



METHODOLOGY FOR VERIFYING THE FULFILMENT OF OBLIGATION

at the deadlines defined in issued licences for mobile service.

March 2016

Stegne 7, p.p. 418, 1001 Ljubljana, tel: 01 583 63 00, fax: 01 511 11 01, e-mail: info.box@akos-rs.si, www.akos-rs.si, tax no.:10482369



Table of content

1.	Contacts	4
1.1. 1.2.	AKOS contacts Operator contacts	4 4
2.	Requested obligations	4
2.1. 2.2.	General Coverage Obligations Special Coverage Obligations in the 800 MHz Band	4 5
2.2.1. 2.2.2. 2.2.3. 2.2.4.	Special Coverage Areas Fulfilment of special coverage obligations Substitutes for Fixed Wireless Broadband Access (FWBA) Bit rate of the user experience	5 6 6 6
3.	Verifying preparation	7
3.1.	Timetables	7
3.1.1. 3.1.2. 3.1.3. 3.2. 3.2.1	Timetable for Si.mobil Timetable for Telekom Timetable for Tušmobil Material published on WEB page to be used by operators PZNN	
3.2.2. 3.2.2. 3.2.3.	SVN prebivalci 100 m 2014 Verifying methodology	
4.	Input documents from the operators	12
4.1. 4.2. 4.3. 4.4.	For report on fulfilling general coverage obligations For report on fulfilling special coverage obligations For report on fulfilling FWBA obligations Information about peak hour	12 13 13 13
5.	Flowchart	14
5.1.		
0.11	Flowchart description	19
5.1.1. 5.1.2. 5.1.3. 5.1.4	Flowchart description Data submission Data importing Verifying base stations Calculation	19 19 19 20 20
5.1.1. 5.1.2. 5.1.3. 5.1.4. 5.1.5.	Flowchart description Data submission Data importing Verifying base stations Calculation Evaluation of calculated results	19 19 20 20 21
5.1.1. 5.1.2. 5.1.3. 5.1.4. 5.1.5. 5.1.6. 5.1.7. 5.1.8.	Flowchart description Data submission Data importing Verifying base stations Calculation Evaluation of calculated results Comparison of calculated results Cross-checking procedure Final approval of the report	19 19 20 20 21 21 22 22
5.1.1. 5.1.2. 5.1.3. 5.1.4. 5.1.5. 5.1.6. 5.1.7. 5.1.8. 5.2.	Flowchart description Data submission Data importing Verifying base stations Calculation Evaluation of calculated results Comparison of calculated results Cross-checking procedure Final approval of the report Detailed description of discrepancy classes	
5.1.1. 5.1.2. 5.1.3. 5.1.4. 5.1.5. 5.1.6. 5.1.7. 5.1.8. 5.2. 5.2.1. 5.2.2. 5.2.2. 5.2.3.	Flowchart description Data submission Data importing Verifying base stations Calculation Evaluation of calculated results Comparison of calculated results Cross-checking procedure Final approval of the report Detailed description of discrepancy classes Significant discrepancy in covered area on national basis Significant discrepancy in coverage in limited number of regional areas No significant discrepancy	
5.1.1. 5.1.2. 5.1.3. 5.1.4. 5.1.5. 5.1.6. 5.1.7. 5.1.8. 5.2. 5.2.1. 5.2.2. 5.2.2. 5.2.3. 6.	Flowchart description Data submission	



6.3.	FWBA point to point connectivity report	34
7.	Description of Measurement Procedure	36
7.1. 7.2. 7.3. 7.4.	Objective Methods of Measurement Mobile Measurements Mobile Measurements In a Vehicle	36 36 36 37
7.4.1. 7.4.2. 7.4.3. 7.5. 7.6.	Measurement Equipment Antenna Test User Terminal, Scanner Mobile Measurements On Foot Measurement Parameters	37 37 37 38 38
7.6.1. 7.7.	TSMW (LTE) - RF scanner measurement parameters Software	38 39
8.	Definition and description of measured parameters	39
8.1.	SINR calculations	39
8.1.1. 8.1.2. 8.2.	Alpha Shannon equation Peak throughput Required RSRP value for 10 Mbps	40 41 41
8.2.1. 8.2.2. 8.2.3.	Link budged Measurement results RSRP Reference value	41 42 43
9.	Monitoring/evaluating of FWBA availability to end users	44
9.1.	Monitoring/evaluating of FWBA availability based on submitted data	44
9.1.1. 9.1.2. 9.1.3. 9.1.4. 9.2.	Completeness of data Import of FWBA data and subscriber default values Verifying the FWBA connections Evaluation of calculated connection results Monitoring/evaluating availability of minimum required capacity FWBA for end users	44 44 44 44 (min
0.2	2Mbit/s)	45
9.3.1	Fixed Measurements	45
10.	Conclusions	



These rules of procedure determine all tasks and specify all steps in the period of verifying the fulfilment of obligation after each deadline (due date) defined in issued decisions on the assignment of radio frequencies.

1. Contacts

1.1. AKOS contacts

Table 1: Contact person from AKOS

Name	Telephone number	Email
Iztok Lampe	01 583 63 62	iztok.lampe@akos-rs.si
Meta Pavšek Taškov	01 583 63 63	meta.pavsek@akos-rs.si
Željko Smiljanić	01 583 63 18	zeljko.smiljanic@akos-rs.si
Janja Varšek	01 583 63 43	janja.varsek@akos-rs.si
Matija Brodnik	01 583 63 79	matija.brodnik@akos-rs.si
Miran Vozlič	02 740 02 21	miran.vozlic@akos-rs.si
Niko Gaberc	02 740 02 22	niko.gaberc@akos-rs.si
Aleš Blatnik	01 583 63 78	ales.blatnik@akos-rs.si

1.2. Operator contacts

Table 2: Contact person from the operators' side

Name	Operator	Telephone number	Email
Marko Anžič	Si.mobil	040 440 137	marko.anzic@simobil.si
Mojca Štros	Telekom Slovenije	01 472 23 47	mojca.stros@telekom.si
Martina Denovnik	Tušmobil	01 600 01 85	martina.denovnik@tusmobil.si

2. Requested obligations

2.1. General Coverage Obligations

Operators – license holders of parts of the spectrum in bands under 1 GHz must provide commercial wireless electronic communications services in all assigned bands under 1 GHz in such a way that:

- 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.

All the above obligations take effect on the day the applicant is assigned an individual frequency band under 1 GHz.

The 800 MHz radiofrequency band with its special propagation ability (good rural and indoor coverage) is especially useful, in line with The strategic guideline of the Ministry of Education, Science and Sport no. 381-8/2011-MVZT/13 of 19 September 2013 (hereinafter referred to as Strategic Guidelines). In this context obligation of providing commercial wireless electronic communications services in 800 MHz band means that operator has to provide mobile broadband services at bit rate of the user experience of at least 10 Mb/s downlink (outdoor) (see chapters 2.2.4 and 5.1.4.1).

Operators – license holders 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.

The exact Timetable for each operator is provided in 3.1.

2.2. Special Coverage Obligations in the 800 MHz Band

The Strategic Guidelines emphasizes that with very limited public funds for the construction of broadband infrastructure on so-called white spots, where electronic communications operators have no commercial interest for building networks, LTE technology appears to be suitable to help us get closer to achieving the European Digital Agenda development objectives also regarding the large number of white spots. This is especially important in Slovenia with its exceptionally dispersed population.

The Strategic Guidelines states in lines three, four and five that the public tender with a frequency auction of the 800 MHz, 900 MHz, 1800 MHz, 2100 MHz and 2600 MHz frequencies must include:

the obligation of ensuring access to mobile communications to the largest possible share of population,

the requirement for providing rural area coverage with LTE mobile communications, with the goal of
providing basic internet access to supplementing the construction of fixed broadband infrastructure, and
contributing to the Digital Agenda objective, and

 taking into account, the open broadband networks constructed using ESRR funds, which will set priority rural areas for LTE coverage.

With the goal of bridging the digital divide in the areas where no access to fast broadband services is possible, and providing coverage of the so-called white spots with basic internet access for households on fixed locations, agency decided that in addition to the general coverage obligations, one operator (the auction resulted that operator with special coverage obligation was Si.mobil d.d.), has to provide mobile broadband services at a bit rate of at least 10 Mbit/s downlink (outdoor) to at least 95% of the population of the Republic of Slovenia within 3 years see Timetable in chapter 3.1.1. Operator may fulfil this obligation using any assigned frequency bands.

2.2.1. Special Coverage Areas

Within the scope of the special obligation of covering 95% of the population of the Republic of Slovenia, the Agency has for the purpose of providing suitable coverage of white spots in rural areas and appropriate regional distribution, as well as in accordance with the Strategic Guidelines, published a list of 300 locations – settlements or connected groups of settlements¹ (hereinafter referred to as the settlements from the list) – which are either not covered or poorly covered by a fixed broadband network. Within the scope of above requirements, the operator for which special coverage obligations apply, is obliged to provide coverage to 75 selected settlements from a list² published in the decision on the initiation of a public tender after the first year, another 75 after the second year (150 total), and additional 75 after the third year (225 total), all selected at the operator's discretion. The operator is obliged to provide at least 75% population coverage in each of the selected settlements from the list.

The Agency shall monitor the deployment of broadband networks in the country with a special emphasis on rural areas and may amend the list of settlements if necessary. Such action shall be taken in case that there is

¹ Attachment 1 of Decision allocating radio frequencies No. 38144-1/2014/4 from 26.05.2014

² A decision on the initiation of a public tender with a public auction No. 38144-11/2013/1 from 30.12.2013 (Official Gazette No.. 114/2013), modified with a decision on the initiation of public tender with a public auction No. 38144-11/2013/23 from 5.2.2014 (Official Gazette No.10/2014)



an updated information that in one or more of the listed settlements a fixed broadband network has been deployed with the bitrate available of at least 10 Mbit/s downlink. Any modification of the list of settlements should base on results of an analysis provided by Agency and as well on possible recommendations provided by the operator with special coverage obligations. The Agency shall be able to make changes to the list but should not remove the settlements or groups of settlements where an operator has already begun the construction of base station, and modifications as well should not affect the number of settlements or groups of settlements on the list.

2.2.2. Fulfilment of special coverage obligations

The special coverage obligation shall be considered as fulfilled if, based on the data supplied:

- The total covered population within 3 years 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 requested services (see chapter 2.2.1) in accordance with the schedule and requirements from this section.

Each population location shall be considered as covered with a bit rate of 10 Mbit/s downlink if the resulting signal and signal to interference plus noise ratio is greater than or equal to a specified values in chapter 8.

2.2.3. Substitutes for Fixed Wireless Broadband Access (FWBA)

The obligation of network deployment is tied to the list of 300 settlements from the list, as the network shall provide to these settlements mobile services and as well a suitable substitute service for fixed broadband access. The operator is obliged to 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 bit rate of user experience of at least 10 Mbit/s downlink and with a minimum bit rate of at least 2 Mbit/s, and a minimum guaranteed bit rate of at least 1 Mbit/s uplink. FWBA service has to be provided only for those permanent residence and business addresses and institutions registered with the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES), which do not have other option of receiving a suitable alternative broadband connection with a bit rate of at least 10 Mbit/s, and which are within the settlements' borders. In providing this bitrate with a user experience of at least 10 Mbit/s or a minimum data bit rate of at least 2 Mbit/s, the operator is obliged to design its network properly, and when doing so he may use any assigned frequency band. The Agency has the right to verify the suitability of the network design.

2.2.4. Bit rate of the user experience

Additionally in issued decision (licence)³ is more precise explained what is meant by »a user experience of at least 10 Mbit/s downlink and with a minimum data transfer rate of at least 2 Mbit/s, and terminally assured uplink speeds of at least 1 Mbit/s«:

When monitoring the license holder obligation fulfilment imposed by the preceding paragraphs and verifying his network capacity, the Agency will use the results of the bit rate measurements done by users, with their terminals connected to application (AkosTestNet), which is approved by the Agency and is running on the Agency's measuring server. The bit rate of the user experience of at least 10 Mbit/s obligation is fulfilled, if in at least 90% of measurements the bit rate speed equals or exceeds 10 Mbit/s. This takes into account measurements made outside the peak hour time. The holder of the decision defines the peak hour time for his

³ Decision allocating radio frequencies No. 38144-1/2014/4 from 26.05.2014



network in duration up to 2 hours and he provides the information to the Agency in accordance with Chapter 4.4.

Requirement regarding minimum guaranteed bit rate of 2 Mbit/s to the user is fulfilled if in the bit rate speed measurements to the user measured over a period of one hour (60 minutes) the bit rate of 2 Mbit/s is available in at least 99.9% of the time. The license holder has to provide as well a minimum guaranteed bit rate of at least 1 Mbit/s to the base station (up-link) in at least 99.9% of the time, measured in the time period of one hour (60 minutes).

3. Verifying preparation

3.1. Timetables

3.1.1. Timetable for Si.mobil

Simobil is obliged⁴ to send the plan of fulfilling special coverage obligations 4 times a year until 15.1., 15.4., 15.7. and 15.10. until its fulfilment by specifying, which base stations are planned to be built to cover a certain location¹. The last date is 15.4.2017.

In the Plan the following data should be provided:

- The list of locations with associated base stations which cover these locations,
- The calculation of coverage of each location,
- Starting date of construction of each base station and to what phase it has already been constructed,
- The estimated time of each base station to be put into operation.

In the Plan should be base stations which are planned to fulfil special coverage obligations for 800 MHz band for the first, second and third year. The milestones are specified in Table 3. Data to be provided for each base station are specified in Chapter 4.2.

⁴ Attachment 1 of Decision allocating radio frequencies No. 38144-1/2014/4 from 26.05.2014



Table 3: A detailed schedule for Si.mobil

Milestone obligation	Due date	Requested input data
1 st yearat 800 MHz	31.5.2015	
25% of population at 800 MHz	31.5.2015	Chapter 4.1
75 out of 300 settlements	31.5.2015	Chapter 4.2
FWBA service availability	31.5.2015	Chapter 4.3
coverage report	30.6.2015	
2 nd year at 800 MHz	31.5.2016	
50% of population at 800MHz	31.5.2016	Chapter 4.1
150 out of 300 settlements	31.5.2016	Chapter 4.2
FWBA service availability	31.5.2016	Chapter 4.3
coverage report	30.6.2016	
1 st year at 900 MHz	4.1.2017	
25% of population at 900MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
3 rd year at 800 MHz	31.5.2017	
3 rd year at 800 MHz	31.5.2017	
95% of population 10Mb/s	31.5.2017	Chapter 4.2
75% of population at 800MHz	31.5.2017	Chapter 4.1
225 out of 300 settlements	31.5.2017	Chapter 2.2
FWBA service availability	31.5.2017	Chapter 2.3
coverage report	30.6.2017	
2 nd year at 900 MHz	4.1.2018	
50% of population at 900 MHz	4.1.2018	Chapter 4.1
coverage report	5.2.2018	
3 rd year at 900 MHz	4.1.2019	
75% of population at 900 MHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	



3 rd year over 1 GHz	4.1.2019	
25% of populationover1 GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5 th year over 1 GHz	4.1.2021	
40% of population over 1 GHz	4.1.2021	Chapter 4.1
coverage report	5.2.2021	



3.1.2. Timetable for Telekom

Table 4: A detailed schedule Telekom Slovenije

Milestone obligation	Due date	Requested input data
1 st of yearat800 MHz	31.5.2015	
25% of population at800MHz	31.5.2015	Chapter 4.1
coverage report	30.6.2015	
ODŠT(900,1800MHz) replacement	4.1.2016	
2nd Year at 800 MHz	31.5.2016	
50% of population at 800 MHz	31.5.2016	Chapter 4.1
coverage report	30.6.2016	
1st year at 900 MHz	4.1.2017	Charles 4.4
25% of population at 900MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
3 rd year of 800 MHz	31 5 2017	
75% of population at 800 MHz	31.5.2017	Chapter 4.1
coverage report	30.6.2017	
2 nd year of 900 MHz	4.1.2018	
50% of population at 900MHz	4.1.2018	Chapter 4.1
coverage report	5.2.2018	
3rd year at 900 MHz	4.1.2019	
75% of population at 900 MHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
3 rd year over. 1 GHz	4.1.2019	
25% of population over 1GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5 ^m year over1 GHz	4.1.2021	
40% of population over 1GHz	4.1.2021	Chapter 4.1
coverage report	5.2.2021	



3.1.3. Timetable for Tušmobil

Table 5: A detailed schedule Tušmobil

Milestone obligation	Due date	Requested input data
1 st year at 800 MHz	31.5.2015	
25% of population 800 MHz	31.5.2015	Chapter 4.1
coverage report	30.6.2015	
ODŠT(900,1800MHz) replacement	4.1.2016	
2 nd Year of 800 MHz	31.5.2016	
50% of population at 800 MHz	31.5.2016	Chapter 4.1
coverage report	30.6.2016	
1 st year at 900 MHz	4.1.2017	
25% of population at 900 MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
2rd	21 5 2017	
	31.5.2017	Charter 4.1
75% of population at 800MHz	31.5.2017	Chapter 4.1
coverage report	30.0.2017	
2 nd year of 900 MHz	4.1.2018	
50% of population at 900MHz	4.1.2018	Chapter 4.1
coverage report	5.2.2018	
3 rd year at 900 MHz	4.1.2019	
75% of population at 900 MHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
3 rd year over1 GHz	4.1.2019	
25% population over 1GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5 th year over1GHz	4.1.2021	
40% population over1 GHz	4.1.2021	Chapter 4.1
coverage report	5.2.2021	



Prior to verifying the following material has been distributed to the operators:

3.2.1. PZNN

AKC

— 31.05.2014⁵: The database (PZNN20140531.xlsx) of populated addresses to be used for coverage calculation in the case of special coverage obligations - determining coverage for individual settlements. It contains geocoded distribution of the population of the Republic of Slovenia in relation to permanent residence on a record date. AKOS created PZNN database combining data from the Register of Spatial Units and Population Register.

3.2.2. SVN prebivalci 100 m 2014

 22.01.2015⁶: Distribution of the population of the Republic of Slovenia - the list of populated raster cells 100 m x 100 m grid (<u>SVN prebivalci 100 m 2014</u>.xlsx) used as population units (with relevant centre of the unit given in D96/TM and GK/D48 coordinate system) for coverage calculation of the Republic of Slovenia.

3.2.3. Verifying methodology

— 24.4.2015: Draft Methodology for verifying the fulfilment of obligation

4. Input documents from the operators

After the deadline operator Telekom and Tušmobil have to submit data as described in chapter 4.1. Si.mobil has to submit data as described in chapters 4.1, 4.2 and 4.3.

4.1. For report on fulfilling general coverage obligations

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 cell (sector):
 - unique ID's of the cell in the network
 - azimuth direction (degrees);
 - horizontal 3 dB beamwidth (degrees);
 - combined mechanical and electrical downtilt (degrees);
 - vertical 3 dB beamwidth (degrees);
 - the effective isotropic radiated power EIRP;
 - an indication of the frequency blocks used in each cell ;
- a map of Slovenia with base station locations and covered areas (GIS format, vector graphics, georeferenced raster images (eg.: * .tif and *. tfw) with 100m raster or less - multiple 25m), together with an indication of the maximum levels of technical parameters, which were the basis for the presented coverage of the network;
- and the list of covered raster cells ("Ime_celice") from the published list of "SVN prebivalci 100 m 2014.xlsx" with the level of coverage, calculated on that basis;

⁵ http://www.akos-rs.si/pznn-podatkovna-zbirka-naseljenih-naslovov

⁶ http://www.akos-rs.si/porazdelitev-prebivalstva-republike-slovenije-v-100-m-x-100-m-mrezi-



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 cell (sector):
 - unique ID's of the cell in the network
 - azimuth direction (degrees);
 - horizontal 3 dB beamwidth (degrees);
 - combined mechanical and electrical downtilt (degrees);
 - vertical 3 dB beamwidth (degrees);
 - the effective isotropic radiated power EIRP;
 - an indication of the frequency blocks used in each cell;
- a map of Slovenia with base station locations and covered areas (GIS format, vector graphics, georeferenced raster images (eg.: * .tif and *. tfw) with 50m raster), together with an indication of the maximum levels of technical parameters, which were the basis for the presented coverage of the network);
- the list of covered raster cells ("Ime_celice") from the published list of "SVN prebivalci 100 m 2014.xlsx" with the level of coverage, calculated on that basis;
- a list of covered populated addresses ("HS_MID") from the published list "PZNNNapaka! Vira sklicevanja i bilo mogoče najti.20140531.xlsx" in certain settlements from the list as determined in Annex 1 of DARF (Decision on Allocation of Radio Frequencies) and its subsections;
- the population coverage in percent for each selected settlement from above list of covered populated addresses ("HS_MID");

4.3. For report on fulfilling FWBA obligations

The submitted information must comprise:

- A list of addresses ("HS_MID") from the published list "PZNNNapaka! Vira sklicevanja ni bilo mogoče ajti.20140531.xlsx" at which FWBA service is provided,
- the number of FWBA connections at these addresses,
- the base station data (unique cell ID) from which these FBWA subscribers receive signal (as defined in Chapter 4.2)

4.4. Information about peak hour

General and special cover obligations in the 800 MHz frequency band will be monitored outside of the peak hour. The peak hour in length of maximum 2 hours must be defined by the holder of the decision on allocation of radio frequencies. Information about peak hour must be sent to the Agency together with other data in accordance wuth the timetables specified in Chapter 3.1.



5. Flowchart





















5.1. Flowchart description

5.1.1. Data submission

5.1.1.1. Data not submitted within due date

If data is not submitted in deadline an urgent reminder shall be send within next working day.

5.1.1.2. Completeness of data

Submitted data is visually checked that all requested files is submitted and file has all the required fields and that the fields are not blank and that are without obvious value and formatting errors. In case that data is not complete and/or not correct and/or not in the right format, urgent reminder shall be send.

5.1.2. Data importing

5.1.2.1. Import of Base station data

Data submitted is imported in the agency's calculation tool. In case that at the import the software will report errors, data formatting and correctness has to be done. If data can be easily corrected by agency (less than 2 working days) than the verifying of locations is done (See 5.1.3).

5.1.2.2. Mistakes in the list of Base station data

Data submitted must be in accordance with chapter 4.1. (general coverage obligation) or 4.2. (special coverage obligation). The base stations' cells' IDs must be unique and data has to be complete, correct and in right format in order to be able to calculate the coverage. If data is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

5.1.2.3. Import of submitted covered raster cell data

Data submitted by operator is imported and transformed to format used in the agency's calculation tool.

5.1.2.4. Mistakes in submitted covered raster cell data

Data submitted must be in accordance with chapter 4.1. (general coverage obligation) or 4.2. (special coverage obligation). Operator may send in another format as far as agency is able to translate these data into its own software tool. He has to provide the technical parameters used in calculation of provided covered raster cells, so that agency can evaluate the reported picture and compare to the own calculation.

If data is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

5.1.2.5. Submitted statement which raster cells are covered

Data submitted (the list of covered raster cells) must be in accordance with chapter 4.2. Operator must clearly mark, which raster cells are covered.



If the statement is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

5.1.2.6. Submitted statement which populated addresses in settlements are covered

Data submitted (the list of covered populated addresses - HS_MID's) must be in accordance with chapter 4.3. Operator must clearly mark, which HS_MID's are covered.

If the statement is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

5.1.2.7. Submitted peak hour

Submitted peak hour information must be in accordance with chapter 4.4.

If the statement is not submitted complete and/or correct an urgent reminder shall be send.

5.1.3. Verifying base stations

The reported base stations are checked if they are in operation. The coordinates of base station site locations are compared with old location data's and cell ID's are compared with existing measurement database. If it is needed the additional in field measurements are done. Especially the correctness of the coordinates are compared with existing data and checked by other means (such as detailed map verifying and a physical visit of location in the case that the discrepancies in submitted and expected data are too high). The found discrepancy (especially the non-existing/operating base stations) are cleared up with operator and the corresponding locations correctness are done. Then the calculations can start, see 5.1.4.

5.1.4. Calculation

5.1.4.1. How the calculation is done

Based on the submitted data in accordance with 5.1.1 (Data submission), the calculations shall be made to assess the fulfilment of the coverage obligations. The analysis shall be made based on technical parameters of base stations and by using the ICS Telecom software (a software tool for planning and analysing telecommunication and broadcasting networks and radio frequency spectrum planning, which is used by numerous European national regulatory agencies) from the French developers ATDI. The analysis shall be made on a model selected in accordance with the ITU-R P.1812 recommendation, with cell load of 15% and 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).

5.1.4.2. General coverage obligation

Based on data provided by operator coverage of population of Republic of Slovenia, based on the raster cells grid ($100 \times 100m$) is being calculated by the agency's calculation tool. Firstly the RSSP coverage is calculated according to the parameters defined in chapter 8 Definition and description of measured parameters . Additionally also the RSRQ, the signal to noise ratio SINR(PDSCH) and corresponding throuput mapping is calculated for all base stations sectors in the corresponding network. The printed reports - maps and coverage lists of 100m grids and % coverage are produced.



5.1.4.3. Special coverage obligation

Based on operator data and PZNN data (see **Napaka! Vira sklicevanja ni bilo mogoče najti.**) the population overage of each covered settlement (selected by operator from the list of 300's) is being calculated by the agency's calculation tool. Firstly the RSSP coverage is calculated, according to the parameters defined in chapter 8 Definition and description of measured parameters . Additionally also the RSRQ, the signal to noise ratio SINR(PDSCH) and corresponding throuput mapping is calculated for all base stations sectors in the corresponding network. The printed reports - map's and coverage lists of HSmid's from PZNN and % coverage of each settlement are produced.

5.1.5. Evaluation of calculated results

First calculated results are evaluated based on previous experience, calculations and existing measurements data. In case of significant difference in comparison to the expected values and existing measurements data, rechecking of data is done in accordance with 5.1.2.1. and 5.1.2.6. If no mistake found in data, technical and clutter parameters for calculations are re-evaluated. If a mistake in technical parameters for calculation is found, calculations in accordance with 5.1.4 are repeated.

In case of no significant difference in comparison to the expected values comparison with imported data submitted by operator is done.

5.1.6. Comparison of calculated results

Calculated coverage is compared with imported covered raster cell⁷ data and the list of covered raster cells provided by the operators.

Discrepancy in coverage is evaluated. It can be sorted into 3 classes:

- 1) Significant discrepancy in covered area on national basis (see 5.1.6.1)
- 2) Significant discrepancy in coverage in limited number of regional areas (see 5.1.6.2)
- 3) No significant discrepancy (see 5.2.3)

5.1.6.1. Significant discrepancy in covered area on national basis

In case of significant discrepancy in covered area on national basis (see 5.2.1) a system mistake in operators' parameters is suspected. Therefore, agency acts in accordance with 5.1.2.2 and/or 5.1.2.4 and/or 5.1.2.5.

5.1.6.2. Significant discrepancy in coverage in limited number of regional areas

In case of significant discrepancy in coverage in limited number of regional areas (see 5.2.2) a discrepancy in clutter data between agency and operator is suspected. Therefore agency prepares an internal requirement for measurements on areas where this kind of difference is most significant. The procedure is pending, until results of measurements completed (see chapter 7 Description of Measurement Procedure).

5.1.6.3. Results in case of significant discrepancy in coverage in limited number of regional areas

Monitoring results can give 4 possible scenarios:

1) Results can confirm operator's calculations

^{7 5.1.2.3} Import of submitted covered raster cell data



- 2) Results can confirm agency's calculations
- 3) Results can measure better coverage than shown by both calculations
- 4) Results can measure worse coverage than shown by both calculations

In case 1, when the results confirm calculations done by the operator, the results provided by operator are approved (see 5.2.3). Agency should at a later stage improve its calculation model.

In case 2, when the results confirm calculations done by agency, the actual technical parameters (maximum levels), which were the basis for the presented coverage of the network by the operator is reconsidered and if needed additional clear up of discrepancy with operator is done.

In case 3, when the results are better than results provided by calculations, the results provided by operator are approved (see 5.2.3).

In case 4, when the results are worse than results provided by calculations, the actual technical parameters (maximum levels), which were the basis for the presented coverage of the network by the operator is reconsidered and additional clear up of discrepancy with operator is done. Agency should improve its calculation model as soon as possible.

5.1.7. Cross-checking procedure

If existing measurements data are not sufficient (at least 10 areas in different parts of the Republic of Slovenia) for cross checking with calculated data agency prepares an internal requirement for measurements of covered areas to make a final cross - check the data provided by operator. After the results of measurement are completed (See 5.1.6.2), the findings are summarized. In case of positive results see 5.1.8 (Final approval of the report).

5.1.8. Final approval of the report

In case of positive results after the cross-checking procedures in chapters 5.1.7 and 9.2, 9.3 (additionally for special coverage obligation) the operators report is finally approved and his general coverage obligation under 2.1 and / or his special coverage obligation with FWBA obligations under 2.2 to 2.2.4 is fulfilled and the operator is consequently informed.

In case of negative results, the findings are reported to the operator.

5.2. Detailed description of discrepancy classes

5.2.1. Significant discrepancy in covered area on national basis

Significant discrepancy in covered area on national basis means, that the covered area is more than 2% different in the whole territory of Slovenia, if we compare both calculations. If it is from raster map evidently that exist cell coverage area without base station in his origin (or base station without covered area) evidently the system mistake exist. In case that each covered zone is bigger than we can presume that a higher threshold is used, and the actual technical parameters (maximum levels), which were the basis for the presented coverage of the network by the operator is reconsidered.

In that case, there must be a system mistake in operators' parameters and additional clear up of discrepancy with operator is done.



5.2.2. Significant discrepancy in coverage in limited number of regional areas

Significant discrepancy coverage in limited number of regional areas means, that the covered area is more than 2% different in max. 10 regions of the territory of Slovenia when comparing both calculations.

In that case there can be a discrepancy in clutter data between agency and operator. The actual clutter code on these areas must be compared with the existing situation on these areas (aero view pictures). If discrepancy is be noticed, the measurement on the field will prevail.

5.2.3. No significant discrepancy

If discrepancy is below the values from 5.2.1 and 5.2.2, no significant discrepancy exist.

6. Guidelines on importing / using data and calculation (ICS Telecom)

For verifying the fulfilment of obligations, AKOS will use ATDI's ICS telecom software V. 13.0.0. from 15 January 2015. ICS Telecom is radio planning and technical spectrum management software which is capable of modelling any size of radio system from intensive local area to extensive countrywide.

6.1. Launching ICS telecom

When we open the ICS telecom software we click on "File" and select "New project". After that, the "Project manager" window opens. This window allows easy handling of layers as well as whole projects. When we have "Project manager" window opened we have to provide all necessary content in "Project content" section. For the proper functioning of project it is necessary to provide 1) Digital terrain model, 2) Map image, 3) Colour palette, 4) Vector layer, 5) Parameters, 6) Network objects and 7) User colour palette. All necessary content is available on S:\projekti\LTE\Spremljanje_nadzor drive and Z:\atdi drive. For **1)** Digital terrain model we select Z:\atdi\DATA\25m: Slovenia_25m.RGE file, for **2)** Map image we select Z:\atdi\DATA\MAPS SlovenijaOkolica 2 DTM + SVN MAP 1 file, for **4)** Vector layer we select S:\projekti\LTE\Spremljanje_nadzor\ATDI_izracun Simobil_0_defclut.PRM file, for **5)** Parameters we load an empty LTE.EWF file in which we will import base stations data and for **7)** User colour palette we select S:\projekti\LTE\Spremljanje_nadzor\ATDI_izracun RSRP.P11 file.

After the project content is selected we save the project (it is saved as BMP file) and then load it for preview.

D: meta.pavsek	(fix \ATDI Wadzor pokrivanja Simo	bil.PRO	Open project
Project content			
Items	File Name		Status
Digital terrain model (.GEO)	D: meta.pavsek fix ATDI atdi	DATA\25m\Slovenia_25m	ок
Map image (.IMG)	\fix \ATDI \atdi \DATA \BING M	APS\K176-APEK.BIM	OK
Color palette (.PAL)	D:\meta.pavsek\fix\ATDI\atdi\	DATA MAPS SVN MAP 1. pa	al OK
Clutter layer (.SOL)	undefined		
Building layer (.BLG)	undefined		172
Vector layer (.VEC)	\fix\ATDI\atdi\Izracuni Simol	AVTOCESTA.VEC	OK
Map server file (.MAP)	undefined		
Parameters (.PRM)	\fix\ATDI\atdi\DATA\MAPS\	Simobil_0_defclut.PRM	OK
Network objects (.EWF/.E	\fix\ATDI\atdi\Izracuni Simol	pil\simobil 3.3.2015.EWF	OK
User color palette (.P11)	D: meta.pavsek (fix (ATDI atdi)	DATA MAPS RSRP.P11	OK
Result (.FLD)	undefined		
•			
Browse Remo	ve Explorer	ag and urop	
Recent projects	Pass of 1994	Status Date last onene	
Dulmete equesitiful ATDI less	. 000	OK 11/7/2014	
D:/meta.pavsek/fix/ATDI/pon	n1 PRO	OK 11/7/2014	
D:\meta.paysek\fix\ATDI\Wad	dzor pokrivania Simobil.PRO	OK 4/3/2015	
	ster pererranja annoann rea	10/2010	
// // // // / / / //			
double-click to select existing p	project) Select	Remove from list	Reset list



Data on base stations is saved in S:\projekti\LTE\Spremljanje_nadzor\ATDI_izracun_Vnos1.xlsx file. The inputs that are sent from the operators must be connected to this file and saved as CSV file. To import created CSV file we click on "File", then move on "Import" and select "Generic ascii file...". Please note that we must first import "Vnos1.xlsx" file to get column titles (Col *n*).



When we have CSV file imported we import the data to the map by clicking "Import on map".



Ascii	file																											-	×	Asc	ii file							
Col 1		Col 2		Co	al 3		Col	4		Col 5		C	al 6		Col 7		Co	818		Col9		Col	10		Col11		Co	al 12		Col 1	_	Col	12		Col 3	2		Col 4
12		•		-			•			-		-			-		•					-			-										•			1
Col13		Col 14		Ca	si 15		Col	16		Col17		0	bi 18		Col 19		Co	xi20		Col21		Col	22		Col23		Co	124		Col13		Col	114		Col15	-		Col15
-		-		-			•			•		•			•		•							10			*					•			+			-
Col25		Col26		Ca	si27		Col	28		Col29		0	x130		Col31		Co	32		Col33		Col	34		Col35		н	pattern		Cel25		Cri	126		Col27	6		Col28
		*		•			*			•		•			-		•					•		· · ·	•		*		•			•			+			-
Record	Col 1	Col 2 Co	ol 3 Col	4 Col 5	5 Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 14	Col 15	Col 16	Col 17	Col 18	Col 19	Col 20	Col 21	Col 22	Col 23	Col 24	Col 25	Col 26	Col 27	Col 28	Col 25	9 Col 30				0.10	0.14	e.i.e			
100000000																														Keco	.a Col 1	. COLZ	COLZ	C01 4	COIS C	LOID	1017 1	_0(8 C
																														1	Vr	C	A	In	In M	N 5	St >	Caro y
																														2	1	IM	IM	N	A 5	Si (5 3	ZD 2
																														3	2	K	Brnik	Br	73 5	S 6	5	14 4
																															3	K	Brnk	Br	73 5	S (5	14 4
																														5	4	K	Brnik	Br	73 5	Si 6	5	14 4
																														6	5	K	Here	Lj	73 5	S (5	14 4
																														7	6	Karr	H	L3	73 5	9 e		14 4
																														8	7	K	H	ų	73 5	9 t	5	14 4
																														9	8	U	51	C	73 5	s e	•	14 4
																														10	9	LJ	Si	ć	73 5	S 6	5 :	14 4
																														11	10	L	Sl	c	73 5	S 6	5	14 4
																														12	11	U	Zito	5	73 5	9 e	5	14 4
																														13	12	U	Zito	S	73 5	S 6	5	14 4
																														14	13	U	Кр	Tb	74 5	S 6	5 :	14 4
																														15	14	LJ	кр	Tb	74 5	S (5	14 4
																														16	15	U	Ko	0	74 5	S (5	14 4
	Boor	mimo es	marator																											17	16	U	Ko	O	74 S	s e	5	14 4
	02.14	odvisno	od nasta	vitev																										18	17	U	Ko	0	73 5	S 6	5 :	14 4
4																								_					,	10	10	11	Te	0	74 0	6 V	6. O	14 4
Separat	1	refres	h Defa	ult coord	inate co	de Vrst	tica;Ca		_		_		_	_		_	_		ile to impr	ort	projekt	ALTE Sp	remljanj	e_nadz	OF ATO	izracur	1	K		Separa	stor ,	a re	fresh	Default	coordinat	te code	Vrstic	a;Ca
Repla	ce if recor	rd exists in	n station i	database	e (DB sta	ition)		Upde	ate on m	ap station	ns: prima	rvkev =	calsion							FCC	PRN/PLT	MSI ant	ennas mi	ust be st	tored in 18	BASE ant	tennas fi	older			-	74	and a state		about 0			
								-				-		-	-	1				-	r in pag	10210	vere * ar	40.4 1	proc p	1000	-			Rep	sace if rec	toro exis	10 11 508	con dat	auase (D	o stato	en y	
Impor	t to statio	on databas	se	Import to	o subscri	ber data	abase		lipdate o	n map sti	ations		Import	on map		4	_	-	_		dand.		SUIL				U		Close	Imp	ort to stat	tion data	ibase	Ing	port to su	bscribe	r databi	ase
_	_	_	_	_	_	_	_	_	-	507	-	-			-		-	-		-	-	-						-	_	_	_	_	_	200 C	-	_	_	-

When all the data is imported to the map, we get the following view:



To check or to set parameters just click on wanted base station and select "Parameters". When "Tx/Rx parameters" window opens we can see parameters in tabs "General", "Patterns", Channels", "Site" and "eNodeB setup".



Raw data is still without LTE parameters for eNodeB and antennas. We load these parameters by selecting "Object" tab and click "Load TRX...". To load LTE parameters we select LTE.TRX.



Following two pictures show default parameters for antenna and eNodeB. In a lightly loaded cell assumption of 15% of the overhead is in accordance with 3GPP (1 OFDM symbol per subframe, L1 for 10 MHz) specifications, so the value 1 for PDCCH symbol and antenna configuration 2/2 are used.



AKOS



nput		Output		ОК
FDD TDD		#RE/PRB/subframe	16	Cance
Cyclic prefix		Number of OFDM symbols per subframe	14	
Normal		Total Number of PRBs per TTI	50	
C Extended		Reference signal	9.524	
Antenna configuration	>>	Primary synchronization signal (PSS)	0.171	
No. arrays T/R 2 / 2		Secondary synchronization signal (SSS)	0.171	
TDD		PBCH / PRACH	0.314	
DL-to-UL configuration	_	PDCCH (ind. PCFICH, PHICH) / PUCCH	4.762	
DL-to-UL config 1	_	PDSCH	85.057	
Special subframe format type	_			
Subframe Format 7	×			
Regural DL/UL subframes	4			
Special subframes	4			
DL/UL ratio	100.00			
Bandwidth (kHz)	10000.00			
	1			
PDCCH symbol(s)				



6.2. Calculation

After we have selected all necessary inputs we can start with calculation.

First, we need to select frequency band for which we want to make a calculation. This is done by selecting "Object" and then click "Isolate...". "Selection" window will open. In "Selection" window we select frequency range for calculation (see picture below).

et Subscriber Satellite Statistics Dath D.E. Maarune Spectrum Database	biast Reports Tools 2					
162,500 7 544 C 0 Ch	Object reports Tools .	0.0000 or 0		Andes 0.0 0.0 0.0	•	
	Object properties (F5)	ACU TOURD JAKON	Swet Jose BV/ 9/ 1 LL/ 1	Vitaria Maricovo	tanjsak	Tx/Rx
	Delete +	DOV#BILLS IL	TOTAL HIST SID	The states	Petrijanec	0001 -T: KR014
	Activate +	rije trica e Gora encia concerto	ska Bistrica Pragersko	Lesiovec V Vitanical	Vinica	0002-T: KR014
L ANT LAND	Mask	MARKEN PIL	L FREER P	FIRE LACE	2 X	0003-1: KH014
and it is the work with	Isolate	AL PARTICIAN	Modrate Laskover V Ha	and Charles and the second	Vi	dovec 0005-T: KR121
Tours Marrie Criamat and	Isolate from callsign	A STATISTICS	A Maispark	Letter Junior	novnik	
	Isolate from file list	Rep 21 Polane 60 - 17	Shade Later	Trakoścan		Bert 0007-T: LJ000
Viewer In Constant A Market In Constant	Filter	A WYC A Require Same TUSH	The Same	F ST V	- All	0009-7-1-1000
Changes The dollar	De-activate station without coverage	Selection	100 Contractory	and the second second	Sec. Sec.	X
Tel Kan Vedered The All All All All	Re-root stations	Randwidth	Radiated power	Francisco Multico	CS status	
tina t GD Stra Centile Cannot Posta	Ne-son stations ,		Rediated pome	Band	(i) All	OK
Hote Creina Remnik Percel A Long Kamnik Potta 21	Call sign	Selection	Al Selection	Al Al Selection	Orphan	Cancel
A HAR THE THE AND THE AND THE	Station Color +		C Section	Selection	Not orphan	
High Contraction of the State o	Change technical parameters	Min (kmz): 12.50	Min (w): 1	Min (Mnz): 790.000000	Coverage	C Reep previous filter
A CREATE A PROPERTY AND A REAL AND A	Change cx parameters	Max (kHz): 1000.00	Max (W): 250000	Max (MHz): 862	() Al	Method
Start Storts Lots TS Lotevo Kanton La Chief Com Portia Mengers Chief Com Starts	Change general parameters	2			Present	PRO NO
Mediode Gorensida Predinical assessor C 2011 C Kolcevo Karton Kal	Change system overhead parameters	Call-sign	Site code (Trig)	Group (ident)	Not present	And And
Medvode Hotel Lipa Brode Stratton Ob Saver 1442	Change antenna		() Al	(Al	Status	
Mercator Konzeg P - Taning Simobility and The Prilliphan MS	Change frequency group	C Selection	Selection	Selection	Al	
K Hotel Lost - Hotel - A La Con Lose	Change DF parameters	C String:	String:	String:	Selection	
Maccator Notecte Control & Doy Besnica on Lubian Proto Do Sav	Change Radar parameters	×			Unknown (0)	Ignored (8)
Mechanica and Annual Annual State Provide a Section of Library (RTV Lip Sta	Change from ascii file	Address	Info (2)	C/I (dB)	Lost (1)	Accepted (9)
e Gonte annual de Alacha Doo Manni Log Local Anne - Artic - Artic - Contra	Undate parameters	AI	() Al	(ii) All	Prospect (3)	On Hold (11)
tones of the participant of the state	Load TRY	Selection	Selection	Selection	In hand (4)	Parallel (12)
Vinage Gotce a	Load InA	<u> </u>			Connected (5)	Temporary (13)
and the first of the state of t	Link and MW antenna orientation	String	String	C/I <= 20	Beta tester (7)	Ealed (15)
THE AND THE ACCOUNT OF THE ACCOUNT O	Satellite antenna orientation	Z Star (D) (Chantar	Name of the	The same (Michaele)		
FIX VICTOR AND AND AND A	Attach coverage to activated station	Inio (1) / Cluster	Network ID	bit rate (moli/s)	Modulation	Color (Black=noc)
Trategolder Harrison 1 - Contractor - Contractor	Group coverages	All Columbus	Al Calcular	Al Selection	noc 🔻	
THE STATE AND LAND	Group coverages	Section 1	O Section	Obecom	Type of element	Sectorization
1 1 Antonio Internet Contractor Contractor	Group stations	String String	String	Mbit/s >= 0.0001	Al	() All
ALARY NEW THE AND A CARLEY AND	Station polygon +	<u>[]</u>			O TX /RX	Selection
Construction of the second sec	Site coordinates	Number of sub connected	Number of sub attached client	Call number	Direction finder Direction finder	Min (nb): 1
Continue C. V. 2 Content State TS D. C. M. M. C. C. Marcella Vicence State TS	Extend radius / sector coverage	🛃 💿 Al	(i) All	Al	Satellite	Max (ob):
u Hotel Krait		Vin Selection	Selection	Selection	Microwave	- ax (10).
Central Student Bole TS Nemata Var Prinek	otenjske Topice	Min (#): 0	Min (#): 0	Min: 0	Attached polygon	
Hand Canada Base Tal A Contract State Contract	my how when	Max (#): 1000	Max (#): 1000	Max: 1000	Al	
Nemia Val	NA WARKS	S. 1000	1000	1000	Present	String: case-sensitive
	V V MICHDIM	*				

The process of calculation is presented in following steps:

- 1. Select »Coverage calculation and analysis« tab:



2. Select »Tx/Rx FS coverage calculation...« when drop down menu shows.



3. »Coverage parameters« window will open. Set parameters (e.g. 1.50 for Height of Rx antennas, 30.000 for Distance, etc.) and select »Model...« button.





4. After selecting »Model...« button the »Propagation model selector« window will open. Once again select »Model...« button, this time in last opened window.



5. »Propagation models« window will open. To select propagation model we have to click on one out of three »...« buttons (see picture below).





6. After selecting »...« button »Open propagation model« window will open. We select »prop1812.dll« file and click »Open« button.

ropagation models								×		0
	JO I	Programske	e datoteke (x86) + A	TDE + ICS telecom + PLUGS +	Models	• D Fredő Madels			Acries	
odel presets C	brganiziraj +	Nova mapa					H · O ·	Dob	Ertina	
Freshel method	3	Base -	Ine *		Datum spremente	170	Vellost	I-I VI	Participant	2
ETU-4.370		Pees	3 JG.dl		6.3.2003 12:32	Razširitev programa	304 KB		SCORE LU	Ty Ax F5 coverage calculation
(TU-R. 525		PilePrint	mfc100.dl		11.6.2011 0:58	RecBritev programa	4.295 KB	Zaborit pri	EN CAR	Radial coverage calculation and
TU-R \$25/526 beig.		HOM	a mil.dl		19.2.2999 10:51	Register programe	36 KB	Coverage parameters		K Receiver coverage calculation
ITU-A. 1225		Ineces	🗟 mod370_7.dl		3.1.2008 14:54	RazBritev programa	160 KB	Standal of the sectors	white the second	Advanced coverage calculation
mu-R 1946		87	🚯 msvcr 100.dll		11.6.2011 0:58	Razširitev programa	756 KB	negocorna antere	as (m) HINO	30 coverage
TU-R. 452-15		locs	B. troven		5.8.2004 13:00	Reclinitev programa	335 KB	Distance	e (km) 30.000	Composite coverage (ctrl+C)
TU-R 452-14		OSGeo-4W	🗟 Prsp 368-7.dl		5.10.2011 17:57	Rezőritev programa	40 KB	Minimum coverage value	(dBu)	Best server coverage (ctrl+8) Best server coverage (c bits
GPP-LTE (urban)		PLUGS	S prop 452.dll		9.6.2014 12:20	Rezűritev programe	166 KB	Washed Hus	which is a	Site everlapping
SPP & TE (rural)		AddOnst	😼 prop 539. dll		19.6.3012 22:59	Razširitev programa	2.219 KB	in the out of a		Simultaneous coverage 16 bits
UI method		MOL 32	PROP 1546.dl		1.6.2012 9:20	Razširitev programa	833 KB	Perform missin	ig osverage(s)	Strukaresun caverage
Hata - Cost 231		MDL64	prop1812.dl		6.4.2009 14:58	Recipitev programe	141 /08	- 73.	(1)	 Detect any Lanceus coverage
Extended Hata		Models	RRCD4 dl	6	14.4.2006 8:46	Razőritev programa	1.855 KB	Model Options	CK Cancel	Padar composite coverage
Valfach-Begeni		Projects +	SatLOS.dl	·.	26.4.2005 17:05	Razširitev programa	220 KB		Line	Receiver coverage
for the		Ime de	teteler laund 912	at		Extension * d	. ¥	Propagation m	odel selector	Z) F3D deplay
94 1009 Nedum firequency *** Sigmove UPHF (x86)	۶.	C Area (4) C Deta Bull C Deygout	yallon Ington 66 method	C AND THE REPORT C ANNUE (CANADA AND C ANNUE (CANADA AND C ANNUE (CANADA AND C ANNUE (CANADA AND)		Field strangt	h-E offset	Proje 14	Clutter	Active view: composite coverage (ctrl with Active view: best server coverage (ctrl with Active view: site overlapping coverage Active view: simultaneous coverage
line Ty By effective		 Pree mp Tip subpe 	10id (5) (th lows (6)	0° 04/202000.0254				Add	(1000)	Popup menu setup
heights		C More met	hods	Anomalia a neurostation			Date:			Volavje
- Flat earth profile eent		F2 fi	action 1.00	a substant frid officer.			1		how of	2
mult			Statement of the second se	E Busters Friday			121			and the second se
Revenue protie		T Spherical	wave	1 Docard [341]			100	Destaughtik	Inor	73 F

6a The »Recommendation ITU-R P.1812« window will appear. Check needed components and set parameters. When this is done close the window by clicking on »Close« button.

Man Direct Coverane Microw ropagation models	we Multimust Subser	Recommendation ITU-R P.1812			
del mesets	Diffraction gent	- Propagation attenuation components	Parametere	Angles	
Freshel method	C Bidinatan me	riopagation attenuation components	r didincicis	Dob Krtina	Coverage calculation and
Wotner method	C Delta Bulinot	E.F. CHURNER	Time & Trans		4
ITU-R 370	C Devoout 941	Line of sight / Diffraction	1 me - 50.000		12/RX PS coverage calculation
ITU-R 525	C MD 91 metho				The coversities carcinetion
ITU-R. 525/526 Devg.	C ITU-R 526, r	I ✓ Diffraction	1	ters 2	Addar coverage carculation S
ITU-R 525/526 Bull.	C ITU-R 526, c		Location % [50,000	-	Receiver coverage calculation
ITU-R 1225	C Deygout 661	Multipath and focusing effects			Advanced coverage calculation
ITU-R 1546	C ITU-R 1225			intennas (m)	30 coverage
ITU-R 1812-3	C W-1 Cost 23		Sea level surface refractivity NO 330	Distance (Inc)	
ITU-R 452-15	C Visibility / Inc	Tananakaria aratkar	000	historice (only 30.000	Composite coverage (ctrl+C)
ITU-R 452-14	No diffraction	I ropospheric scatter		e value (dBu)	 Best server coverage (ctri+6)
Durkin	E		deltaN = [N(0m) - N(1000m) 1 Ao		Best server coverage 16 bits
3GPP-LTE (urban)	Lateral diffre	Ducting / Layer reflection	dense (riterin) (riterenin) [40	ed threshold 45	Site overlapping
3GPP-LTE (rural)	Power corret				Simultaneous coverage 16 bits
Olumius Alata Davide	TT 149 452 /r		Path center latitude (*) 45.0	n missing coverage(s)	Smultaneous coverage
Okumura-Hatajuavida.	1 104(452)		(all our all all all all all all all all all al	11	Smultaneous cx
Extended Mata	0=randor			tions CK Cancel	 Limited simulaneous coverage
Cost 231 open			\sim		Radar composite coverage
Walfisch-Ikegami	Subpath attenu.			Callo	Heceiver coverage
	C Standard-Rh		Development of the Party and t	tion model selector	Differences
Area table	C Standard	Reverse profile	Close Do not send hat Earth profile		ZU F3D display
	C MD 91 metho		Lise default clutter codes	p models: 4.	Active view: coverage calculation
SM 1009	C Coarse integ			Model	TT- I THE I HAVE A THE I HAVE A
Medum frequency***	C Fine integrat			CUR	Active view: composite coverage (ctrl+shift-
Skywave LFMF (x86) 🗲	C Area (4)	C desert 50%	med strength +c-offset		Active view best server coverage (corrant
> prop 1812	C Delta Bulingto	n C temperate 90%	zine 🛄 💦	Indoor	Active view: site overlapping coverage
	C Deygout 66 m	ethod C temperate sea 50%			Active view: simulareous coverage
Composite output(")	Free ellipsoid	5) 6 continental 90%.	Zadvc A	dd	Popup menu setup
- Use Tx/Rx effective	 No subpath lo 	s (6)	Barow		Capital American
neights Flat worth mode and	C More methods	···· Anomalous propagation			Volavlje
to DLL	FZ fractio	1 1 00		I	t
Revenue mentile		Ducting	50	La Cat	mi c
	Spherical wav		Podmolnik pr	Javor	Malo Trebrieve
≤ 50,0 xme 50.8 ≫	Fourth-power		Sent	pavel	2
		\sim	0rie		
theoked, internal diffraction/subpl	ath model will be added to	the external DLL rodel 7		a contraction of the second	Mali Vrh pri
Save.	Load. 1	ndoor Clutter Close		Veliki	Prezganju
			Dole pri	Lipoglav	ośćine
Ligojna	- 10C V	Contra	Skofljici	Mali Lipoglav 12>	aver 8
		Lipe	Gentilies and	Repce	a jei o
H Y	Bevke	A PERMIT	SADIQUE		Le la
Sinja Gorica		1 AN ANNI			Polica
ra Vrhnika	Blatna	A A A A A A A A A A A A A A A A A A A			
B	rezovica	lazaro	Matena Smar	e-sup.	
	10.00	2006 2000 2006 2000	2004 2004 2000 Package		2 los



7. After selecting the propagation model click on »Clutter...« button do define clutter parameters.

	ij 👻 Nove mape					····	Deb Itelina	
esnel method	Base _	Ine *		Datum spremenbe	70	Vellost	- W	2
JAR. 370	🕌 Pees 😸	3 JG.dl		6.3.2003 12:32	Razširitev programa	304 KB		Ty Rx F5 coverage calculator
14.525	B Hierint	S mfc100.dll		11.6.2011 0:58	Recipitev programa	4.295 KB	Zaborit pri	Eastar coverage calculator
HR 525/525 Desg.	HOM	a mil.dl		19.2.1999 10:51	Rezőritev programe	35 KB	Coverage parameters	Receiver coverage calculation
I-R. 1225	H-535	a mod370_7.dl		3.1.2008 14:54	RazBritzy programa	160 KE	8	Advanced coverage calculation
UR 1546	RP III	Nover 100.dl		11.6.2011 0:58	Razšritev programa	756 KB	Height of Rx antennas (II)	30 chronoge
44. 452-15	k locs	B. myort.dl		5.8.2004 13:00	Register programa	335.85	Distance (km) 30.000	Composite coverage (ctri+C)
J-R 452-14	S OSGeo 4W	Prop 368-7.dl		5.10.2011 17:57	Regoritev programa	40 KB	Mininum coverage value (dBu)	 Best server coverage (ctrl+8)
rkin BD ATE (Labora)	PLUGS	prop 452.dl		9.6.2014 12:20	Rezűritev programe	166 KB	· · ·	Best server coverage 16 bits
PPATE (rural)	AddOne:	Si prep538.dll		19.6.3012 22:59	Razbiritev programa	2.219 KB	Wanted threshold 45	Simultaneous coverage 16 bits
I method	AddOner	PROP 1546.dl		1.6.2012 9:20	Register programa	803 KB	Parform missing ovverage(s)	Stukaresus caverage
amure-Hete/Devid	MD 64	prop1812.dl		6.4.2009 14:58	Regititev programe	141 KB	-3	Simultaneous ox
xtended Hata	Models	RRC04.dl	0	14.4.2006 8:46	Razőritev programa	1.855 KB	Model Options	Carcel Safet controlle sperger
lost 231 open	Projects	Sati OS di	b .	26.4.2005 17:05	Raziritev programa	220 KB		Receiver coverage
alfach-Begerni								Differences.
Area table	Ime c	istotekes prop1812.0	11		Extension: *.d	0 ×		20 F3D deplay
dum frequency*** move LFHF (x86)	C Ares (4) C Deta Du C Deygout	grauxer lington 166 method	 Conversion of Head State Conversion State Conversion State Conversion State Conversion State 		Field strangt	h-E offset szine	Ver	Outlat Active view best server coverage (ctil Indoor Active view site overlapping coverage Active view simultaneous coverage
Use Ty Dy effective	 No subo 	ath loss (6)	00 00//2020/00/00%				Add	Popup menu setup
heights	C More me	thods				Date		Volavije
Plat earth profile eent to DLL	FZf	iaction 1100	with sect histofican			1		man to the
Recerco proble	C Sharra	Inche	Ducting			1		- and s
		merlen					Podmotnik Podlipoglav	Malo Trebelevi
100.0 Time 50.0 %	Providence in the second secon						Contraced	

8. »Clutter parameters« window will open. Here we can select needed parameters and confirm them by clicking on »OK« button.

del presets		Diffraction geometry	Clease			Sope	nodel ci	efficient	Ingiu	a .	Do	and for	e9	0	140	Coverage calculation of
Freinel method Wigner method ITU-R. 370 ITU-R. 525 ITU-R. 525/526 Derg, ITU-R. 525/526 Derg.		C Bulington method C Detts Bulington C Dergout 94 method C MD 91 method C ITU-R 526, round mask C ITU-R 526, round mask C ITU-R 526, cluders	Earth radiu Earth radiu RIMS wave	s ium (land) n ium (seuk) hesight (m)	9930 9930 0.00	A fi	actor T Attenue fraction (1.0 5 (dt ton (d5,fan) 6 correct. (d5) 6		Z	Vir aborit pri erage paramete	•	1	€	Ty Av FS overa Df coverage calc Rectar coverage i Receiver coverage	er calculation
TU-R 1225		C Devgout 66 method	E DUR P	Clutter p	arameters									1,-	×	je calculation
MU-R 1812-3		C W-1 Cost 231	Vanna (Clutter cod	ie Name	Attenui	ation (dt) Clutter height	Reflection: Rho (0-1)	triangAm2	Surface factor	Diffraction factor	Station/km2	Stidev (dt)	Tip	1
10-R 452-15		C Visibility / Indoor	HPO	0	open	9.8	0.2	1	0.300	1.0000	1.000	1.00	1.000	1.00	P rx ground	e (ctr(+C)
aikin		1. No ormaction loss	E ann arr	1	vilage	0.0	0.0	6	0.300	1.0000	1.000	1.00	1.000	1.00	Frix ground	ge 16 bits
PP-LTE (urban)		Lateral diffraction (UTD)	F Rain att	2	suburban	9.0	0.0	8	0.300	1.0000	1.000	1.00	1.000	1.00	P reground	Law warm
Emethod		J Power correction (angle)	Rain (2	3	urban	2.0.	0,0	15	0.300	1.0000	1.000	1.00	1.000	1.00	P rs ground	1002
umure-Hete/Devids.	- 22	TTU-R: 452 (p2p)	Time (0.0)	4	dense urban	0.0	0.0	30	0.300	1.0000	1.000	1.00	1.000	1.00	P regrand	12.0
ita - Cost 231 itended Hate	1	Time (0 to 50%) 50.000	Eso	5	forest	0.0	0.2	12	0.300	1.0000	1.000	1.00	1.000	1.00	P rx ground	IT COMPANY AND THE STATE
st 231 open		& health attenuation		6	hydro	0.0	0.0	0	0.300	1.0000	1,000	1.00	1.000	1.00	P reground	CALIFOR .
sifect-Bagemi		C Standard EM	Troposcatte	7	high urban	0.0	0,0	50	0.300	1.0000	1.000	1.00	1.000	1.00	Farment	
Ariea table		C Standard	Tropo II	8	park/wood	0.0	0.0	4	0.300	1.0000	1.000	1.00	1.000	1.00	Fragment	
1000		C MD 91 method	C amode	9*	roof - building	0.0	0.0	0	0.300	1.0000	1.000	1.00	1.000	1.00	France I	age calculation
edure frequency ****		C Prie integration	C AURTO	10	178	0.8	0.8	0	0.300	1.0000	1.000	1.00	1.000	1.00	Franci	bsitz coverage (ctrl vshift
move UPMP (x86) 5		C Area (4)	Citeret	TTT.	Land	0.0	0.0	0	0.300	1.0000	1.000	1.00	1.000	1.00	Damand	verlapping coverage
prop 1812		C Devoout 66 method	C tunor	12	(in the second	0.0	0.0	10	0.500	1.0000	1.000	1.00	1.000	1.00	- IN POOR	aneous coverage
Composite output(*)		Free elipsoid (5)	@.01%.b	12	anjun,	0.40	0.0	0	0.300	1.0000	1.000	1.00	1.000	1.00	. 💦	
Use Tx/Rx effective heights		No subpath loss (6) Nors getted:		14	com oursi	10.00	0.0	0	0.00	1.0000	1.000	1.00	1.000	1.00	. '?	1
Flat earth profile sent		FT faster	Anomalizus	12	uperiora	9.9	4.9	u	0.300	1.0000	1.000	1.00	1.000	1.00		
Revenue coulde		F2 Hacton 1.00	E Ducting	10	mend	0.0	10.0	0	0.300	1.0000	1.000	1.00	1.000	1.00		1
Inn Tree Son 15		Spherical wave		16	indoor 1	9.0	0.0	10	0.300	1.0000	1.000	1.00	1.000	1.00		-
Transit (Transit			-	17	induor 2	0.0	0,0	0	0.300	1.0000	1.000	1.00	1.000	1.00		D
herked, internal diffraction/s	ubpath m	odel will be added to the external D	u ode 7	18	indoor 3	0.0	0,0	0	0.300	1.0000	1.000	1.00	1.000	1.00		1
s Seve		Load Indoor	Outler	19*	Border*	Q.II.	0.8	0	0.300	1.0000	1.000	1.00	1.000	1.00		19
Ligojna Sinja Gorica ra Vrhnika	Blatr Brezos 732	Bevke ica 1098 1411	Gorice	Previous	*	- au		II R A A A A A A A A A A A A A A A A A A	Heght fi Indoor building acti. + Reference frequ	actor L.O tten. 0.0 ency 2665.0	Path/Su C T/R dS T/R Rx c Do n	b,Rx cov (R) over dutter over ground spot wer ground relaxe ot calculate diffrac	Tx/Jam/Mi C T/R ov 5 C T/R ov	W (T) er dutter er ground 581	-1 = none	



9. After we define propagation model we close the »Propagation models« window by clicking on »Close« button...

del presets Diffraction geometr	Cimate	Slope model coefficient	Dub .	
All servers and an analysis of the servers and an analysis of the servers and analysis of the ser	Clinite Earth radius (in (loss) Earth radius Eart	Slope model caefficient A facture [1.0] 0 (80) 0.0 Attenuation (68,8m) 0 0.000 Diffraction correct: (48) 0 0.00 If fraction correct: (48) 0 0.00 If fraction correct: (48) 0 0.00 If fractions (18,10,10) 0 0.000 If fractions	rigiu Control de la control de	An Comparison of the set of the s

10. ...we close the »Propagation model selector« window by clicking on »Close« button...





11. ...and we close the »Coverage parameters« window by clicking on »OK« button.



12. When steps from 1 to 11 are done the calculation starts and at the end the calculation data (field strength) is presented.



The results has to be saved in the network file (File>>Save>>Save network file(*.EWF)).

6.3. FWBA point to point connectivity report

In this chapter are presented steps on how to create the FWBA point to point connectivity report. From the report can be seen all the corresponding parameters (RSRP, RSSI, RSRQ, SINR (PDSCH)) of each individual connection.



The process of creating the report is presented in following steps:

1. Click on »Subscriber« tab, select »Point to point« option in drop down menu and then select »4G LTE connectivity report...« option.



2. The »IRF (LTE)« window will open. Select needed parameters and click »OK« button.





3. The connectivity report will generate in .csv file. We can save the report as .csv or .xlsx file.



7. Description of Measurement Procedure

7.1. Objective

Mobile network measurements are conducted for the purpose of on site verification of the actual technical parameters, which are important for mobile network's performance. This method also verifies the accuracy of the data on geographic locations of the cells, their technical parameters, and the coverage area, which are periodically submitted by owners of broadband mobile networks. The measured parameters are also required for analysing potential issues, such as: signal levels being too low, signal ratios, various interferences and detecting errors in networks' parameter settings. Mobile network measurements are also the only method the Agency has of verifying whether the computer simulations match the coverage in the field.

7.2. Methods of Measurement

Two methods are used for conducting measurements:

- 1. Mobile measurements, and
- 2. Fixed measurements

7.3. Mobile Measurements

With mobile measurements the location of the measurements changes during the measurement itself. For such measurements all the results are accompanied with the data on the time and location of the measurement.

Mobile measurements are conducted in two ways:

- in a vehicle, or
- on foot



Most of the measurements are conducted in a vehicle. They are conducted on foot only in those areas where network parameters need to be measured, however the area is not accessible by vehicle.

7.4. Mobile Measurements In a Vehicle

Mobile measurements in a vehicle make it possible to conduct the measurements for several networks and technologies at once in relatively short time for a broad area, which has to be accessible by vehicle.

7.4.1. Measurement Equipment

The scope of the measurements is limited by the installed equipment, which consists of a test user device (a test mobile phone or modem), an antenna on the roof of the vehicle, and the software. Because of the number of technologies operating across different frequency bands, the limited technical parameters of the test terminals, and the number of operators, effective verifications require the use of a broadband scanner. Except for the antennae, all the measurement equipment is installed inside the vehicle.

7.4.2. Antenna

The measurement antenna is installed on the roof of the vehicle at a height of about 2 meters, measuring 0.5 meters above the standardized measurement height. The average gain of the unfocused antennae used for measurements with the whole loss figured in is at least 0 dBi, which is also taken into account as antenna gain when making calculations. Considering the manufacturers' data, the gain in certain directions may be higher by 1 to 3 dB, however this can be disregarded, as during mobile measurements the line of connection between the antenna and the receiver is constantly changing, and hence no gain can be attributed to any particular direction.

The strength of the received signal also depends on the height of the receiving antenna, and is increased due to the 0.5 meter higher antenna – depending on the frequency band – from 1 dB at 800 MHz, to 3 dB at 2600 MHz.

The expected difference in measurements of the signal strength when measuring with test terminals with one antenna installed on the vehicle at 1.5 meters and the other at 2 meters, is between 3 and 6 dB.

7.4.3. Test User Terminal, Scanner

Commercial mobile phones with unmodified hardware and modified firmware are used for test user terminals. Considering the comparative table of pros and cons of such a phone and a scanner, its recommended use is only in the measurements, which cannot be conducted with a scanner. These are end-to-end measurements. For all other measurements the scanner is used, as it can conduct all the measurements and parameter demodulations, of a user terminal in standby mode, but with significantly greater speed and accuracy across all frequency bands, regardless of the service provider.



Table 6: Comparison of usability of a test user terminal and an RF scanner

	Test device (UE)		RF scanner	
Frequency limitation	Certain bands	$\mathbf{\Lambda}$	NO	↑
Limited to one operator	YES	$\mathbf{\Lambda}$	NO	↑
Costs of services	YES	$\mathbf{\Lambda}$	NO	↑
QoS	YES	↑	Partially	Ľ
Network connection	YES	>	Partially	Ľ
Coverage	Partially	ĸ	YES	↑
Accuracy	Low	$\mathbf{\Lambda}$	High	↑
Speed	Low	$\mathbf{\Lambda}$	High	↑
Price	Low	↑	High	\mathbf{A}

7.5. Mobile Measurements On Foot

Mobile measurements on foot are conducted exclusively on test user terminals using software for conducting measurements. The installed GPS receiver is used for determining the location of the measurements.

7.6. Measurement Parameters

When conducting measurements and recording the results of the measurement parameters only the basic network parameters and system settings need to be determined. It is important that they do not change between individual measurements. All the measured parameters and events are recorded.

7.6.1. TSMW (LTE) - RF scanner measurement parameters

- RSRP: Power of the LTE Reference Signals spread over the full bandwidth and narrowband. A minimum of -20 dB SINR (of the S-Synch channel) is needed to detect RSRP/RSRQ
- RSRQ: Quality considering also RSSI and the number of used Resource Blocks (N) RSRQ = (N * RSRP) / RSSI measured over the same bandwidth Narrowband N = 62 Sub Carriers (6 Resource Blocks) Wideband N = full bandwidth (up to 100 Resource Blocks / 20 MHz)
- RSSI: Total power, includes interferences, power of other cells and traffic. It's measured over the full bandwidth
- Ptot: Is the narrowband RSSI that considers only Synch-Signal (62 Sub Carriers)
- SINR: Signal to Interference and Noise Ratio based on the Synch-Signal
- RS-SINR: SINR based on Reference Signals (narrowband and wideband).
- ISI: Channel Impulse Response (CIR) measurement shows mainly Multi-Path delays to detect Inter-Symbol-Interference (ISI)
- Doppler: The Doppler shift is measured relatively. It is based on the CIR measurement and can measure a shift of -100 to +100 Hz. This corresponds to a driving speed of approximately 160 km/h at 700 MHz



- — CP: The Cyclic Prefix is automatically detected by the TSMW whether it's the normal (7 symbols per slot)
 or the extended (6 symbols per slot)
- CN: Condition Number based on MIMO Matrix

7.7. Software

Software must provide the function of displaying individual measurements and events on geographical maps, as well as the analysis of the selected measurement parameters.

A software analysis conducted at a later date must support selecting various criteria, so there is no need for these criteria to be defined before the measurements are made. This way the analysis of the measurement results can be based on different criteria, as set after the measurements have already been completed.

8. Definition and description of measured parameters

8.1. SINR calculations

The required SINR is the main performance indicator for LTE and the accurate knowledge required SINR is central to the authenticity of the throughput and thus the process of dimensioning. Required SINR depends up on the following factors:

- Modulation and Coding Schemes (MCS)
- Propagation Channel Mode
- Higher the MCS used, higher the required SINR and vice versa. This means that using QPSK ½ will have a lower required SINR than 16-QAM ½.

The SINR (Signal to Interference plus Noise ratio) is expressed as follows:

$$SINR = \frac{S}{I_{own} + I_{oth} + N}$$

- S: Useful signal (received power)
- I own: Own cell interference (close to zero due to the orthogonally of subcarriers)
- I oth: Other cell interference
- N: Noise power

Equasion 1: SINR calculations

The required SINR can be estimated by two different methods:

- By using the "Throughput vs. average SINR tables. These tables are obtained as an output of link level simulations. For each type of propagation channel models and different antenna configurations, different tables are needed.
- By using the Alpha Shannon formula. Alpha-Shannon formula provides an approximation of the link level results. Thus, in this case, no actual simulations are needed, but factors used in Alpha-Shannon formula are needed for different scenarios.



8.1.1. Alpha Shannon equation

It shows that the throughput of a modem with link adaptation can be approximated by an attenuated and truncated form of the Shannon bound. (The Shannon bound represents the maximum theoretical throughput than can be achieved over an AWGN channel for a given SNR). The following equations approximate the throughput over a channel with a given SNR, when using link adaptation:

	Thr = 0	for SNIR $<$ SNIR $_{MIN}$
Throughput, Thr, bps / Hz =	Thr = α .S(SNIR)	for SNIR $_{min}$ < SNIR < SNIR $_{MAX}$
	$Thr = Thr_{MAX}$	for SNIR $>$ SNIR $_{MAX}$

Where:

- S(SINR) is the Shannon bound: S(SINR) = $\log_2(1 + SINR)$ bps/Hz
- α Attenuation factor, representing implementation losses
- SNR_{MIN} Minimum SINR of the codeset, dB
- Thr_{MAX} Maximum throughput of the codeset, bps/Hz
- SINR_{MAX} SINR at which max throughput is reached S⁻¹(Thr_{MAX}), dB

Equasion 2: Alpha Shannon formula

The parameters α , SNRMIN and THRMAX can be chosen to represent different modem implementations and link conditions. The parameters proposed in table 1 represent a baseline case, which assumes:

- 1:2 antenna configurations
- Typical Urban fast fading channel model (10kmph DL, 3kmph UL)
- Link Adaptation (see table 1 for details of highest and lowest rate codes)
- Channel prediction
- HARQ

Table 7: Parameters describing baseline Link Level performance for E-UTRA Co-existence simulations

Parameter	DL	UL	Notes
α , attenuation	0.6	0.4	Represents implementation losses
SINR _{MIN} , dB	-10	-10	Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL)
Thru _{MAX} , bps/Hz	4.4	2.0	Based on 64QAM 4/5 (DL) & 16QAM 3/4 (UL)

Table 7 shows parameters proposed for the baseline E-UTRA DL and UL. (from ETSI TR 136 942 or 3GPP TR 36.942).

In case of 10MHz channel and taking in account the 15% of load and the additional 15% of system overhead the Alpha Shannon formula give according to the above parameters

Table 8: Results of Alpha Shannon formula in case of 10MHz channel, 15% of load, 15% system overhead

10MHz	50 RB	100%	50,0			
		85%	42,50			
		-15%	-6,375			
		0,722500	36,125			
ThPd (Mbps)	reqThPdRB	reqSE	Thr	S _{DL} (bps/Hz)	SNIR	SNIR(dB)
10,0	0,277	1,538	1,538	2,56312	4,9098	6,91
Thr=α.S(SNI	R)					
S(SNIR) = log	g2(1+SNIR) b	ps/Hz				
$\alpha_{DL} = 0,6$						

For 10MHz bandwidth and requested 10Mb/s the SINR must be app. 7 dB.



8.1.2. Peak throughput

Peak throughput represents a theoretical upper bound on what can be achieved on the channel in terms of throughput or capacity.

Peak throughput depends on:

- Bandwidth configuration (1.4; 3; 5; 10 and 20MHz)
- SINR conditions (depends on the path loss attenuations, transmitted power...)
- MCS (Modulation Coding Scheme) achieved
- n°PRB allocated to PDSCH channels

Peak throughput calculation requires a table of correspondence (between SINR vs. Throughput).

From tables presented by operators (at the time of the preparation for tender for the allocation of radio frequencies) and vendors can be seen also 7 dB SINR for requested 10Mb/s in 10 MHz bandwidth.

8.2. Required RSRP value for 10 Mbps

8.2.1. Link budged

From link budged calculation:



Figure 1: Link budged parameters

we came to the next value as described in Table 9.



Table 9: Link budged parameters

Body loss	dB	5
reqSNR (10Mbps) Interference margin	dB dB	6,9 3
KTBF	dBm	-122,2
KTB (15kHz)	dBm	-132,2
Thermal noise KT	dBm/Hz	-174
Noise figure	dB	10

Our assumptions for interference margin and body loss are typical values from industry practice.

For fade margin it was taken from ITU-R P1812: for 800 MHz the location variability of 4,3 dB and confidence factor of 0,77 (normal cumulative distribution).

8.2.2. Measurement results

8.2.2.1. FWBA access ("Fritzbox") speed tester measurements on location Jeruzalem



Figure 2: Speed tester measurements on location Jeruzalem – for FWBA access ("Fritzbox") The actual RSRP field strength is min. 3dB lower (antenna gain – cable loss).

8.2.2.2. Netztest data

Based on the samples (433 measurements performed with AKOS UE) in Netztest:





Figure 3: 433 measurements performed with AKOS UE in Netztest

Taking in consideration that the absolutely accuracy of the UE RSRP measurements is ± 6 dB and that our measurements comparing with the scanner measurements show 6 dB less values, the requested value of RSRP is -103 dBm.

In case of measurements results the additional margin is taken in so the RSRP > -100 dBm is good coverage and RSRP < -110 dBm is not good. The values in between are questionable, but can be accepted.

8.2.3. RSRP Reference value

Regarding the reference RSRP value of -103 which was a reference value used by agency when calculating coverage, several measurements of RSRP value which were made in monitoring campaigns show, that when using scanner TOP1 value was taken into account, which means the value of the cell covering scanner with the highest signal. When measuring with mobile terminal such terminal measures RSRP value of the cell to which it is connected (service cell), which is not necessarily the cell with the strongest signal, as terminal need some threshold to switch to another cell. Therefor it is not necessary that at the same location we get the same RSRP value from the scanner and from the terminal.

In other words, if the measurements were done using terminals instead of scanner the values would be statistically for 5 dB lower that using scanner. In the first phase agency has taken into account that the measurements between -103 in -108 dBm are questionable, but can be accepted. At value -108 dBm the only difficulty which was noticed was, that the capacity of Uplink begins to decrease. The mobile coverage obligations for 800 MHz band in the decision of allocation of radio frequencies is defined that operator has to provide mobile broadband services at a bit rate of at least 10 Mbit/s downlink (outdoor), but there is no provision regarding UL (uplink).

Therefore from professional stand point is proposed to change the value of reference RSRP to -108 dBm in order not to be too restrictive and not to put to operators additional burden for meeting coverage obligation requirements.

The agency has as well considered a comment by operators regarding the inclusion of body loss (5 dB) in determination of RSRP value of -103 dBm for coverage calculation. This operator agrees that such adjustment



may be valid for received telephone calls if the terminal is in a pocket of a person. The majority of terminals most of the time is not used close to the body. For example tablet, TV set and as well smart phone are used in front of the user when downloading data. Therefore in such usage there is no 5dB body loss present.

Based on measurements and taking into account comments from operators regarding body loss when terminal is not used for voice telephony (which is today valid for LTE), the agency decided to modify reference RSRP value for coverage calculations from -103 dBm to-108 dBm.

9. Monitoring/evaluating of FWBA availability to end users

The operator is checked weather is it offering FWBA in accordance with obligation (see chapter 2.2.3). The actual commercial offer is compared to the requested obligation (offered data rates, CPE installing options, ...) and then the submitted data are evaluated.

The appropriate internal or external customer-premises equipment (CPE) with a suitable antenna should be part of the offer.

9.1. Monitoring/evaluating of FWBA availability based on submitted data

9.1.1. Completeness of data

Submitted data is visually checked. A list of addresses at which FWBA service is provided, the number of FWBA connections at these addresses, the base station cell ID's from which these FBWA subscribers receive signal have to be submitted in accordance with chapter 2.3. The base station cell ID's are crosschecked with base station's data (see chapter 2.2) and it has to be provided for each subscriber and has to be uniform. All other required fields are checked too in accordance with chapter 5.1.1.2.

9.1.2. Import of FWBA data and subscriber default values

FWBA addresses are in accordance with data submitted imported in the subscriber database of the agency's calculation tool. In case that at the import the software will report errors, data formatting and correctness has to be done. If data can be easily corrected by agency (less than 2 working days) than the checking of connections is done (see chapter 5.1.2.6). Data submitted must be in accordance with chapter 4.3. For the subscriber parameters, the next default values will be used: EIRP = 23dBm, h_{ant} <=5m, DL>=10Mbit/s. If data is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

9.1.3. Verifying the FWBA connections

For the imported FWBA subscribers in the subscriber database of the agency's calculation tool and corresponding parent base stations (from 4.2) the point to point connectivity report is produced. The report – excel table is stored on a disk. From the report can be seen all the corresponding parameters (RSRP, RSSI, RSRQ, SINR(PDSCH)) of the each individual connection.

9.1.4. Evaluation of calculated connection results

First calculated results are evaluated based on previous experience, calculations and existing measurements data. In case of significant difference in comparison to the expected values and existing measurements data, rechecking of data is done in accordance with 5.1.5.



If FWBA data and/or FWBA parameters is not submitted complete and/or correct and/or in right format an urgent reminder shall be send.

If no mistake found in data and parameters, then the agency prepares an internal requirement for monitoring of coverage of FWBA places where this kind of difference is most significant and the procedure in chapter 5.1.6 is used accordingly for comparison of results.

9.2. Monitoring/evaluating availability of minimum required capacity FWBA for end users (min 2Mbit/s)

In accordance with 2.2.3 base station capacity has to be designed to guarantee the FWBA subscriber minimum data transfer rate of at least 2 Mbit/s. To verify the suitability of the operator network design the required minimum throughput of the base station sector will be calculated using the following formula:

Min.throughput of FWBA BS sector=(No.of FWBA subscribers * 2 + 10) Mbit/s

Equasion 3: Minimal required throughput of the base station sector

If data minimum throughput of the base station sector is less than number of FWBA subscribers*2 Mbit/s. +10 Mbit/s, minimum required capacity requirement is not fulfilled.

9.3. Monitoring/evaluating of FWBA availability based on measurements on the field

In the case of subscriber complaint concerning quality of service - actual reached transfer rates, the unsuitability will be checked by QoS monitoring at the subscriber location (outdoor measurements, or if it is needed on the actual subscriber CPE).

9.3.1. Fixed Measurements

When the performance of a mobile network for fixed access needs to be verified, these measurements are conducted at the locations where the equipment was installed. The measurements are conducted with the equipment provided by the operator. When several measurements need to be conducted within a certain period, they are made by installing an automatic measurement system, which includes the customer premises equipment (CPE) as well as a computer with software for periodically testing the following parameters:

- downlink data rates
- uplink data rates
- network latency ping
- jitter, and
- packet loss

The testing period is determined on a case by case basis, and may be short, from just 30 minutes when constantly failing to achieve minimum requirements, to several days when certain parameters are occasionally not reached.

The minimum required capacity requirement (see 2.2.4) must be fulfilled.



10. Conclusions

Based on the submitted data in accordance with 5.1.1, the calculations shall be made to assess the fulfilment of the coverage obligations. (see 5.1.4).

The coverage obligations (general coverage obligations 2.1 and/or special coverage obligations 2.2 to 2.2.2) are fulfilled if the percentage of covered population is not less than required in DARF (Decision on Allocation of Radio Frequencies) (see chapter 2) based on calculations using RSRP value of -108 dBm (see 8.2.3). FWBA service obligations (see 2.2.4) are fulfilled if all criteria from chapter 9 (Monitoring/evaluating of FWBA availability to end users) is met. Agency informs operators on the results of evaluation.

In case that the obligations are fulfilled, the cross check of the results in accordance with chapters 5.1.7 and 9.2, 9.3 (discrepancy between agency and operators data) will be done only on operators request.

The Agency publishes data based on its calculations and conclusions in accordance with this methodology.