within tolerance.

For example, if a radio system can achieve a Receive Signal Strength Indicator (RSSI) of -64 dBm at the subscriber end and there is a noise floor of -90 dBm, the SNR would be 26 dBm. Supposing the Radio System characteristics enabled this to operate at MCS9, the PHY rate might be 173 Mbps based on the manufacturers specifications for the channel size for that system. Given a MAC Efficiency of say, 80%, the potential maximum IP throughput would be 138 Mbps. In this example, we can ignore power and frequency, as we have already derived the RSSI.

Manufacturers of most popular equipment used by WISPs in the UK publish data about modulation rates and signal strength and/or SNR in tabular or spreadsheet form. These data can be used to predict optimum speeds that can be delivered. However, the real-world speeds may be impacted by the number of subscribers that any radio system has registered to an access point. The Observed Equipment Performance section of this report can be used as a general guide to throughput and performance.

GUIDE TO LINK PERFORMANCE CALCULATIONS

Wireless signals lose energy over distance at a predictable rate where there are no obstructions over the signal path. The energy lost is generally known as Free Space Path Loss (FSPL).

The free space path loss is the loss in signal strength of a signal as it travels through free space. This value is usually calculated by discounting any obstacles or reflections that might occur in its path. IEEE defines it as "The loss between two isotropic radiators in free space, expressed as a power ratio."

This can be calculated thus: -

$$FSPL = 20\,log_{10}(d) + 20\,log_{10}(f) + 20log_{10}\left(\frac{4\pi}{c}\right) - G_{Tx} - G_{Rx}$$

Where -

d = Distance between the antennas.

f = Frequency

G (Tx) = The Gain of the Transmitting Antenna.

G (Rx) = The Gain of the Receiving Antenna.

c = Speed of light in vacuum (Meters per Second)

It should be noted, that the above FSPL calculation does not consider atmospheric absorption or variations in altitude. This includes water and oxygen absorption, which can be very significant on certain frequencies (more details available HERE). Generally, such factors have a relatively low impact on signals below 6 GHz, which are most common for FWA services at present. However, these can be very dramatic on higher millimetre Wave (mmW) bands and allowances should be factored into Connected Nations reporting if used (eg. 60GHz V-Band).

LINK BUDGET AND SNR CALCULATION

The following example shows how to calculate a specific link budget where the link distance is known. This is independent of radio system and the output could be used to match with the characteristics of the radio system to estimate SNR and modulation rates (and consequently speed).

In this example, the following assumptions have been used: -

- Nominal frequency 5.7GHz
- EIRP for transmission 36dBm
- Client-side receiver gain 23dBi
- Local Noise Floor -90dBm

Using these parameters, the radio system would have a headline RSL of -67.12 dBm at 7.5km distance. The receiver would have an SNR of 19.88 dB, which can be used to estimate modulation rate and speeds.

This can very easily be validated thus: -

Using this calculation and a distance of 7,500 metres, link budget at 5.7 GHz is: -
Loss = 92.5 + 20 x log10 (7,500/1,000) + 20 x log10 (5,700/1,000)
= -125.119 dB

Calculating signal with 36dBm power and 1 dB line loss is: -
Receive Signal = 36 + 23 – 125.119 – 1
= -67.1189 dB

Calculating SNR with -67.12 dB RSL and -90dB Noise Floor is: -
SNR = (-67.12) – (-90)
= 22.88 dB

INTERFERENCE MITIGATION

When operating on the 5.4 GHz and 5.8 GHz bands, UKWISPA recommends the following approaches to mitigating interference from the operator's own equipment as well as other radio sources.

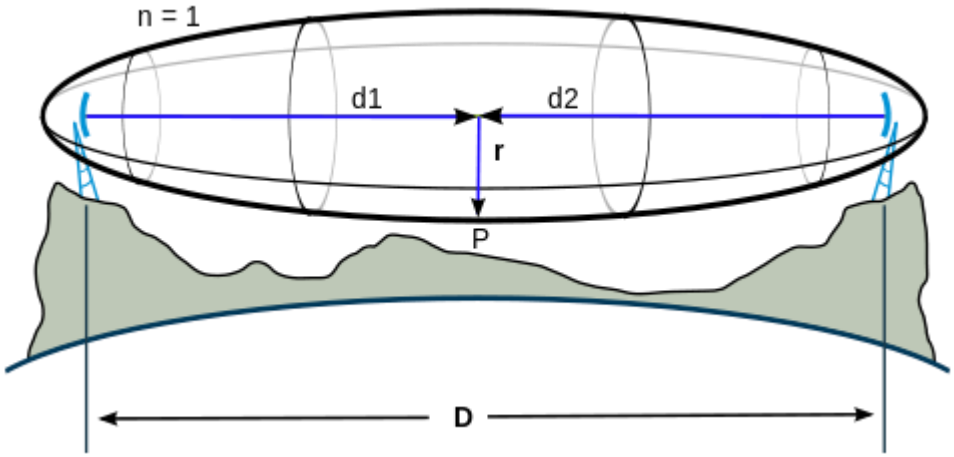
1. Focused sector antennas with high Beam Efficiency (BE). BE expresses the forward gain of an antenna system relative to its lobes and incorporates front/back ratio. High BE means that the amount of forward gain is high relative to the gain in all other directions. High BE antennas such as the RF Elements Asymmetric Horns on many base stations can be located in very close proximity to one another and provide very focused coverage patterns. This ensures low noise, creating improved SNR and resulting modulation rates and allows for very high levels of spectrum re-use. Moreover, high BE antenna systems have extremely low sensitivity in all directions other than the forward beam. This means that signals from all other directions do not enter the radio system which makes them extremely resistant to interference. This is a significant factor in ensuring the risks from interference are low.
2. GPS Synchronisation in TDD radio systems ensure that all base stations in a locality transmit and receive at exactly the same time. This reduces the general noise floor, resulting in higher SNR and facilitating more spectrum re-use. This means that higher speeds and lower bit error rates occur, resulting in high data throughput and high spectral efficiency.
3. Beam Forming antennas and radio systems should be used in higher-density locations. The Cambium 450M radio system offers substantially higher spectral efficiency than most other radio systems such as 802.11 or LTE systems as it is a 14 x 14 Massive MIMO system. The 14 x 14 digital matrix array produces 7 discrete beams over a 90 degree forward spread on a single channel. As each of the beams are very narrow, they focus on small groups of subscribers, providing very high performance. This also results in active nulls which reduce the effect of interference dramatically, as the radio system cannot receive external radio signals from all other directions. The Radwin Jet Series radio system incorporates their proprietary Bi-Beam beam-steering capability within their base stations, which also offers significant benefits beyond traditional sector antennas. Bi-Beam provides narrow transmission and receive antenna profiles that are steered towards its associated subscribers.
4. Radio systems with Active Filters create sharp and persistent nulls from the edges of each channel in use. This has the dual benefits of masking noise from other radio sources that partially overlap with an active channel, but also reduces the size of guard bands that would otherwise be needed. The result is that more active channels can be used in an area with low risk of interference. Such filters do not exist in older 802.11 based systems such as Ubiquiti M5 or MikroTik SXT.
5. The high Spectral efficiency that results from the measures set out above has the further benefit of needing less overall spectrum to deliver high quality service and speeds. This means that fewer channels are used by each operator and therefore unused spectrum can often be found if high energy interference is detected within the main beam pattern of a sector antenna. This allows a rapid ability to change channels if needed to avoid external interference or radar hits, further reducing risk.

MAPPING AND HEIGHT DATA

Reliable link speed calculations require clear signal Line of Sight (LoS), as different obstructions can be made from different materials which will incur differing levels of attenuation. It follows that good QoE can only be delivered where there is a sufficiently high signal quality, so it is recommended that coverage claims consider the level of LoS on a link.

In order to determine the quality of LoS, mapping data will be required that accurately reflects the shape of the ground and obstructions between transmitter and receiver. Most WISPs currently deliver most of their connections to FWA customers using the 5 GHz bands B and C (5,470 – 5,725 and 5,725 – 5,850 MHz). These bands suffer significant attenuation from physical obstructions within the signal path.

LoS is defined by Fresnel Zones which are ellipse shaped areas between any two radio antennas. The distance between the two radio antennas and the frequency of operation are required to compute the radius of the Fresnel Zone.



Fresnel zone: D is the distance between the transmitter and the receiver; r is the radius of the first Fresnel zone (n=1) at point P. P is d1 away from the transmitter, and d2 away from the receiver.

It is recommended that Connected Nations reporting is based on LoS calculations that incorporate both terrain and surface data models to ensure that the coverage claims take into account ground and surface obstructions. For the best quality coverage, 100% of the first Fresnel should be clear along the signal path, but it is accepted that some radio systems, especially those operating below 5 GHz are able to deal with near Line of Sight (nLoS) and any assumptions in this regard should be stated in Connected Nations submissions.

If a Connected Nations submission does not incorporate the method of coverage calculation, then the submission will be hard to accept by Ofcom and may be disregarded.

Calculations should be performed from each base station to each premises in the operator's coverage area. It is important that the coverage calculations are specific to each individual premises and not to the postcode. Ofcom uses the Unique Property Reference Number (UPRN) to identify each premises. The UK's UPRN database is maintained by Ordnance Survey on behalf of the government.

EXAMPLE "MODEL" COVERAGE METHODOLOGY

An ideal approach to preparing a coverage report would incorporate the following: -

1. For each Base Station or Access Point define the precise location, mount height, sector beam direction and width (as relevant), nominal frequency, nominal power expressed as EIRP, channel width and the radio system (make/model).
2. Define the assumed subscriber unit gain.
3. Define the maximum assumed connection range or minimum target RSL for a subscriber unit to achieve the declared connection speeds.
4. Using reasonable quality terrain and surface data, together with a level of Fresnel clearance appropriate to the radio system and operating frequency assumed, calculate the FSPL and RSL (link budget) on the path from the base station to the premises. Ideal minimum specification height data for Fresnel clearance calculations would be 5m resolution DTM and 2m resolution DSM or polygon data on the 5 GHz bands. Significantly lower resolution data would be acceptable only for much lower frequency transmissions such as TV White Space (TVWS) at sub 1 GHz.

Using the above model, LoS calculations and RSL or SNR calculations can be performed to prepare a Coverage List. Where partial LoS or nLoS coverage is included, the attenuation model used for trees, buildings and ground obstructions should be included.

The Coverage List should include the details and assumptions used for each calculation as part of the list or as an associated note.

COVERAGE POLICIES AND NETWORK DIMENSIONING

When a Coverage List has been prepared for a base station or a network, consideration should be given to the load of the system.

The system load should consider the following elements: -

- Number of potential properties associated with each base station with LoS and the specific limitations of the radio system being used. This is to ensure that consideration has been given to what the operator will do in the event of over-subscription of a particular base station. For example, if 1,000 premises are assumed to be covered by a single base station on the edge of a town, the operator will need to describe their policy when the maximum station count for that base station is reached or will need to trim the number of premises in scope.
- Number of potential properties associated with the location at which base stations are included. This is to ensure that consideration is given to the total load at a site. For example, if a site has potential coverage of 8,000 premises it is unrealistic to assume that tens of base stations could be installed at the site due to the lack of non-overlapping channels that can coexist. Therefore, the operator should declare their policy for dealing with enquiries from potential customers that would cause excessive load to a site.
- Average traffic assumptions per subscriber at busy hour periods (typically 8 pm to 10 pm, but may vary). This can be used to verify the total backhaul capacity is reasonable for a site. This should also consider any child sites that may be dependent on a site where chains or meshed sites are deployed. Bandwidth requirements for a number of users can be calculated using the following calculation: -

  $$B = (N . A + 2 . SD) H$$

  Where: -

  B = Aggregated bandwidth limit with 95% confidence
  N = Number of dependent users
  A = Average (mean) bandwidth requirement per user
  SD = Standard Deviation of data requirement per user
  H = Busy hour multiplier

Note that empirical evidence suggests that Standard Deviation of data consumption per user is approximately 1.2 times the average bandwidth requirement. Equally, the average bandwidth requirement per user during busy hour is approximately double the overall average bandwidth requirement per user (i.e. busy hour multiplier = 2).

Coverage Policies should set out how the operator deals with the following circumstances: -

How new customer and upgrade enquiries are treated when either: -

- an individual base station is fully loaded with clients
- the maximum number of stations is reached for a base station
- the maximum throughput capability of the base station is reached
- there is insufficient backhaul capacity available at the site or depended sites

DATA SOURCES

PREMISES DATA

Ordnance Survey makes their authoritative UPRN data available without cost under their OS OpenData initiative. This data set includes the following key information that is needed for Connected Nations reporting:-

- UPRN
- Geodetic Coordinates (Latitude and Longitudes)
- Cartesian Coordinates (Eastings and Northings)
- All addressable locations in GB (England, Wales and Scotland, but excluding Northern Ireland)

Please note that this does not include address or postcode information or property heights. It should also be noted that not all addressable locations in this data set are regular premises, as it is based on AddressBase Premium. As such it also includes features such as locations with planning permission, utility sites such as turbines, wells and parks. Ofcom will filter these locations from any submissions they receive.

Open UPRN can be accessed HERE.

If the operator wishes to obtain full address data, or data covering Northern Ireland, the most comprehensive data sets are AddressBase that can be purchased by the operator.

DIGITAL ELEVATION DATA

There are many free and commercially available height data sources available for the UK. There are no free data sets that cover the whole of the UK at high resolution.

The following free data sources are commonly available: -

Product	Description	Source	Comments
SRTM	30m Resolution Terrain Data collected by Space Shuttle in 2000.	USGS	Now quite out of date and very low resolution not suitable for wireless modelling at microwave or better.
ALOS World 3d	30m Resolution Surface Data collected by JAXA (Japanese space agency).	JAXA	Better than SRTM and more up to date, but only 30m resolution and no surface data. Not suitable for wireless modelling above 1 GHz.
OS Terrain 50	DTM data layer for GB at 50m resolution.	Ordnance Survey	50m resolution data is only suitable for low frequency wireless modelling sub 1 GHz. No surface features included.
Environment Agency LiDAR	Up to 25cm DSM Data and 2m DTM for approximately 70% of England	Gov.uk	Area of interest needs to be checked carefully as the coverage of each layer at each resolution is quite irregular.

Defra Spatial SurfZone	Composite LiDAR and SONAR data for coastline and flood risk areas, collected primarily by Environment Agency. Targeted for full England coverage in 2022.	DEFRA	Mixed samples from 25cm to 2m resolution DTM and DSM for much of England. Approximately 85% coverage in England. Gaps in coverage should be checked carefully, as well as data tile 'edges' where composite sets are used.
LiDAR Composite for Scotland	Composite data collected for Scotland	EA	Extremely limited coverage of mixed resolutions.
Welsh Composite LiDAR Dataset	Composite elevation data for Wales.	Lle Wales	Approximately 70% Coverage.

Other free data is available via OPENDEM

The following Commercial Data Sources are commonly available: -

Product	Description	Source	Comments
Bluesky	2m Surface and 5m Terrain data available for all GB. National Tree Canopy database and local LiDAR is also available	BlueSky	Together with Get Mapping, these data represent the most comprehensive and accurate national coverage available.
Get Mapping	Height Data for much of England, Wales and Scotland	getmapping	In addition to the Bluesky data, localised data from Atkins Global and Geoinformation Group can be obtained here.
Emapsite	Range of map data from multiple sources	emapsite	One-stop shop for OS and other commercial products.
Ordnance Survey	MasterMap Topography Layer.	OS	Includes very accurate built-world, but not trees. Can work well in conjunction with DTM and National Tree Canopy with vector based modelling systems.
Intermap	Nextmap	Intermap	Up to 2m resolution data claimed globally.
Vricon	Vricon DTM and Vricon DSM	Vricon	Claimed global coverage at .5m resolution, but may not be comprehensive in rural areas.

MODELLING SOFTWARE

There several free and commercial tools and programs that can help with coverage modelling. Connected Nations requires data per premises based on their UPRN. This means that the modelling software must be able to map coverage by UPRN in order to be considered.

The following is a list of applications that are commonly available that will help with the preparation of Connected Nations reporting. It should be noted that many of these systems originate from mobile network planning and may not feature address coverage as standard. Such systems can produce viewshed polygons that can be used with property mapping data to create coverage lists.

Declaration of interest: The author of this report has a direct interest in the WISDM application from Wireless Coverage Ltd.

Product	Description	Source	Comments
Ranplan Professional	Powerful design and planning system for WiFi and LTE networks.	Ranplan	Well established radio planning system for indoor and outdoor applications.
EDX Signalpro	RF Planning software with modules for fixed wireless modelling.	EDX	Needs supplementary work to include UPRN data.
WISDM	Purpose-built application for WISPs to model coverage.	Wireless Coverage	Includes a feature designed to support Connected Nations report production.
HTZ Communications	Advanced RF engineering and planning system	ATDI	Needs supplementary work to include UPRN data.
CloudRF	Low-cost RF propagation service.	CloudRF	Needs supplementary work to include UPRN data.
Splat!	Open source RF modelling system for Linux	QSL	Open source toolkit, alongside Proj4 that is commonly used within other RF modelling systems. Requires a good degree of technical competence to use fully.

LIST OF ACKNOWLEDGEMENTS

We would like to thank the following contributors for their help in preparing this document: -

- James Saunby, Greysky Consulting
- Mark Turvey, RADWIN
- Ian Bushrod, MS (Distribution)
- Simon Staddon, Cambium Networks
- Tim Porter, W3Z
- Matthew L. Appleton, Voneus

LIST OF MEMBERS CONSULTED IN THIS REPORT

Airbytes Communications Limited	Gigabeam	Wave Internet
ARWisp	High Tide Consulting Limited	Wessex Internet
Baltic Broadband Limited	Highland Wireless	Airfibre Limited
Briant Communications Sussex	Husky Networks	Boundless Networks
Cambrian Connect Ltd	Internet Central	M24Seven
Cosmos	Legend Telecom	Orbital Net
Country Connect Ltd	Lochielnet	Pure Broadband
Day 1 Connectivity Ltd	Martley Web Mesh	Quickline Communications
Drimnin Broadband	Monsternet Highland Ltd	Voneus Ltd
Duplia	MyComms Ltd	W3Z Broadband
EAV Net	N.I Technology Ltd	Aviat Networks
EvoSoft Group Ltd	Rapid Rural Internet Services	Cambium Networks
F1 IT Ltd	Scottish Sea Farms	Curvalux UK Limited
Fluidity Connect	Signa Technologies Ltd	Flying Voice
GigAir Ltd	SkyLight Broadband	LinITX
Hello Internet	TxRx Communications	MS Distribution
Highland Community Broadband	UltraNetworks Ltd	RADWIN
NWIMS	Virair Networks	Rapid Wireless
One Wireless	Westend WiFi limited	RF Elements
Quantum Communications Ltd	Wide FM	Tenda
RevoBlue Communications Ltd	WiFi Scotland	Ubiquiti Networks
Stix Internet Limited	Wildanet Ltd	WISDM by Wireless Coverage Ltd
Sunart Telecom	Alnwick Computers/Alncom	Cambridge Communication Systems
Telecom ITM West Yorkshire	APC Solutions (UK) Limited	Commscope
Top Smart Homes Limited	Borderlink Broadband	DiViNetworks
Vale WISP	Buchan Consultancy Services Ltd	Preseem
Western Peak Limited	DRAGON WIFI	Siklu
West WiFi	Fibre WiFi	Winncom Technologies
Wi Fibre Ltd	Formartinet	Whalebone
Yonet Telecom Ltd	Go Internet	Azotel
Bliss Internet	I Need Broadband Ltd	Faelix Limited
Bogons Ltd	InTouch Systems	Global Good Net Works Limited
Borders Online Ltd	Kencomp	Love Hz
Broadway Partners	Lonsdale Network Services Ltd	Proactive International PR
Caudata Ltd	Net1 (NI) Limited	Rapier Systems Ltd
Couldnet IT Solutions	Secure Web Services	
Cloud Wireless	Symmetris	
Converged Communications	Village Networks	
Cromarty Firth Wireless	Vispa Ltd	
Fibrecast Ltd		
Frambroadband Ltd		

ANNEX 1 – SAMPLE CONNECTED NATIONS QUESTIONS

Please provide the following information about your fixed wireless network as at the Start Date.

1. Please describe a typical installation set up from access point through to customer premises in terms of the technologies used, deployment geometry and service delivered to the customer. Please include any policy you have for maximum customers per access point for each Radio System (Eg Ubiquiti Rocket M5 Series)

2. Please outline your policies for services you provide at different distances where possible using the following table. Please include your most commonly used systems and packaged speeds.

Radio System (Eg Ubiquiti Rocket M5 Series)	Typical Channel Size (10, 20, 40 MHz etc)	Typical Installation Distance (mtrs) or RSL (dB) for 10 Mbps Connections	Typical Installation Distance (mtrs) or RSL (dB) for 20 Mbps Connections	Typical Installation Distance (mtrs) or RSL (dB) for 30 Mbps Connections	Typical Installation Distance (mtrs) or RSL (dB) for [other 1] Mbps Connections	Typical Installation Distance (mtrs) or RSL (dB) for [other 2] Mbps Connections

3. For each antenna on an access point site, that does or could provide service without the installation of new equipment, please provide in the tab marked "Q3" in the:

    a. the coordinates (latitude/longitude or easting/northing) of the antennas or access points used to provide the connection[1];
    b. the frequency[2] of the transmission used to provide the connection;
    c. the height of antenna (above ground level) used to provide the connection;
    d. the manufacturer and model used of the access point and/or antenna technology used to provide the connection;
    e. The bearing or beam of highest intensity in degrees from north of the antenna or access points used to provide connection. Where an omnidirectional antenna is used, please state 0 (zero);
    f. the EIRP (Effective Isotropic Radiated Power) of the access point/antenna used to provide the connection;
    g. the number of Customer Premises' Equipment (CPEs) served by this site;

4. For each property:

    a. at which you serve a customer through an existing network without the installation of new access points or any change to the existing antenna configuration;

    b. that could potentially be served without the installation of new access points;

[1] e.g. NGR to 10m or GPS position (to OSGB or WGS84 datum).
[2] Licenced frequency parameters or sub band and channel width in-use if licence-exempt.

please provide the UPRN (Unique Property Reference Number) of the property, or the address (which must include at minimum the property number and postcode) if the UPRN is not available.

5. For existing customers,

    a. the address of the premises to which the connection is made (as specified in Question 4a), which must include at a minimum the property number and postcode;

    b. whether the customer is a residential or business user (if known);

    c. the package information available, such as:
        i. Maximum advertised speed;
        ii. predicted/point of sale download speed (please separately specify if this is a predicted or point of sale speed and explain what this estimate is based on);
        iii. Guaranteed minimum download and upload speed communicated to the customer and explain what this estimate is based on;
        iv. Measured physical layer rate (measured at point of installation) or maximum possible connection speed between the ISP's access network and the consumer premise.[3]

    d. the customer premises equipment (CPE) used to provide the connection:
        i. equipment manufacturer name and model number;
        ii. antenna gain and installation height.

    e. the monthly data cap on this connection, if applicable.

6. Please confirm whether your predictions in response to question 5c have accounted for the use of the CPEs referred to in question 5d.

7. Please provide us with a detailed description of the steps you take to ensure the accuracy and quality of the coverage data provided to us in questions 2, 3 and 4. This should include any steps you have taken, or routinely take, to validate the accuracy of predictions (e.g. through measurement campaigns), to update planning or engineering models and to check or quality assure the data prior to submission to us.

[3] For example, any data you hold from speed measurement tests that were run at the time of the set up of the connection.