AKOS

AGENCY FOR COMMUNICATION NETWORKS AND SERVICES OF THE REPUBLIC OF SLOVENIA

METHODOLOGY FOR VERIFYING THE FULFILMENT OF OBLIGATION

at the deadlines defined in issued licences for mobile service.

March 2016

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AKOS

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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 settlements[1] (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 list[2] 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 coverage area of the base stations covering settlements from the list even though they are not located 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 obliged[4] 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 location[1]. 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
1st 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	
2nd 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	
1st year at 900 MHz	4.1.2017	
25% of population at 900MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
3rd year at 800 MHz	31.5.2017	
3rd 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	
2nd year at 900 MHz	4.1.2018	
50% of population at 900 MHz	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	

3rd year over 1 GHz	4.1.2019	
25% of populationover1 GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5th 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
1st 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	
25% of population at 900MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
3rd year of 800 MHz	31.5.2017	
75% of population at 800 MHz	31.5.2017	Chapter 4.1
coverage report	30.6.2017	
2nd 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	
3rd year over. 1 GHz	4.1.2019	
25% of population over 1GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5th 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
1st 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	
2nd Year of 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	
25% of population at 900 MHz	4.1.2017	Chapter 4.1
coverage report	5.2.2017	
3rd year at 800 MHz	31.5.2017	
75% of population at 800MHz	31.5.2017	Chapter 4.1
coverage report	30.6.2017	
2nd 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	
3rd year over1 GHz	4.1.2019	
25% population over 1GHz	4.1.2019	Chapter 4.1
coverage report	5.2.2019	
5th year over1GHz	4.1.2021	
40% population over1 GHz	4.1.2021	Chapter 4.1
coverage report	5.2.2021	

3.2. Material published on WEB page to be used by operators

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

3.2.1. PZNN

— 31.05.2014[5]: 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

— 22.01.2015[6]: Distribution of the population of the Republic of Slovenia - the list of populated raster cells 100 m x 100 m grid (SVN prebivalci 100 m 2014.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, geo-referenced 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-

4.2. For report on fulfilling special 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, geo-referenced 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 "PZNN**Napaka! 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

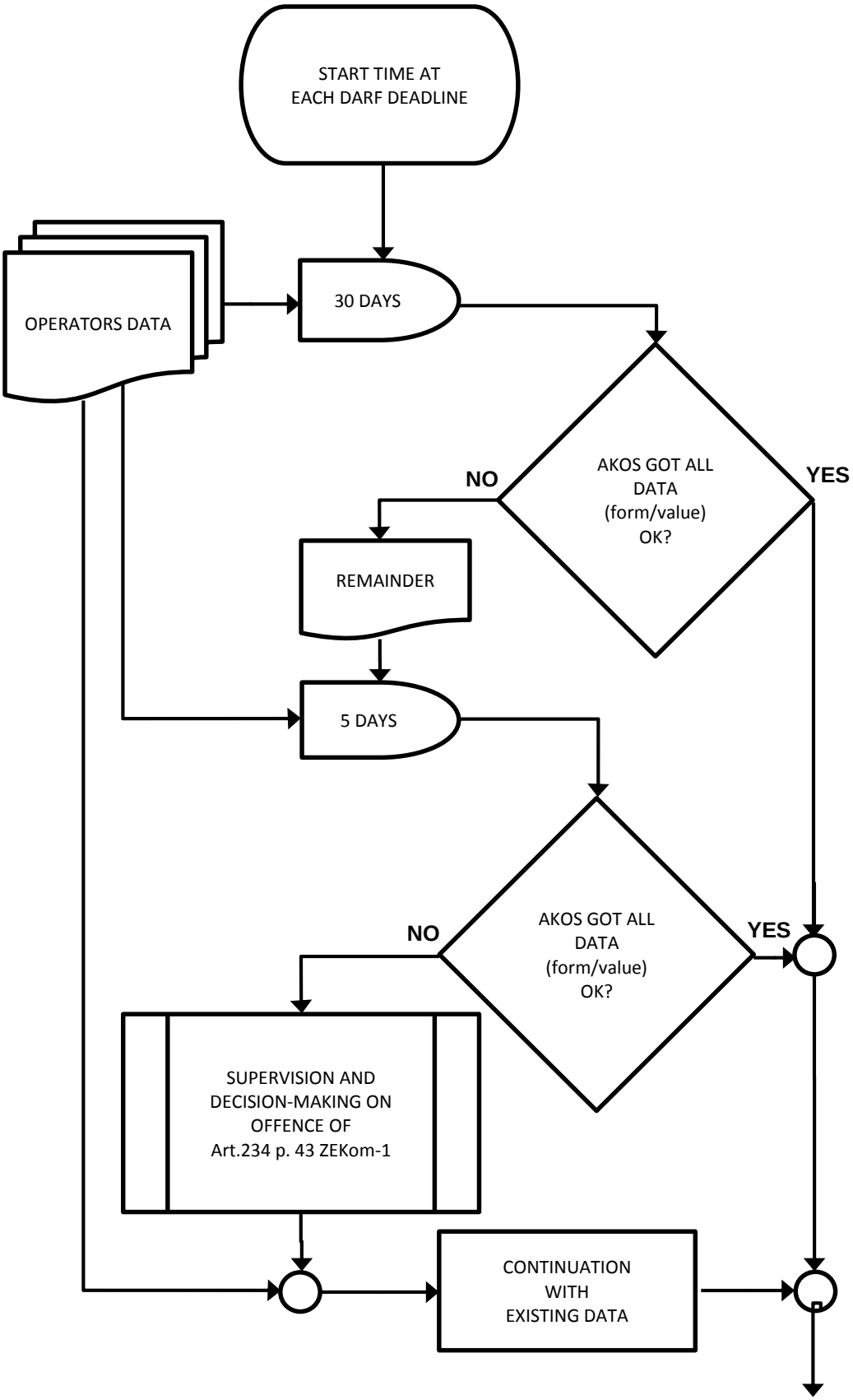
The submitted information must comprise:

- A list of addresses ("HS_MID") from the published list "PZNN**Napaka! 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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OK?
NO
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REMAINDER
5 DAYS
AKOS GOT ALL
DATA
(form/value)
OK?
NO
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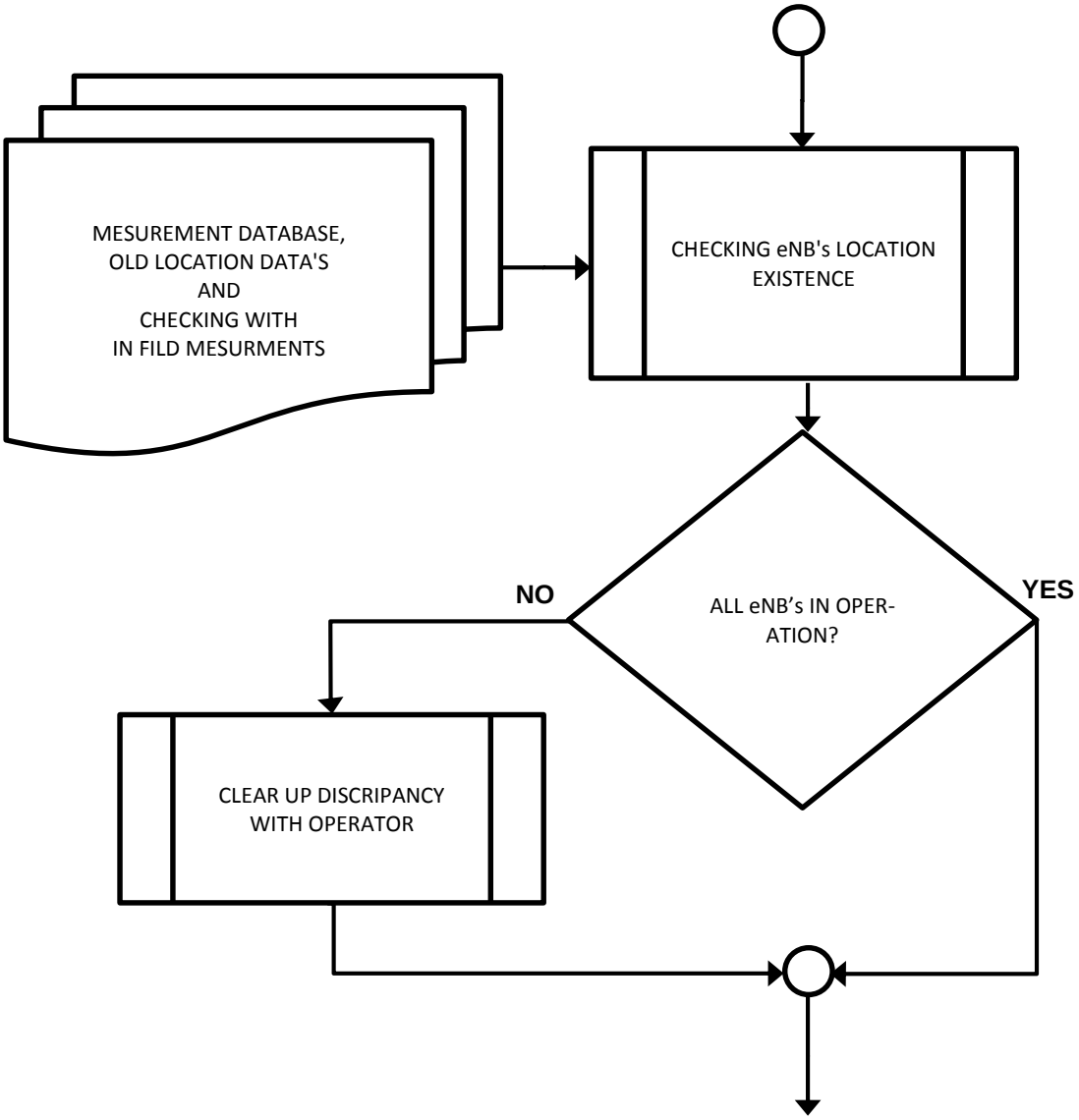
SUPERVISION AND
DECISION-MAKING ON
OFFENCE OF
Art.234 p. 43 ZEKom-1
CONTINUATION
WITH
EXISTING DATA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OLD LOCATION DATA'S
AND
CHECKING WITH
IN FILD MESURMENTS
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EXISTENCE
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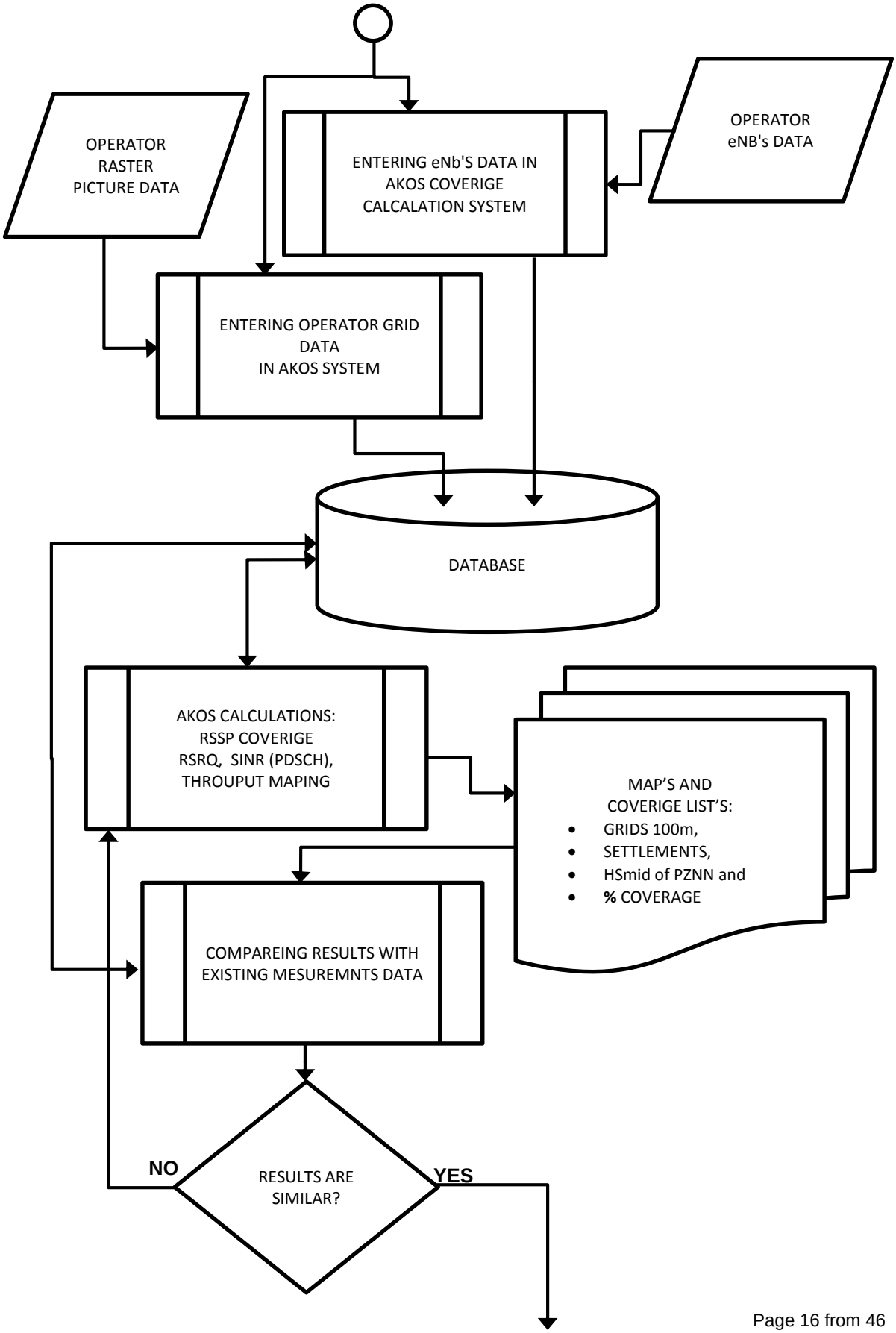
ATION?
NO
YES
CLEAR UP DISCRIPANCY
WITH OPERATOR


OPERATOR
RASTER
PICTURE DATA
ENTERING eNb'S DATA IN
AKOS COVERIGE
CALCALATION SYSTEM
OPERATOR
eNB's DATA
ENTERING OPERATOR GRID
DATA
IN AKOS SYSTEM
DATABASE
AKOS CALCULATIONS:
RSSP COVERIGE
RSRQ, SINR (PDSCH),
THROUPUT MAPING
MAP'S AND
COVERIGE LIST'S:
GRIDS 100m,
SETTLEMENTS,
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% COVERAGE
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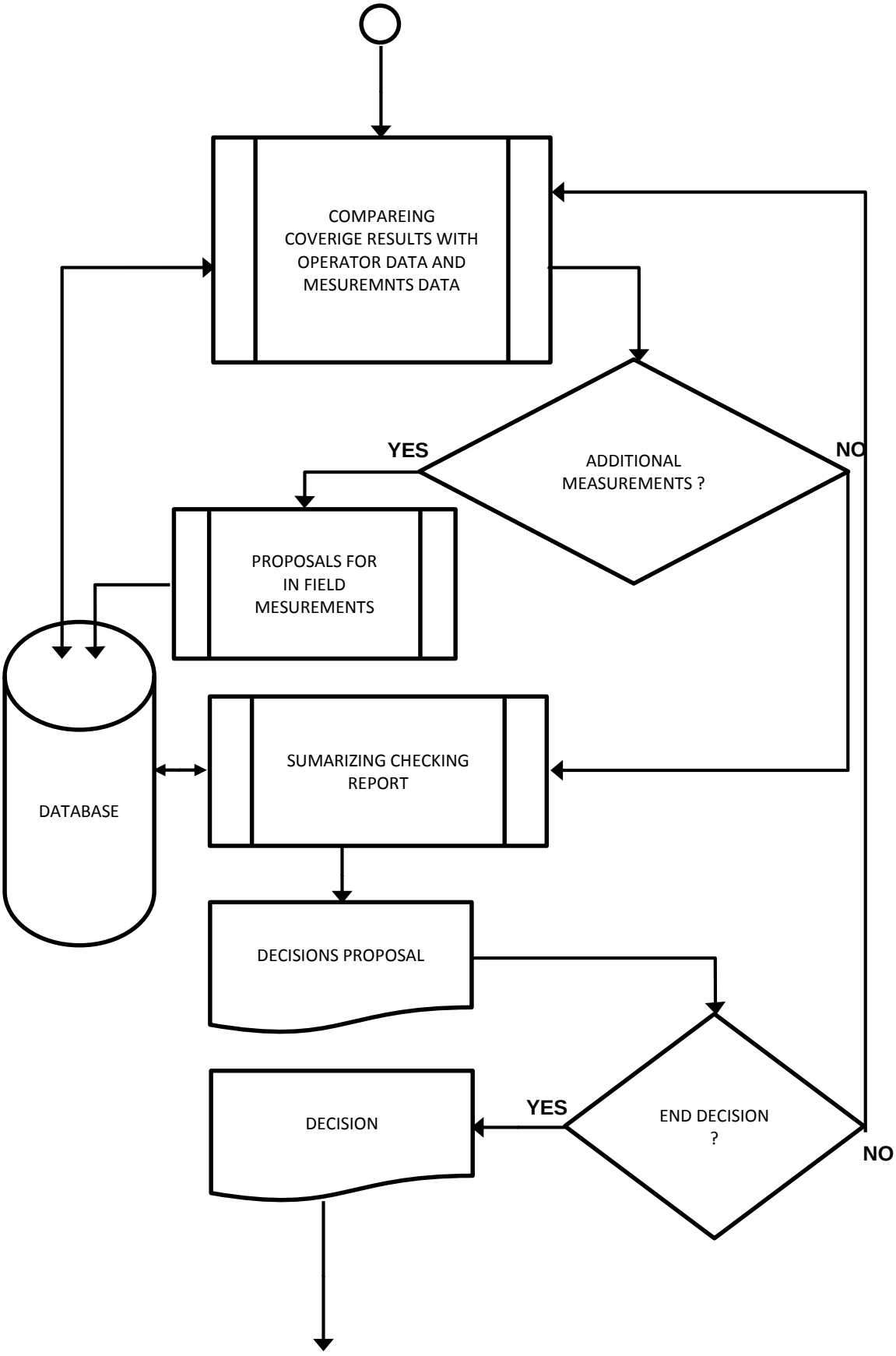
EXISTING MESUREMNTS DATA
RESULTS ARE
SIMILAR?
NO
YES


COMPAREING
COVERIGE RESULTS WITH
OPERATOR DATA AND
MESUREMNTS DATA
ADDITIONAL
MEASUREMENTS ?
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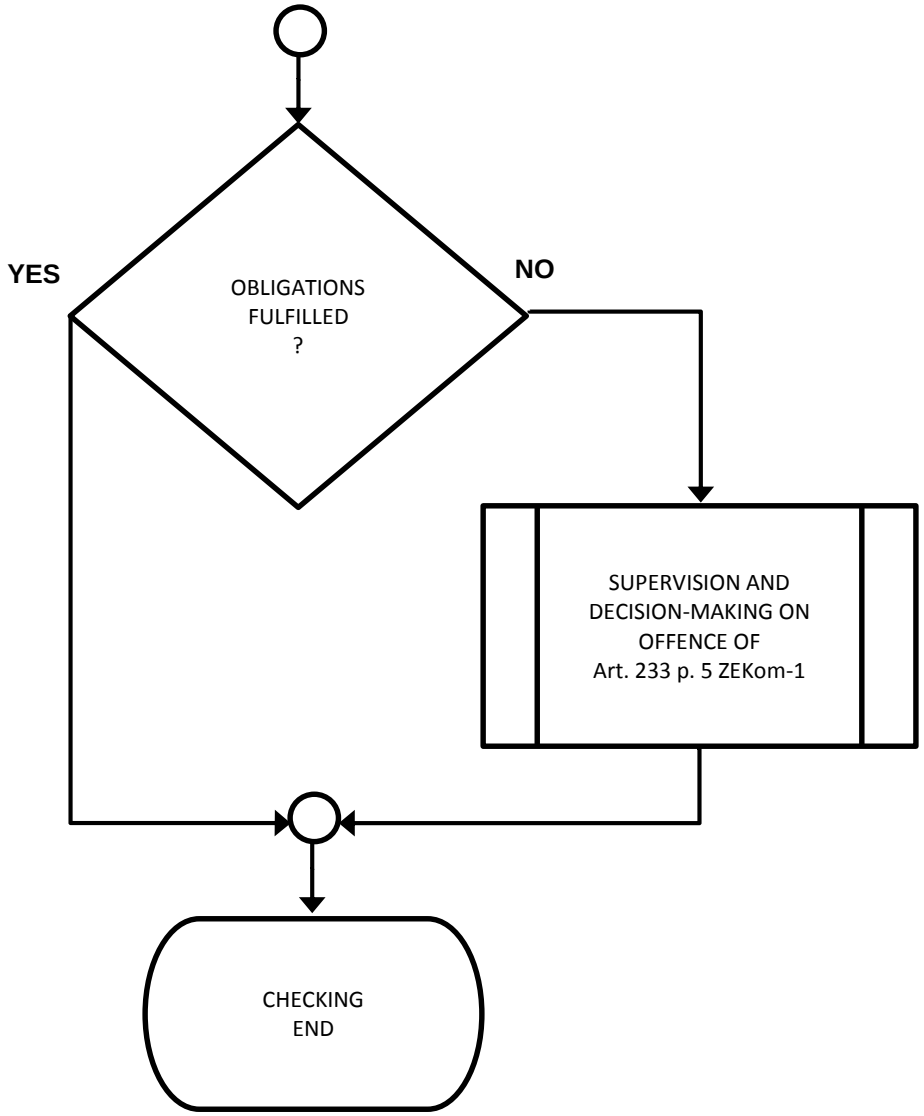
PROPOSALS FOR
IN FIELD
MESUREMENTS
DATABASE
SUMARIZING CHECKING
REPORT
DECISIONS PROPOSAL
END DECISION
?
YES
NO
DECISION


YES
OBLIGATIONS FULFILLED ?
NO
SUPERVISION AND DECISION-MAKING ON OFFENCE OF Art. 233 p. 5 ZEKom-1
CHECKING END

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 × 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 cell[7] 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 measurementsare 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 measurementsof 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.

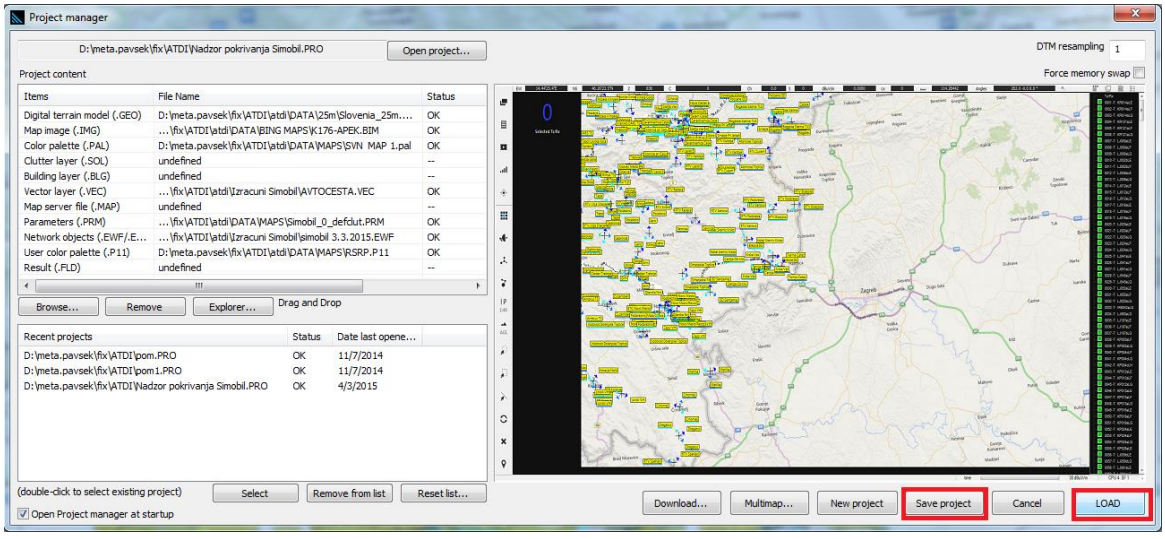
6. Guidelines on importing / using data and calculation (ICS Telecom)

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.

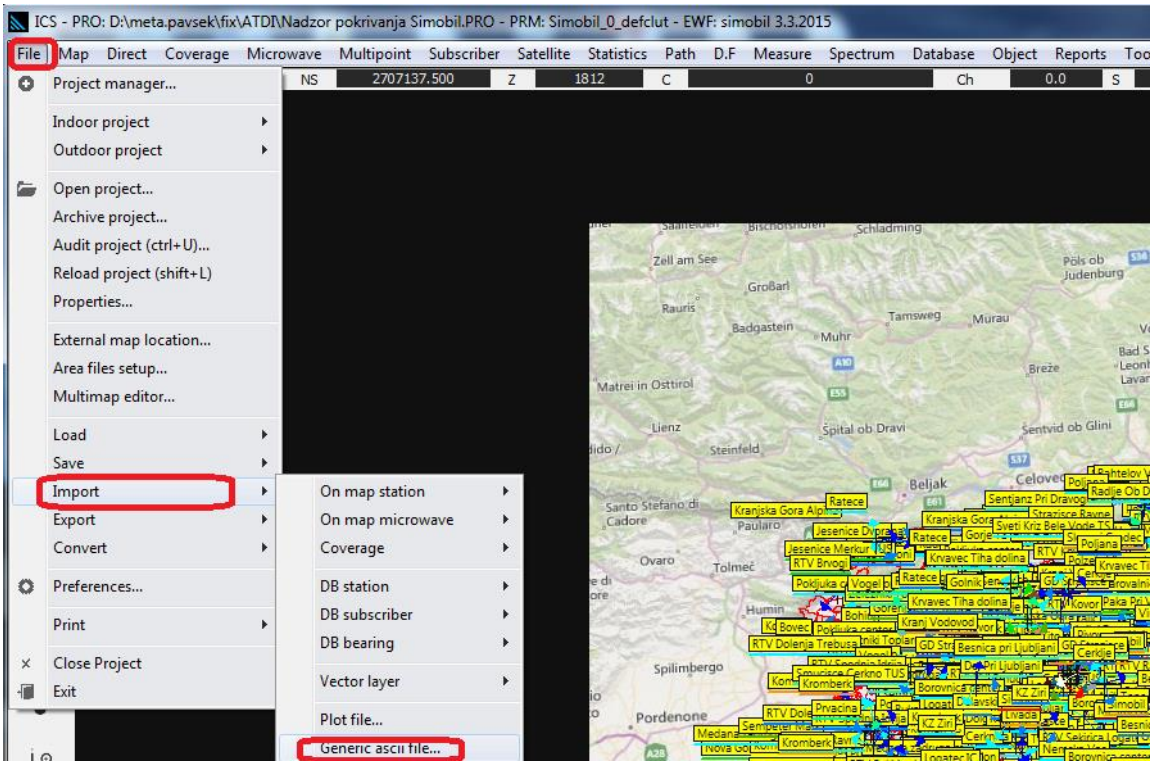
6.1. Launching ICS telecom

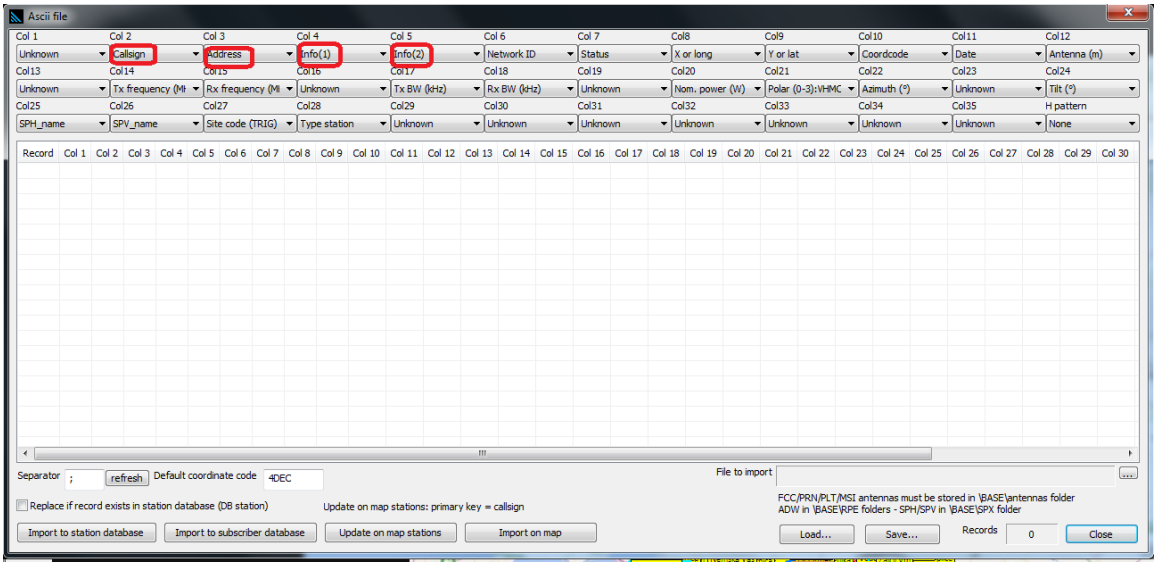
When we open the ICS telecom software we click on "File" and select "New project". After that, the "Project manager" window opens. This window allows easy handling of layers as well as whole projects. When we have "Project manager" window opened we have to provide all necessary content in "Project content" 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\MANUALS\ICS Telecom\BING MAPS K176-APEK.BIM file, for **3)** Colour palette 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 file, for **5)** Parameters we select S:\projekti\LTE\Spremljanje_nadzor\ATDI_izracun Simobil_0_defclut.PRM file, for **6)** Network objects 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.

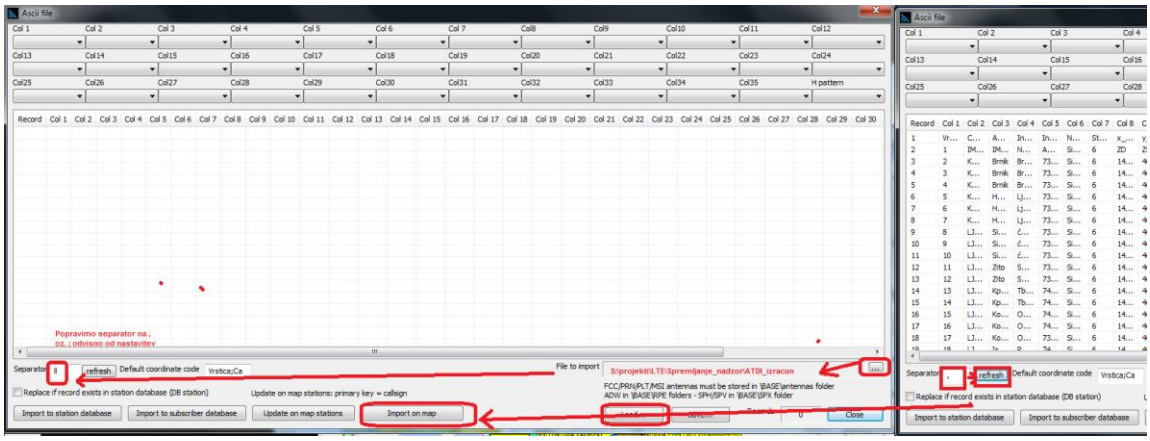


Data on base stations is saved in S:\projekti\LTE\Spremljanje_nadzor\ATDI_izracun_Vnos1.xlsx file. The inputs that are sent from the operators must be connected to this file and saved as CSV file. To import created CSV file we click on “File”, then move on “Import” and select “Generic ascii file…”. Please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

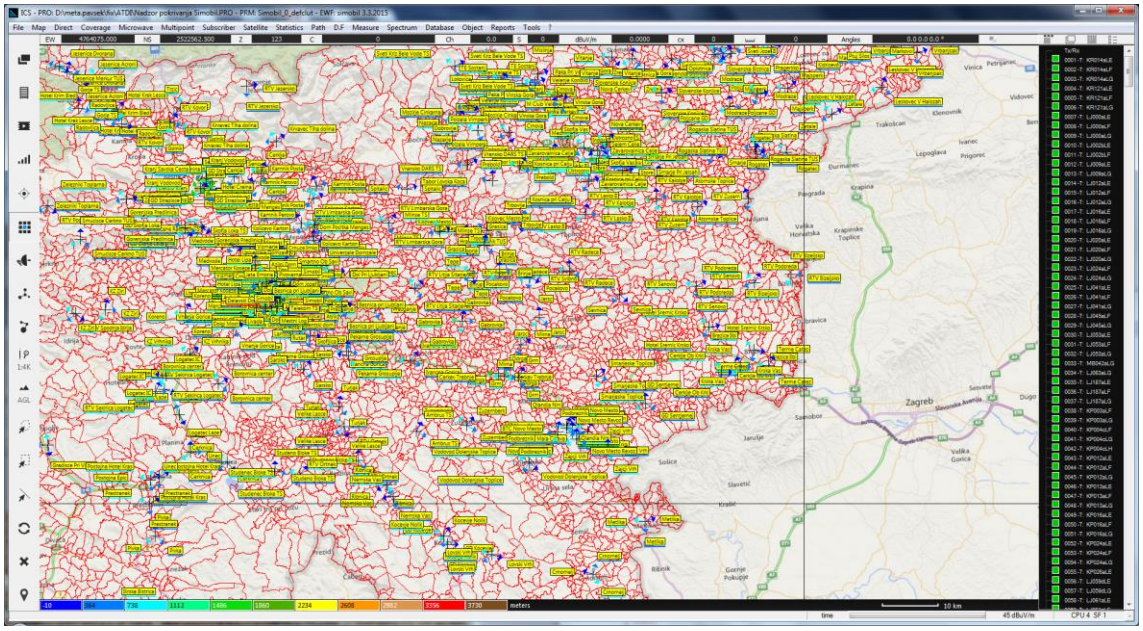




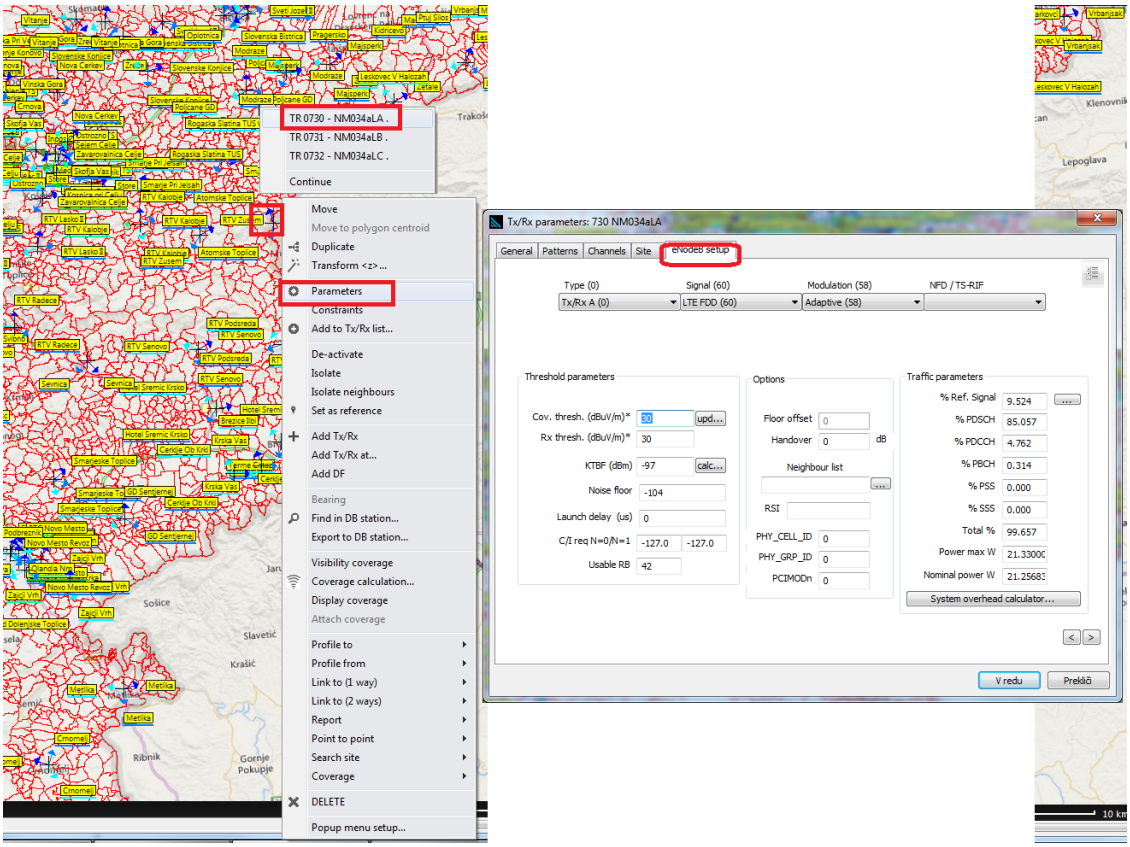
When we have CSV file imported we import the data to the map by clicking “Import on map”.



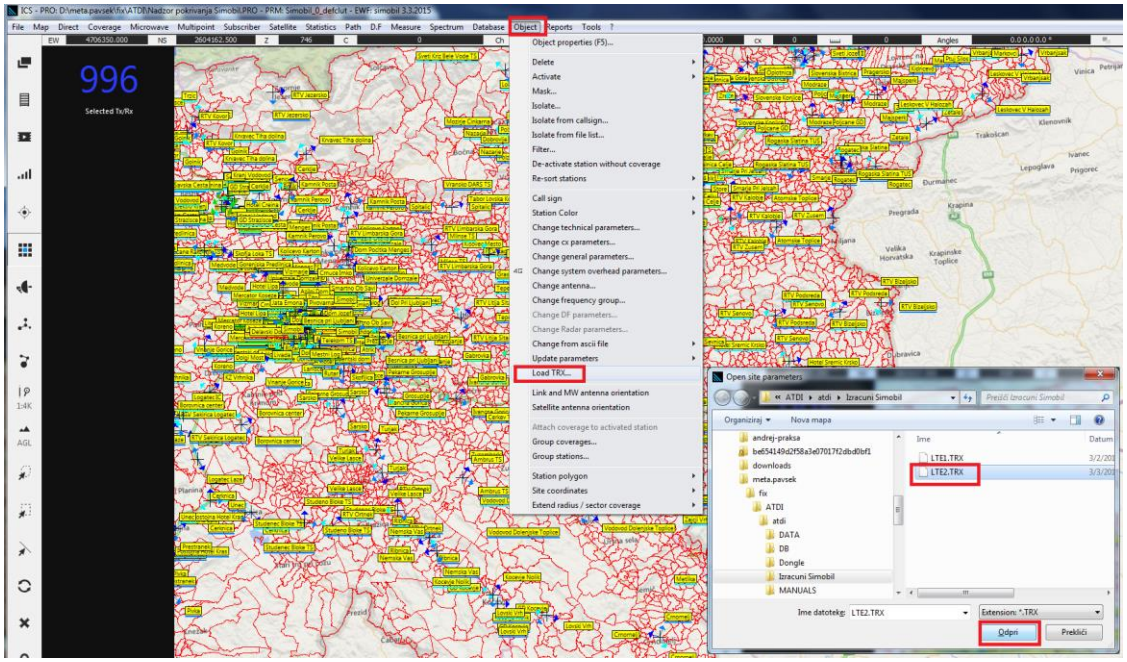
When all the data is imported to the map, we get the following view:



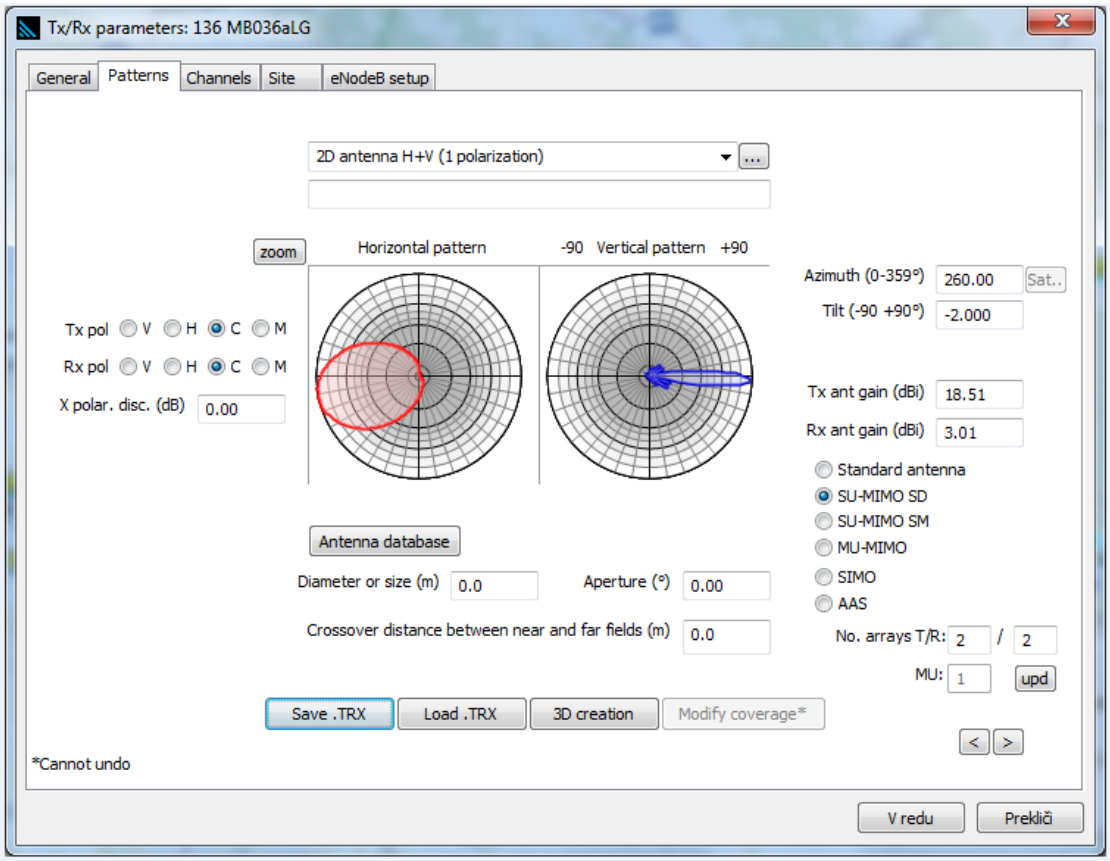
To check or to set parameters just click on wanted base station and select “Parameters”. When “Tx/Rx parameters” window opens we can see parameters in tabs “General”, “Patterns”, Channels”, “Site” and “eNodeB setup”.

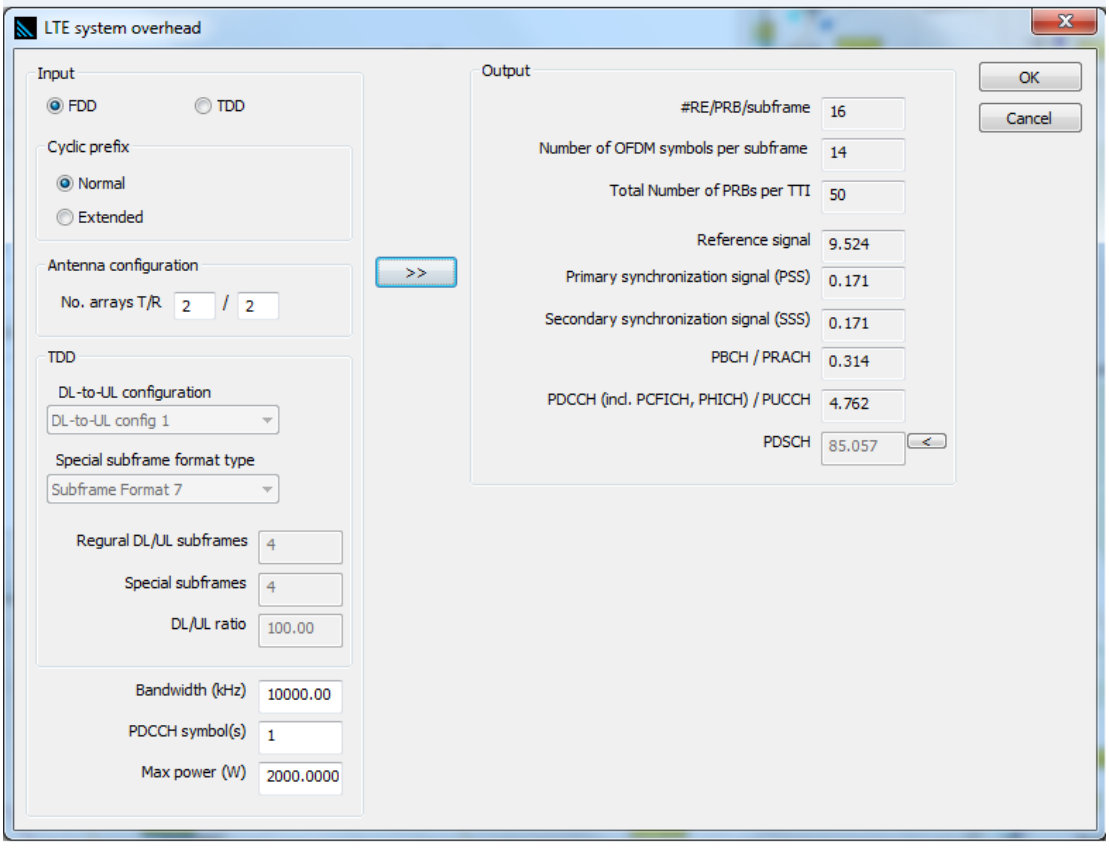


Raw data is still without LTE parameters for eNodeB and antennas. We load these parameters by selecting "Object" tab and click "Load TRX…". To load LTE parameters we select LTE.TRX.



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.

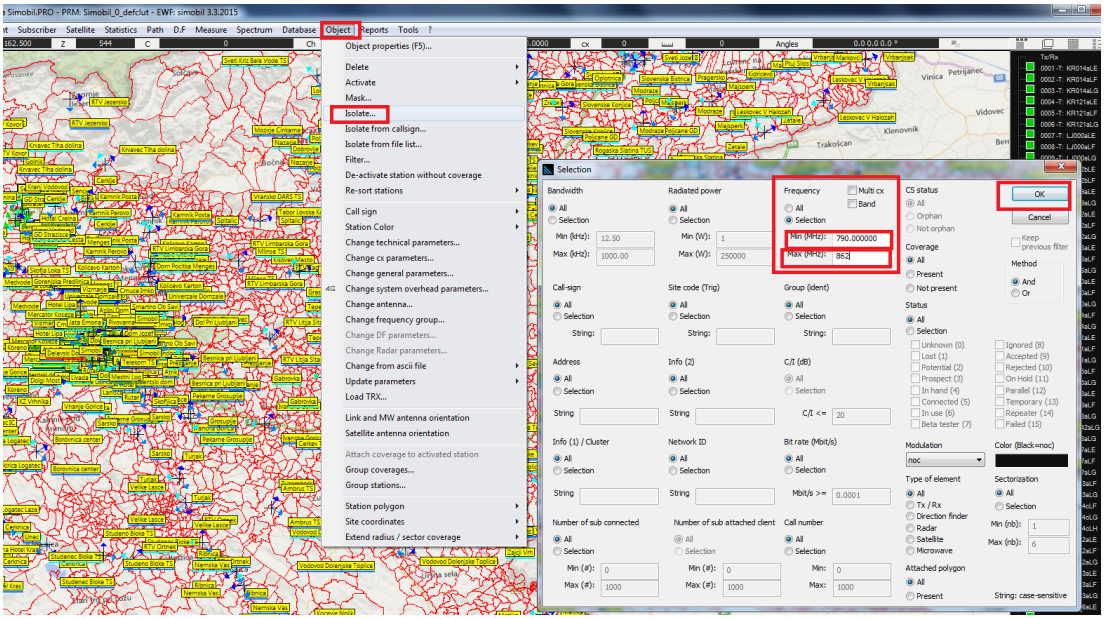

Tx/Rx parameters: 136 MB036aLG
General
Patterns
Channels
Site
eNodeB setup
2D antenna H+V (1 polarization)
zoom
Horizontal pattern
-90 Vertical pattern +90
Tx pol V H C M
Rx pol V H C M
X polar. disc. (dB) 0.00
Azimuth (0-359°) 260.00
Sat..
Tilt (-90 +90°) -2.000
Tx ant gain (dBi) 18.51
Rx ant gain (dBi) 3.01
Standard antenna
SU-MIMO SD
SU-MIMO SM
MU-MIMO
SIMO
AAS
No. arrays T/R: 2 / 2
MU: 1
upd
Antenna database
Diameter or size (m) 0.0
Aperture (°) 0.00
Crossover distance between near and far fields (m) 0.0
Save .TRX
Load .TRX
3D creation
Modify coverage*
*Cannot undo
V redu
Prekliči


LTE system overhead
Input
FDD
TDD
Cyclic prefix
Normal
Extended
Antenna configuration
No. arrays T/R 2 / 2
TDD
DL-to-UL configuration
DL-to-UL config 1
Special subframe format type
Subframe Format 7
Regural DL/UL subframes 4
Special subframes 4
DL/UL ratio 100.00
Bandwidth (kHz) 10000.00
PDCCH symbol(s) 1
Max power (W) 2000.0000
>>
Output
#RE/PRB/subframe 16
Number of OFDM symbols per subframe 14
Total Number of PRBs per TTI 50
Reference signal 9.524
Primary synchronization signal (PSS) 0.171
Secondary synchronization signal (SSS) 0.171
PBCH / PRACH 0.314
PDCCH (incl. PCFICH, PHICH) / PUCCH 4.762
PDSCH 85.057
OK
Cancel

6.2. Calculation

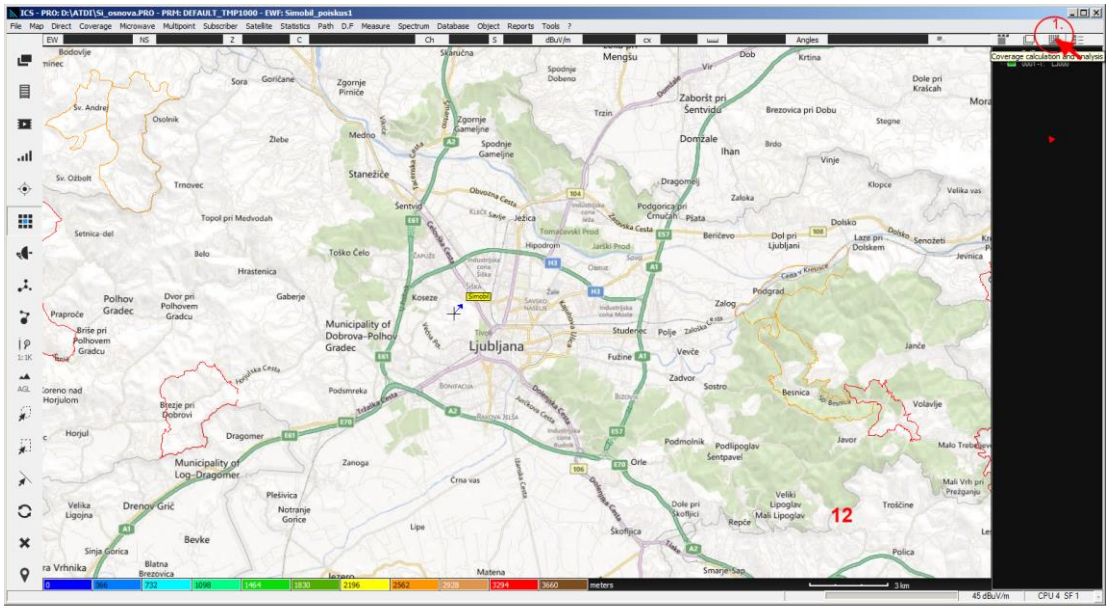
After we have selected all necessary inputs we can start with calculation.

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).

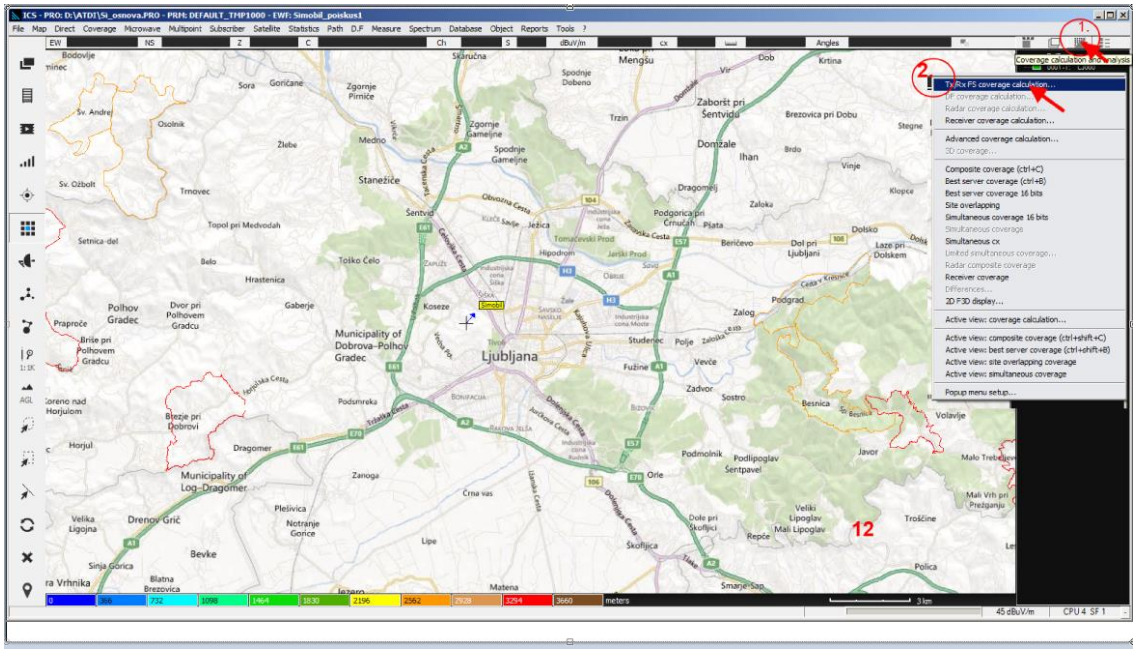


The process of calculation is presented in following steps:

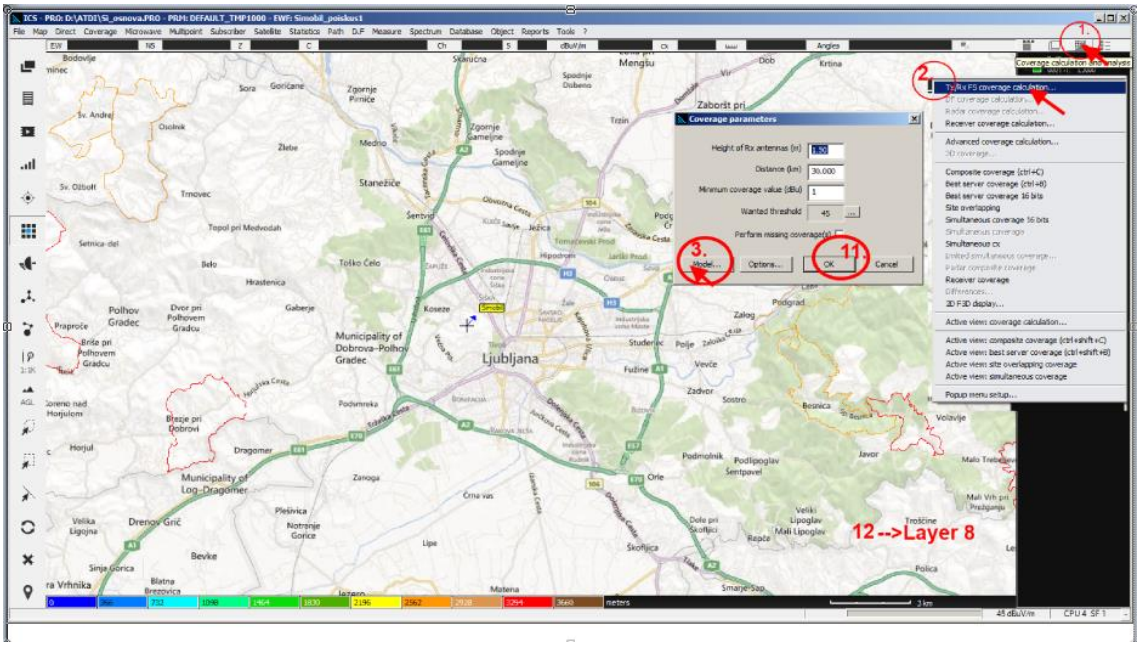
1. Select »Coverage calculation and analysis« tab:



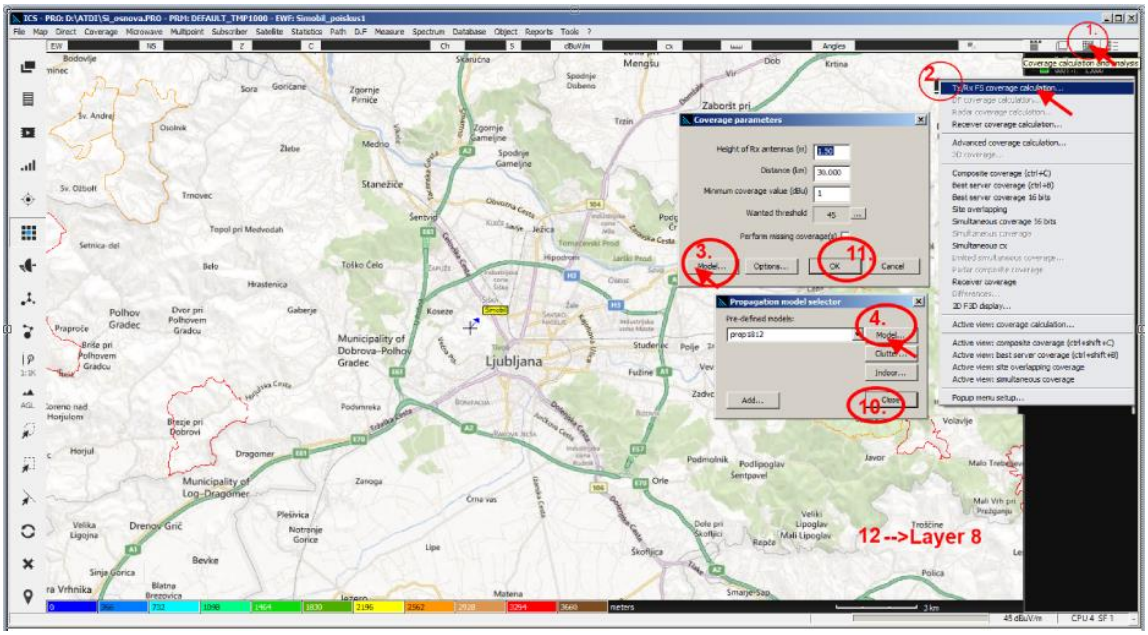
2. Select »Tx/Rx FS coverage calculation…« when drop down menu shows.



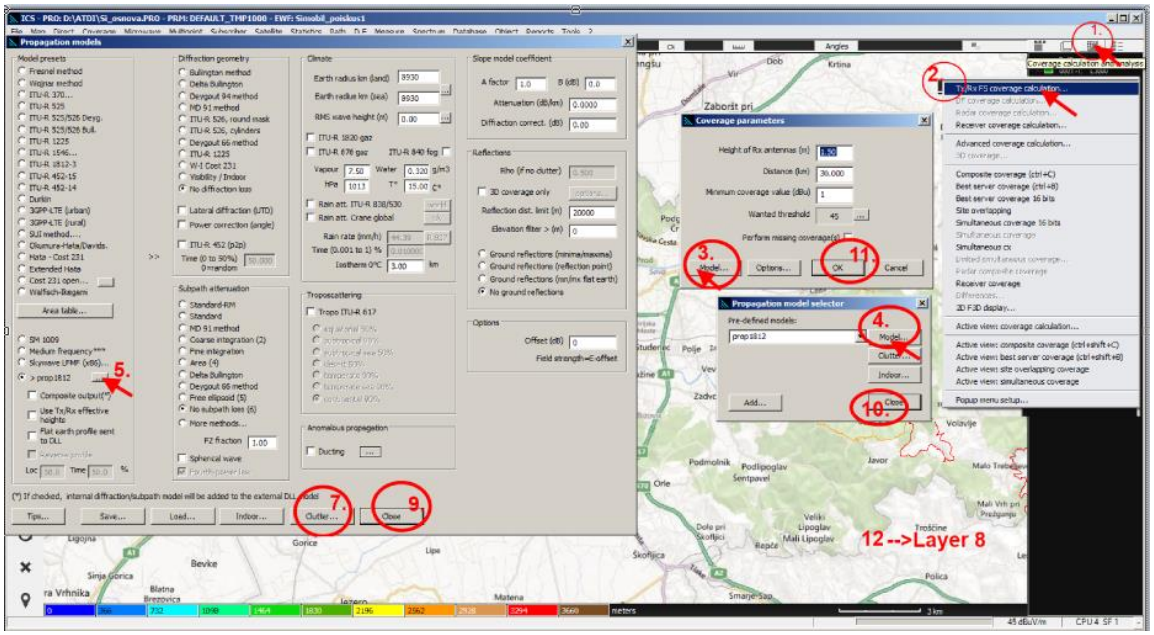
3. »Coverage parameters« window will open. Set parameters (e.g. 1.50 for Height of Rx antennas, 30.000 for Distance, etc.) and select »Model…« button.



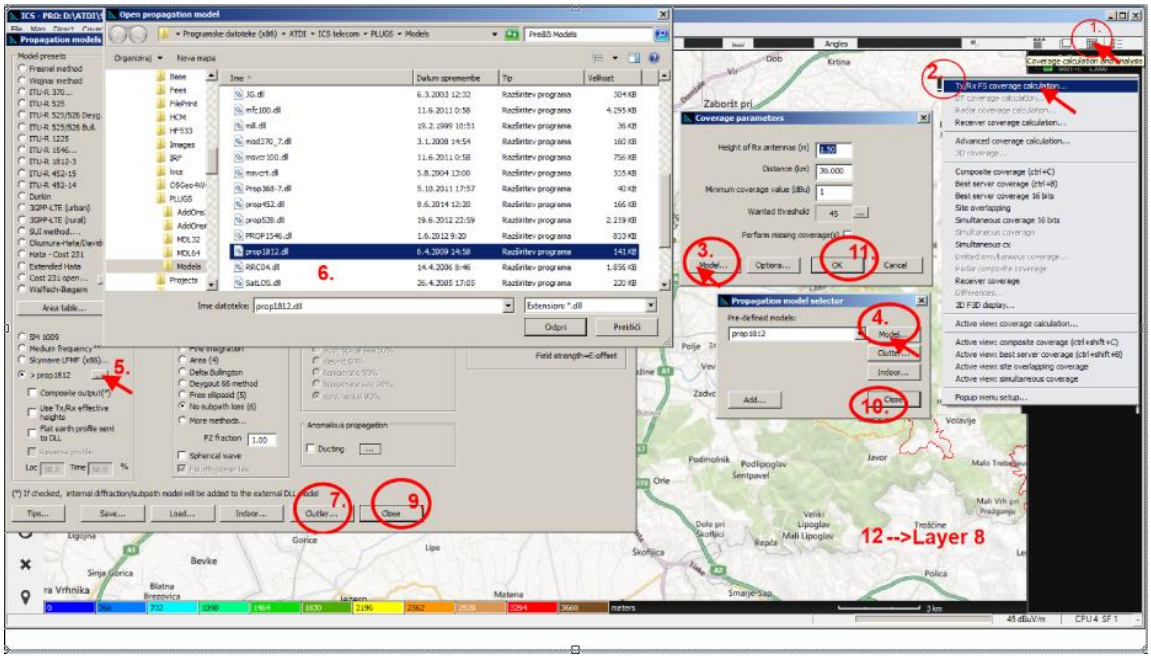
4. After selecting »Model…« button the »Propagation model selector« window will open. Once again select »Model…« button, this time in last opened window.



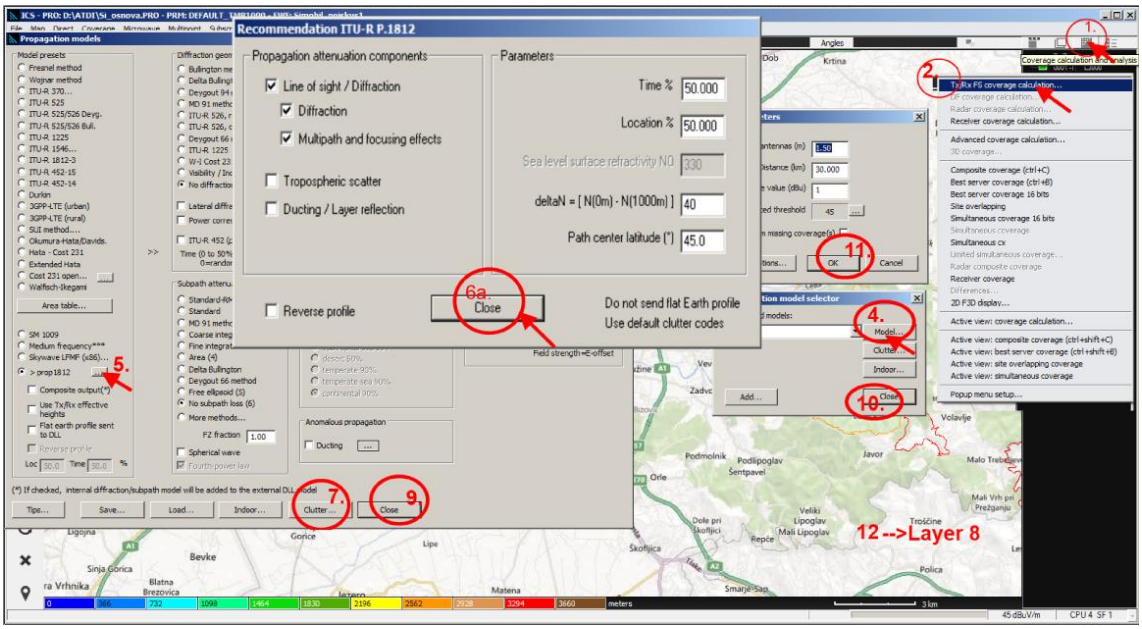
5. »Propagation models« window will open. To select propagation model we have to click on one out of three »…« buttons (see picture below).



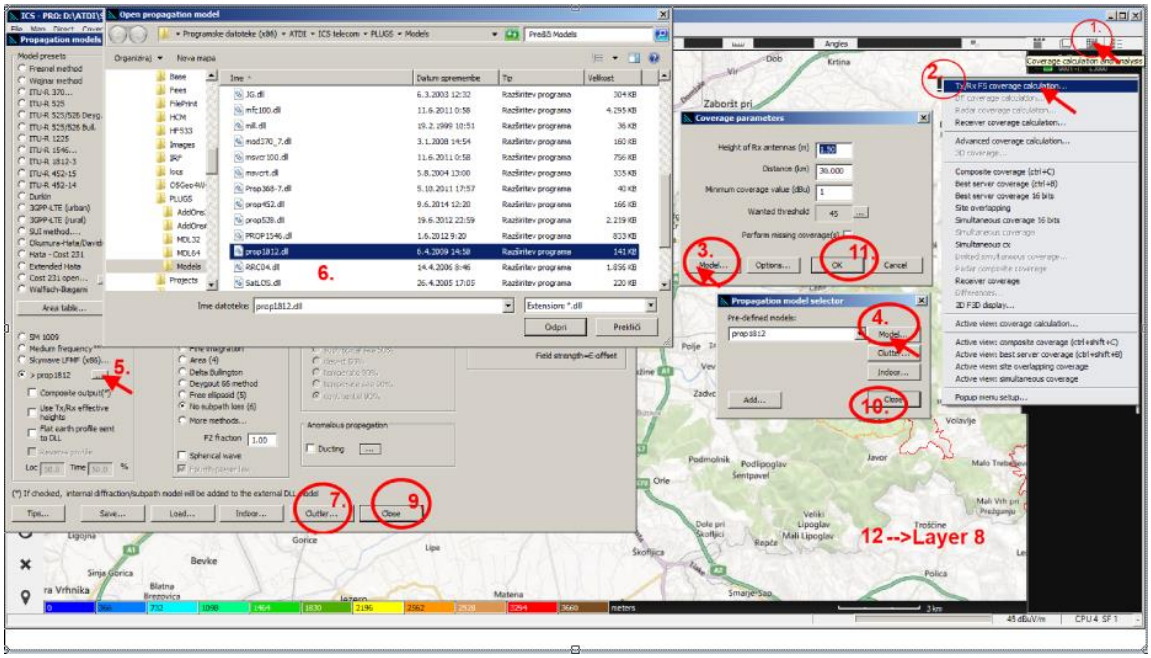
6. After selecting »…« button »Open propagation model« window will open. We select »prop1812.dll« file and click »Open« button.



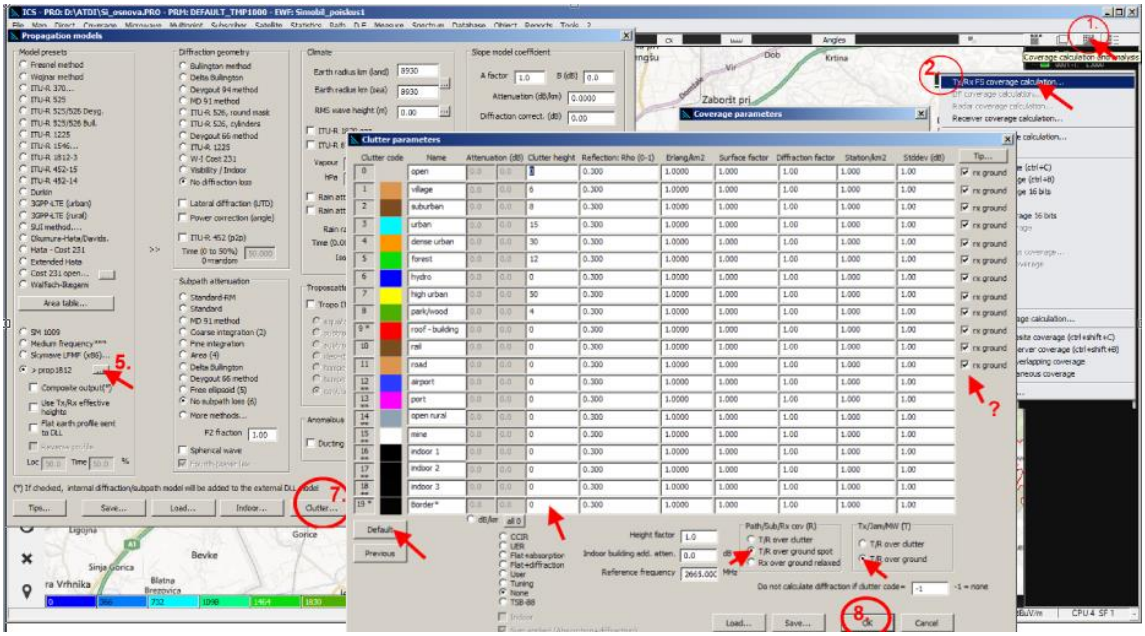
6a The »Recommendation ITU-R P.1812« window will appear. Check needed components and set parameters. When this is done close the window by clicking on »Close« button.



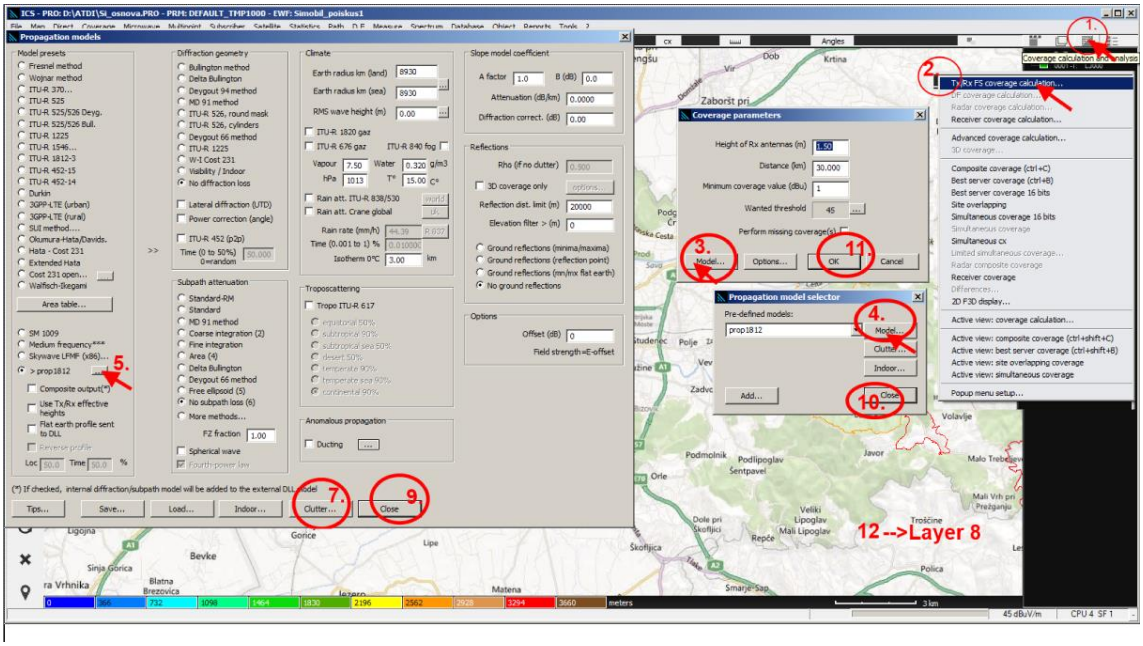
7. After selecting the propagation model click on »Clutter…« button do define clutter parameters.



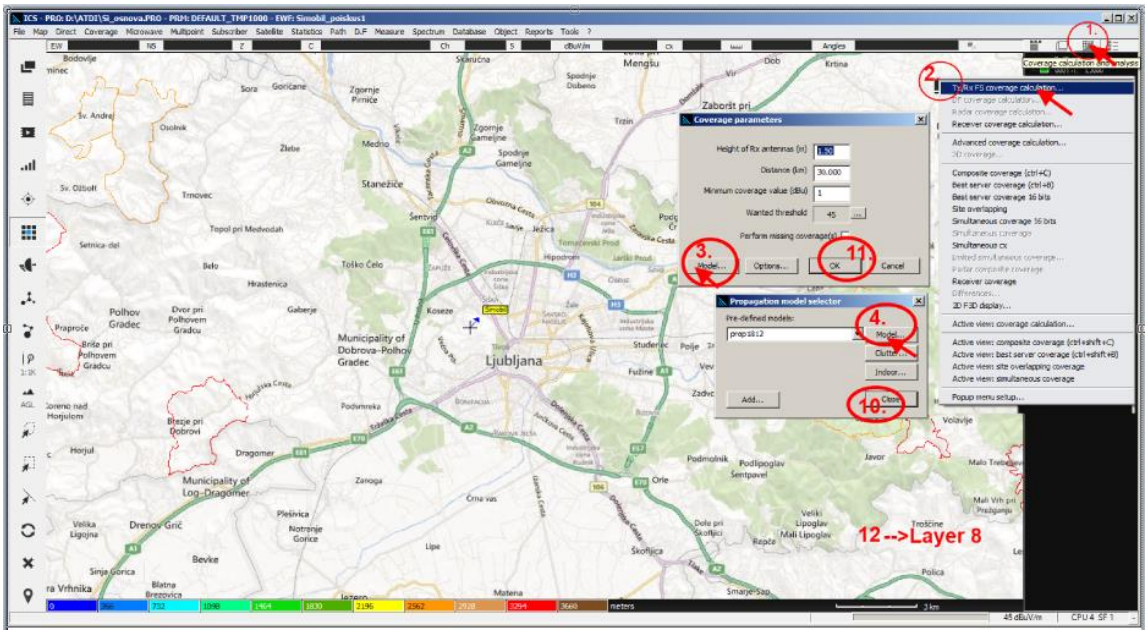
8. »Clutter parameters« window will open. Here we can select needed parameters and confirm them by clicking on »OK« button.



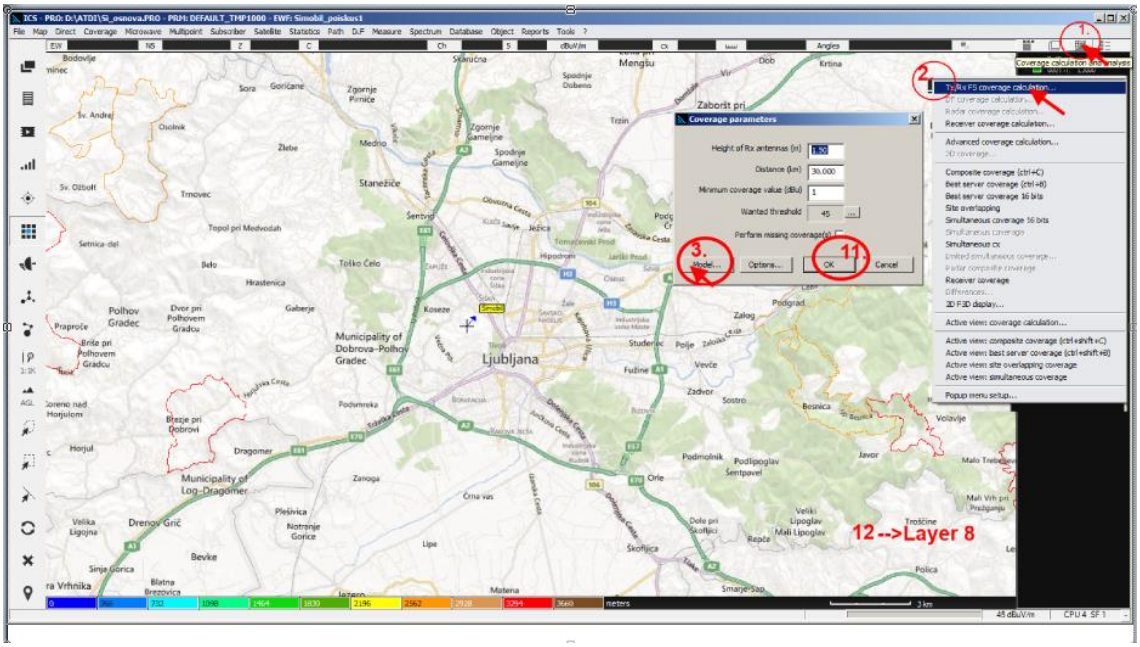
9. After we define propagation model we close the »Propagation models« window by clicking on »Close« button…



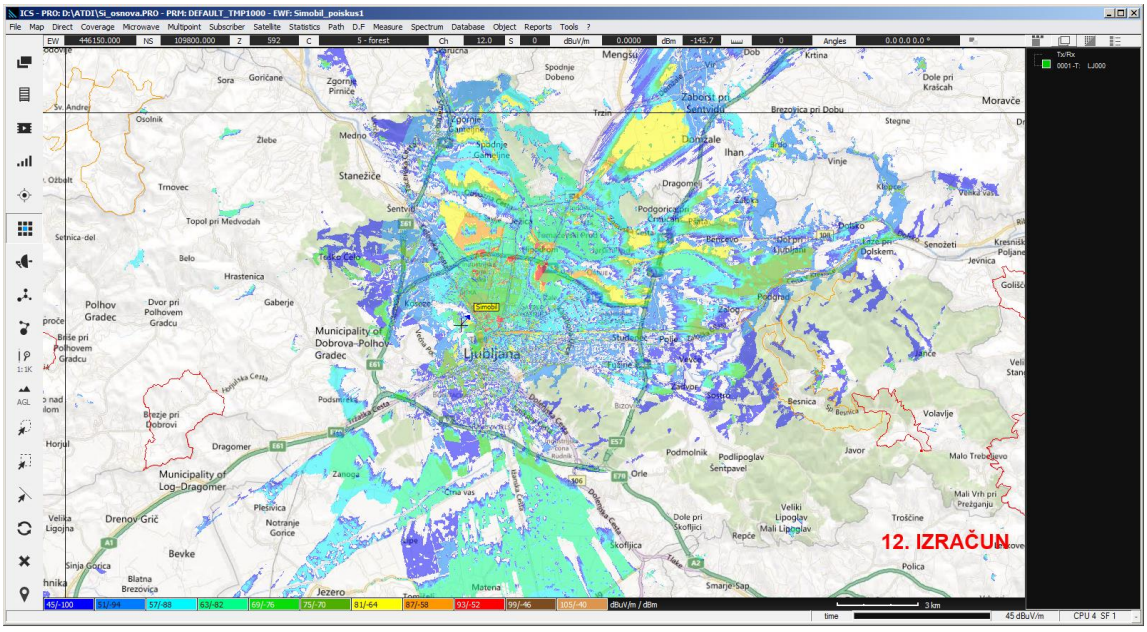
10. …we close the »Propagation model selector« window by clicking on »Close« button…



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.



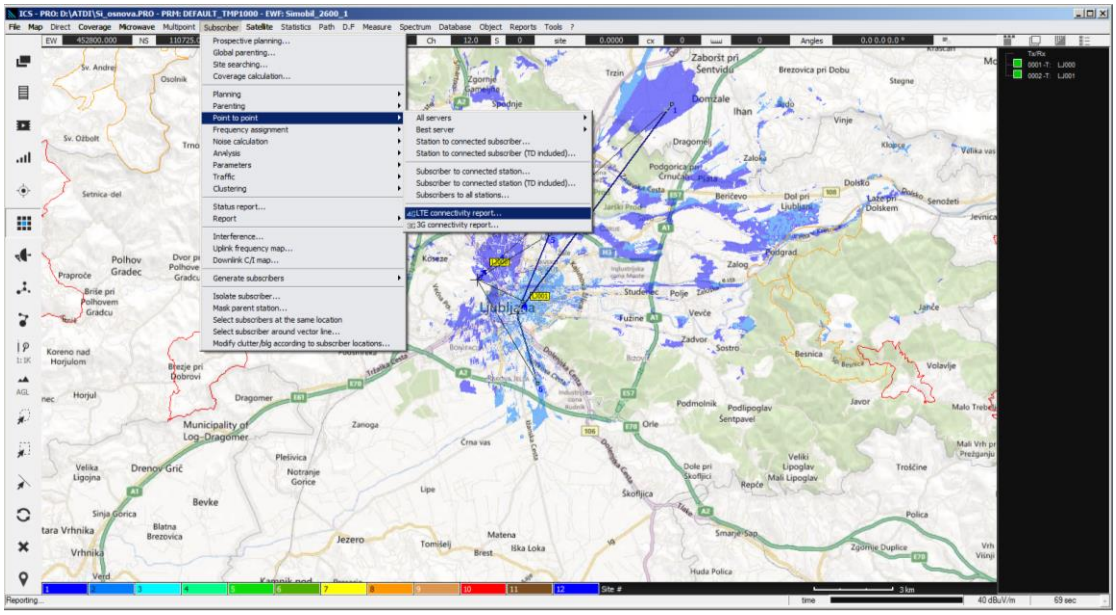
The results has to be saved in the network file (File>>Save>>Save network file(*.EWF)).

6.3. FWBA point to point connectivity report

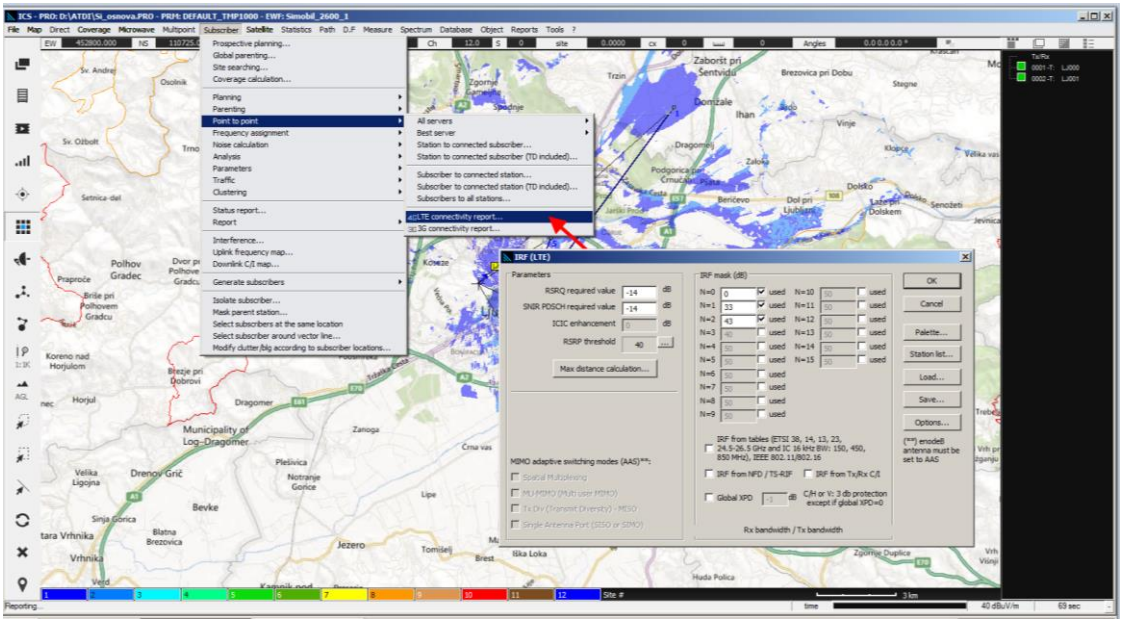
In this chapter are presented steps on how to create the FWBA point to point connectivity report. From the report can be seen all the corresponding parameters (RSRP, RSSI, RSRQ, SINR (PDSCH)) of each individual connection.

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

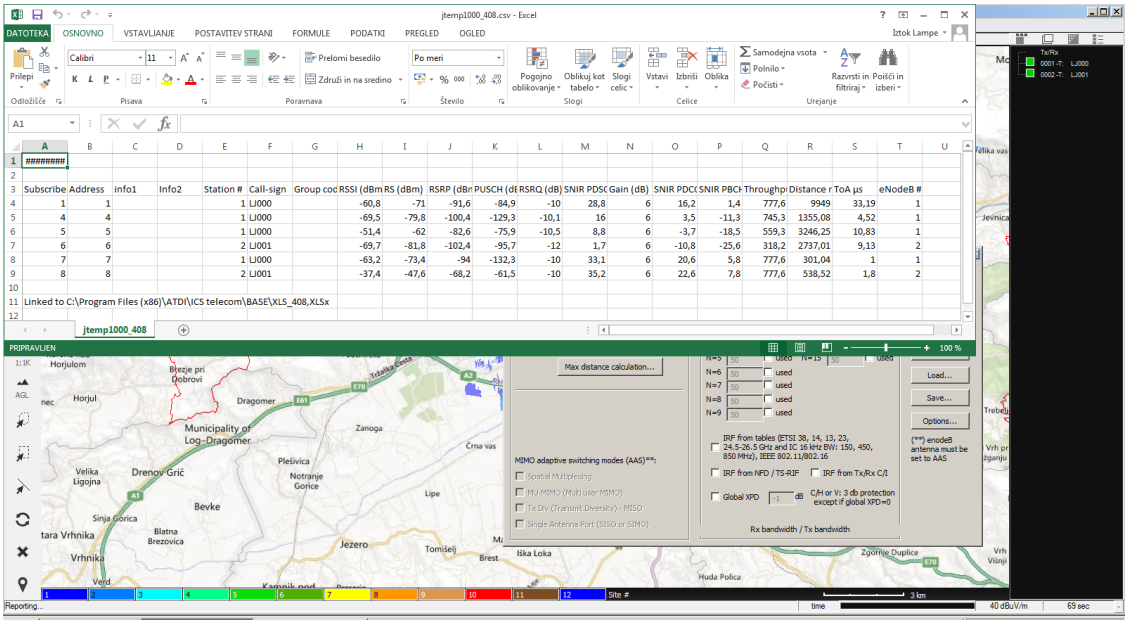
1. Click on »Subscriber« tab, select »Point to point« option in drop down menu and then select »4G LTE connectivity report…« option.



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	↓	NO	↑
Limited to one operator	YES	↓	NO	↑
Costs of services	YES	↓	NO	↑
QoS	YES	↑	Partially	↙
Network connection	YES	→	Partially	↙
Coverage	Partially	↙	YES	↑
Accuracy	Low	↓	High	↑
Speed	Low	↓	High	↑
Price	Low	↑	High	↓

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:

$$Throughput, Thr, bps/Hz = \begin{cases} Thr = 0 & \text{for } SNIR < SNIR_{MIN} \\ Thr = \alpha.S(SNIR) & \text{for } SNIR_{min} < SNIR < SNIR_{MAX} \\ Thr = Thr_{MAX} & \text{for } SNIR > SNIR_{MAX} \end{cases}$$

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(SNIR)
S(SNIR) = log2(1+SNIR) bps/Hz
α_{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:

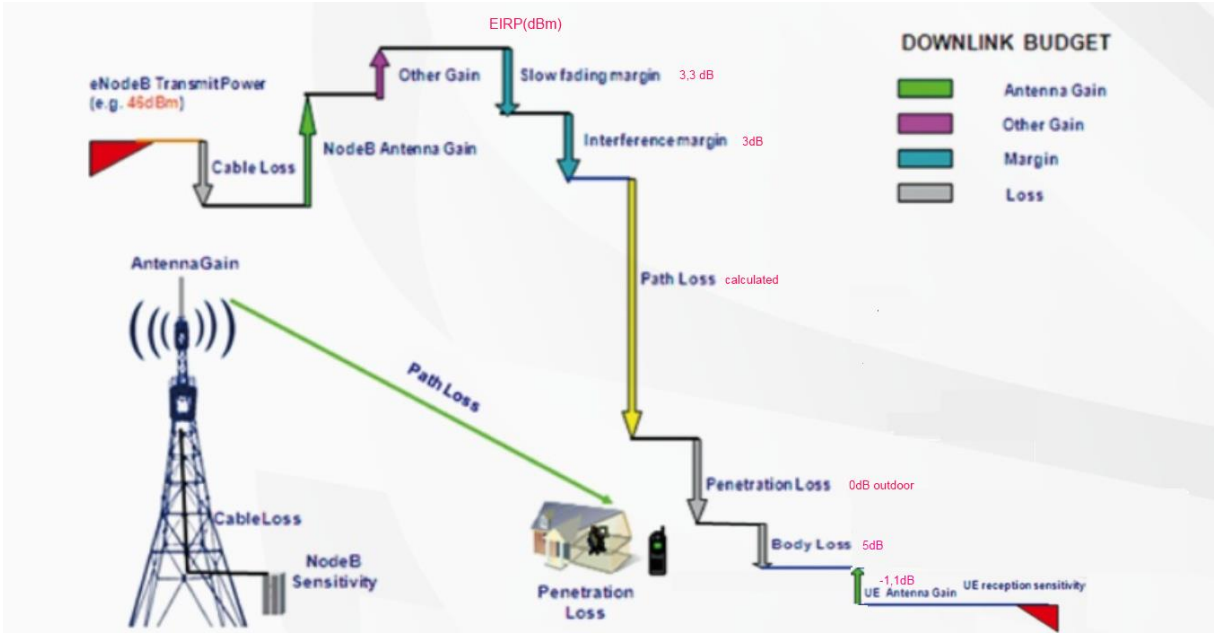


Figure 1: Link budged parameters

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

Table 9: Link budged parameters

Noise figure	dB	10
Thermal noise KT	dBm/Hz	-174
KTB (15kHz)	dBm	-132,2
KTBF	dBm	-122,2
reqSNR (10Mbps)	dB	6,9
Interference margin	dB	3
fade margin	dB	3,3
Body loss	dB	5
Rxgain	dB	-1,1
reqRSRP(10Mbps)	**dBm**	**-102,9**

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

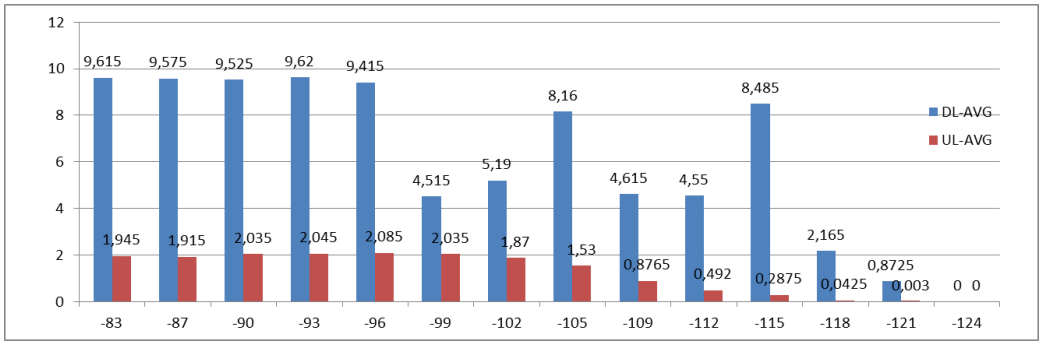


Figure 2: Speed tester measurements on location Jeruzalem – for FWBA access (“Fritzbox”)

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:

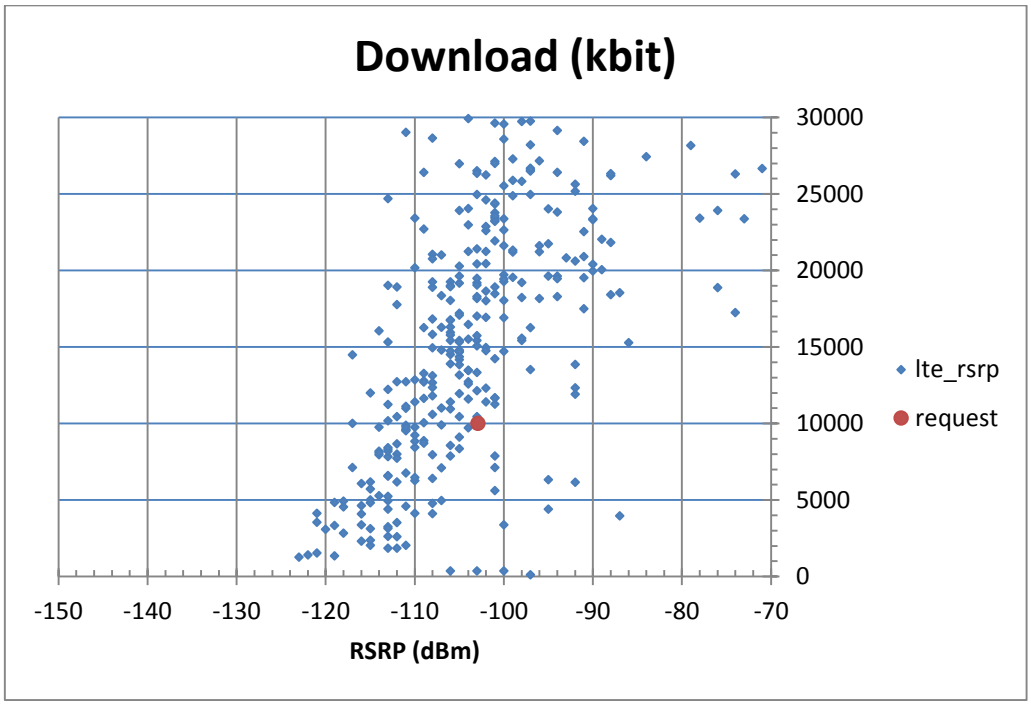


Figure 3: 433 measurements performed with AKOS UE in Netztest

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.

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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.