



4G Coverage Obligation  
Notice of Compliance  
Verification Methodology: LTE

Statement

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# Contents

Section		Page
1	Introduction	1
2	Summary of approach	3
3	Key parameters to be used in the SINR calculation	6
4	Overview of the calculation method	7

## Section 1

# Introduction

1.1 Section 5 of the Statement on the award of 800 MHz and 2.6 GHz spectrum states that a coverage obligation will be included in the licence that will authorise use of the frequencies 811 to 821 MHz paired with 852 to 862 MHz<sup>1</sup>. The associated licence condition is included in the relevant schedule to the template licence, included as an Annex to the Information Memorandum published by Ofcom at the same time as the Statement.<sup>2</sup>

1.2 The coverage obligation is specified as:

*“6. Coverage Obligation*

*(a) The Licensee shall by no later than 31 December 2017 provide, and thereafter maintain, an electronic communications network that is capable of providing, with 90% confidence, a mobile telecommunications service with a sustained downlink speed of not less than 2 Mbps when that network is lightly loaded, to users:*

- (i) in an area within which at least:*
  - a. 98% of the population of the United Kingdom lives, and*
  - b. 95% of the population of each of England, Wales, Scotland and Northern Ireland lives; and*
- (ii) at indoor locations that meet the condition specified in paragraph 6(b)(ii) of this Schedule, which are within any residential premises within the area specified in paragraph 6(a)(i).*

*(b) For the purposes of paragraph 6(a)(ii) of this Schedule:*

- (iii) the service must be provided using radio equipment which is not situated inside the relevant residential premises;*
- (i) the condition referred to is that the radio signal propagation loss from the outside of the building to the location inside the building does not exceed:*
  - a. 13.2dB for radio signals in the frequency ranges 791MHz – 821MHz and 832MHz – 862MHz;*
  - b. 13.7dB for radio signals in the frequency ranges 880MHz – 915MHz and 925MHz – 960MHz;*
  - c. 16.5dB for radio signals in the frequency ranges 1710MHz – 1785MHz and 1805MHz – 1880MHz;*
  - d. 17.0dB for radio signals in the frequency ranges 1900MHz – 1980MHz and 2110MHz – 2170MHz;*
  - e. 17.9dB for radio signals in the frequency range 2500MHz – 2690MHz;*
  - f. Any other propagation loss notified to the Licensee by Ofcom in respect of radio signals in any other frequency band.”*

1.3 For the purposes of this notice, we interpret:

- a ‘*network [that] is lightly loaded*’ as having a single user demanding service within the serving cell, and the surrounding cells of the network are loaded to a

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<sup>1</sup> See Section 5 of the Statement on the award of 800MHz and 2.6GHz spectrum

<sup>2</sup> See Licence Schedule: licence for the 800 MHz band with coverage obligation

light level (by which we mean the common channels only are transmitting at 22% of the maximum cell power).

- 1.4 Below we summarise our approach to monitor and verify compliance with this obligation based on a service provided using current LTE technology, noting that the obligation holder may use any of its portfolio of licensed mobile spectrum in order to meet the obligation. However, it will also be open to the obligation holder to meet the obligation with alternative mobile broadband technologies if they wish to. Should this be requested then we confirm that we will provide a relevant compliance verification methodology for that technology. In order to ensure that it is consistent with this LTE-based methodology we will ensure consistent principles are applied.

## Section 2

# Summary of approach

- 2.1 In order to assess whether a terminal located at any specific reference indoor location can receive the minimum downlink speed, we consider that the following condition needs to be met:
- the signal to interference plus noise ratio (SINR) of the relevant data channel (i.e. the Downlink Shared Channel (DL-SCH) for LTE systems) needs to be above a threshold required to sustain a downlink speed of not less than 2 Mbps. We set out below how that threshold is to be calculated
- 2.2 Our approach is to calculate a SINR(DL-SCH) distribution for a hypothetical test terminal located at a reference indoor location at each population point taking into account signals from the 20 closest base sites operating in that band.
- 2.3 The SINR threshold used to verify compliance with the obligation will be dependent on the bandwidth of the LTE channel being assessed. The SINR threshold is derived from TR 36.942<sup>3</sup> as shown in Table 2.1, however a minimum SINR cut-off is assumed at -5dB and this is reflected in the threshold applied in the verification process.

Bandwidth (MHz)	Theoretical SINR Threshold	SINR Threshold applied in verification
10	-4.1 dB	-4.1 dB
15	-6.1dB	-5.0 dB
20	-7.5 dB	-5.0 dB

**Table 1: SINR thresholds**

### Population distribution model

- 2.4 A population dataset based on residential delivery point data at a postcode unit level will be used. The current version of this is Geopoint Plus R53, however we will use the latest version as at 31<sup>st</sup> December 2016.
- 2.5 Population from the latest census data will be uniformly distributed across all residential delivery points within each census output area.

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<sup>3</sup> See Annex A Section A.1 of 3gpp TR 36.942 Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios", <http://www.3gpp.org/ftp/Specs/html-info/36942.htm>

- 2.6 The most up to date full census dataset will be used in any assessment. For the first verification exercise this will be the 2011 dataset<sup>4</sup>.
- 2.7 For subsequent compliance verification exercises, the version of source data for the population distribution that is current one calendar year prior to the date of the verification will be used.

### Propagation model

- 2.8 A median path loss will be calculated using ITU-R Recommendation P.1812-2 “A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands”<sup>5</sup>.
- 2.9 This recommendation predicts signal levels at the median of the multipath distribution exceeded for a given percentage of time, the assessment will use a time percentage of 50%.
- 2.10 Predictions are based on the terrain profile and clutter along the path.
- 2.11 A clutter end correction is applied at transmitter and receiver. This is based on a representative clutter height assigned to each clutter category. The representative clutter height depends not only on the typical physical height of clutter objects but also on the horizontal spacing of objects and the gaps between them.
- 2.12 We will use the default parameters for representative clutter heights as defined in P.1812-2. These are given in Table 2.

Clutter type	Representative clutter height (m)	
	Use in profile equation <sup>6</sup>	Use in Terminal clutter losses <sup>7</sup>
Water/sea	0	10
Open/rural	0	10
Suburban	10	10
Urban/trees/forest	15	15
Dense urban	20	20

**Table 2: Default information for clutter-loss modelling in P.1812-2**

- 2.13 Location variation can be considered to be approximately a lognormal distribution with zero mean. The location variation specified in P.1812-2 will be implemented using a standard deviation  $\sigma_L$  within the Monte Carlo process that will be used to create the SINR distribution:

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<sup>4</sup> The 2011 data set is expected to be released in plenty of time for the first verification. Should this not be available then we will revert back to the 2001 dataset

<sup>5</sup> <http://www.itu.int/rec/R-REC-P.1812-2-201202-l/en>

<sup>6</sup> Equation 1c in P.1812-2

<sup>7</sup> Section 4.76 in P/1812-2 applicable to Equation 64b for water/sea/open and rural categories and Equation 64a for the other categories

$$\sigma_L = K + 1.3 \log(f) \quad \text{dB}$$

with a value of  $K = 5.1$  dB for Urban and Suburban clutter and  $K = 4.4$  dB for all other clutter types listed in Table 2. Frequency,  $f$ , is in GHz.

### Terrain database

- 2.14 Ordnance Survey “Land-form Panorama<sup>®</sup>” 50 m resolution digital terrain map data shall be used.

### Clutter database

- 2.15 The 50 metre resolution clutter dataset produced by Infoterra shall be used.
- 2.16 This dataset identifies 10 different clutter categories. For location variation these are mapped to the required urban, suburban and open clutter designations as outlined in Table 3.

Category	Description	Clutter Designation
1	Dense Urban	Urban
2	Urban	Urban
3	Industry	Suburban
4	Suburban	Suburban
5	Village	Suburban
6	Parks/Recreation	Open
7	Open	Open
8	Open in Urban	Open
9	Forest	Open
10	Water	Open

**Table 3: Infoterra clutter code mapping**



### Section 3

## Key parameters to be used in the SINR calculation

- 3.1 Table 4 contains the key parameters to be used in the SINR calculation; these are given for 800, 1800 and 2600 MHz. Should assessment be required for any other frequency band, suitable parameters will be set by Ofcom upon request from the licensee with the obligation.

Parameter	800 MHz	900 MHz	1800 MHz	2100 MHz	2600 MHz
UE Noise figure	10 dB	10 dB	10 dB	9 dB	9 dB
UE Antenna gain	0 dB	0 dB	0 dB	0 dB	0 dB
D-SCH Power	78%	78%	78%	78%	78%
Common channels	22%	22%	22%	22%	22%
Body/orientation loss	2.5 dB	2.5 dB	2.5 dB	2.5 dB	2.5 dB
Reference indoor location loss	13.2 dB	13.7dB	16.5 dB	17.0 dB	17.9 dB

**Table 4: Key parameters for LTE**

- 3.2 Theoretical radiation patterns taken from 3GPP TR36.814 tuned to the supplied antenna beamwidths will be applied in the SINR calculation.

$$\text{Azimuth pattern: } A_H(\varphi) = -\min \left[ 12 \left( \frac{\varphi}{\varphi_{3dB}} \right)^2, A_m \right]$$

$$\text{Elevation pattern: } A_V(\theta) = -\min \left[ 12 \left( \frac{\theta - \theta_{tilt}}{\theta_{3dB}} \right)^2, SLA_v \right]$$

The values of  $\varphi_{3dB}$ ,  $\theta_{3dB}$  and  $\theta_{tilt}$  are supplied inputs,  $A_m = 25$  dB and  $SLA_v = 20$  dB.

## Section 4

# Overview of the calculation method

4.1 The calculation would proceed along the following lines, illustrated in Figure 1:

- The operator supplies data for each site in its network. This data should include all of the following:
  - Unique site reference
  - location (6 figure NGR);
  - height above ground level (metres);
  - number of sectors;
  - for each sector;
    - frequency carrier(s)
    - boresight direction (degrees east of north);
    - boresight gain (dBi);
    - horizontal 3 dB beamwidth (degrees);
    - vertical 3 dB beamwidth (degrees);
    - combined mechanical and electrical downtilt (degrees);
    - maximum transmit power (into antenna) or EIRP (dBm);
- For each population data point:
  - the nearest 20 base stations transmitting on that carrier to the population point are identified;
  - for each sector of the nearest base stations identified in the previous step, the downlink power that would be received by a terminal 1.5 metres above ground level at the population point location is calculated;
  - a theoretical antenna radiation pattern tuned to the beamwidths provided in the input data is applied to each sector;
  - the base station sector (excluding those designated non-serving sites only above) providing the highest received power is designated as the serving sector;
  - non-serving sectors are assumed to be transmitting at 22% of their maximum power (i.e. they are lightly loaded);

- a SINR of DL-SCH distribution is created using a Monte Carlo process calculated by assuming 0.5 location variability cross-correlation between the serving and non-serving sites;
- if the 90% percentile of the resultant SINR distribution is calculated to be greater than or equal to the SINR threshold in Table 1 the population point is deemed to be served;
- if the first carrier does not serve the point the next and subsequent carriers (until all provided carriers are exhausted) will be assessed in turn. If one of them meets the criteria in the points above the population point is deemed to be served;
- the population associated with the served population point is added to the 'cumulative total population served' and the 'cumulative population served' of its associated nation. Once the value of 'cumulative population served' is greater than or equal to 98% population of the UK and 95% population of each nation, the licence condition will be deemed to have been met and the verification process is stopped.

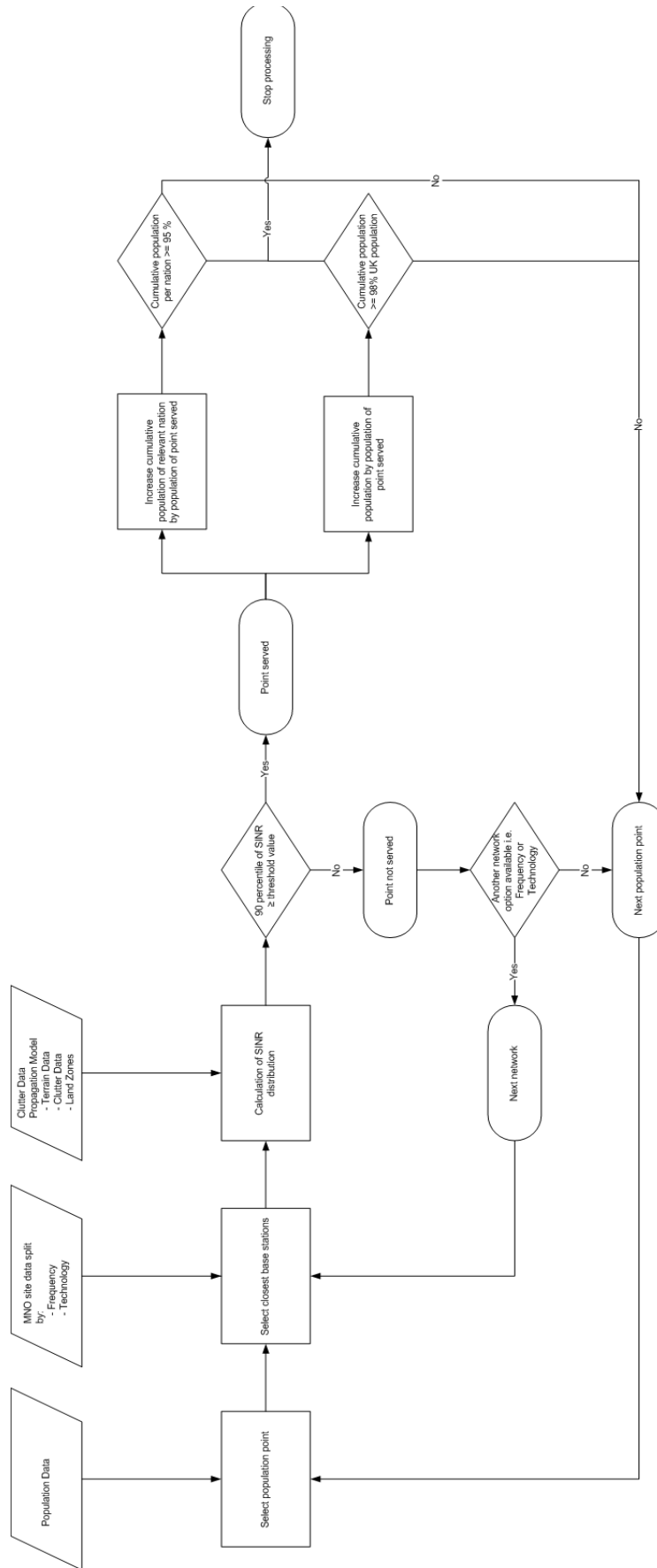


Figure 1: Process Overview