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Annex 3

to Call for offers for the purpose of awarding the rights to use radio frequencies to ensure a public communication network in the 1800 MHz and 2600 MHz bands

Calculation and measurement for the purposes of checking the coverage of the territory by the signals of mobile broadband data networks

1 INTRODUCTION

The purpose of this document is to set out the methodical approach and the basic terms and conditions of the calculation of coverage and the control measurement for evaluation of adherence to the terms and conditions laid down on the Holders of Authorisation to use frequencies in the 1800 MHz and 2600 MHz bands.

a) Coverage is understood to be the operation of a public electronic communication network with the use of the frequency allocations obtained in the Tender in the 1800 MHz and 2600 MHz bands that is able to provide a high-speed Internet access service of a speed of at least 2 Mbit/s (download) within 7 years from the effective date of the decision about radio frequency allocation and 5 Mbit/s (download) in the subsequent period, with 75 % probability of indoor reception (indoor coverage) without the use of an external aerial and with 85 % probability of indoor reception with the use of an external aerial.
b) The results of predictive calculations provided to the Office by the network operator in the form of suitably-structured data are the priority in evaluating coverage by the signals of the mobile network.
c) The evaluation of coverage will be done on a map of the Czech Republic with a defined graticule of 100 x 100 m (coordinates in UTM format).
d) The Office will check the provided predictive calculations using calculations of the technical parameters of the network provided by the Holder of an allocation. A diffraction model of signal transmission (ITU-R 1812 version 3) will be used for calculations that takes into consideration the influence of morphology for higher frequencies in rural areas (the used terrain model in SW for the calculation has definition of 2 x 2 seconds).
e) If there is variance between the predictive calculations of the network operator and the calculations of the Office, it is assumed that subsequent measurement will be conducted of the absolutely required parameters to ensure the possibility of an objective consideration of coverage of territory and number of inhabitants by mobile data network signals.
f) The measured parameters and their limits relate to the LTE systems operated according to current ETSI standards and 3GPP specifications. If a different system is used (for example LTE-A), the equivalent parameters will be measured and evaluated according to its specifications.
g) The network operator documents satisfaction of the terms and conditions of coverage using coverage maps from computer predictions in which satisfaction of the terms and conditions of population coverage is documented.

2 THE EVALUATION OF DATA

a) Predictive coverage maps will invariably be submitted during a check of satisfaction of the terms and conditions of the practical use of frequencies according to section 7.3 of the Call for Offers.
b) Aggregate data will be presented to the Office at an initial interval of 1 month, in that this may be adjusted later as required.
c) The Office will provide the Holder of an Allocation, on request, with a vector map of the Czech Republic with graticule of 100 x 100 m according to point 1 c), featuring the attributes of district, municipality and number of inhabitants, and a detailed work methodology with a map and support programmes for evaluation.
d) The operator will add a map with its own layer, with identification of coverage (covered / not covered) of each 100 x 100 m square. The arithmetic average will be used in the case of conversion from more detailed segmentation (for example, 20 x 20 m).

3 THE MEASUREMENT OF COVERAGE

One of the parameters under consideration in checking satisfaction of the terms and conditions of frequency allocation is the determination of coverage by signal of mobile high-speed access to data services.

3.1 The conditions of measurement

a) Measuring the parameters of the LTE signal is undertaken “on the move” with an omnidirectional aerial placed at a height of 1.5 m or 3 m.
b) The calculation of coverage is done for an aerial at the terminal at a height of 1.5 m; if it is necessary to measure with an aerial height of 3 m, the correction k_v is used to convert the level (of power, of the intensity of the electromagnetic field) to the reference height of the aerial of 1.5 m:

   $P_{1.5m} = P_{3m} – k_v$, in which k_v = 5 dB for the 1800 MHz band and
   k_v = 6 dB for the 2600 MHz band.

c) Diversity measurement with 2 aerials (MIMO) is preferred.
d) When measuring the level, the measured value is corrected such as to correspond to gain of the aerial of G_i = 0 dB and attenuation of the feeder of 0 dB.
e) If required, this corrected value is converted into the intensity of the electromagnetic field (measurement in the case of disputes with foreign administrations in border areas).
f) Measurement is only conducted outside a building; coefficients representing attenuation of LTE signal as a result of passing through the wall of the building are used for the supposition of coverage inside buildings in different frequency bands (with regard to the need to use one coefficient, this supposition is invariably loaded with a significant error).
g) Coefficients representing attenuation of LTE signal as a result of passing through the wall of the building are the following:
   k = 11 dB for the 1800 MHz band and
   k = 13 dB for the 2600 MHz band.

3.2 Measured parameters

With respect to the intelligence of elements of radio networks, in particular BS (dynamic changes of power, forming radiating bundles of aerials according to the requirement of the UE etc.) for the objective consideration of territorial coverage with an LTE signal, the parameters of the signal (frequency) will be measured with limit values ensuring the functionality of the radio network:

a) Reference signal received power - RSRP

minimum value:	-122 dBm	– based on the physical properties of the UE
margin:	4 dB	– for real environment
limit value:	-118 dBm	(outdoor)

limit values for indoor (with correction for attenuation of the building walls), for reception without use of an external aerial for 75 % reception probability:

frequency band	RSRP
1800 MHz	-107 dBm
2600 MHz	-105 dBm

When using an external aerial, we can assume assurance of coverage with 85 % reception probability (gain of aerial is a minimum of 2.5 dBi, suitably-chosen location); outdoor reception is automatically ensured.

b) Signal to interference plus noise ratio - SINR

limit value: -5 dB

The SINR, measured for reference channels, has an unambiguous relationship to achievable data speed. There is no need to correct the value depending on the frequency band as a result of the influence of the same attenuation of useful and interfering signal. The stated limit value stands for the same conditions as the reference signal received power RSRP.

Table of limit values for coverage measurements

System	Frequency band [MHz]	RSRP [dBm]	SINR [dB]
LTE	1800	-107	-5
LTE	2600	-105	-5

N.B. The limit values of the measured parameters are stated for aerial height of the UE of 1.5 m.

3.3 Requirements on measuring equipment

a) Measuring aerial

- An aerial with an omnidirectional radiating diagram, vertical polarisation and defined gain (for the possibility of correction of the measured value for defined system gain of $G_{ant} – b_{nap} = 0$ dB) is used for measuring “on the move”.
- The coaxial cable between the aerial and the receiver input (if used) must have defined attenuation in the operational frequencies band (for the chance to correct a measured value).

b) The scanner

- The scanner must allow for measurement of the parameters of RSRP and SINR for reference signals according to the relevant specifications of ETSI and 3GPP.
- UE with the corresponding parameters or arbitrary equivalent equipment that complies with the requirements on the objective measurement of the specified parameters can also be used for measurement.

4 MEASURING DATA SPEED

The speed of data transmission in mobile networks according to point 1 a) will be measured against a server with measuring data that will be located at a place with guaranteed connectivity of at least 1 Gbit/s in the following cases:

a) When investigating complaints regarding the interference of network operation or failure to observe the speed contractually guaranteed between the client and the service operator.
b) During random measurement in order to check adherence to the terms and conditions laid down in the Tender.

The methodical procedure of measuring the speed of data transmission in mobile networks according to the LTE standard is published on the Office's website[1].

Measuring the speed of data transmission in mobile networks will be done as follows:

4.1 Stationary measurement

- In the case of random measurement according to point 4 b) – the measurement of four consecutive hours, invariably a minimum of four times each hour, with a minimum time interval of individual measurements of 10 minutes.
- In the case of measurement according to point 4 a) – measurement for a period of 1 hour.

4.2 Measurement "on the move"

- Measurement "on the move" is used according to the requirements of the Office in order to ascertain the indicative blanket spread of achieved data speeds and in checks of satisfaction of the terms and conditions of the Tender for coverage of highways.
- An analysis of the results ascertained by way of mobile measurement can be used to determine the place in which stationary measurement will be carried out according to point 4.1.

The required speed is achieved in the case that:

- The transmission speed achieves the required value (2 Mbit/s or 5 Mbit/s) in at least 50 % of the measurements in the relevant measurement series and place.
- The average speed of all measurements in the relevant measurement series and place achieves at least 75 % of the required value (1.5 Mbit/s or 3.75 Mbit/s).

A measuring terminal or equivalent equipment with software that allows the time flow of transmission speed to be monitored and analytical and statistical calculations over and above the ascertained data to be conducted is used to measure data speed.

Measurement will be done from the above-mentioned mobile equipment via the network of the operator against a server with guaranteed connectivity to the backbone network.

If the above-mentioned speed conditions are not satisfied, one repeat measurement will be conducted for verification purposes.

5 THE PROCEDURE DURING MEASUREMENT

The general principles used during measurement:

a) The measurement of RSRP and SINR parameters in a populated area will be conducted in the standard way of measurement "on the move", as is the case when measuring the signals of other mobile networks (GSM, CDMA).
b) When measuring a populated area, measurement "on the move" is first carried out along the main roadways of the location being measured and the results are compared with the coverage maps presented by the network operator. In the case

[1] http://www.ctu.cz/cs/download/aktualni_informace/measurement_speed_15_08_2013.pdf

that the measured values fundamentally differ from the predicted values, detailed measurement on all accessible roadways is carried out in municipalities.

c) In the case that the measured coverage differs significantly from the predicted, a meeting will be arranged between the Office and the network operator at which agreement will be reached on onward procedure, the aim being to ascertain the causes of the differing results.
d) Measurements of the intensity of the electromagnetic field must be carried out in border areas in order to evaluate adherence to the planned parameters in accordance with valid recommendations or bilateral/trilateral agreements within the scope of the HCM Agreement.
e) During evaluation, the measured data will be compared with the predicted coverage values provided in map form by the operators of networks according to point 2 d).

6 ABBREVIATIONS USED

BS	*Base Station* – designated as eNodeB in the LTE system
UE	*User Equipment* – also terminal