ECC Report 231

Mobile coverage obligations

Approved 6 March 2015

0 EXECUTIVE SUMMARY

In 2014, ECC had noted the need to assess the various coverage obligations in force and how they are controlled/assessed (measurement and/or simulation). For that ECC invited ECC PT1 to develop a questionnaire on coverage obligations and how they are controlled (measurement and/or simulation). 29 administrations[1] have replied to the questionnaire including a number of non-EU countries indicating a significant interest in the subject. A summary of responses was drafted by ECO, see ANNEX 3:. The previous results of the questionnaire from RSPG/BEREC on coverage obligations were also used in the development of this Report.

The analysis carried out in this Report is seeking to provide the following:

- Overview of the current situation regarding coverage obligations in CEPT identifying the types of coverage obligations in practice;
- Analysis of the current criteria's for the availability of coverage per type of service;
- Analysis of the enforcement of coverage obligations for Rights of Use/licences to use the spectrum;
- Make suggestions for future practice.

Based on the analysis (of responses) done in this Report, it becomes clear that many different approaches have been chosen throughout the CEPT concerning coverage obligations and relevant enforcement measures. It is difficult to seek to establish one harmonised approach to coverage obligations and enforcement, largely due to the different policy reasons for national administrations in deciding to set coverage obligations, such as specific areas of population or geographical coverage requirements. It should be noted that the definitions and enforcement of coverage obligations are to be considered as a national matter.

[1] In addition one administration replied that is was unable to answer the questions for the time being.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
BEREC	Body of European Regulators for Electronic Communications
CEPT	European Conference of Postal and Telecommunications Administrations
CPICH	Common pilot channel
dBµV/m	Decibel above 1 microvolt per meter
dBm	Decibel referenced to milliwatts
DTM	Digital terrain model
ECC	Electronic Communications Committee
ECC PT1	ECC Project Team 1 - IMT matters
e.i.r.p.	equivalent isotropically radiated power
GIS	Geographic information system
GSM	Global System for Mobile Communications
ITU	International Telecommunication Union
JRC	Joint Research Council
kbit/s	kilobit per second
LTE	Long Term Evolution
Mbit/s	Megabit per second
MFCN	Mobile/fixed communications networks
NRA	National regulatory authority
RSCP	Received signal code power
RSPG	Radio Spectrum Policy Group
RSRP	Reference signal received power
RxLEV	Received signal level
RxQUAL	Received signal quality
SINR	Signal-to-interference-plus-noise ratio
UMTS	Universal Mobile Telecommunications System
WAPECS	Wireless Access Policy for Electronic Communications Services
WCDMA	Wideband Code Division Multiple Access
WG FM	Working Group Frequency Management

1 INTRODUCTION

In 2011 BEREC/RSPG issued a questionnaire on 'Economic and social value of spectrum'. The purpose of that survey was to collect information on the assignment process in a number of WAPECS frequency bands. The answers to the questionnaire did not contain any information on the current field strength or signal level necessary to achieve the required coverage in mobile telephony/data networks. From the answers to the BEREC/RSPG questionnaire it can be concluded that there is a large variation in the coverage and service obligations from one country to another, even from one frequency band to another, and they indicate a large variation in the choice of monitoring/enforcement.

In 2014, ECC had noted the need to assess the various coverage obligations in force and how they are controlled/assessed (measurement and/or simulation). In the end the collected information could help to reach a best practice or a common understanding of the criteria to establish whether a certain area is considered to be covered. For that ECC launched a questionnaire to collect information about the current coverage obligations and how these obligations are enforced in public cellular networks (800 MHz, 900 MHz, 1800 MHz, 2 GHz, 2.6 GHz) throughout the CEPT countries.

In total, 29 administrations[2] have replied to the questionnaire including a number of non EU countries (see Annex 3) showing evidence of a significant interest in the subject. A summary of responses was drafted by ECO, see ANNEX 3:. The previous results of the questionnaire from RSPG/BEREC on coverage obligations were also used in the development of this Report. From the answers to the ECC questionnaire it can be understood that the conclusions from the /RSPG/BEREC questionnaire remain valid.

In many European countries coverage requirements/obligations are included in the Rights of Use (or licence conditions) of the public mobile networks operators but not the criteria to service coverage (e.g. signal strength). Furthermore, as there is no harmonisation for coverage, different coverage requirements/obligations and criteria's are used in different countries. The same technologies and the same type of network equipment and terminals are used, but the national context might lead to different needs (for instance, importance of the indoor coverage in some countries, small interest of geographical coverage in countries with large area uninhabited) and coverage obligations, which could also respond to national policy objectives. Additionally there is a growing demand in some countries to provide this kind of information to end-users, especially when certain requirements (data rates, indoor coverage etc.) are included in the Rights of Use (or licence conditions) of the public mobile networks operators.

Describing the different practices on how coverage is defined and assessed among the CEPT countries could help administrations in supervision of the Rights of Use/licence conditions.

Various deliverables on coverage measurement are already available in ECC, such as the ECC Report 103 [1] on UMTS coverage measurements that describes a method to measure UMTS coverage, and ECC Report 118 [2] with a monitoring methodology to assess the performance of GSM networks. Both methodologies are based on practical measurements in the field given information of the coverage and some indicators about the quality of service of the network at specific points and at specific moments on time. ECC has identified the need to develop a similar Report on LTE measurements.

Therefore, the analysis carried out in this Report is seeking to provide the following:

- Overview of the current situation regarding coverage obligations in CEPT identifying the types of coverage obligations in practice;
- Analysis of the current criteria's for the availability of coverage per type of service;
- Analysis of the enforcement of coverage obligations for Rights of Use/licences to use the spectrum;
- Make suggestions for future practice.

[2] In addition one administration replied that is was unable to answer the questions for the time being.

The Report is structured as follows:

- In Chapter 2, different types of coverage obligations (voice coverage and data coverage) are introduced as well as the relevant observations of the responses to questionnaire on these obligations, and the associated criteria for the availability of coverage per type of service;
- In Chapter 3, enforcement related topics are highlighted;
- In Chapter 4, an additional possibility for future practice is shown;
- In Chapter 5, criteria and enforcement issues are analysed;
- In Chapter 6, conclusions are drawn;
- In Annex 1, the summary of responses are provided statistically;
- In Annex 2, an example of smartphone application to gather crowdsourced performance data is presented;
- In Annex 3, a summary of the responses to the questionnaire is provided
- In Annex 4, the list of references.

2 COVERAGE OBLIGATIONS AND ASSOCIATED CRITERIA

This chapter includes an overview of the current situation regarding coverage obligations in CEPT countries which responded to the questionnaire on coverage obligations, and associated criteria for the availability of coverage per type of service. The results shown in this section are based on the answers from the questionnaire available in ANNEX 3: (some statistical analysis of the questionnaire is available in Annex 2) launched by ECC PT1 as well as the RSPG/BEREC questionnaire on 'Economic and social value of spectrum'.

A quick analysis of the answers shows that of the 29 answers:

- 24 administrations have imposed coverage obligations regarding the voice service in one or more frequency bands;
- 25 administrations have imposed coverage obligations regarding the data service in one or more frequency bands.

The following sections are describing in more detail the types of coverage obligations used in the CEPT administrations.

2.1 TYPES OF COVERAGE OBLIGATION

A vast majority of CEPT administrations have imposed some sort of coverage obligations through Rights of Use/licences to use spectrum for public mobile communications. Some have set up coverage obligations for the voice service, some for the data service and some for both.

Two main types of coverage obligations can be extracted from the questionnaire:

- **Population coverage**: the operator needs to cover a percentage of the population;
- **Area coverage**: the operator needs to cover a percentage of the territory.

According to the answers to the questionnaire, population coverage obligations are more commonly used than area ones and in some countries both apply.

The coverage obligations can be gradual through time. For example, in Belgium for the 800 MHz band, the coverage obligation, that does not include the voice service, is:

- 30% of population 2 years after obtaining licence;
- 70% of population 4 years after obtaining licence;
- 98% of population 6 years after obtaining licence.

The coverage obligations can also be combined, like in Denmark for the 800 MHz band, where for one licensee the following obligation, 98 % geographical coverage and 99.8 % population coverage with other specific terms has been assigned.

However specific assumptions for the coverage obligations, like indoor or outdoor coverage, are in the majority of cases not defined in the Right of Use/licence conditions.

Some countries have coverage obligations than can be provided with the combination of frequency bands or technologies in use. This applies mostly to data services (800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz or a subset of these bands) but it can also apply to voice services. For example, Portugal has now its obligations by service, voice and data, and these can be fulfilled using all the frequencies/technologies that are allocated/authorised for the mobile operators.

On the contrary, some countries have specific coverage obligations per frequency band or technology in use.

It should be noted that the coverage obligations can be different from one licensee to another in the same country. For example in Finland there are two different coverage obligation sets in the 800 MHz frequency band, one has higher obligations compared to two other licences:

- The mobile network has to cover 95 % of the population of mainland Finland within three years of the license period, and 99 % of the mainland of Finland's population within five years of the license period;
- Two other mobile networks have to cover 97 % of the population of mainland Finland within five years of the license period begins.

This is due to auction rules and also certain roll-out restrictions in coordination agreements with neighbouring countries and the protection of the use of DTTB channel 60 in Finland.

In some cases coverage obligations are considered fulfilled, for example in the 900 MHz and 1800 MHz bands allocated to MFCN a long time ago. In the event of renewed licences or spectrum auctions for such bands, quite strong coverage obligations have been established, with a possibility to fulfil the obligation by combining different frequency ranges or aggregate coverage in various bands. Sweden, for example, by the time of prolonging the licences in the 900 MHz band, laid down an obligation to maintain considerable voice coverage. Some administrations have turned to such obligations as a measure of universal service obligation (e.g. voice and data).

Some administrations have developed specific coverage obligations to respond to a national demand. For example:

- In Portugal, each mobile operator has the obligation to cover 160 parishes geographically and these coverage obligations only can be met with the use of frequencies in the 800 MHz and 900 MHz bands (the operator should communicate if they intend to use the 900 MHz band);
- In France, in order to maximise the geographical coverage, “area of high priority” has been defined, area with a low density of population (the area represents 63 % of the territory and 18 % of the population) for the LTE deployment. The operators have an obligation to cover a certain percentage (population) of this area (40 % in January 2017 and 90 % in January 2022). In order to help this deployment, the administrations facilitate the association of different operators for the installation of base stations (one base station for several operators). Some similar obligation has been developed for GSM and UMTS;
- In Sweden one of the frequency blocks in the 800 MHz band was auctioned on condition that the licensee should cover certain uncovered identified permanent homes and business places with data communications to a rollout cost of a least approximately 30 000 000 euro;
- It was indicated that in some cases issued Rights of Use/licenses contain also more general obligations related to coverage obligations e.g., obligations to install a certain number of base stations per predetermined territory (square kilometres).

2.2 CRITERIA ASSOCIATED TO COVERAGE OBLIGATIONS

Chapter 2.1 of this Report gives an overview of the possible coverage obligations currently imposed by service through Rights of use/licencing schemes in CEPT countries which answered to the questionnaire.

Following sections analyse the current criteria for the availability of coverage per type of service, voice and data, reported in the survey.

2.2.1 Criteria for voice coverage

The answers to the questionnaire indicate various kinds of criteria to be fulfilled for voice coverage. The different criteria possible that were described in the answers to the questionnaire are:

- **The ability to make a phone call**: for example in France, the criteria for voice coverage is the ability to make a one-minute phone call, outside of buildings, walking with pedestrian speed;
  - The advantage of this criterion is that it gives a realistic usability for defining the coverage.

- **The field strength**: the answers to the questionnaire give a range from 38 to 58 dBµV/m. Some additional prerequisites can be given such as the height above ground (from 1.5 to 1.7 m) and a probability at cell edge (from 50 to 75 %);
  - This criterion gives the opportunity to verify easily the voice coverage, but also tenable the administrations to make some calculation for a theoretical coverage. It links directly the field strength to the voice coverage. In reality this connection may not be that easy as other parameters such as the cell load for example might have an impact on the possibility to make a phone call.
- **The signal strength**: the answers to the questionnaire give a range from -106 to -75 dBm. Some additional prerequisites can be given such as the height above ground (from 1.7 to 3 m) and a probability of cell load (30% in the 2.1 GHz band);
  - Same remarks as for the field strength.
- **Quality measurement for voice service**: for example a value of RxQUAL ≤ 4 is defined in one CEPT country;
  - According the ECC Report 118 RxQUAL value is used together with a certain RxLEV value during the measurement as a decision threshold to define if locations are covered or not e.g. RxLEV≥ 18 (≥ -92 dBm) and RxQUAL ≤ 4 [2].
- **A specific bitrate as an indication/criterion for voice coverage**: the answers to the questionnaire give a range from 12.2 to 144 kbps. The condition to be outdoors is given as an additional prerequisite.
  - The bitrate, as the ability to make a phone call, is a criterion that is realistic but which is harder to use in practice to calculate the coverage of an operator.

A majority of administrations use the field strength or signal strength as criteria to evaluate the availability of voice coverage. In general those administrations which are using signal strength as criteria have defined a higher value for GSM than for UMTS.

2.2.2 Criteria for data coverage

The answers to the questionnaire indicate various kinds of criteria to be fulfilled for data coverage. In many cases a bitrate is defined but not all answers provide all the necessary prerequisites. Different possible criteria were described in the answers to the questionnaire.

- **Maximum theoretical data rate**: for example in France, the maximum theoretical data rate has to be at least 60 Mbit/s on the downlink in bands where LTE technology is assigned;
- **Downlink data rate**: a majority of administrations define a minimum downlink data rate to achieve. Different values are given, from 144 kbps to 30 Mbps for broadband frequency bands, lower values are given for narrowband frequency bands.
  - Some administration make these obligations evolve with time, asking an initial downlink data rate, and increasing it after a number of years;
  - Some administrations answered that as a condition in the license, there is an obligation for some areas to be covered with a higher downlink data rate than others. For example in Austria, where it is 2 Mbit/s downlink and 0.5 Mbit/s uplink for specific municipalities, and 1 Mbit/s downlink and 0.25 Mbit/s for the rest;
  - It is also possible to take into account the variation through the day. For example Iceland asks for downlink coverage: 10 Mbps (sometime during 24 hours), 3.85 Mbps (24 hour average) and 2.5 Mbps (average 3 hours peak time) within 4 years after obtaining licence.
- Some administrations asked for a **minimum of population to be covered with a specific minimum data rate,** some required coverage of specific location before extending the coverage to other places;
- The term **outdoor coverage** is also used in some answers to the questionnaire;
- **Limit values for RSRP** and **SINR** are also used. In Czech Republic, for the LTE 800 MHz, the limit value for RSRP is -109 dBm (outdoor) and for SINR is 5 dB.

The different criteria (population, evolution through time, location specificity, etc.) can be combined in order to give more flexibility to administrations and to adapt the obligations to the country's needs.

3 ENFORCEMENT OF SERVICE (VOICE AND DATA) COVERAGE

Most of the CEPT countries did not define a common set of parameters agreed both by the regulator and by the mobile operators to check the service coverage. Nevertheless, an example in the questionnaire can be highlighted. United Kingdom defined a verification methodology for assessment of the coverage, included in the Rights of Use of the mobile operators, where assumptions like the propagation model to be used in the calculations, the population distribution model, the terrain database, etc. are included.

3.1 SUPERVISION METHODS CURRENTLY IN USE

The answers to the questionnaire describe a broad variety of methods for supervision of compliance of the coverage obligations imposed.

In the questionnaire, four main methods were listed as possible supervision techniques, and are described in the following sections.

3.1.1 Operators provide information on their network coverage

Some administrations ask or require the mobile operators to report on their network coverage and how they are fulfilling their obligations. The administrations which have specified periodic information stated that operators need to provide annual information on their network coverage. In some countries this information needs to be provided on band-by-band and even technology basis. It is not clear in the answers to the questionnaire how they validate the coverage data sent by the mobile operators, but theoretical studies or field measurements (respectively section 3.1.2 and 3.1.3) could be used to confirm the information from the operators if the administrations have the necessary tools and databases to perform the coverage studies as well as knowledge of the relevant network parameters.

3.1.2 Theoretical studies run by the administrations/NRA

Administrations can decide to run some theoretical calculations to assess the network coverages of the different mobile operators based on some technical information provided by the operator. These studies can determine either the population or/and the territory coverage.

An example of a list of information needed is given below, based on the data given by Slovenia and Latvia in the questionnaire, in order to compute the coverage:

- The locations of the base stations in accordance with a specified geographical projection / coordinates of base station (degrees);
- Indication of site name, network name, network type;
- Antenna height of base station and effective antenna height above ground level in meters;
- Transmitting frequency;
- For each sector:
  - Azimuth – direction (degrees);
  - Horizontal / vertical 3 dB beamwidth (degrees) / antenna type and diagram;
  - Combined mechanical and electrical downtilt (degrees);
  - The effective isotropic radiated power e.i.r.p. / effective radiated power e.r.p. (dBW);
  - Antenna gain (dBi);
  - An indication of the frequency blocks used in each cell (sector);
- A map with base station locations and covered areas (GIS / GEO TIFF format, vector graphics, defined by the NRA in cooperation with each operator);
- A list of raster cells covered and the coverage level calculated on that basis

It is then up to the administration/NRA to compute the theoretical coverage based on different assumptions.

For example a possible list of parameters to define:

- A propagation model
- Lognormal location variation with a specified standard deviation;
- A specified terrain database (DTM);
- A specified clutter database;
- Specified population locations and settlement identifiers;
- Specified use equipment noise figure and antenna gain;
- Theoretical base station antenna azimuth and elevation radiation patterns;
- Network load;
- Time and location probability;
- Received signal strength or field strength level;
- Antenna receiver height.

It should be noted that this type of theoretical studies require a specific tool, particular expertise and is generally expensive. In some countries, these kind of theoretical studies are verified by spot or field measurements in order to estimate the reliability of the simulation.

It can be highlighted that United Kingdom defined a verification methodology for assessment of the coverage, included in the Rights of Use of the mobile operators, where assumptions like the propagation model to be used in the calculations, the population distribution model, the terrain database, etc. are included.

3.1.3 Field measurements

The administrations/NRA can conduct tests on the license holder's network and measure the coverage and/or the quality of service at times and places of its choice in order to verify that the submitted information regarding base stations and coverage is an accurate representation of the current state of the license holder's network. These tests can be intended to verify for example the base station parameters, level of field strength and quality of service at some end users locations.

4 ADDITIONAL POSSIBILITY FOR FUTURE PRACTICE

4.1 CROWDSOURCING TO VERIFY MOBILE COVERAGE

One administration has mentioned the idea of using a smartphone app to log signal strength and coordinates for further analysis.
Examples can be found at http://opensignal.com/ and http://www.speedtest.net/pt/mobile/.

There are also a number of applications that perform measurements on network speeds (uplink/downlink) with various methods, most usually only top speed for both directions is given as a result. More advanced methods contain, recognition of terminal type, location, network type, average speeds, see https://www.netradar.org/en. A more detailed example of the system requirements can be found at ANNEX 2:.

This method needs further investigation and the methodology they use to assess the coverage of the network in specific points needs to be clarified. The disadvantage of this methodology, as well as the field measurements to assess the coverage and/or QoS of the mobile network, is that the information is only available at locations where participating mobile phones exist and does not give an overall overview of the network coverage. The advantage of this methodology is that with "sufficient" measurements at the same specific location, it will be possible, with time, to have a real shape of the network at that specific location.

It should also be noted that the Joint Research Center (JRC) is working on an application which seeks to crowdsource spectrum monitoring, by early 2015[3]. It should be noted that ECC expressed a statement on this new form of monitoring application further to a workshop on this new form of monitoring spectrum[3].

[3] http://www.cept.org/ecc/groups/ecc/client/introduction/ecc-statement-on-spectrum-occupancy-workshop

5 CRITERIA AND ENFORCEMENT

Criteria and enforcement are related as enforcement defines the methodology to be used to assess the criteria defined for service coverage.

In principle the criteria to assess/for assessing the availability of voice coverage could be easy to confirm. If it is possible to make a phone call there is coverage and from section 2.2 this can in theory be translated into a field or signal strength, but not for the cases where there is signal strength but also co-channel interference (e.g. in GSM the availability of signal doesn't mean the possibility to make a voice call because it is possible to have co-channel interference or the channels can be full occupied by other users). Additionally, if a theoretical study is done, where there is a need to define the assumptions including the propagation model chosen and, the availability of the needed signal calculated by the tool in a specific location to make a voice call, this does not mean that in reality in that location the needed signal to make a phone call will be available. It should be noted that administrations do not agree to one single value to be used in their obligations for voice coverage.

In the case of data coverage it is just as easy to require a certain bitrate. High signal strength does not guarantee a high bitrate itself, for example high cell load, high speed user (in a train/on a highway) will influence the available bitrate and end-user experience. However, with theoretical studies and some assumptions (e.g. the available bandwidth is all allocated to one user per cell) it would be possible to determine some coverage predictions for different bit rates but, that would not correspond exactly to the reality.

This means that theoretically speaking, even only with studies, the calculation of the data service is more difficult than for the voice service.

Concerning the tolerance (margin allowed for coverage obligations) compliance established by the administration from the answers received to the questionnaire it can be concluded that the majority of administrations do not establish a tolerance.

Based on the above mentioned aspects, it is clear that establishing a comprehensive and precise measure to verify coverage obligations is rather a complex exercise. This is particularly difficult given the need to define an agreed methodology/criteria among the regulator and the mobile operators. In fact, all these uncertainties can lead to some difficulties (in particular on the legal grounds) to demonstrate unambiguously and to implement the consequential enforcement measures concerning a possible non-compliance of the coverage obligations.

6 CONCLUSIONS

Based on responses to questionnaire on coverage obligations, this Report describes various approaches in force in some CEPT countries. These coverage obligations are laid out in licences to use spectrum today. A number of different ways to define the criteria for both voice and data coverage is discussed. In consequence a number of different approaches to enforcement have been identified in this Report.

Based on the analysis (of responses) done in this report, many different approaches have been chosen throughout the CEPT concerning coverage obligations and relevant enforcement measures. It is difficult to seek to establish one harmonised approach to coverage obligations and enforcement, largely due to the different policy reasons for national administrations deciding to set coverage obligations, such as specific areas of population or geographical coverage requirements. It should be noted that the definitions and enforcement of coverage obligations are to be considered as a national matter.

ANNEX 1: STATISTICAL ANALYSIS OF THE QUESTIONNAIRE

Table 1: The number of CEPT administrations which have indicated coverage obligations for voice/data, demographic/geographic

Frequency band MHz	Demographic		Geographic	
	Voice	Data	Voice	Data
800	7	14	5	9
900	15	7	9	8
1800	12	10	10	10
2100	12	12	6	7
2600	7	12	2	3

Note 1: Some administrations do not have coverage obligations directly connected to a specific frequency band or technology

Table 2: Types of criteria for voice coverage

Type of criteria	Range (if relevant)	Possible additional prerequisites	Counts[4]
"It must be possible to make a phone call"	-	1 minute phone call using regular terminal	3
Field strength	38 – 58 dBµV/m	1.5 – 1.7 m above ground. 50 – 75% probability at cell edge	11
Signal strength	-106 – -75 dBm	1.7 – 3 m above ground. 30 % cell load (@2.1 GHz)	17
Bitrate	12.2 – 144 kbit/s	Outdoor	3
No requirement	-	-	70[5]
No criteria defined	-	-	21[6]

[4] The numbers indicate the total of frequency-and-band-administration-combinations.
[5] 9 administrations have no obligations for voice coverage in any of the investigated frequency bands.
[6] 10 administrations have one or more licensees with coverage obligations where it appears that there is no criteria defined.

Table 3 : Downlink user experience criteria for data coverage for the 800 MHz band

Country	Broadband		Narrowband	
	Down-link [Mbit/s]		Up-link [Mbit/s]	
Austria	2	0.5		
Austria	1	0.25		
Belgium	3			
Croatia				
Cyprus				
Czech Republic	2			
Czech Republic	5			
Denmark	10			
Estonia	5			
Finland				
France				
Germany				
Iceland	2.5			
Iceland	7.5			
Ireland				
Italy	2			
Latvia				
Liechtenstein				
Lithuania	2			
Lithuania	4			
Luxembourg				
Malta				
Montenegro				
Netherlands				
Norway	2			
Portugal	Under discussion			
Serbia				
Slovak Republic	2	0.256		
Slovenia	10			
Spain				
Sweden	1			
Switzerland				
United Kingdom	2			
Average	3.705882	0.33533		
Answered	17	3		
No answer	16	30		
Median	2	0.256		

ANNEX 2: AN EXAMPLE OF SMARTPHONE APPLICATION TO GATHER CROWDSOURCED DATA

General

The quality of service here means the real user experience when a number of measurable parameters will be measured at end-user terminal. The measured parameters evaluate the data transfer performance and its fluctuations over time of user equipment communication interfaces. The intention is to estimate broadband service regionally and thoroughly with conventional terminals. These measurements should be the subject of a large number of users and the variety of their mobile terminals; therefore a smartphone / tablet application is a preferred option here.

Measurement application for smartphones and tablets

The measurement application must be able to perform measurement on the mobile network (WLAN is optional). Measurements have to be performed with location accuracy of 100 m. The chosen measurement method shall not be weighted in anyway i.e. geographically, demographically or in time (within days or months).

The measurement application has to be freely available to the public via application stores or provider's web page. The applications should provide various measurement results to end-users if they wish, at least the main parameters related to data transfer measurements (download/upload speeds and delay), these should be calculated in the same way as they are delivered to the main system. It is preferable to have the control interface at least in English (and/or in national language).

Measurement consolidation service

At initial stage the measurement service shall be able to receive and store at least 10 000 relevant measurement events each month; however a reliable enough estimate would require millions of relevant measurement events eventually. A single measurement event has to meet the following requirements to be considered relevant:

1. Result is obtained from the user within an operator defined area such as city/county/post code area.

2. Locations is defined as accurately as possible, however privacy needs to be respected. Therefore defined area can be pixelated. Also on each pixel the list of minimum parameters listed in Section "Measured parameters" needs to be stored.

3. The event is based on a single measurement started by the end-user separately or started in the same terminal automatically or by application triggered measurements. The time interval between consecutive measurements has to be at least 10 seconds.

4. At least 50% of the measurements have to be based on the location data in a manner that allows positioning of measurements by 100 meters accuracy.

Measured parameters

The measurement data must include in each measurement event, the following elements:

5. Time of event: The time when the measurement is completed, at least with one minute accuracy.

6. Measurement Location: Location information should be provided as precisely as possible. Documentation should describe the precision and how the location is specified (e.g. coordinate system). If the measurements use different measurement modes and thus a variety of locations accuracy can be expected, the measurement data should clarify which positioning method for each measurement is used.

7. Data transfer rate (download): Measured data transfer rate of the network to the end user direction must notify transferred megabits per second (Mbit / s). It should be clearly described how this value is generated. It is also possible to provide more values, for example, peak and average transfer rates.

8. Data transfer rate (upload): Measured data transfer rate of the end-user to the network direction must notify transferred megabits per second (Mbit / s). It should be clearly described how this value is generated. It is also possible to provide more values, for example, peak and average transfer rates.

9. The delay (latency): The end-user experience in network latency in milliseconds (ms). It can be reported as a one-way latency or round-trip delay time. It should be clearly described how this value is generated. It is also possible to provide more values, for example, maximum and average delay.

10. The network technology in use: There should be a record on each event which network technology (used by the terminal interface technology) was used. Classification can be more accurate, but it has to include at least the following distinction between GSM, UMTS and LTE technologies and fixed connections, if appropriate.

11. The operator: Each event should record which operator was used by the end user.

Any measurement data must not contain individualised information on privacy.

ANNEX 3: SUMMARY OF THE RESPONSES TO THE QUESTIONNAIRE

Questionnaire on enforcement of coverage obligations to be sent to CEPT administrations

Introduction

The purpose of this questionnaire is to collect information about the current coverage obligations and how these obligations are enforced in public cellular networks (800 MHz, 900 MHz, 1800 MHz, 2 GHz, 2.6 GHz) throughout the CEPT countries. It is not the intention to set common coverage obligations or assumptions such as area to be covered by a certain service, to define bitrates or to establish deadlines.

ECC had noted the need to assess the various coverage obligations in force and how they are measured and enforced. In the end the collected information could help to reach a best practice or a common understanding of the criteria to establish whether a certain area is considered to be covered. If feasible this could translate into a common set of technical parameters to be used to determine radio coverage using both measurement and/or simulation tools.

In consequence, ECC invited ECC PT1 to develop this questionnaire on coverage obligations and how they are controlled (measurement and/or simulation) and to report at next ECC meeting in March 2014.

ECC agreed the need to reuse as appropriate the information available in particular from the previous results of a questionnaire from BEREC/RSPG on coverage obligations.

Results of BEREC/RSPG-questionnaire

In 2011 BEREC/RSPG issued a questionnaire on 'Economic and social value of spectrum'. The purpose of that survey was to collect information on the assignment process in a number of WAPECS frequency bands. The answers to the questionnaire did not contain any information on the actual field strength or signal level necessary to achieve the required coverage in mobile telephony/data networks.

The answers related to aspects on coverage obligations in the BEREC/RSPG-questionnaire are collected in the Annex to this document.

From the answers to the BEREC/RSPG questionnaire it can be concluded that there is a large variation in the coverage and service obligations from one country to another and, even from one frequency band to another.

- In some countries the operators must provide a specific minimum service level to a certain minimum percentage of the area of the country, to a certain number of citizens or even to specific locations within the county.
- In other countries there are no coverage obligations at all or the coverage obligations has been removed from the licence once they were reached a number of years after launch of the service.
- The coverage obligation may differ also from one frequency band to another in a given country.

The answers also indicate a large variation in the choice of monitoring/enforcement.

- Some administrations are satisfied with a periodic (annual, bi-annual etc) statement from the operator proclaiming that the obligations are fulfilled.
- Other administrations conduct their own measurements and compare the result to coverage maps supplied by the operators.

Though some administrations have provided the information that the operators must provide a certain level of coverage for voice/telephony or a certain minimum bit rate, there is no information about what field strength is necessary to provide coverage or how to verify a bit rate.

New questionnaire

As already stated, it is not the intention to set common coverage obligations or assumptions such as area to be covered by a certain service, to define bitrates or to establish deadlines.

ECC will further discuss the issue at the next meeting based on the summary of responses received.
CO has received replies from the following 30 countries: Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark*, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein***, Lithuania, Luxembourg, Malta, Montenegro, The Netherlands, Norway, Portugal, Serbia, Slovak Republic, Slovenia, Spain, Sweden , Switzerland and the United Kingdom.**

GENERAL COMMENTS

Hungary:

Referring to the Questionnaire on coverage obligations please be informed that the Hungarian Administration cannot answer this questionnaire at the present time as the tender documentation concerning the use of broadband services in the frequency bands indicated in the questionnaire is under consideration in Hungary. The first draft of the documentation was published at the end of November 2013 and was followed by a public consultation in December 2013. According to the comments received during the consultation the specification concerning coverage obligations and their enforcement is subject to reconsideration. We will be in the position to answer this questionnaire only when the tendering documentation is finalised.

Liechtenstein:

For your information, we are currently considering the allocation of the 800 and 2600 MHz to our main operators based on technology neutrality approach.

As for the GSM and UMTS existing licenses in the 900/1800 and 2100 MHz bands, we foresee a possible re-farming of the bands in the future upon request.

Question 1 Coverage obligations – definitions and criteria to fulfil the obligations

In case coverage obligations are defined for operators of public mobile telephony/data networks in your country:

Question 1: **In case coverage obligations are defined for operators of public mobile telephony/data networks in your country:***	
a) What are the coverage obligations in force in various mobile bands (if response has not been already provided in RSPG BEREC questionnaire attached)? Please specify.	
Cyprus	See table below
Czech Republic	Please see table below
Denmark	See table
Finland	Only for 800 MHz we have coverage obligations, see table below
France	Response already provided in RSPG BEREC questionnaire
Hungary	Roll-out obligations apply only to broadband systems with a minimum nominal channel bandwidth of 5 MHz and only for the frequency bands acquired in the tendering process completed in 2014 (including bands 800 MHz, 900 MHz, 1800 MHz, 2600 MHz). The general requirements regarding roll-out obligation and coverage assessment can be found in ANNEX 2 of the Documentation for the tender announced in the subject of spectrum licences for broadband services (http://nmhh.hu/dokumentum/163276/2014_mobile_broadband_tender_doc_en_20140526.pdf) Roll-out obligations in force applicable to broadband networks shall be fulfilled according to the following: • if a licensee acquired a spectrum licence in the tendering process completed in 2014 for the frequencies forming part of Packages including frequency bands 800 MHz, 900 MHz, 2600 MHz, shall ensure coverage of at least 96% of the national population and at least 90% of the country's geographic area within 60 months, and a population coverage of at least 99% by the end of the 10th year upon obtaining the spectrum licence. In case of 800 MHz frequency blocks affected by the operation of television broadcasting stations in the neighbouring countries, coverage shall be ensured within 48 months of the shutdown of the neighbouring country's television broadcasting network (which shall not result in a deadline shorten than from 60 months from obtaining the licence), and a population coverage of at least 99% by the end of the 10th year upon obtaining the spectrum licence); • special roll-out and coverage obligations are applicable for the 800 MHz band and in special conditions for the 2600 MHz band (see table 1). The measurable threshold levels are defined in Table 2 under the answer to Question 2
Ireland	Please refer to Table 1, below
Latvia	E.g. obligation to provide coverage, temporal obligation of population coverage (%), obligation to obtain a certain number of radio frequency assignment use permits, obligation to install a certain number of base stations per square kilometres
Norway	See table below

Portugal	Portugal answered the RSPG BEREC questionnaire. Some updated information is now provided. 800 MHz: For each lot of 2 x 5 MHz the operator is obliged to cover a maximum of 80 parish areas where the broadband mobile coverage is either inexistent or at least not adequate. The list of parishes to be covered was fulfilled by ANACOM in august 2013, and each mobile operator has now the obligation to cover 160 parishes geographically (as there are three mobile operators in Portugal, each of them with 2 x 10 MHz of spectrum allocated, they will have to cover 480 parishes - in a total of 4260). Geographically, the obligation for each of these local areas imposes the coverage of at least the headquarters of the parish. The objective of this coverage obligation is to guarantee that even in the remote areas people will have access to mobile broadband provided by at least one operator. At the same time, the intention has also been not to impose unnecessary burden to operators as the remote areas are usually not commercially attractive. The mobile broadband service to be made available must enable data transmission speeds which are equal to the highest speed provided by the commercial offers subscribed to, at any given time, by customers in the lowest quartile of such offers when ranked according to maximum transmission speed of the offer subscribed to. These obligations must be fulfilled in at least 50% and 100% of the parishes within maximum periods of 6 months and 1 year respectively following ANACOM's notification as to the end of the existing restrictions on the operation of the 800 MHz band (due to DTT emissions in Spain). The notification is foreseen to be done during 2014. The definition of the methodology to calculate the data transmission speeds was in public consultation and, currently, ANACOM is finalising the analysis to the responses received. These coverage obligations only can be meet with the use of frequencies in the 800 MHz and 900 MHz bands (the operator should communicate if they intend to use the 900 MHz band). VOICE AND DATA RATE UP TO 9600 bps: In the beginning (90's) coverage obligations were established for the voice service to be provided either by GSM 900 or DCS 1800. In the licenses renewal made (2000's …), operators were obliged to maintain at least the levels of coverage they ensured at the time the licenses were renewed [reference date] for voice and data rates up to 9600 bps. The mobile operators sent the required information by the Regulator, having as the basis the reference date, and since that reference date the coverage obligations, for voice and data rates up to 9600 bps, are defined is terms of: • Total population covered on [reference date]; • Total population covered by borough council on [reference date]; • Total population covered by locality with more than 10000 inhabitants on [reference date]. These obligations can be fulfilled using all the frequencies/technologies that are allocated/authorised for the mobile operators, namely, 800 MHz, 900 MHz, 1800 MHz, 2 GHz and 2,6 GHz. DATA RATE OF 144 kbps AND OF 384 kbps:

<table>
<tr><td></td><td>These obligations were originally associated with the UMTS license (2 GHz) and are the following:

<table>
<tr><th rowspan="3">OPERATOR NAME</th><th colspan="2">POPULATION COVERAGE (%)</th><th colspan="2">AREA COVERAGE (%)</th></tr>
<tr><th colspan="2">DATA RATE</th><th colspan="2">DATA RATE</th></tr>
<tr><th>144 kbps</th><th>384 kbps</th><th>144 kbps</th><th>384 kbps</th></tr>
<tr><td>OPTIMUS</td><td>60.8%</td><td>29.7%</td><td>23.8%</td><td>7.8%</td></tr>
<tr><td>TMN</td><td>77.3%</td><td>7.7%</td><td>38.3%</td><td>0.07%</td></tr>
<tr><td>VODAFONE</td><td>99.3%</td><td>78.9%</td><td>83.5%</td><td>49.9%</td></tr>
</table>

These obligations can be fulfilled using all the frequencies/technologies that are allocated/authorised for the mobile operators, namely, 800 MHz, 900 MHz, 1800 MHz, 2 GHz and 2,6 GHz.</td></tr>
<tr><td>Serbia</td><td>The quality parameters for electronic communication networks under public bidding regime are set in Rulebook on quality parameters for publicly available electronic communication services and monitoring of electronic communication activity (Official Gazette of RoS Nos. 73/11 and 3/14) (Rolebook)
http://www.ratel.rs/upload/documents/Regulativa/Pravilnici/Telekomunikacije/Rulebook%20on%20-quality%20parameters%20for%20publicly%20available%20electronic%20communication%-20services%20and%20monitoring%20of%20electronic%20communication%20activi.pdf</td></tr>
<tr><td>Slovak Republic</td><td>- We have no universal coverage obligations for various mobile bands. Into next table providing with you information about all new coverage obligations after Electronic Auction in Slovak Republic of the end 2013
Updated SVK Coverage obligations</td></tr>
<tr><td>Slovenia</td><td>a) territory coverage obligations in force:
GSM (900 MHz + 1800 MHz) more than 96%
UMTS more than 67% (except one operator with 20 %)
see table for TRA-ECS</td></tr>
<tr><td>Switzerland</td><td>See comments in Table 1</td></tr>
<tr><td>United Kingdom</td><td>Please replace the previous RSPG BEREC information with the table below (ECO: presumably UK asks to replace its national info in the BEREC questionnaire with the new information provided in Table 1 below)</td></tr>
<tr><td colspan="2">b) Do you define the assumptions (e.g. outdoor/indoor coverage, height, service, map scale) the right use/authorisation?</td></tr>
<tr><td>Cyprus</td><td>N/A</td></tr>
<tr><td>Czech Republic</td><td>Please see table below</td></tr>
<tr><td>Denmark</td><td>See table</td></tr>
<tr><td>Finland</td><td>For 800 MHz, reasonable indoor coverage is obligation</td></tr>
<tr><td>France</td><td>Outdoor coverage</td></tr>
<tr><td>Ireland</td><td>Please refer to Table 1, below</td></tr>
</table>

Latvia	No
Norway	The coverage obligations are specified as outdoor coverage
Portugal	No
Serbia	No
Slovak Republic	No
Slovenia	No
Switzerland	See comments in Table 1
United Kingdom	Yes. Please see table below for details
c) How do you define whether or not coverage is achieved, per coverage obligation?	
Cyprus	Authorised Entities inform us on a regular basis about their coverage percentage
Czech Republic	o Data provided by operators; o Administration calculations with the following criteria: ▪ Map resolution 100×100m; ▪ Statistical model of signal propagation (ITU 1546-2CA). ▪ Calculated over maps with detailed population distribution (building / block of buildings level). ▪ For details, please see http://www.ctu.cz/cs/download/vyberova_rizeni/invitation_to_tender_15_08_2013_appendix_3.pdf
Finland	This is under consideration.
France	- Drive tests to check the reliability of the coverage map - Computation of the percentage of population covered, based on the map, using a population database which geographically distributes the French population over the territory
Ireland	Please refer to Table 1, below.
Latvia	Operators usually provide annual information on their networks coverage. Information on issued radio frequency assignment use permits can be taken into account.
Norway	Licensees have to report to NPT each year. NPT will both use data simulations and spot test measurements. NPT is considering to develop a mobile app for users to measure and report data throughput to NPT. The report will indicate a GPS position (or cell ID - depending on the privacy level agreed) of the mobile and average data speed.
Portugal	We perform theoretical studies per coverage obligation, and if the results of the studies are higher than the coverage obligation it means that it is achieved
Serbia	Per coverage obligations. The operators are required to submit the results of the measurement of the basic set of parameters pertaining to network quality monitoring, at least once a year, using the forms which are specified in the Rulebook
Slovak Republic	- This is defined through the minimum guaranteed transmission speed for the end-user (without aggregation), crucial for meeting the transmission criteria is the outdoor transmission speed
Slovenia	From tender documentation: **A. MONITORING THE FULFILLMENT OF COVERAGE OBLIGATIONS** The Agency shall monitor the fulfillment of population coverage obligations in two ways, namely: - based on the calculation of coverage using the information about base stations submitted to the Agency by the holder of the DARF;

	and - based on random measurements of service quality at user locations, which the Agency conducts at its own discretion to verify the accuracy of information submitted by the holder of the DARF. The holder of a DARF must within a month of expiry of a deadline for meeting coverage obligations as set in the DARF and at the Agency's request submit relevant documentation on network operation related to the fulfillment of coverage obligations comprising selected technical parameters and simulation of service levels provided by the network. The submitted information must comprise: - the locations of the base stations in accordance with a specified geographical projection; - heights above ground level in meters; - For each sector: - azimuth – direction (degrees); - horizontal 3 dB beamwidth (degrees); - combined mechanical and electrical downtilt (degrees); - vertical 3 dB beamwidth (degrees); - the effective isotropic radiated power e.i.r.p.; - an indication of the frequency blocks used in each cell (sector); - a map of Slovenia with base station locations and covered areas (GIS format, vector graphics, defined by the Agency in cooperation with each operator); - a list of raster cells covered and the coverage level calculated on that basis; and - in the event of special coverage obligations for the 800 MHz band: - a list of covered populated addresses[1] in certain settlements from the list as determined by this tender documentation in Chapter A.7.3.4.3 Special Coverage Obligations in the 800 MHz Band and its subsections; - the population coverage in percent for each selected settlement in accordance with the data base on populated addresses (available on the Agency's website); - and a list of addresses (HS_MID) and the number of FWBA connections at these addresses. Based on the information about base stations submitted by the holders of DARFs and the tests made in the field based on the list of active base stations, the calculations shall be made to assess the fulfillment of the coverage obligations. The analysis shall be made based on technical parameters of base stations and by using the Agency's software tool for planning and analyzing telecommunication and broadcasting networks and radio frequency spectrum planning. The analysis shall be made on a model selected in accordance with the ITU-R P.1812 recommendation, with raster cells in the 100 x 100 m grid as population units (e.g. Geostatistical database of the Statistical Office of the Republic of Slovenia. Detailed information about the calculation procedure shall be made available when the decisions on the assignment of radio frequencies are issued in collaboration with each holder of a decision on the assignment of radio frequencies. **A.1 CALCULATING THE COVERAGE WHEN VERIFYING THE FULFILLMENT OF SPECIAL COVERAGE OBLIGATIONS IN THE 800 MHz BAND** Based on the information about base stations submitted by the holder of a Decision on the Assignment of Radio Frequencies, the calculations shall be made to assess the fulfillment of the coverage obligations. The calculation of coverage is based on the service provided by technologies in accordance with 3GPP TS 36.201 V11.1.0 (2012-12) and other 3GPPP technical specification – versions 8

	and 9 for the E-UTRA air interface, or ETSI EN 301 908-13 V6.2.1 (2013-10), ETSI EN 301 908-14 V6.2.1 (2013-10) standards in the 800 MHz frequency band. A holder of a DARF with imposed special coverage obligations must fulfill these obligations with technologies in accordance with 3GPP TS 36.201 V11.1.0 (2012-12) and other 3GPPP technical specification – versions 8 and 9 for the E-UTRA air interface, or ETSI EN 301 908-13 V6.2.1 (2013-10), ETSI EN 301 908-14 V6.2.1 (2013-10), whereby it can also fulfill the obligations using other frequencies at its disposal. Based on this data, the Agency shall calculate the locations and the number of population points, where services are provided, in accordance with the following assumptions: - median propagation loss based on the ITU-R P.1812 recommendation with specified clutter parameters and a time percentage of 50%; - lognormal location variation with a specified standard deviation; - a specified terrain database (DTM); - a specified clutter database; - specified population locations and settlement identifiers ; - specified use equipment noise figure and antenna gain; - theoretical base station antenna azimuth and elevation radiation patterns taken from 3GPP TR36.814; - network load of 15%; Each population location shall be considered as covered with a bitrate of 10 Mbps downlink if the resulting predicted signal to interference plus noise ratio is greater than or equal to a specified value. The coverage obligation shall be considered as fulfilled if, based on the data supplied: - the total covered population is at least 95% of the total population of Slovenia, and - at least 75% of the population within every settlement or group of settlements shall have access to services - in accordance with the requirements from Chapter A.7.3.4.3 Special Coverage Obligations in the 800 MHz Band and its subsections; and in accordance with the schedule and requirements from these sections. **A.2 VERIFICATION MEASUREMENTS** The Agency shall at its own discretion, conduct tests on the license holder's network and measure the quality of service at times and places of its choice in order to verify that the submitted information regarding base stations and coverage is an accurate representation of the actual state of the license holder's network. These tests shall be intended to verify the base station parameters, level of field strength and quality of service at some end users locations to directly verify network coverage determined by the above calculation. For the purposes of verifying the provision of FWBA service, the Agency may verify capacity and network coverage
Switzerland	See comments in Table 1
United Kingdom	Coverage obligation assessment is carried out as per the methodologies. The relevant links are provided in table below
d) If you defined/identified measurable threshold levels such as field strength or minimum bit rates – please specify relevant values.	
Cyprus	See table below
Czech Republic	o LTE 800 MHz - limit values RSRP (Reference signal received power) -109 dBm (outdoor), SINR (Signal-to-interference-plus-noise ratio) 5 dB;

	o LTE 2600 MHz - limit values RSRP -105 dBm (outdoor), SINR 5 dB. o All bands: Downlink speed min. 2 Mbit/s (first 7 years) and min. 5 Mbit/s (afterwards). o For details, please see http://www.ctu.cz/cs/download/vyberova_rizeni/invitation_to_tender_15_08_2013_appendix_3.pdf
Denmark	See table
Ireland	Please refer to Table 1, below
Norway	For the coverage obligations in the 800 MHz band, a bit rate of 2 Mbps applies. Further details are in the table below. No field strength level is defined
Portugal	That information is provided by each of the operators
Serbia	Specified in the table below
Slovak Republic	- In the 800 MHz band: 2 Mbit/s for downlink and 256 kbit/s for uplink; - In the 1800 MHz band: 12.2 kbit/s for the GSM technology for voice phone services; 2 Mbit/s for downlink and 256 kbit/s for uplink in the case of other technologies; - In the 2600 MHz band: 2 Mbit/s for downlink and 256 kbit/s for uplink
Switzerland	See comments in Table 1
United Kingdom	As explained in table below

*Note: The purpose of this question is to collect information on for example actual field strengths considered to be sufficient to provide coverage in mobile phone networks. It is also the intention to collect information on the required bit rate within the coverage area. Please continue the list of technologies/bands, if necessary.

Table 1					
Country	**Frequency band**	**Technology**	**Coverage obligation in force (e.g. voice service, data service, geographic, demographic, roads, towns etc.)**	**Coverage criteria – Voice service (e.g. RSSI, field strength, probability, height above ground etc.)**	**Coverage criteria – Data service (e.g. bit rate, peak hour/day average etc.)**
Austria	800 MHz	neutral	* 25% of population * additional 95% obligation taking into account coverage by other bands; * additional coverage obligation for specific municipalities, see https://www.rtr.at/en/tk/multibandauktion_AU for details	indoor for specific municipalities, else outdoor; indoor is defined as outdoor 1,5 m above ground - 20dB additional atteniuation	* 2 Mbit/s downlink und 0,5 Mbit/s uplink for specific municipalities; * 1 Mbit/s downlink und 0,25 Mbit/s uplink for 25%//95%
	900 MHz	neutral (expiring GSM usage)	* up to 98% narrow band (voice) * additional 95% broadband taking into account coverage by other bands for some blocks (from 2016 onwards) See https://www.rtr.at/en/tk/multibandauktion_AU for details	outdoor	* broadband: 1 Mbit/s downlink und 0,25 Mbit/s uplink * narrowband: 12,2/12,2 kbit/s
	1800 MHz	neutral (expiring GSM usage)	* up to 98% narrow band (voice) * additional 95% broadband taking into account coverage by other bands for some blocks (from 2016 onwards) See https://www.rtr.at/en/tk/multibandauktion_AU for details	outdoor	* broadband: 1 Mbit/s downlink und 0,25 Mbit/s uplink * narrowband: 12,2/12,2 kbit/s
	2100 MHz	UMTS	50% of population See https://www.rtr.at/en/tk/FRQ_2100MHz_2000_AU for details	outdoor	144 kbit/s
	2600 MHz	neutral	25% of population See https://www.rtr.at/en/tk/FRQ_2600MHz_2010_AU for details	outdoor	1 Mbit/s downlink, 256 kbit/s uplink
Belgium	800 MHz	Technology neutral	- 30% of population 2 years after obtaining licence. - 70% of population 4 years after obtaining licence. - 98% of population 6 years after obtaining licence - supplementary obligation (for one of the 3 licences only) for 60 specific towns 3 years after obtaining licence These obligations can be reached using other bands (900 MHz, 1800 MHz, 2100 MHz and 2600 MHz)	No obligation for voice service	3 Mbit/s available 24 hours a day, 7 days a week
	900 MHz	GSM	Combined obligation for 900 MHz and 1800 MHz	RXQUAL ≤ 4	No obligation for data

			Coverage commitment (not publicly available) was a selection criteria in the beauty contest procedure		service
	1800 MHz	GSM	Combined obligation for 900 MHz and 1800 MHz Coverage commitment (not publicly available) was a selection criteria in the beauty contest procedure	RXQUAL ≤ 4	No obligation for data service
	2100 MHz	IMT	- 30% of population 3 years after obtaining licence. - 40% of population 4 years after obtaining licence. - 50% of population 5 years after obtaining licence - 85% of population 8 years after obtaining licence (this last obligation can be reached using the 900 and 1800 MHz bands)	No specific criteria	No specific criteria
	2600 MHz	Technology neutral	No coverage obligation		
Croatia	800 MHz	LTE	50% of the country 5 years after HAKOM declares that there is acceptable level of interference from neighbouring countries. Refers to the outdoor coverage	Not defined	Not defined
	900 MHz	GSM UMTS LTE	95% of population and 75% of the country for T-Mobile and VIPnet regardless of technology in use. For Tele2 who is 3rd operator in the market 93% of population and 82% of the country and it refers to 900, 1800 and 2100 MHz together regardless of technology in use Refers to the outdoor coverage	Not defined	Not defined
	1800 MHz	GSM UMTS LTE	95% of population and 75% of the country for T-Mobile and VIPnet regardless of technology in use. For Tele2 who is 3rd operator in the market 93% of population and 82% of the country and it refers to 900, 1800 and 2100 MHz together regardless of technology in use. Refers to the outdoor coverage	Not defined	Not defined
	2100 MHz	UMTS	50% of population for T-Mobile and VIPnet. For Tele2 who is 3rd operator in the market 93% of population and 82% of the country and it refers to 900, 1800 and 2100 MHz together regardless of technology in use. Refers to the outdoor coverage	Not defined	Not defined
	2600 MHz	The licenses have not been issued.			
	3500 MHz	WiMAX	Operator has obligation to install a certain number of base stations in defined time periods	Not defined	Not defined
Cyprus	800 MHz	No licenses granted in this band.			

	900/1800/-2100 MHz The licenses granted in these bands include bandwidth from all three bands. Coverage obligations are linked with technology and not with the band itself.	GSM	Incumbent – 90% geographical coverage from the date of issue of the licence 2nd Operator – 50% geographical coverage within 2 years from the date of issue of the licence and 75% geographical coverage within 4 years from the date of issue of the licence	Minimum signal level (BCCH) in all covered area -102 dBm	
		UMTS	For the 2 existing operators 60% geographical coverage within 10 years from the date of issue of the licence. For the 2 existing operators there was an adjustment in 2013 when their licenses were amended and became technology neutral (ie. GSM/UMTS/LTE allowed in all three band), that is 70% geographical coverage within 2 years from the date of amendment of their licence	Minimum signal level (P-CPICH) in all covered area -106 dBm	
		4G (LTE, WiMAX)	For the 2 existing operators, 40% geographical coverage within 5 years from the date of amendment of their licence (their license was amended in 2013 and became technology neutral). Newcomer (license was issued on 7 February 2014), 40% geographical coverage within 3 years from the date of issue of licence and 65% geographical coverage within 5 years from the date of issue of the licence	Minimum signal level (pilot) in all covered area -106 dBm	Access the Internet with at least 30Mbps, in all covered area
	1800 MHz	See answer for 900MHz			
	2100 MHz	See answer for 900MHz			
	2600 MHz	No licenses granted in this band.			
	3400-3800MHz	No licenses granted in this band.			
Czech Republic	800 MHz	Technology neutral (Commission Decision 2010/267/EU)	CZE districts divided into groups A (low density of population) and B (other districts). **Within 30 months:** at least 30 of 32 districts from Group A. **Within 5 years:** 100% of the districts of Group A, at least 22 districts of Group B, at least 50% of transit railway corridors, motorways and express roads. **Within 7 years:** 100% of Group A and Group B districts, transit railway corridors I to IV, motorways and express roads. **Required coverage:** 95% of each district's population with	n/a (data only)	Downlink 2 Mbit/s (first 7 years), 5 Mbit/s (afterwards)

			a 75% probability of indoor coverage without use of an external antenna		
	900 MHz	Technology neutral (Commission Decision 2011/251/EU)	Not relevant, all the obligations within the 900 MHz spectrum awards had already been reached		
	1800 MHz	Technology neutral (Commission Decision 2011/251/EU)	Not relevant, all the obligations within the 1800 MHz spectrum awards had already been reached		
	2100 MHz	Technology neutral	Not relevant, all the obligations within the 2100 MHz spectrum awards had already been reached.		
	2600 MHz	Technology neutral (Commission Decision 2008/477/ES)	**Within 7 years:** 10% of the population of the Czech Republic	n/a (data only)	Downlink 2 Mbit/s (first 7 years), 5 Mbit/s (afterwards)
Denmark	800 MHz	Neutral	2 licenses in total. One license without coverage obligation, one license with the following obligation: 98 % geographical coverage and 99.8 % population coverage, in approx 1/3 of the post districts in DK, 3 years after obtaining the licence, covered with 10 Mbps downlink outdoor		*Down link user experience: 10 Mbps outdoor, qualified by simulations and/or measurements by the licensee*
	900 MHz	GSM	5 licenses in total. 1991 (2 licenses): 95 % geographical coverage for all licenses 2000/2001 (2 licenses): The tender had a two step minimum requirement: 40 % geographical coverage after 3 years and 90 % geographical coverage after 5 years. 2010 (1 license): No coverage obligation.	46 dBµV/m, 1.5 m above ground outdoor, 75 % location probability on cell edge	-
	1800 MHz	GSM	7 licenses in total. 1997 (4 licenses): The minimum requirement in the tender for three of the licensees was 50 % geographical coverage within 5 years. The fourth license (won by Telenor) had no coverage obligation. 2000/2001 (2 licenses): The operators have to fulfil the minimum requirements from the tender: 25 % geographical coverage within 3 years and 45 % geographical coverage	54 dBµV/m, 1.5 m above ground, 75 % location probability on cell edge, for outdoor coverage	-

			within 5 years. 2010 (1 license): No coverage obligation		
	2100 MHz	UMTS	The coverage obligation in connection with the auction in 2001 had to be fulfilled in two steps. 2004: 30 % demographic coverage 2008: 80 % demographic coverage The same coverage obligations applied in the 2005 auction, but the deadline for implementation was 2009 and 2013 respectively	38 dBµV/m, 1.5 m above ground, 50 % location probability on cell edge, for outdoor coverage, corresponding to a data speed at 12,2 kbit/s	-
	2600 MHz	Neutral	4 licenses. No coverage obligation	-	-
Estonia	800 MHz	Technologically neutral (LTE)	Only networks with nation-wide coverage allocated. In frequency range 801-811/842-852 MHz operator has obligation to erect at least 199 base stations (outdoor), service coverage 95 % of territory (except cities)	58 dBµV/m/5MHz, 1.7 m above ground	5 Mbps downlink
	900 MHz	Technologically neutral (LTE/UMTS/GSM)	Only networks with nation-wide coverage allocated		
	1800 MHz	Technologically neutral (LTE/UMTS/GSM)	Only networks with nation-wide coverage allocated		
	2100 MHz	Technologically neutral (UMTS/LTE)	Only networks with nation-wide coverage allocated. One licence has obligation: 80% of population 7 years after obtaining licence		One licence has obligation: Minimum data speed rate 144 kbit/s (in towns), 64 kbit/s (outside towns)
	2600 MHz	Technologically neutral (LTE)	Only networks with nation-wide coverage allocated. Operators are obliged to install in the territory of the country the number of base station declared in their bid during the period declared in their bid	58 dBµV/m/5MHz, 1.7 m above ground	2 Mbps Downlink
Finland	800 MHz	technology neutral (assumption: LTE)	Three licences (from 1.1.2014) with outdoor and reasonable indoor coverage. Operator 1: 97 % of population 5 years after obtaining licence Operator 2: 95 % of population 3 years after obtaining licence 99 % of population 5 years after obtaining licence		basic coverage

			Operator 3: 97 % of population 5 years after obtaining licence		
	900 MHz		None	None	None
	1800 MHz		None	None	None
	2100 MHz		None	None	None
	2600 MHz		None	None	None
France	800 MHz	LTE	See RSPG BEREC questionnaire		Maximum theoretical data rate has to be at least 60 Mbit/s on the downlink (assessment of obligations under development)
	900 MHz	GSM/UMTS	See RSPG BEREC questionnaire	ability to make a one-minute phone call	
	1800 MHz	GSM (and LTE for Bouygues Telecom)	See RSPG BEREC questionnaire	ability to make a one-minute phone call	LTE: Maximum theoretical data rate has to be at least 60 Mbit/s on the downlink (assessment of obligations under development)
	2100 MHz	UMTS	See RSPG BEREC questionnaire	ability to make a one-minute phone call	
	2600 MHz	LTE	See RSPG BEREC questionnaire		Maximum theoretical data rate has to be at least 60 Mbit/s on the downlink (assessment of obligations under development)
Germany	800 MHz		For this the federal states of Germany provided lists of areas that were not yet sufficiently provided with broadband services, divided into stages of priority. Only when 90 % of the population in one priority stage has been covered can the frequencies be used for coverage of the areas in the next priority stage. This obligation was set in response, particularly, to the political objective of nationwide	No general specifications. Ex post parameters according to test and measurement services of the authority	No general specifications. Ex post parameters according to test and measurement services of the authority

			broadband rollout		
	900 MHz		Commitment up to 98% of the population in GSM license		
	1800 MHz		for frequencies assigned technology and service neutral in 2010: 25 % of population as from 1 January 2014 50 % of population as from 1 January 2016	No general specifications. Ex post parameters according to test and measurement services of the authority	No general specifications. Ex post parameters according to test and measurement services of the authority
	2100 MHz		25 % of population as from 1 January 2014 50 % of population as from 1 January 2016	No general specifications. Ex post parameters according to test and measurement services of the authority	No general specifications. Ex post parameters according to test and measurement services of the authority
	2600 MHz		25 % of population as from 1 January 2014 50 % of population as from 1 January 2016	No general specifications. Ex post parameters according to test and measurement services of the authority	No general specifications. Ex post parameters according to test and measurement services of the authority
Hungary	800 MHz	neutral	These obligations apply to 3 mobile network operators acquiring frequencies in the 800 MHz band: • coverage across the municipal boundaries of some localities (listed in the Appendix of the tender) shall be ensured within 12* months upon licence acquisition; • coverage shall be ensured within the municipal boundaries of localities with populations between 1.000 – 6.000 residents within 36* months following licence acquisition *for mobile frequency blocks affected by the operation of television broadcasting stations in neighbouring countries coverage shall be ensured within 12 months following the shutdown of television broadcasting networks of neighbouring countries.	Minimum indoor and outdoor signal strength values are contained in Table 2 of question 2.	

	2600 MHz	neutral	These obligations apply only to one mobile network operator (this operator acquired more frequency packages in the 2600 MHz band (see detailed rules in the tender documentation): • in the 2600 MHz band, coverage in at least 70 percent of the area enclosed by the municipal boundaries of localities with a population of or above 30.000 shall be ensured at the latest within 36 months following licence acquisition; in the remaining area representing up to 50 percent of localities with a population of or above 30.000, coverage shall be ensured — using any of the available frequencies, whether acquired previously or in the current tender procedure — at the latest within 36 months following licence acquisition.	Minimum indoor and outdoor signal strength values are contained in Table 2 of question 2.	
Iceland	800 MHz	LTE	Licence A: 99.5% of homes and businesses 4 years after obtaining licence – 10 Mbps. 30 Mbps 8 years after obtaining licence to the same coverage area. Licence B: 93.5% of homes and businesses within 4 years after obtaining licence – 10 Mbps. 30 Mbps 8 years after obtaining licence to the same coverage area	-85 dBm in densed areas and -100 dBm in rural areas, 1.7 m abobe ground	Down link user experience: 10 Mbps (sometime during 24 hours), 3.85 Mbps (24 hour average) and 2.5 Mbps (average 3 hours peak time) within 4 years after obtaining licence. Down link user experience: 30 Mbps (sometime during 24 hours), 11.3 Mbps (24 hour average) and 7.5 Mbps (average 3 hours peak time) within 8 years after obtaining licence. Additional guidelines regarding network neutrality
	900 MHz	GSM/UMTS	Original GSM900 – incumbent: 98% of the population after obtaining license Original GSM900 – second operator:	GSM (1.7 m above ground) -75 dBm in 95% cases in urban	-

			80% of the population after obtaining license	areas -95 dBm in 95% cases in rural areas UMTS (1.7 m above ground) -85 dBm in urban areas -100 dBm in rural areas Less than 2% rejection of calls	
	1800 MHz	GSM/UMTS	No coverage requirements	GSM (1.7 m above ground) -75 dBm in 95% cases in urban areas -95 dBm in 95% cases in rural areas UMTS (1.7 m above ground) -85 dBm in urban areas -100 dBm in rural areas Less than 2% rejection of calls	-
	2100 MHz	UMTS	75 – 100% of homes, depending on areas	58 dBµV/m/5MHz, 1.7 m above ground	
	2600 MHz	MMDS - DTT			
Ireland	800 MHz	See Table** (below)	Liberalised Use Licences in the 800MHz, 900MHz and 1800 MHz bands: Within the Liberalised Use Licence framework, it is expected that a licensee will attain, at a minimum, a coverage level of 70%[7] of the population within 3 years of licence commencement date. Please also refer to related footnote	For Liberalised Use Licences, coverage (applicable to both Voice and Data Services (i.e. no differentiation)) is	See coverage criteria for Voice service

[7] Where the Licensee has deployed more than one Terrestrial System in the 800 MHz, the 900 MHz and/or the 1800 MHz band, it is the combined coverage of these Terrestrial Systems that counts towards the minimum coverage and roll-out obligation set out in the Liberalised Use Licence.

			listed for 2100 MHz. Voice and data services are not differentiated under this licensing framework. Further Information on the Liberalised Use Licensing framework can be sourced at the following link: Liberalised Use Licences	calculated as follows: An average pilot signal will be measured outdoors at a height of 1.5 metres. For propagation prediction systems, a pilot signal covering 95% of the area during 95% of the time is required. Coverage level specification per frequency band, per bandwidth, and per terrestrial system is set out in Table 2	
	900 MHz	See Table** (below)	Liberalised Use Licences in the 800,900 &1800 MHz bands: Same as that described for 800 MHz above	For Liberalised Use Licences, coverage is calculated as follows: An average pilot signal will be measured outdoors at a height of 1.5 metres. For propagation prediction systems, a pilot signal covering 95% of the area during 95% of the time is required. Coverage level specification per frequency band, per	See coverage criteria for Voice service.

				bandwidth, and per terrestrial system is set out in Table 2	
	1800 MHz	See Table** (below)	<u>For Liberalised Use Licences in the 800, 900 &1800 MHz bands:</u> Same as that described for 800 MHz above	<u>For Liberalised Use Licences, coverage is calculated as follows:</u> An average pilot signal will be measured outdoors at a height of 1.5 metres. For propagation prediction systems, a pilot signal covering 95% of the area during 95% of the time is required. Coverage level specification per frequency band, per bandwidth, and per terrestrial system is set out in Table 2.	See coverage criteria for Voice service
	2100 MHz[8]	UMTS	For 3rd Generation Mobile and wireless communications services, adequate coverage is achieved on the provision that Field strength, measured on the pilot signal (from the common pilot channel/downlink) from the outdoor base station, at a height of 1.7 metres, is maintained at a level greater than or equal to 58 dBµV/m over 95% of the area, during 95% of the time	**<u>Vodafone:</u>** The Licensee shall provide UDD full mobility (outdoor) 144kbps demographic Coverage of 85% by year end 2007.	See Coverage Criteria for Voice Service

[8] With regard to Liberalised Use Licences in the 800, 900 and 1800 MHz bands, where the Licensee has deployed one or more than one terrestrial system in the 2100 MHz band, up to 35% of the population coverage (that is to say, one-half) of the 70% of the population coverage obligation, as listed for the 800, 900 and 1800 Mhz bands, may be met using coverage provided by the terrestrial systems in the 2100 MHz band.

				O2: UDD full mobility (outdoor) 144 kbps - demographic Coverage of 80% by year end 2007 demographic Coverage of the 3G network services shall not fall below 80% after 30 December 2007 **Hutchison:** UDD full mobility outdoor at 144 kbps demographic coverage by year end 2007 – 85% Demographic Coverage. **Meteor:** The Licensee shall ensure that its 3G network services achieve demographic coverage of 83% (UDD full mobility @ 144 kbps) on and after 31 October 2012	
	2600 MHz	N/A	N/A	N/A	N/A
Italy	800 MHz		A list of several hundred small municipalities is associated to each frequency block (except one), where data service coverage must be provided following this calendar: - before 31/12/2015: 30% of the municipalities, on 800 MHz or on other frequencies		Minimum single user data-rate: 2 Mbit/s

			- before 31/12/2017: 75% of the municipalities, on 800 MHz or on other frequencies - before 31/12/2019: 37.5% of the municipalities on 800 MHz frequency blocks - before 31/12/2022: 75 % of the municipalities, on 800 MHz frequency blocks		
	900 MHz		Obligations regard voice service. Coverage obligations are in terms of percentage of covered national population and differs among operators: - First and second operator: 90% of national population - Third operator: 96% of national population - Fourth operator: the only obligation is launch of service	Specified values of minimum signal strength, location probability on cell edge, user antenna height and specified propagation model	
	1800 MHz Assigned before the LTE auction in 2011		Obligations regard voice service. Coverage obligations are in terms of percentage of covered national population and differs among operators: - First and second operator: 90% of national population - Third operator: 96% of national population - Fourth operator: the only obligation is launch of service	Specified values of minimum signal strength, location probability, user antenna height and specified propagation model	
	1800 MHz Assigned with the LTE auction in 2011		Launch of data service before 31/12/2013		Minimum single user data rate: 2 Mbit/s
	2100 MHz		Obligation are in terms of data service All “province” (main towns) must be covered before 31/12/2006		Specified value of data-rate (144 kbit/s) and traffic distribution relation to population density
	2600 MHz		Data service coverage obligations follow this calendar : - Before 31/12/2014 : at least 20% of national population and at least 5% of population of each administrative region ; 50% of such coverage can be carried out on different frequencies - Before 31/12/2016: at least 40% of national population and at least 5% of population of each administrative region ; 50% of such coverage can be carried out on different frequencies		Minimum single user data rate: 2 Mbit/s

			- Before 31/12/2023: at least 40% of national population and at least 5% of population of each administrative region on 2600 MHz band		
	3400-3600 MHz		Data service coverage obligations are set for each single region. A score must be reached, based on the number and characteristics of covered municipalities from a provided list		Minimum single user data rate: 2 Mbit/s
Latvia	800 MHz	Technology neutral	Obligation to install at least one base station per 200 km^2 (excluding main cities) within 3 years from the date of assigning rights of use of frequencies	No	No
	900 MHz	Technology neutral	Rights/obligation to provide coverage. E.g. obligation to obtain a certain number of radio frequency assignment use permits	No	No
	1800 MHz	Technology neutral	Rights to provide coverage. Coverage obligations were not specified	No	No
	2100 MHz	Technology neutral	Rights/obligation to provide coverage. E.g. availability of UMTS services at least for 45% of population within 4 years from the date of assigning rights of use of frequencies (temporal obligation)	No	No
	2600 MHz	Technology neutral	For FDD part of the band availability of electronic communications services at least for 55% of population within 4 years from the date of assigning rights of use of frequencies (temporal obligation). Obligation to obtain a certain number of radio frequency assignment use permits for TDD part	No	No
Liechtenstein	800 MHz	Neutrality	no info (allocation is in progress)	no info	no info
	900 MHz	GSM (refarming in progress)	90% of population 2 year after obtaining licence 95% of population 2 year after obtaining licence	minimum field strength 45 dBµV/m; maximum loss rate busy hour 4%; handover success rate 96%; maximum dropped calls 5%	not available
	1800 MHz	GSM (refarming in progress)	90% of population 2 year after obtaining licence 95% of population 2 year after obtaining licence	minimum field strength 51 dBµV/m; maximum	not available

				loss rate busy hour 4%; handover success rate 96%; maximum dropped calls 5%	
	2100 MHz	UMTS (refarming in progress)	Orange: 90% of population 2 year after obtaining licence. Mobilkom, Swisscom: no obligations	no criteria	Orange: minimum data rate 144 kbit/s Mobilkom, Swisscom: no criteria
	2600 MHz	Neutrality	no info (allocation is in progress)	no info	no info
Lithuania	800 MHz	Tech. neutral	30% of sub-districts in 3 years after obtaining licence; 80% of sub-districts in 5 years after obtaining licence; all territory (except some near border territory) till 2020.	No coverage criteria	2 Mb/s for 50% households in 3 years after obtaining licence; 2 Mb/s for 85% households in 5 years after obtaining licence; 4 Mb/s for 95% households till 2020
	900 MHz	GSM, UMTS, LTE	90% of the country	Received signal strength indication (RSSI): For GSM: -75 dBm for the urban territories; -95 dBm for the rest territories. For UMTS: -95 dBm for the urban territories; -114 dBm for the rest territories. For LTE: -72 dBm/5MHz for the urban territories; -92 dBm/5MHz for the rest territories	The same as for voice service
	1800 MHz	GSM, UMTS, LTE	5 biggest municipalities	RSSI at 3 m above ground:	The same as for voice service

				For GSM: -75 dBm for the urban territories; -95 dBm for the rural territories. For UMTS: -95 dBm for the urban territories; -114 dBm for the rest territories. For LTE: -72 dBm/5MHz for the urban territories; -92 dBm/5MHz for the rest territories	
	2100 MHz	UMTS/IMT-2000	3 the biggest cities in 3 years after obtaining licence; 5 the biggest cities in 6 years after obtaining licence	No coverage criteria	No coverage criteria
	2600 MHz	LTE	50% of population in 5 cities in 3 years after obtaining licence 50% of population in 15 cities/towns in 5 years after obtaining licence	No coverage criteria	No coverage criteria
Luxembourg	800 MHz	No more coverage obligations			
	900	No more coverage obligations			
	1800	No more coverage obligations			
	2100	No more coverage obligations			
	2600	No more coverage obligations			
Malta	800 MHz	This band is not in use by mobile services as yet.			
	900 MHz	Technology neutral	In order to ensure maximum benefits for all the users, licensed operators are required to make any service they offer available on a nationwide basis (99% of the Maltese territory). Successful applicants have up to 24 months from the date of assignment to come in line with this obligation and to maintain it from then onwards for the whole duration of the licence	Not defined	Not defined
	1800 MHz	Technology neutral	In order to ensure maximum benefits for all the users, licensed operators are required to make any service they offer available on a nationwide basis (99% of the Maltese territory).	Not defined	Not defined

			Successful applicants have up to 24 months from the date of assignment to come in line with this obligation and to maintain it from then onwards for the whole duration of the licence		
	2100 MHz	UMTS	99% of national territory to be achieved as follows: - 50% of national territory within 24 months from the licence grant. 99% of national territory within 60 months from licence grant	Not defined	Not defined
	2600 MHz	This band is not in use by mobile services as yet			
Montenegro	800 MHz	Not assigned			
	900 MHz	GSM/UMTS	For GSM system in 900 MHz and 1800 MHz bands. For two GSM operators obtaining licence without tender procedure in 2002 - 93% of population until the end of period of licence validity Requested in tender procedure in 2007 for new comer - 50% of population 3 years after obtaining licence and 80% of population 7 years after obtaining licence. Offered by the operator - 96% of population until the end of the first year after obtaining licence	Percentage of populated area in the country where signal strength is above -99 dBm. (For UMTS in case of 30% cell load)	
	1800 MHz	GSM/LTE	For GSM system in 900 MHz and 1800 MHz bands. For two GSM operators obtaining licence without tender procedure in 2002 - 93% of population until the end of period of licence validity Requested in tender procedure in 2007 for new comer - 50% of population 3 years after obtaining licence and 80% of population 7 years after obtaining licence. Offered by the operator - 96% of population until the end of the first year after obtaining licence. For LTE system (by reframing in 2012): Offered by the operators – Opeartor 1: 20% of population until the end of the first year after obtaining licence, 30% of population 2 years after obtaining licence and 40% of population 3 years after obtaining licence. Expected data rates up to 172 Mb/s in DL and 57 Mb/s in UL on each eNodeB. Opeartor 2: 18% of population 2 years after obtaining licence and 35% of population 3 years after obtaining licence. Expected data rates up to 100 Mb/s in DL and 50 Mb/s in UL on each eNodeB	Percentage of populated area in the country where signal strength is above -99 dBm	For LTE maximal expected data rates on each eNodeB.

	2100 MHz	UMTS	Requested in tender procedure in 2007 - 25% of population 3 years after obtaining licence and 50% of population 5 years after obtaining licence for existing GSM operators and 25% of population 3 years after obtaining licence and 50% of population 7 years after obtaining licence for new comer. Offered by the operators - Existing GSM operator 1: 40% of population until the end of the first year after obtaining licence, 75% of population 3 years after obtaining licence and 97% of population 5 years after obtaining licence. Min. data rate of 128 kb/s and max. data rate of 3.6Mb/s until the end of the first year after obtaining licence, 6 Mb/s 2 years after obtaining licence and 14.4 Mb/s 3 years after obtaining licence, on each NodeB. Existing GSM operator 2: 11% of population until the end of the first year after obtaining licence, 28% of population 3 years after obtaining licence and 53% of population 5 years after obtaining licence. Min. data rate of 64 kb/s and max. data rate of 384 kb/s until the end of the first year after obtaining licence, min. data rate of 384 kb/s and max data rate of 1.8 Mb/s 3 years after obtaining licence, on each NodeB. New comer (2G/3G): 75% 3 years after obtaining licence, 90% of population 5 years after obtaining licence. Min. data rate of 128 kb/s and max. data rate of 3.6Mb/s until the end of the first year after obtaining licence, on each NodeB. After tender procedure in 2012 for additional frequencies for UMTS system in the bands 900 MHz and 2100 MHz: Offered by the operators - Operator 1: 97% of population until the end of the first year after obtaining licence. Operator 2: 57% of population until the end of the first year after obtaining licence	Percentage of populated area in the country where signal strength is above -99 dBm in case of 30% cell load	Minimal and maximal data rates in case of 30% cell load
	2600 MHz	Not assigned			
Netherlands	800 MHz	Neutral	Geographical coverage defined per 2 x 5 MHz licensed spectrum. After 2 years 308 km²; after 5 years 7471 km². The operator will need to offer a public electronic communications service in this area		None
	900 MHz	Neutral	Geographical coverage defined per 2 x 5 MHz licensed spectrum.. After 2 years 257 km²; after 5 years 2567 km². The		None

			operator will need to offer a public electronic communications service in this area		
	1800 MHz	Neutral	Geographical coverage defined per 2 x 5 MHz licensed spectrum.. After 2 years 37 km²; after 5 years 367 km². The operator will need to offer a public electronic communications service in this area		None
	2100 MHz	UMTS, Upcoming licenses: Neutral	Existing licenses: Coverage of population (60% of population). Gradual coverage: big cities, all cities > 25.000 inhabitants, all main roads and waterways and airports. Upcoming licenses: Geographical coverage. 27,5 km² / 5 MHz @ 2 years 275 km² / 5 MHz @ 5 years		144 Kbit/sec outdoor 95%/time. Upcoming licenses: None
	2600 MHz	Neutral	Geographical coverage defined per 2 x 5 MHz licensed spectrum.. After 2 years 20 km²; after 5 years 200 km². The operator will need to offer a public electronic communications service in this area		None
Norway	800 MHz	Technology neutral, mobile broadband	Access to mobile broadband for 40 % of the population within 4 years after obtaining the licence, applicable to all licensees in the 800 MHz band		Outdoor coverage, delivered service shall have an average net download speed of minimum 2 Mbps at any time. Details will be discussed between NPT and the licensees during the first year of the licence period (2014)
	800 MHz	Technology neutral, mobile broadband	Access to mobile broadband for 98 % of the population within 5 years after obtaining the licence, applicable to one licensee in the 800 MHz band (2 x 10 MHz). The licensee may use frequencies in other bands as well to fulfil the coverage obligations		Outdoor coverage, delivered service shall have an average net download speed of minimum 2 Mbps at any time. Details will be discussed between NPT and the licensees during the

					first year of the licence period (2014)
	2100 MHz	3G	Licensee shall offer 3G services that cover 40 % of the population within 6 years after obtaining the licence		Minimum data speed of 128 kbps in the area covered
Portugal	800 MHz		Under evaluation		
	900 MHz		The relevant parameters are provided by the mobile operators, and used as appropriate in the coverage studies that we do to evaluate the results reported by the mobile operators. Please see our answer to question 2		
Serbia	800 MHz	-	-	-	-
	900 MHz	according to Licence GSM (subject of ongoing discussion)	**Telenor, Telekom Serbia**: all the geographical obligations had been reached before the current licences are assigned to these two operators. **VIP**: 80% of population and 90% of the country 4 years after obtaining licence. 2 Mbps in 20 specific towns 3 years after obtaining licence	according to Licence requirements for RxLev > -95 dBm	according to Licence requirements Down link: 128 kbps Up link: 64 kbps
	1800 MHz	according to Licence GSM1800(subject of ongoing discussion)	**Telenor, Telekom Serbia**: all the geographical obligations had been reached before the current licences are assigned to these two operators. **VIP**: 80% of population and 90% of the country 4 years after obtaining licence. 2 Mbps in 20 specific towns 3 years after obtaining licence	according to Licence requirements for RxLev > -95 dBm	according to Licence requirements Down link: 128 kbps Up link: 64 kbps
	2100 MHz	according to Licence UMTS (subject of ongoing discussion)	60% of population 3 years after obtaining licence	according to Licence requirements for CPICH RSCP > -105 dBm	
	2600 MHz	-	-	-	-
Slovak Republic	800 MHz		25% of population - until 31.12.2015; 50% of population – until 31.12. 2017; 70% of population – until 31.12. 2018;	No.	downlink 2 Mbit/s (uplink 256 kbit/s)
	900 MHz				
	1800 MHz		25% of population - until 31.12.2015; 50% of population - until 31.12.2018;	No.	downlink 2 Mbit/s (uplink 256 kbit/s), (for GSM technology 12,2 kbit/s)
	2100 MHz				
	2600 MH		10% of population - until 31.12.2015;	No.	downlink 2 Mbit/s

			25% of population – until 31.12. 2018;		(uplink 256 kbit/s)
Slovenia	800 MHz	TRA-ECS	Special coverage obligation for one lot in 800 MHz band (2 x 10 MHz or 2 x 15 MHz): 95% of population of Slovenia (10 Mb/s DL outdoor) including 225 of 300 settlements (at least 75% population covered) after 3 years MS and FWBA (fixed wireless broadband access) with at least 10 Mbps DL or a minimum data transfer rate 2 Mbps. Operator may use any of the frequency bands assigned. General coverage obligations: Applicants must provide commercial wireless electronic communications services for: - existing operators and new entrants which acquire reserved parts of the spectrum in the 800 MHz band (category A3) provide coverage in this band to: -25% of the population of the Republic of Slovenia after 1 year, -50% of the population of the Republic of Slovenia after 2 years, -75% of the population of the Republic of Slovenia after 3 years. - new entrants provide coverage to: - 25% of the population of the Republic of Slovenia after 2 years, - 50% of the population of the Republic of Slovenia after 3 years. - 75% of the population of the Republic of Slovenia after 5 years, where new entrants which at the same time acquire reserved parts of the spectrum in the 800 MHz band (category A3) are bound by the obligations from the first indent of this paragraph.		Operator th whom 800 MHz lot with special coverage obligations is assigned must provide: - Mobile broadband services at a bitrate of at least 10 Mbps downlink (outdoor) to at least 95% of the population of Slovenia and within this obligation - cover as well 225 of 300 settlements (with at least 75% population covered) after 3 years: (after the first year 75 selected settlements from the aforementioned list, another 75 after the second year (150 total), and another 75 after the third year (225 total), all selected at the operator's discretion) The obligation of network deployment is tied to this list, as the network shall be providing these settlements or groups of settlements with mobile services as

					well as with a suitable service substituting for fixed broadband access. The operator must provide the service substituting for fixed wireless broadband access (FWBA) by installing appropriate internal or external customer-premises equipment (CPE) with a suitable antenna, providing a transfer speed for a user experience of at least 10 Mbps downlink and with a minimum data transfer rate of at least 2 Mbps, and terminally assured uplink speeds of at least 1 Mbps. FWBA service is obligatory only for those addresses of permanent residences and businesses, as well as institutions registered with the AJPES, which do not have the option of receiving a suitable alternative broadband connection with a bitrate of at least 10 Mbps, and which are within the area of

					coverage for individual settled locations, even if they are not a part of a settlement or a contiguous group of settlements from the list below. In providing this bitrate with a user experience of at least 10 Mbps or a minimum data transfer rate of at least 2 Mbps, the operator must appropriately design its network, and in doing so may use any of the frequency bands it was assigned. The Agency has the right to verify the suitability of the network design
	900 MHz	TRA-ECS	General coverage obligations: Applicants must provide commercial wireless electronic communications services for: - existing operators and new entrants which acquire reserved parts of the spectrum in the 800 MHz band (category A3) provide coverage in this band to: - 25% of the population of the Republic of Slovenia after 1 year, - 50% of the population of the Republic of Slovenia after 2 years, - 75% of the population of the Republic of Slovenia after 3 years. - new entrants provide coverage to: - 25% of the population of the Republic of Slovenia after 2 years, - 50% of the population of the Republic of Slovenia after 3 years.		

			- 75% of the population of the Republic of Slovenia after 5 years, where new entrants which at the same time acquire reserved parts of the spectrum in the 800 MHz band (category A3) are bound by the obligations from the first indent of this paragraph		
	1800 MHz	TRA-ECS	General coverage obligations: Applicants which acquire parts of the spectrum in bands above 1 GHz must provide commercial wireless electronic communications services by using any of its assigned bands above 1 GHz in such a way that they provide coverage to: -25% of the population of the Republic of Slovenia after 3 years, -40% of the population of the Republic of Slovenia after 5 years, All the above obligations take effect on the day the applicant has at its disposal an individual frequency band above 1 GHz		
	2100 MHz	TRA-ECS	General coverage obligations: Applicants which acquire parts of the spectrum in bands above 1 GHz must provide commercial wireless electronic communications services by using any of its assigned bands above 1 GHz in such a way that they provide coverage to: - 25% of the population of the Republic of Slovenia after 3 years, - 40% of the population of the Republic of Slovenia after 5 years, All the above obligations take effect on the day the applicant has at its disposal an individual frequency band above 1 GHz		
	2600 MHz	TRA-ECS	General coverage obligations: Applicants which acquire parts of the spectrum in bands above 1 GHz must provide commercial wireless electronic communications services by using any of its assigned bands above 1 GHz in such a way that they provide coverage to: - 25% of the population of the Republic of Slovenia after 3 years, - 40% of the population of the Republic of Slovenia after 5		

			years, All the above obligations take effect on the day the applicant has at its disposal an individual frequency band above 1 GHz		
Spain	800 MHz		30 Mbit/s available to 90 % of citizens living in population centres of less than 5.000 inhabitants Obligation to operators holding 2x10 or more spectrum in 800 MHz band allocated in 2011 Focus on areas where coverage at 30 Mbit/s is not available through other technologies The Ministry will approve an Extension Plan identifying the uncovered areas	Not decided yet	Not decided yet
	900 MHz		According to a decision took in 2011, operators benefitting from refarming had to provide UMTS 900 in rural areas Investments had to be addressed to population entities of less than 1.000 inhabitants Deadline for investment was 31 December 2013 For the provision of UMTS900 operators could choose either to reach a volume of investment or to reach a number of population actually covered	Population centre covered with a minimum level of signal of -90 dBm outdoor	
	1800 MHz		Coverage obligation in cities higher than 500,000 inhabitants before 1999		
	2100 MHz		Coverage obligation in cities higher than 250,000 inhabitants before 2003		
	2600 MHz		No coverage obligations		
Sweden	450 MHz		Used for CDMA2000, obligation to cover 80 percent of the land, at least with mobile telephony		
	800 MHz	An appropriate and cost-effective rollout covers the following costs: - Cost of infrastructure for the transmitter location - Cost of infrastructure in radio equipment and other facilities	Coverage obligation concerns FDD6. The licence holder shall cover all permanent homes and fixed places of business that do not have data communications services with a particular bit rate identified by PTS, though no more than a rollout cost of 300 000 000 Swedish kronor (excluding value added tax) plus an annual adjustment for inflation. The licence holder shall cover through rollout at least seventy-five (75) per cent of the permanent homes and fixed places of	Frequency Division Duplex, FDD. Effect-limits for different frequencies (block edge mask)	According to the decision coverage' means: - an appropriate and cost-effective rollout in accordance with the provisions of PTS's guidelines for appropriate and cost-effective rollout, and - that an end user

		required to provide coverage according to the requirement on coverage and rollout. This includes the cost of - roads up to the site where the radio base station is to be installed if none exists and this is required, - the radio base station, - the building or the space where the radio base station is located; climate control required for the equipment to function as intended, - the support systems required for the installation to function generally, e.g. power, masts for attaching radio antennae, foundations for the building and masts, radio antennae, cables, radio waveguides, etc. required to satisfy the technical specifications that apply to radio coverage within these areas,	business on the list no later than 31 December 2013. PTS shall send this list to the licence holder no later than by January 2013, and; from and including 2014 and beyond, the licence holder shall cover through rollout all of the permanent homes and fixed places of business on the list no later than by 31 of December each year. Rollout shall continue until the rollout cost amounts to the amount stated above		gains access to data communications services in at least one room in the permanent home or at the fixed place of business so that the end user can receive services with a bit rate of 1 Mbps, or a higher applicable data rate for functional access to the Internet where the home or place of business has been identified. 'A bit rate of 1 Mbps' in item (ii) above means: -that the bit rate amounts to at least 1 Mbps at some point in time in a day, -that the average rate amounts to at least 750 kbps in a day, and -that the average rate for four consecutive hours when the speed is at its lowest amounts to at least 500 kbps

		- installation and commissioning, and - work directly linked to the construction of infrastructure at the transmitter location, e.g. excavation			
	900 MHz		The licence holder shall keep the percental coverage per county, for mobile telephony, until 2015. Coverage can be offered through own, or other licence holders, network in 900 MHz, 1800 MHz and 2.1 GHz-bands	Block egde mask	
	1800 MHz		-	-	-
	2100 MHz		-	-	-
	2600 MHz		-	-	-
Switzerland	800 MHz 900 MHz 1800 MHz 2100 MHz 2600 MHz		Answer: General obligation regarding utilisation: the licensee is obliged to use the allocated frequencies as set out in Article 1 TCA and to provide commercial telecommunications services over its own transmission and reception units. In addition, the licensee must ensure the coverage of 50% of the population of Switzerland with mobile radio services via their own infrastructure by 31 December 2018 latest. Remark: the above last obligation is already fulfilled by the licensees. There are no voice coverage or data service coverage criteria defined in the licenses		
United Kingdom	800 MHz	Technology Neutral	The Licensee shall by no later than 31 December 2017 provide, and thereafter maintain, an electronic communications network in an area within which at least 98% of the population of the United Kingdom lives and 95% of the population of each of England, Wales, Scotland and Northern Ireland lives. An electronic communications network that is capable of providing, with 90% confidence, a mobile telecommunications service at indoor locations with a sustained downlink speed of not less than 2 Mbps when that network is lightly loaded. The service must be provided using radio equipment which is not situated inside the relevant residential premises. For all assumptions and parameters, please refer to the verification methodology (http://stakeholders.ofcom.org.uk/binaries/consultations/award-	N/A	N/A

			800mhz/statement/4GCov-verification.pdf) The coverage obligation is attached to one of the 800 MHz licences. The relevant licensee may use other cellular frequency bands or any technology to fulfil this obligation		
	2100 MHz	Technology Neutral	The Licensees must provide an electronic communications network by 20 June 2013, that is capable of providing mobile telecommunications services to an area within which at least 90% of the population of the UK lives and with a 90% probability that users in outdoor locations within that area can receive the service with a sustained downlink speed of not less than 768 kbps in a lightly loaded cell. For all assumptions and parameters, please refer to the verification methodology (http://stakeholders.ofcom.org.uk/binaries/consultations/2100-MHz-Third-Generation-Mobile/annexes/methodology.pdf) The licence conditions have since been varied and the licensees may use other cellular frequency bands or any technology to fulfil this obligation		

Table provided by Ireland:**

Terrestrial Systems and bandwidth	800MHz FS (dB(µV/m))	800MHz Ec/Io or BLER	900MHz FS (dB(µV/m))	900MHz Ec/Io or BLER	1800MHz FS (dB(µV/m))	1800MHz Ec/Io or BLER
GSM (0.2MHz)	45	N/A	46	N/A	54	N/A
UMTS (5MHz)	49	-8	50	-8	57	-8
LTE (5MHz)	47	10^2	48	10^2	55	10^2
LTE (10MHz)	44	10^2	45	10^2	52	10^2
LTE (15MHz)	42.5	10^2	43.5	10^2	50.5	10^2
LTE (20MHz)	41	10^2	42.5	10^2	49.5	10^2

Table - The coverage level specification per frequency band, per bandwidth, and per terrestrial system.[9][10]**

[9] where:
- FS = Field Strength;
- BLER = Block Error Rate; and
- Ec/Io = The ratio of the received energy per chip and the interference level.

With regard to Table**, above :
- Where both a FS and an Ec/Io or BLER metric are specified in Table 5 for a particular Terrestrial System (i.e. UMTS7 and LTE8), an area will be deemed to have coverage where the Ec/Io or BELR exceeds the levels as set out in Table 1, even if the Field Strength is less than the value shown in the Table 1.
- Where a FS metric is the only metric specified in Table 1 for a particular Terrestrial System (i.e. GSM), an area will be deemed to have coverage where the Field Strength in Table 1 above is met.

[10] Should WiMAX, or any other terrestrial systems be deployed in one or more of the 800, 900, or 1800 MHz bands, measurement standards will be defined in accordance with, as appropriate, relevant international standards and recommendations, but for indicative purposes such standards are likely to be based on the following:
- For measurement purposes – an average pilot signal field strength of “X” measured outdoors at a height of 1.5m, or a Carrier to Interference (C/I) ratio of –Y dB

Question 2 Enforcement

Question 2: **How do you supervise compliance to the coverage obligations?** **Please specify relevant methods, values for each technology/frequency band/licence as relevant for your country.**	
Croatia	Generally, operators are obligated to send all relevant technical data for particular base station and reports which include statement about population and territory coverage percentage. There is also a possibility to have coverage maps for each operator. Based on received data HAKOM is performing measurements/calculations on representative samples in order to verify the licence obligations
Estonia	At the moment the coverage obligation is applicable only in 800 MHz band and only for operator who has won the first license in “beauty contest”. Estimation was made after the start date of provision of services which was specified in the bid
Hungary	See below
Ireland	ComReg can perform it’s own drive tests, and conduct map comparison with Operator provided data. There are also a number of Operator obligations with regard to the provision of relevant information to Comreg, outlined below: **GSM 900/1800 Services.** Measurements to determine coverage shall be carried out using; i) in the case of the GSM 1800 mobile telephony service, a 1 Watt terminal operating outdoors, and; ii) in the case of the GSM 900 mobile telephony service, a 2 Watt terminal operating outdoors. Alternatively, signal strength measuring equipment may be used. The licensee is also obliged to publish maps related to the above listed terminal powers. The Licensee is obliged to keep a log ("the network log") and, approximately every 3 months, must provide a copy of the log relating to ComReg, reporting all events consisting of network disturbances, failures and periods of scheduled unavailability which occurred over that time period. Details provided in the network log should include the date, start time, duration of the event, and the estimated number of terminals affected. The Licensee must also provide, on request, all measurement information considered necessary to adequately determine performance against mandatory service standards which have been specified to the Licensee. Operators are also obliged to provide: • An up to date list of the locations of the base transceiver stations; • A mechanism for identifying the base station that is handling a call at any given time; • An adequate number of test numbers (SIMS). **3G Services.** The Licensee shall keep a log (the “network log”) for the purposes of recording and tracking all periods of system unavailability. The Licensee shall maintain this network log in a manner that will demonstrate, to the satisfaction of the Commission, that such a network log is an adequate means of assessing whether the Licensee is complying with its system availability obligations under this licence. This Log will be made available to ComReg on request. For the purposes of carrying out service quality surveys, the Licensee shall provide, on request, to the Commission the following:-

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• For propagation prediction systems – a pilot signal field strength of “X” over 95% of the area during 95% of the time.

	• Maps showing Coverage for 3G service. • An up to date list of the locations of the base transceiver stations; • A mechanism for identifying the base station that is handling a call at any given time; • An adequate number of test numbers (SIMS). **Liberalised Use Licence Obligations:** For the purposes of carrying out coverage and quality of service compliance checks, the Licensee shall, on request, provide to the Commission the following: • Maps showing Coverage as defined in Section 3 of this Schedule; • An up-to-date list of the locations of the "Base Station"2 transmitters; • An adequate number of test numbers (SIMS). **Further operator obligations:** • Every twelve months, the Licensee shall submit an annual compliance report to ComReg on coverage. • The measurements required for this compliance report will be agreed with ComReg in advance and the compliance report shall have sufficient detail and granularity to allow the ComReg to verify the Licensee's measurements. • Where the Licensee claims to have met minimum coverage and roll-out obligations for the first time, the compliance report is required to contain drive test measurements. Thereafter, upon request by ComReg, the Licensee must carry out drive test measurements and submit these results to ComReg
Latvia	Operators usually provide annual information on their networks coverage. Information on issued radio frequency assignment use permits can be used
Montenegro	Operators don't provide any measurement results to the administration
Norway	Throughout Question 2 we have used the 800 MHz band as example as this is the band with most relevance
Portugal	To evaluate the theoretical coverage - excluding the 800 MHz obligations that are under evaluation - we do theoretical studies with a mobile planning tool called XG-PLANNER (please consult http://www.lstelcom.com/en/). First we ask mobile operators to give us details about the planning of their network, including elements like link budget, sensitivity, propagation model, digital maps, population maps, etc.. Than we analyse the information and if it is correct, in a theoretical basis, we use our mobile planning tool to replicate the studies done by the mobile operators, as far as we can, and check if the results (% of area and population covered) that we obtain are of the same magnitude. In case that the results are completely different, a more detailed analysis is carried out, e.g by checking the results with a survey in sample areas (to be defined). It should be noted that ANACOM register the location and some parameters like the e.i.r.p. of each base station of the mobile operators. Before we set up this methodology we pondered to approve a common methodology to the three mobile operators, to calculate the coverage of their UMTS networks. However one of the disadvantages is that imposing one common methodology could give not "real" results (for instance the propagation model used for the operators could be different and imposing a kind of "universal" propagation model could change the "real" coverage results)
Sweden	PTS provides three examples of supervision methods and coverage obligations, see below

<table>
<tr><th colspan="2">a) Is there a common set of technical parameters agreed between the administration and the operator to determine radio coverage using both measurement and/or simulation? If yes, which parameters are established (e.g. propagation models, map resolution, cell loading)?</th></tr>
<tr><td>Austria</td><td>Parameters and the way of measurement are specified in the license conditions (see URLs mentioned in the table above</td></tr>
<tr><td>Belgium</td><td>No</td></tr>
<tr><td>Croatia</td><td>No</td></tr>
<tr><td>Cyprus</td><td>N/A</td></tr>
<tr><td>Czech Republic</td><td>• Measurement:
o LTE 800 MHz - limit values RSRP (Reference signal received power) -109 dBm (outdoor), SINR (Signal-to-interference-plus-noise ratio) 5 dB;
o LTE 2600 MHz - limit values RSRP -105 dBm (outdoor), SINR 5 dB.
o For details, please see http://www.ctu.cz/cs/download/vyberova_rizeni/invitation_to_tender_15_08_2013_appendix_3.pdf
• Simulation:
o Map resolution 100×100m;
o Statistical model of signal propagation (ITU 1546-2CA) and diffractive model of signal propagation (ITU 1812).
o Calculated over maps with detailed population distribution (building / block of buildings level).
o For details, please see http://www.ctu.cz/cs/download/vyberova_rizeni/invitation_to_tender_15_08_2013_appendix_3.pdf</td></tr>
<tr><td>Denmark</td><td>No</td></tr>
<tr><td>Estonia</td><td>There is an agreed value (58 dBµV/m/5MHz) for estimating coverage in the degree of Ministry of Economic Affairs and Communications.</td></tr>
<tr><td>Finland</td><td>No, but we are working on it and hope that the ECC work will provide solutions.</td></tr>
<tr><td>France</td><td>Operators have to provide reliable coverage maps (see question 1.c)).
An ARCEP decision states the methodology used to verify coverage.</td></tr>
<tr><td>Germany</td><td>No</td></tr>
<tr><td>Hungary</td><td>For purposes of coverage, roll-out obligations shall be considered as being met if the signal level measured with a measuring receiver on the decoded broadcast control channel (BCCH)— measured at a height of 1.8 m above sea level and with an antenna gain of 0 dB, also taking the channel spacing of the technology applied (GSM, UMTS, WiMAX or LTE) into account — reaches the technical requirements for coverage. Minimum indoor and outdoor signal strength for the tendered frequency bands are contained in the Table 2.

Table 2
<table>
<tr><td rowspan="2">Band</td><td colspan="3">Outdoor</td><td colspan="3">Indoor</td></tr>
<tr><td>GSM (RxLev)</td><td>UMTS (RSCP)</td><td>LTE (RSRP)</td><td>GSM (RxLev)</td><td>UMTS (RSCP)</td><td>LTE (RSRP)</td></tr>
<tr><td>800 MHz</td><td>-</td><td>-96 dBm</td><td>-110 dBm</td><td>-</td><td>-86 dBm</td><td>-100 dBm</td></tr>
<tr><td>900 MHz</td><td>-93 dBm</td><td>-96 dBm</td><td>-110 dBm</td><td>-81 dBm</td><td>-84 dBm</td><td>-98 dBm</td></tr>
<tr><td>1800 MHz</td><td>-93 dBm</td><td>-96 dBm</td><td>-110 dBm</td><td>-73 dBm</td><td>-76 dBm</td><td>-90 dBm</td></tr>
<tr><td>2600 MHz</td><td>-</td><td>-96 dBm</td><td>-110 dBm</td><td>-</td><td>-74 dBm</td><td>-88 dBm</td></tr>
</table></td></tr>
</table>

	Remarks: Signal levels were defined taking into account ETSI TR 102 581. Abbreviations: RxLev (Received Signal Level): reception level of the BCCH – Broadcast Channel; RSCP (Received Signal Code Power): Pilot (reference) channel level measured after decoding; RSRP (Reference Signal Received Power): Received performance of the reference carrier.
Iceland	No
Ireland	Yes; map based, employing population polygons and field strengths determined using propagation models.
Italy	See Table****
Latvia	No
Liechtenstein	No
Lithuania	There is a common set of parameters for measurement of radio coverage for GSM, UMTS and LTE networks which are performed by our administration (drive tests). These parameters, as well as methodology of how these measurements should be performed and how they should be compared to operators' coverage simulation results are written in a legislatively approved methodology
Malta	Generally, operators are requested to send reports containing information on their achieved coverage percentage of the national territory. The Malta Communications Authority then performs measurements to verify compliance with the relevant licence obligations
Montenegro	There is set of measurement parameters to determine radio coverage agreed between the administration and the operators based on relevant ITU-R documents
Netherlands	For 2 GHz (UMTS) there is a common set of technical parameters agreed. This is the base for a protocol how to conduct measurements to verify the coverage and quality of service of the networks involved. For the 'new" licences in the 800 MHz, 900 MHz, 1800 MHz and 2,6 GHz band (and as well for the future 2 GHz band licences) the coverage-demands are strongly simplified. In this moment only for 2,6 GHz a coverage-obligation is mandatory. For this band a simple measurement-protocol is agreed with the operators. There is only a coverage-obligation, no quality of service-obligation. For the other bands the same protocol will be used as soon as the coverage obligation is mandatory
Norway	No, the process of establishing common set of technical parameters will start in 2014. However, there will be both simulations and measurements. Each licensee is obliged to report to NPT 31 January each year, starting 2015
Portugal	No. However a set of minimum technical parameters should be provided to the regulator, by each operator, justifying the coverage results achieved, per service, namely: • Description of the exterior coverage in maps of adequate scale (minimum 1:1 500 000); • The assumptions and methodology for the dimensioning of the coverage, and in minimum the following elements should be provided: o Maps used in the calculations including the population maps; o Propagation models; o Indication of measurements done to calibrate the propagation models, if applicable;

	o Sensitivity per service; o Typical antennas used including radiation patterns; o Link budgets
Serbia	The quality parameters for electronic communication networks under public bidding regime are set in Rulebook
Slovak Republic	Terms of coverage, percentage of the population and bit rate
Slovenia	see above text from tender documentation
Spain	800 MHz: not decided yet 900 MHz refarming: criteria set by the Administration
Sweden	Yes, see examples below
Switzerland	No
United Kingdom	Yes. The parameters are given in the following links (http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/4GCov-verification.pdf) (http://stakeholders.ofcom.org.uk/binaries/consultations/2100-MHz-Third-Generation-Mobile/annexes/methodology.pdf)
b) Do you perform measurements and how are these measurements performed (e.g. spot-test/drive-test, measurement equipment, antenna type, antenna height, etc)?	
Austria	Yes, implementation according to (a): spot-tests using consumer-terminals
Belgium	Last measurements (3G) were made with commercial handsets for 1000 tests points
Croatia	Yes. Measurements are performed on Rohde & Schwarz ROMES platform
Cyprus	N/A
Czech Republic	o Measurements performed only in case of difference between operator calculated coverage and administration calculated coverage. o Measurements performed during driving on all available public roads with 2 omni-directional antennas held at a height of 1.5m (MIMO). All measurements are performed outside of buildings. Coefficients for each frequency band are used for assessing indoor coverage
Denmark	No
Estonia	Before supervision of license conditions the operator provided all data needed (map where min 95% of coverage with at least 58 dBµV/m/5MHz and min download speed 5Mbit/s are guaranteed, locations of requested 199 base stations, all other technical information about network). Drive test was used to determine min field strength values to estimate service coverage. Spot-tests at random positions were used to determine required min download speed 5Mbit/s. To evaluate the LTE 800 MHz network coverage, ETSA used the RSSI (received signal strength indicator) signal strength values coming from the data USB modem during the measurement path. We used conversion factor from RSSI to field strength. ETSA averaged the signal strengths measured outside the cities after each travelled 100 m
Finland	Not until now, but in the future we will carry out coverage measurements to verify the coverage maps provided by the operators (e.g. drive test, R&S TSMU scanner, omnidirectional antenna, R&S ROMES measurement software)
France	Reliability of coverage maps are checked with drive tests, using regular terminals
Germany	Spot-test / drive-test
Hungary	For purposes of assessing network coverage, the Authority shall be conducting location registration tests and stationary measurements on a randomised basis, checking parameters of network coverage and determining whether prescribed levels are being met. The Authority shall assess the fulfilment of roll-out and coverage obligations along the following considerations: • **Coverage of localities with up to 6,000 residents:** Within the municipal boundaries, the measured signal strength remains above

	the minimum indoor level prescribed for the band throughout at least 70 percent of paved roads. • **Coverage of localities with 6,000 to 30,000 residents:** In a randomly selected area within the municipal boundaries and representing at least 50 percent of the locality's geographic area, the measured signal strength remains above the minimum indoor level prescribed for the band throughout at least 70 percent of paved roads. • **Coverage of localities with a population of or above 30,000 residents:** In a randomly selected area of at least 10 km2 within the municipal boundaries, the measured signal strength remains above the minimum indoor level prescribed for the band throughout at least 70 percent of paved roads. • **Coverage in Budapest:** throughout 90 percent of each individual previously identified route, as well as the area within the ring road, the measured signal strength reaches the minimum indoor level prescribed for the band along the entire length of specified roads and within the area marked out by these roads; • **National geographic coverage:** on all national motorways, carriageways and single and double-digit primary roads as well as primary road no 100, the measured signal strength remains above the minimum outdoor level prescribed for the band along 90 percent of the total length of each individual route. • **National population-based coverage:** The licensee shall, within 30 days of the deadline applicable to the roll-out and coverage requirements listed under Question 1, declare to the Authority in an MS Excel spreadsheet its national population-based coverage achieved, based on the latest statistical data available for the year preceding the enquiry and also featuring the number of residents covered per locality as well as their coverage as a proportion of both the local and national population. Total national population-based coverage is achieved when, for any randomly selected locality featured in the licensee's spreadsheet, the coverage rate established using the measurements specified under Question2 point b) reaches or exceeds the respective proportion reported by the licensee.
Iceland	spot-test/drive-test, equipment TSMW Romes from ROS
Ireland	Drive tests utilising Swissqual type equipment
Italy	Spot and drive tests are occasionally but not regularly performed by local ministry headquarters with available instruments (spectrum/network analyzers)
Liechtenstein	No
Latvia	No
Lithuania	Our administration performs measurements of the coverage of UMTS and GSM networks (drive test type) and spot test measurements for LTE, UMTS and GSM networks. For drive tests for now we use Agilent E6474A equipment with omnidirectional antennas and antenna height of 3 meters. In the near future our administration is going to change drive test antenna height to 1,5 and as well renew drive test equipment
Malta	Measurements are performed generally using consumer terminals.
Montenegro	We perform measurements on drive-test base by mobile monitoring station using R&S TSMQ scanner, proper GSM and UMTS antennas mounted on the top of monitoring vehicle
Netherlands	Yes, i.e. in the 2,6 GHz band we perform (drive) test with network analysis tools, 20 spot-test on 20 square kilometres per 5 MHz. (all new licences in the Netherlands have a frequency span of 5 MHz). The spot-tests are performed with a normal standard network-terminal outside the monitoring vehicle and are conducted per licence. On a spot we are downloading a file from our FTP server to determine if the service provided by the network is effective. The download speed is not part of the test, only the download itself
Norway	NPT will perform spot test measurements of the reported data. The test will be performed by using the three top selling mobile terminals from the previous year, which have support for the relevant frequency bands for mobile broadband. Average downlink data speed will be logged

<table>
<tr><td></td><td>together with geographical position. All measurements will be done outdoor</td></tr>
<tr><td>Portugal</td><td>We did several surveys to assess the QoS of Voice and Video-telephony Services, of GSM and WCDMA Network Coverage, in the main Urban Agglomerations and on the Major Roads of Mainland Portugal and also in the main trains, available in the following link: http://www.anacom.pt/render.jsp?categoryId=293535&channel=graphic#horizontalMenuArea
However this information is not used to evaluate the coverage obligations.
The level of coverage (« Boa » - good ; « Aceitável » - acceptable ; « Má »- bad ; « Inexistente » - nonexistent) for GSM and UMTS networks agreed by ANACOM and the mobile operators and are the following:
<table>
<tr><th>Cobertura</th><th>GSM</th><th>WCDMA</th></tr>
<tr><td>Boa</td><td>RxLev ≥ –85 dBm</td><td>CPICH RSCP ≥ –95 dBm</td></tr>
<tr><td>Aceitável</td><td>–95 dBm ≤ RxLev < –85 dBm</td><td>–105 dBm ≤ CPICH RSCP < –95 dBm</td></tr>
<tr><td>Má</td><td>–110 dBm ≤ RxLev < –95 dBm</td><td>–115 dBm ≤ CPICH RSCP < –105 dBm</td></tr>
<tr><td>Inexistente</td><td>RxLev < –110 dBm</td><td>CPICH RSCP < –115 dBm</td></tr>
</table></td></tr>
<tr><td>Serbia</td><td>No</td></tr>
<tr><td>Slovak Republic</td><td>It will be discussed in line with 4.2.5 Verifying the Conditions of Efficient Frequency Usage of the conditions of the tender by form Electronic Auction 2013. (http://www.teleoff.gov.sk/data/files/35571.pdf)</td></tr>
<tr><td>Spain</td><td>800 MHz: not decided yet
900 MHz refarming: on the spot test for a given sample (size of sample set according to statistical approach)</td></tr>
<tr><td>Sweden</td><td>In some cases PTS performs measurements and in other cases PTS collects coverage data from the operators in order to supervise coverage obligations, see three examples below</td></tr>
<tr><td>Switzerland</td><td>No</td></tr>
<tr><td>United Kingdom</td><td>No. Measurements are not performed for the purposes of coverage obligation verification. However, improving mobile coverage for consumers is a priority area for Ofcom and we have published a five point plan to improving mobile coverage (http://consumers.ofcom.org.uk/2013/11/five-point-plan-to-improving-mobile-coverage/). Ofcom also has a duty to report on the national communications infrastructure every 3 years. As part of this program the mobile network operators provide their predicted network coverage annually to Ofcom. In the past Ofcom has undertaken measurement campaigns and compared results to operator predictions, on an ad-hoc basis (e.g. http://www.ofcom.org.uk/static/research/CRFS_report.pdf)</td></tr>
<tr><td colspan="2">c) Does the operator provide measurement results and how are these measurements performed?</td></tr>
<tr><td>Austria</td><td>No</td></tr>
<tr><td>Belgium</td><td>No</td></tr>
<tr><td>Croatia</td><td>No</td></tr>
<tr><td>Cyprus</td><td>N/A</td></tr>
<tr><td>Czech Republic</td><td>Operators provide only calculation results</td></tr>
<tr><td>Denmark</td><td>We know that the operators perform their own measurements, but not how they are performed</td></tr>
<tr><td>Estonia</td><td>Sometimes operators provide measurements but these are not part of the process of supervision of license condition</td></tr>
</table>

Finland	To be decided. Concerning indoor coverage, the operators are obligated to provide measurement data on case by case, if necessary
France	Operators don't provide measurements results to ARCEP
Germany	No
Hungary	No, the operator shall only give declaration according to the procedure described under the bullet point "National population-based coverage" in the answer to Question 2 b) and the Authority performs measurements to verify this.
Iceland	No
Ireland	On achieving their licence obligations, the operator provides map-based data utilising the appropriate propagation model and population polygons, which have been verified by the operators own drive test
Italy	Generally, measurements are not required from operators
Latvia	No
Liechtenstein	Operator provides coverage plots if requested
Lithuania	Operators do not provide measurement results, only simulation data
Malta	No
Montenegro	Operators don't provide any measurement results to the administration
Netherlands	The operators provide coverage-information, generated by their planning tools. The spot-test are performed in the areas provided by the operators.. For 2,6 GHz the coverage-obligation is a minimum of 20 square kilometres per 5 MHz. 20 spots are randomly picked in the coverage-area(s) provided by the operators. At these spots an attempt is made to contact the network-service with the use of a standard network-terminal suited for the service provided (at this moment all the providers offer wireless internet access by dongle). If an attempt fails, two other attempts are made with a minimum interval of 1 minute. If these attempts also fail, one final measurement on this spot is conducted another day . When this attempt is successful the measurement on that particular spot is a Pass, otherwise the measurement on that particular spot is marked as Fail. On a total of 20 spots 18 measurements must be successful to provide a positive outcome, otherwise the network coverage is marked as unsatisfactory
Norway	No
Portugal	No
Serbia	The operators are on regular base required to submit the results of the measurement of the basic set of parameters pertaining to network quality monitoring, at least once a year, using the forms which are specified in the Rulebook
Slovak Republic	No, requiring records based on calculations model which will be verified by measurements ad hoc inspections
Slovenia	See above text from tender documentation
Spain	800 MHz: not decided yet 900 MHz refarming: operator does not provide measurement results, but only the list of population centres it presumes are covered
Sweden	No, the operators do not provide any measurement results
Switzerland	Yes, the operators give percentage of the coverage of the population and the territory with the different technologies (LTE, UMTS, GSM)
United Kingdom	No
d) Do you perform simulations/predictions/studies and how are these calculated (e.g. which software is used and which variables are set)? Please specify	

Austria	No
Belgium	No
Croatia	Yes, with the following specifications/parameters: - software used: LS telcom and Hnit-Baltic - propagation model: Okumura-Hata and ray tracing models - map resolution: 25m, 50m, 100m - GSM: receiver signal level > -95 dBm - UMTS: CPICH RSCP > -114 dBm - LTE: RSRP > -115 dBm
Cyprus	N/A
Czech Republic	o RadioLab software by Czech company CRCData; o ITU 1546-2CA and ITU 1812 propagation models; o Coverage calculated on the basis of the network technical parameters submitted by the allocation holder
Denmark	No
Estonia	No simulations/predictions/studies are performed
Finland	No planned
France	No simulations or predictions
Germany	No
Hungary	No
Iceland	Yes with ICS Telecom SW
Ireland	No, but it is possible to carry out such tasks using propagation software employing the appropriate propagation model
Italy	See table****
Latvia	Some experimental calculations were done using LS Telecom CHIRplus_BC software for calculations of theoretical coverage of CDMA450 base stations network. The following parameters were taken into account: coordinates of base station, antenna height, effective antenna heights, antenna azimuth, antenna tilt, e.r.p. A transmitting frequency and an antenna type were assumed. Finally, a theoretical coverage (%) of territory was calculated. Used variables: radio wave propagation prediction model (Rec. ITU-R P.1546-1), a receiver antenna height (1.5m, 3m and 10m), time and location probability (50%T; 50%L), a received signal strength level (-75 dBm - indicating strong signal; -85 dBm; -95 dBm - indicating weak signal) for CDMA450 network, a topographical map with 100 m resolution was used
Liechtenstein	No
Lithuania	We perform downlink coverage calculations using software ICS Telecom from company ATDI. Currently two types of clutters are used – rural area and forest. For 900 MHz band we use Okumura-Hata-Davidson propagation model along with Deygout diffraction. For 2100 MHz band we use Cost 231 propagation model along with Deygout diffraction
Malta	No
Montenegro	We perform coverage predictions by using ICS ATDI Telecom software
Netherlands	No, not at the moment, but we want to develop and use simulation tools in the near feature. Especially due to all the different TDD and FDD frequencies in the new licences simulations can be more effective

Norway	NPT will perform simulations by using the reported data from the licensees. NPT will use the system called ICS-Telecom, delivered by ATDI Ltd. Setting of the different variables will be done after discussing these issues with the relevant licensees
Portugal	Please see our answer to question 2
Serbia	No
Slovak Republic	No, we do not plan perform special studies
Slovenia	See above text from tender documentation
Spain	800 MHz: not decided yet 900 MHz refarming: we only perform on the spot tests to verify that, for a given sample of population centres, signal is received with the required power level
Sweden	Based on operator coverage prediction data, PTS performs analysis using Mapinfo, see example 2 below
Switzerland	No
United Kingdom	Yes. The assessment is undertaken using MATLAB software developed within Ofcom. The operator provides the specified base station parameters and these are assessed using the published methodologies
e) Does the operator provide simulations/predictions and how are these calculated? How do you collect this information?	
Austria	The operator provides simulations according to (a) and site positions in a GIS-format
Belgium	Yes. Operators provide a text file with 0 (no coverage) and 1 (coverage) for squares of 200 m x 200 m
Croatia	Not on regular basis. This information can be obtained on HAKOM's demand
Cyprus	N/A
Czech Republic	o Operator only provides calculated coverage for each 100×100m square (covered / not covered); o Format: csv in defined format
Denmark	No
Estonia	No
Finland	We are planning to do this. At first this is based on the operator's own calculations. Later the parameters will be agreed based on the results of the ECC work
France	Operators provide coverage maps, which are deemed to be reliable. No information on the methodology used is demanded. Information is collected in a GIS format (shape)
Germany	Simulations / predictions are provided by the operator. Calculations of this as subset of business policy will not be provided to the agency. Information will be given by the operators
Hungary	Yes, see answer in the bullet point "National population-based coverage" under Question 2 b).
Iceland	Yes, published on the operator web site
Ireland	Yes, Using band appropriate propagation models such as, for example, the COST-Hata model
Italy	Operators are required to regularly send data on their base stations and network coverage, in electronic and paper formats
Latvia	Information on network coverage can be found in operators web pages
Liechtenstein	Operator provides coverage plots if requested
Lithuania	Operators do not provide simulations/predictions results
Malta	No

Montenegro	Operators provide to the administration simulation/prediction results on request
Netherlands	Yes, the operators provide us with their own simulations/predictions of their network coverage. Those simulations/predictions are generated by the operators own planning tools. As we have no detailed knowledge of the parameters used in their calculations we ask them for coverage information in a shape format, so we can copy the layer of information in our own geo tool to generate a coverage map
Norway	Not for the moment, but a conclusion on this will be taken after NPT have discussed the coverage obligations in detail with the licensees
Portugal	Yes they provide. Please see the answer to question 2, and 2.a). Concerning the 800 MHz it is not yet defined how the coverage obligations will be evaluated but a similar process is foreseen
Serbia	No
Slovak Republic	It will be discussed in line with 4.2.5 Verifying the Conditions of Efficient Frequency Usage of the "Conditions of the Tender" by form Electronic Auction 2013
Slovenia	See above text from tender documentation
Spain	800 MHz: not decided yet 900 MHz refarming : no
Sweden	Yes, PTS collects coverage predictions from operators on a yearly basis, see example 2 below
Switzerland	No
United Kingdom	No
f) Do you take into account multiple user scenarios – i.e. would the simulation include a number of users per cell/area other than one?	
Austria	All simulations and measurements are done under real network conditions (actual load)
Belgium	No
Croatia	No
Cyprus	N/A
Czech Republic	No. Simulation is only performed for signal parameters, not speed parameters
Estonia	No
Finland	We have not considered multiple user scenarios so far. We hope that the ECC work will provide solutions
France	Not applicable
Germany	No
Hungary	No
Iceland	No, due to the scarce population of Iceland this is not the same problem as elsewhere.
Italy	Only in the 2100 MHz coverage model multi-user traffic is considered. Traffic distribution is proportional to the population density
Latvia	No
Liechtenstein	No
Lithuania	We do not take into account multiple user scenario
Malta	No simulations are carried out
Montenegro	No
Netherlands	No, we do not take into account the load of the network

Norway	Yes. Details will follow after discussions with the licensees
Portugal	Not for GSM. For UMTS, and as far as the obligations are defined for data rates of 144 kbps and 384 kbps, our approach was to do the studies where we assumed that the cell is working with the maximum number of users (based in maximum cell loading) and using the same type of service, 144 kbps or 384 kbps. It is understood that this scenario is not realistic but served the objective
Slovak Republic	No
Slovenia	No
Spain	800 MHz: not decided yet 900 MHz refarming: no
Sweden	No
Switzerland	No
United Kingdom	A lightly loaded network is considered which is defined as having a single user demanding service within the serving cell, and the surrounding cells of the network are loaded to a light level (by which we mean the common channels only are transmitting at 22% of the maximum cell power).
g) Is there any tolerance (margin allowed for coverage obligations) compliance established in your administration? (e.g. if an obligation of the right of use/authorisation requires 90 % of population/area coverage, will an operator be in breach if the simulation studies performed by your administration come to the result of 88 % of population/area covered?)	
Austria	No, but penalties are linked to degree of violation of obligation
Belgium	No
Croatia	No
Cyprus	N/A
Czech Republic	5% of population in each district (required coverage is 95 % of population in each district, results >= 90% in administration coverage calculation are OK)
Denmark	There is not tolerance in the coverage obligations, they are minimum requirements
Estonia	There are no tolerances established. But if we make on sight field strength measurements with special equipment then uncertainty is taken into account
Finland	We have not considered any tolerances so far. We hope that the ECC work will provide solutions
France	The drive test results are compared to the coverage maps provided by operators: access has to be effective in any point within the coverage area (a local failure tolerance of 5% is accepted). If a discrepancy between the measures and a map is observed, the operator has to take measures either to correct its map or to modify the network coverage so that it matches the map
Germany	No
Hungary	Not specified, included in the method of measurement, see answer under Question 2 b). A licensee may only be granted exemption from meeting the network rollout obligations in the event and to the extent that roll-out is impeded for reasons beyond its control in a specific geographic area and it is unable to fulfil the obligation using another frequency — preferably acquired in the context of this tender or already used in another band. The licensee shall provide valid proof of such circumstances.
Iceland	No
Ireland	No margin allowed in most cases, but 3G is probabilistic coverage

Italy	A specific tolerance margin is defined only in the case of 800 MHz coverage obligations; since in this case the obligations concerns mainly small towns and sparse areas, a coverage obligation is fulfilled even if it misses the target by at most 10%, provided that the number of people to reach the target is lower than 30
Latvia	No
Liechtenstein	The coverage obligations are predefined and has been fulfilled by all operators (Orange, Swisscom, Mobilkom)
Lithuania	We do not use any margin for coverage obligations
Malta	The licence does not provide for tolerances
Montenegro	Yes, there is a tolerance on which we discuss with operators and give additional reasonable period of time to comply with licence
Netherlands	N.A. (see at c.)
Norway	No defined level of tolerance. If simulations show a lower level of coverage than obliged, NPT will investigate this further. NPT believes that 2 Mbps criterion is quite moderate and should be fulfilled without problems by all of the licensees
Portugal	A tolerance is not established. As a first step we try to identify the assumptions of the studies, including the differences between our assumptions and the ones used by the mobile operators (for instance the propagation model could be different); this may provide a god basis to understand the reason of such a difference (e.g. the digital terrain model, the cell loading or other issue). If the difference is explained, a closer look to the issue is required in order to verify if the difference resulting from our internal calculation is negligible. According to some internal analysis it is possible to say e.g. that a difference/error in threshold for coverage of 3 dB results in 2% of area coverage
Slovak Republic	Providers have an obligation to comply with the conditions of coverage specified in their licences.
Slovenia	No
Spain	800 MHz: no tolerance 900 MHz refarming: no tolerance
Sweden	Not applicable at the moment
Switzerland	Not applicable in our case
United Kingdom	No. An operator will be in breach even if the set coverage threshold is missed by a small margin. However, the size of breach and time an operator remains noncompliant is taken into account when considering whether enforcement action may be taken.

******Table provided by Italy**

Frequency band	a)	d)
800 MHz	A coverage model for verifying the coverage obligations via simulations has been agreed. It specifies link budget parameters, the propagation model, map resolution, clutter definition	The coverage data provided by the operators can be verified by simulations. A software tool has been specifically developed to fully implement the agreed coverage model
900 MHz	A coverage model has been agreed. It specifies link budget parameters, the propagation model, map resolution, clutter	

	definition	
1800 MHz Assigned before the LTE auction in 2011	Same model as for 900 MHz	
1800 MHz Assigned with the LTE auction in 2011	No, because there no specific obligations	
2100 MHz	A coverage model has been agreed. It specifies link budget parameters, the propagation model, map resolution, clutter definition	The coverage data provided by the operators can be verified by simulations. A software tool has been specifically developed to fully implement the agreed coverage model
2600 MHz	A coverage model has been agreed. It specifies the cell radius for each clutter category	The coverage data provided by the operators can be verified by simulations. A software tool has been specifically developed to fully implement the agreed coverage model
3400-3600 MHz	No	No

Three examples from Sweden:

Example 1: WCDMA 2100 MHz coverage obligation and supervision method

Licence conditions (only part of)

- Population (voice service) coverage obligation for all licence holders (≥8 860M people shall be covered within a certain time frame).
- Coverage for voice service was defined as a certain field strength (dBuV/m) for the WCDMA control channel (CPICH).

Method for enforcement

A common measurement method was developed by PTS in cooperation with the operators and with support from the Royal institute of Technology (technical university).

- The map of Sweden was divided into defined squares according to the Statistics Sweden Agency, each square of 250*250 m corresponds to a certain population.
- The measurement method was based on measured CPICH field strength over certain geographical area and evaluated with statistical methods.
- The operators subsequently submitted geographical coverage information (predictions based on base station roll out).
- The measurement method only considered areas (measurement squares) where the operators claim coverage and where people live (population>0).
- PTS performed drive tests in 50 municipalities using the agreed measurement method and advanced measurement equipment.
- In each measurement square the operators coverage predictions is compared with measurement results for the same square – when a measurement square pass the measurement the measurement square is counted for
- When a certain number of squares within a measurement area (i.e. municipality) is passed the area is considered as passed and the population in the same area is counted for

Pros
- Advanced supervision measurement method that gives good accuracy and validity

Cons
- Time and resource consuming method

Example 2: Yearly coverage review (statistics collection)

Background
- Based on an assignment from the government PTS collects updated mobile coverage information from all national mobile operators (starting 2013)
- The coverage information includes both voice and data services for all mobile frequency bands (450, 800, 900, 1800, 2100, and 2600 MHz) and all relevant technologies (GSM, WCDMA, CDMA-2000, LTE)
- Requirements
- In cooperation with the mobile operators, PTS has developed a specification including certain technical parameters that defines the baseline for the mobile coverage data (voice and data services)
- The operators shall provide coverage prediction data according to the specification in MapInfo format (geographical format) for all frequency bands and technologies
- The operators shall also provide information about minimum signal thresholds for each service and frequency band
- The coverage data shall be formatted into 250*250 meters squares in a defined geographical grid (for easier analysis)

Analysis
- The annual analysis is based on the delivered coverage data for both voice and data services
- The analysis covers both population and geographical area coverage
- Trends for each service, technology and frequency band can be extracted (comparing year by year)
- Supervision of coverage obligations may be performed by comparing the data against current licence conditions, i.e. the 900 MHz coverage obligation

Pros
- Gives a good overview of the mobile coverage and trends. The information may also be used to verify coverage obligations

Cons
- From enforcement point of view this method has to be combined with measurements (i.e. spot measurements) in order to increase the validity level

Example 3: 800MHz LTE FDD6 License coverage obligation and supervision method

Licence conditions (additional information to the answers in the table, question 1)
- Regarding the list of permanent homes and fixed places of business:
  - The list is renewed each year.

- People with permanent homes or people that represent businesses without access to data communication of at least 1Mbit/second (wired or wireless) can register the adress on PTS webpage.
- Before the list of addresses without data communication is sent to the operator that has the coverage obligation on FDD6, the list is sent to all operators for consideration. This measure is to confirm that there is a lack of coverage of data communication on that spot and that no operator has rollout plans for the area.

Method for enforcement

- Each year the licenced operator sends a list of addresses (picked from the list that PTS one year earlier sent to the operator) that demonstrates the added coverage. For each new covered address the operator also provides information regarding the base station (coordinates, antenna direction, etc) which serves the area where the address is located.
- Propagation simulations between the address and the base station are done, fields measurements are done if the result of the simulation is unclear.
- Technical evaluations are performed concerning the network planning to make sure that the new site does not overlap the coverage from other base stations. The coverage obligation is linked to a condition of maximum expenditure of 300 MSEK (approx. 30 000 000 Euro). The roll-out therefore has to be targeted, specific and cost-effective. The cost of each new base station that fulfils the expectations, as verified by PTS, will be deducted from the 300MSEK.
- The field measurements are in conjunction with the equipment used by the customers.

Pros

- The licence condition pinpoints areas with bad/no data communication.
- The field measurements that rely on the enforcement method are straight forward as there are specific points (addresses) and not areas that need to be verified.

Cons

- The process to evaluate the economics is complex due to the fact that the cost for a base station includes several parameters.
- As PTS allows “non green field sites” to be deducted, the rental cost for antennas etc. in an existing mast can be difficult to evaluate if the operator’s and the owner of the mast have the same main shareholders.

Question 3 Possible relationship with coverage obligations and enforcement

Question 3; **Based on your national experience – do you have any thoughts on how limits in a coverage obligation could be defined and verified in the future? For different technologies (GSM, UMTS, LTE, WIMAX) same of them allowed to share the same frequency band (e.g. 900 MHz) what should be the approach? And if a coverage obligation is done with different technologies operating in different frequency bands what should be the approach?***	
Country	**Comments**
Austria	Based on your national experience – do you have any thoughts on how limits in a coverage obligation could be defined and verified in the future? For different technologies (GSM, UMTS, LTE, WIMAX) same of them allowed to share the same frequency band (e.g. 900 MHz) what should be the approach? And if a coverage obligation is done with different technologies operating in different frequency bands what should be the approach? Yes, see coverage obligations in our recent tender: https://www.rtr.at/en/tk/multibandauktion_AU
Croatia	Thoughts within HAKOM went in two directions. The need to ensure GSM coverage as the universal service and the need to have the adequate data service. At the time of licensing 800 MHz band, it was concluded that the market itself ensures mentioned before. Otherwise HAKOM was ready to react, and in the case of data traffic the idea was to define service of x Mbit/s in certain time intervals. In existing technology neutral licenses, coverage obligations can be met with different technologies.
Cyprus	We have no input for this matter
Denmark	The limits in coverage obligations must be well defined, measurable, transparent and supporting real user needs. An enforcement method could be detailed reporting from the mobile operators, supported by sample measurements (spot checks) carried out by or for the regulatory authority. Documentation from the mobile operators could include statistical models, base station positions, system description, transmitter power, propagation model, link budget, geographical distribution and number of simultaneous users, usage pattern or other information important in order to calculate the fulfilment of obligations. The spot checks should be used to verify the documentation forwarded by the mobile operators. No different method for different technologies. GSM, UMTS, LTE, WIMAX to be treated on equal basis. Furthermore, the DBA conducts a theoretical yearly mapping of the **combined voice coverage for all national operators** in Denmark. As input data for this publication the operators provide the DBA with field strength values (plots), for GSM900, GSM1800, UMTS900 and UMTS2100, with a resolution on 100 meters times 100 meters (designated as a pixel). The technical parameters are provided in the attachment*. As input for the mapping the best server for each pixel is used for the national wide coverage calculations with the receiver sensitivities for a ‘good phone’ and for a ‘less good phone’ used for two mappings. *Attachment: Requirements for the Collection and Processing of Data for Mapping of Mobile Coverage for Voice Communication in Denmark **General** Each operator has to report their field strength calculations for outdoor coverage with a resolution of (pixels) of 100 meters x 100 meters. **Calculations: Technologies and Frequencies** The data must be calculated for all relevant technologies in all relevant frequency band, i.e. separate data for GSM900, GSM1800, UMTS2100 and UMTS900. The reported field strength is defined as the calculated field strength with 95 % probability when log-normal fading is taken into account. **Calculations: Power and Field Strength** **For GSM,** the field strength for a single carrier is defined as equal to the field strength which is available for a voice call. For a given GSM terminal sensitivity this is the field strength there determines the communication range. **For UMTS**, the field strength is defined as the maximum power (of the available total carrier power) for each base station for all parameter settings, which can be used for

	each voice call. The calculation of the field strength in each pixel must be based on the maximum power the operator has set in each cell on each DPDCH to the individual user. Speech coding of 12.2 kbps AMR is used for the calculations.
Estonia	National Spectrum Authorities should decide freely the limits in a coverage obligation. This gives an opportunity to be flexible to motivate operators to focus certain aspects (area coverage, % of population etc.) in roll out. In order to avoid possible disputes later in enforcement process ETSA recommends defining the measurement methodology before issuing the licence with obligation. Especially in the case of beauty contest. Also we would like to point out, that in modern communications networks the parameter "field strength" is not the best parameter for defining network or service coverage. We would recommend defining coverage by download or upload speed which is also much more practical to measure. Modern networks have different intelligent power control options and they may not radiate with full field strength all the time. Also modulations are very complicated which make the field strength measurements very challenging and can cause intolerable uncertainty.
Finland	For the voice service coverage obligation (geographic or population) a minimum signal strength requirement should be defined. For data services different bit rates and specified probability requirements should be defined. These values should be measurable and verified according to measurement methods specified by ECC. Operators are requested to deliver their coverage maps and on special request also measurement results on coverage and data service.
France	The framework is that operators have to publish reliable coverage maps, for each technology (and, if appropriate, for each band), and distinguishing voice and data services. The coverage verification method is defined once and for all for voice and data and can be used for any present or coming technology.
Germany	No general specifications. Ex post parameters according to test and measurement services of the authority.
Hungary	• The mobile network operator can fulfil the obligations for nationwide coverage on technology neutral basis, using any of the frequencies (including bands 800 MHz, 900 MHz, 1800 MHz, 2600 MHz) acquired in the tender procedure in 2014. Special coverage obligations apply only in the 800 MHz band (see Table 1). • The licensee may dedicate any of its other frequencies currently in use — whether acquired previously or in the tender procedure in 2014— for ensuring, as part of its obligations of nationwide coverage, a maximum population coverage of 15%, provided it is located in a band suitable for the provision of public electronic communications services.
Iceland	With the latest development in technology and regulation (GSM/UMTS/LTE in the same frequency band and shared spectrum for operators) it seems logical to require the same coverage obligation within certain time frame for at least GSM, UMTS and LTE. Regulators also have better possibilities in making simulations/predictions than before so surveillance is easier than before. An example can be seen in shadow maps (GSM/UMTS) and coverage map (LTE) published on the Iceland PTA website (see links below). The maps represent all networks (outdoor coverage) but available are also maps for each operator separately. Further information is calculated/predicted (not yet published) regarding number of the population covered/not covered, number of homes covered/not covered (inside/outside), how far to a useful signal etc. Links: Shadow map (no coverage) GSM: http://pfs.is/fjarskipti/kort-og-tidnitoflur/gsm-skuggakort/ Shadow map (no coverage) UMTS: http://pfs.is/fjarskipti/kort-og-tidnitoflur/3g-skuggakort/ Coverage map LTE (800/1800): http://pfs.is/fjarskipti/kort-og-tidnitoflur/4g-utbreidslukort/
Ireland	Yes. Coverage obligations could potentially be based upon Field Strengths and Carrier to Noise Ratios, or Bit Error Rates for quasi error free signal.
Italy	Coverage obligations have the purpose to ensure that frequencies are used efficiently. Obligations should be formulated specifically for each frequency band and type of

	service, independently of technology. Requisites may vary, but as a general rule obligations are defined in terms of percentage of population reached by a good enough quality of service; in each case, required covered population may be set according to appropriate geographical sub-divisions of the national territory.
Latvia	There could be geographical/population coverage obligations or a requirement to obtain a certain number of radio frequency assignment use permits. For verification of geographical coverage obligations an approach could be to perform calculations of theoretical coverage. Therefore the received signal strength threshold values for different technologies and calculation variables for each corresponding frequency band should be defined.
Liechtenstein	There are no thoughts as regards to the above mentioned relationship
Netherlands	In the Netherlands the coverage obligations are defined in a minimum square kilometre coverage of signal- and service per licence. Each individual licence covers 5 MHz. These obligations are individually measured (per licence), the technique used in a specific licence is not of great influence. So multiband coverage with different techniques is no problem in our present method of measurements. Parallel for the near future we would like to develop simulation tools to predict coverage based on information provided by the licensees and our own monitoring- and drive test information, as well as consumer information. If these simulations indicate that an obligation for a particular license is clearly undisputed, we can avoid time consuming test drives. Only in cases of doubt we will perform more extensive measurements.
Norway	In the 800 MHz licences, NPT has focused on the user experience. It is what the user experiences at a given geographical point that matters. This means that measurements by using commercial terminals will be important. One example on how measurements could be done is by using an app on the terminals that logs the data speed and location, and then registers this on a server. By focusing on the user experience you also address the fact that the quality of the terminals can vary. We think that it is difficult to set field strength limits to define coverage, but this might also be done in combination with user experience measurements.
Portugal	For the services voice and data rate up to 9600 bps, and data rates of 144 kbps and 384 kbps, in terms of coverage (excluding capacity) if we have one main technology providing the coverage and others technologies providing capacity in areas already covered by the main technology, the issue could be “easy” to solve and similar to what has been referred above, i.e. calculating the coverage only for the main technology. If this is not the case, the solution could be to calculate the coverage for different technologies/frequencies and in the end mix the different layers to obtain only one, that would be used to calculate the population and are covered. The situation for the 800 MHz band is different because the coverage should be provided at least in specific points well known. So, after we define the data rates that the operators are obliged to deliver at least in those specific points, we could try three different exercises as appropriate, to evaluate the coverage obligations: • Perform theoretical studies similar to the ones we do actually to evaluate the coverage obligations, and using the same approach (consult mobile operators, analyze the information provided, do calculations and check the results); • Perform measurements in the field (field strength measurements and/or data rates measurements); • Do both analyses above.
Slovak Republic	With regard to technological neutrality and service neutrality is not possible to predict the future and not unilaterally change the terms of coverage for frequencies whose license is still valid.
Sweden	One way is to collect prediction data from the operators and perform analysis according to example 2, the theoretical approach could be complemented by spot measurements.
United Kingdom	Coverage obligations as well as the assessment methodology (parameters, signal strength/interference thresholds and etc.) should be defined on a technology neutral basis. This means that coverage required under a licence condition (including a minimum level of capacity) may be delivered using any combination of that licensee’s spectrum holdings or other licences. The licensee can therefore decide which frequencies and technologies may be appropriate to optimise efficiency in any area to

	be served. Ofcom has had a long standing policy to avoid unnecessary technology restrictions in spectrum licences and to maximise the flexibility with which spectrum can be used, subject to the need to limit the risk of harmful interference. Within our liberalisation framework, we have varied the technical licence conditions to be technology neutral.

*Note: The purpose is to identify how limits in future coverage obligations can be established – not what the limits should be. For example: If an administration wants an operator to provide a service of x Mbit/s to y% of the population in a given geographical area z, the question concerns how to define the coverage criteria and how to establish that the obligation has been met. The 'x', 'y' and 'z' values are of no interest for the purpose of this questionnaire.

Annex
RSPG-BEREC_Summa

Replies received from countries rev.4.zip

ANNEX 4: LIST OF REFERENCES

[1] ECC Report 103, UMTS coverage measurements, version of May 2007
[2] ECC Report 118, Monitoring methodology on GSM networks' performance, version of February 2008
[3] Mobile Spectrum Monitoring, Pravir Chawdhry, Francis Clement, Stefano Luzardi (JRC) CEPT Workshop on How Measurement of Spectrum Occupancy Can Help Spectrum Management, 15 January 2014, Mainz (Germany).