Tool Development for Analysis of WCDMA Radio Measurements and Investigation of EcNo and RSCP values before Drop Call

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Abstract: In this work, a tool was developed for the post processing analysis of the drive test measurement files. This tool collects all the necessary information from measurement files and organizes this information to a data base. The tool plots of the Received Signal Code Power (RSCP) measurements on the map along the route of the car, using a color code. The RSCP measurement can be either the RSCP of the best server or the RSCP of a certain Cell. Moreover, a very important plot is also available, the plot which shows where are the interference measurement samples on the map. Finally, an investigation of the EcNo and RSCP values exactly before drop call was done using a large list of measurement files, in order to optimise operator's parameters of the handover algorithm.

Keywords: WCDMA, CPICH, RSCP, EcNo, RSSI, Soft Handover.

1 Introduction

The air interface that is used in Europe and especially in Greece, for third Generation cellular system is Wideband Code Division Multiple Access (WCDMA) [1].

Operating a cellular network is an iterative quality cycle process. In this cycle, the network performance data is gathered from network management systems (NMSs), drive tests, protocol analyzers, and customer complains [2]. A part of the NMSs is the data warehouses which is a database where are stored all the data concerning traffic and performance of the network (i.e., drop calls, Handover causes, etc) during all day. One can find there historical data since the lunching of the network. Moreover, this data are presented per cell, or per base station, or per Radio Network Controller (RNC), or per Mobile Switching Center (MSC) basis.

In this work, the main target was to develop a post processing tool for analysis of third Generation (3G) cellular radio measurements. The measurements are produced from drive tests that an operator performs (measurement campaigns), regularly or not, in order to find areas with poor coverage, or other quality problems. The next step of the optimisation procedure is to analyze those measurements and find why the quality problem occurred at that particular location. Finally, possible solutions are examined in order to resolve the quality problem. Thus, measurement analysis is very important for the optimisation of WCDMA radio networks. Our laboratory is involved in the procedure of the development of a post processing tool in order to have a deeper knowledge regarding the optimisation of a WCDMA Radio Network. In the framework of cooperation between research groups from Universities with the counterparts of industry that is emboldened from the European Union, this research project was born. The WCDMA measurement files, used in this work, was provided by Cosmote, where Cosmote is a Greek cellular network operator.

In the literature there are papers that they use WCDMA measurements either for computation of Mobile Station (MS) velocity [3, and the references in it] or for other reasons i.e., for the verification of Soft Handover Algorithm [4].

The rest of the paper is organized as follows. Section 2 illustrates the tool development, i.e., which information is collected from measurement files and how is organized. Section 3 shows the main results, namely, plots on the map showing the Common Pilot Channel Received Signal Code Power (CPICH_RSCP) measurement [5] - [10] along the route of the car using a color code, either for the best server or for a specific Scrambling Code (SC). Section 4 shows where measurement points, which are corrupted with interference, are located in the map. Section 5 an investigation of the EcNo and RSCP values exactly before drop call was done using a large list of measurement files, in order to optimise operator's parameters of the handover algorithm. Finally Section 6 shows the conclusion and the future work.

2 Tool Development

The software that was developed from our group reads the data from the measurement file(s) which is the input, and creates a database as an output. This database has all information needed for our post processing analysis. Especially, the program reads from the measurement file, the time that the measurement was taken and the exact position, namely, longitude and latitude, which are provided from the Global Positioning System (GPS) which is connected to the measurement tool during the measurement procedure. It is important to stress here those measurements without position information is practically useless from the optimisation point of view. Moreover, the program reads the RSSI measurement, the radio channel used, the Scrambling Codes (SCs) and the corresponding CPICH_EcNo (which for simplicity is also called EcNo) values received from the mobile station which was connected to the measurement tool during the measurement procedure [1], [5] – [10]. Those values, EcNo and SCs, are provided for all cells; serving, monitor and detected set. Monitor set, is the set of cells (with the corresponding SCs) which are included in the cell info of the serving cell and not included in the active set, while detected set is the set of cells which are neither included in the cell info, nor in the active set, but are detected by the mobile station.

Also the number of the active set is provided. The active set number denotes how many sectors are serving at the same time. i.e., if that number is greater than one, we have a soft handover. All the above information is stored in various tables of the database and with the use of the proper queries we can extract the information needed for the post-processing analysis. Then the database file is associated with a software program able to plot graphs.

3 Results

The graphical results provide information about the receiving signal level in the mobile station as well as the exact location where each measurement was taken. Moreover, interference problems, if any, are shown. The first plot, Fig. 1 displays the route that the car did during the measurements. This graph can be plotted on the specific map of the measuring area. In order to add some more information we introduce the second graph, Fig. 2 which shows the same route that was depicted in Fig. 1, but here , a color code has been used. Thus, across the route on the map, the line which shows the route has a specific color for each measurement point. The color depends on the receiving level of the signal, i.e., Common Pilot Channel Received Signal Code Power (CPICH_RSCP) measurement of the best server as received from the mobile station. The term 'best server' is used because the servers can be more than one- soft handover case. In that case, the best server is used for the plot.

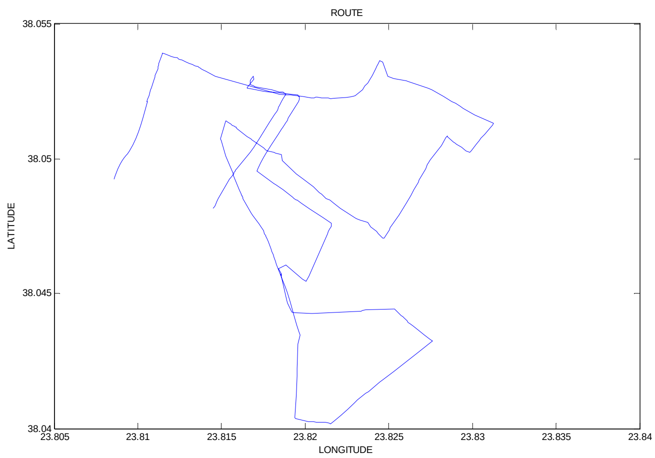

Fig. 1 displays the route that the car did during the measurements.

This measurement indicates the signal level from a specific cell. The mobile station reports to the Radio Network Controller (RNC) all CPICH_RSCP values and the corresponding scrambling codes from the monitoring and detected set of cells and the RNC can 'see' the strongest and how strong are the neighboring cells. The value of the CPICH_RSCP can be easily calculated from Received Signal Strength Indicator (RSSI) and the CPICH_EcNo value using the following formula:

$$CPICH\_RSCP = RSSI + CPICH\_EcNo \quad (1)$$

where CPICH_RSCP and RSSI are in dBm, while CPICH_EcNo is in dB. RSSI is the received wideband power in downlink. This index shows how strong the wideband (5MHz) channel is. Ec/No is the received chip energy relative to the total power spectral density. The CPICH_EcNo is actually the Ec/No of the Common Pilot Channel (CPICH). CPICH_EcNo is the most important measurement in WCDMA from the radio planning point of view, because is the main coverage indicator and has great accuracy due to the fact that this measurement is done in baseband after demodulation. This measurement shows how strong the code power is relatively with the power of the wideband channel RSSI.

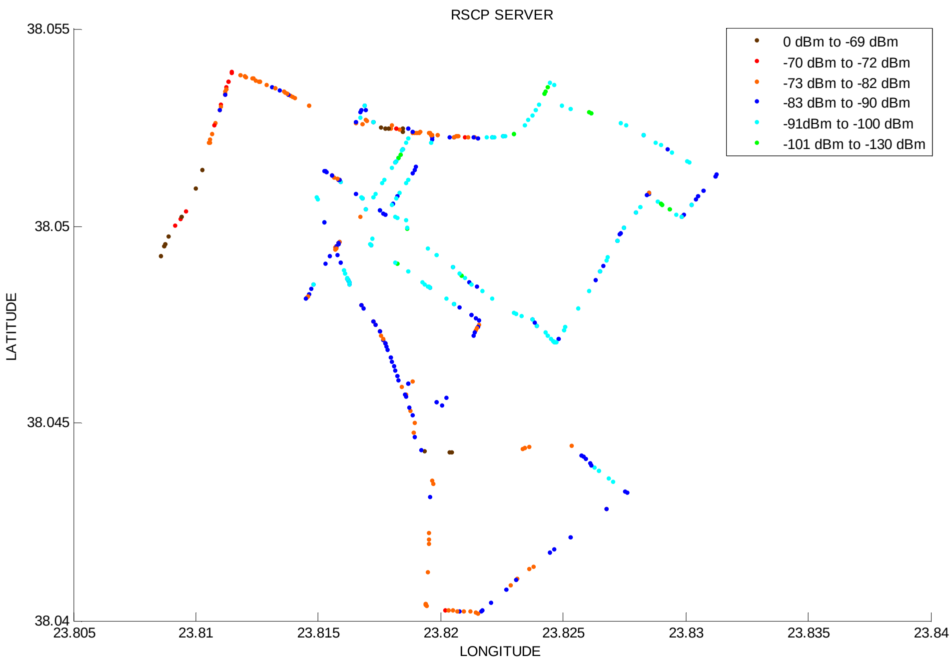

Fig. 2 displays the route that the car did during the measurements and the CPICH_RSCP of the best server using a color code.

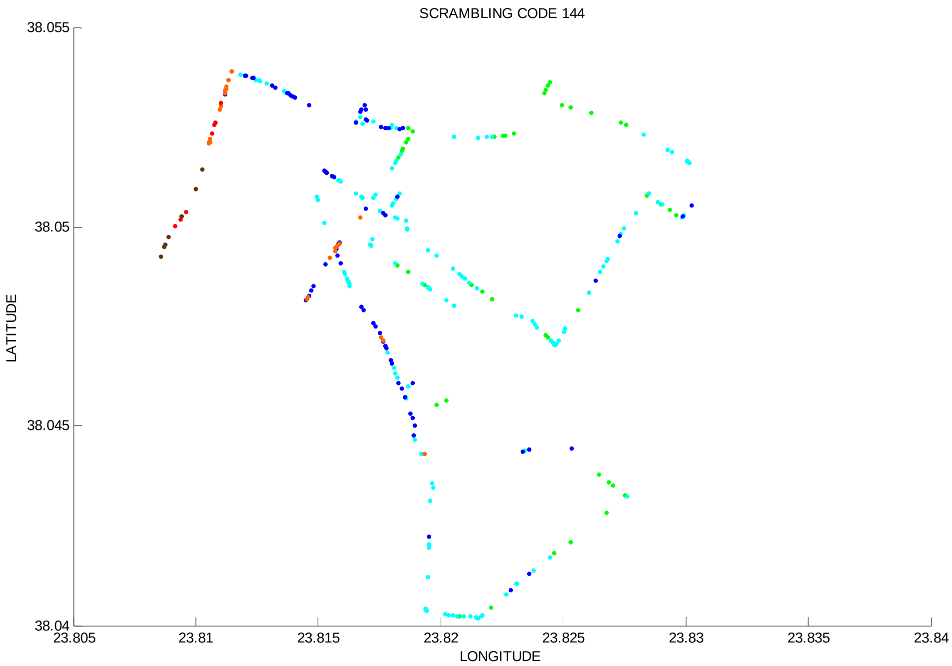

Fig. 3 Shows the coverage of Cell that uses the SC=144 along the route of the car.

In Fig. 3 is plotted the same route as in Fig. 2 using the same color code that is described above, but here is plotted a single scrambling code, the 144. Actually, from the same measurement file, are filtered out only the measurement samples which have the specific scrambling code. But, why this plot is important for the mobile operator? It is well-known that in WCDMA networks in downlink (DL), each scrambling code which detected from the user equipment (UE) corresponds to the signal from a different cell (or sector). Thus, by plotting the CPICH_RSCP using the color code along the measurement route indicates the radio coverage of the specific cell which uses the specific scrambling code. A radio planner or an optimiser can quickly see where the signal is weak or strong and can compare the measurement results with expected coverage according to their planning tool. The software that is developed by our group detects all the scrambling codes of the measurement file and can depict any one of them.

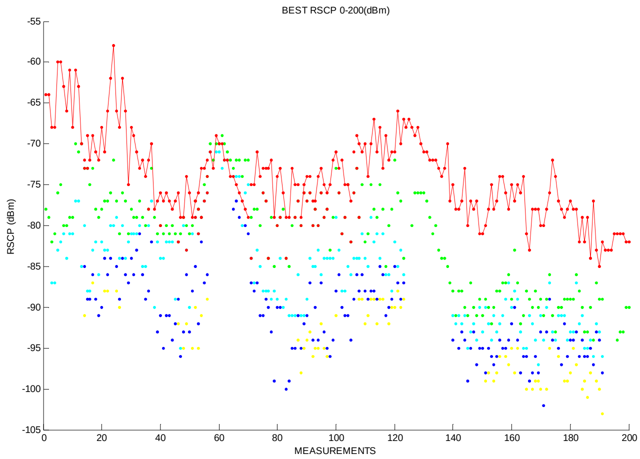

Fig. 4 shows the CPICH_RSCP for the best five cells for each measurement

In Fig. 4 is shown the CPICH_RSCP for the best five cells for each measurement and with the red color is depicted the best server for each measurement.

4 Interference

In Fig. 5 is shown with the red dots the measurements which are corrupted with interference. The horizontal axis presents the CPICH_EcNo in dB (which for simplicity is called EcNo) while the vertical axis depicts the CPICH_RSCP (which for simplicity is called RSCP). Generally in mobile communications industry, interference is defined as the case where the signal level is strong while the quality is poor. Thus, a measurement sample is considered as interference, if the RSCP level is greater than a certain value, i.e., -86dBm, while the EcNo (which is an indicator of quality in WCDMA) is less than a certain value, i.e., -11dBs (poor quality).
So, in this plot (Fig. 5) one can see if there are interference samples (red spots) in the specific measurement file.
In Fig. 6 a more interesting plot is shown. Red spots indicate the locations in the route, where interference is observed using the same criteria as above (EcNo<-11dB & RSCP >-86dBm).
It is obvious that is very important for the planner or the optimiser of a mobile operator to know the exact location of an interference problem. Actually, this is the main advantage of the analysis of the drive tests measurement files over the analysis based on the statistical data from the operator's data warehouses.

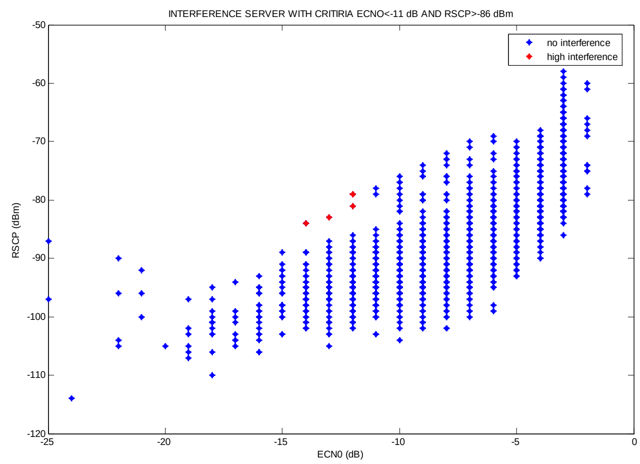

Fig. 5 shows EcNo versus RSCP and with the red dots are the measurements which have interference.

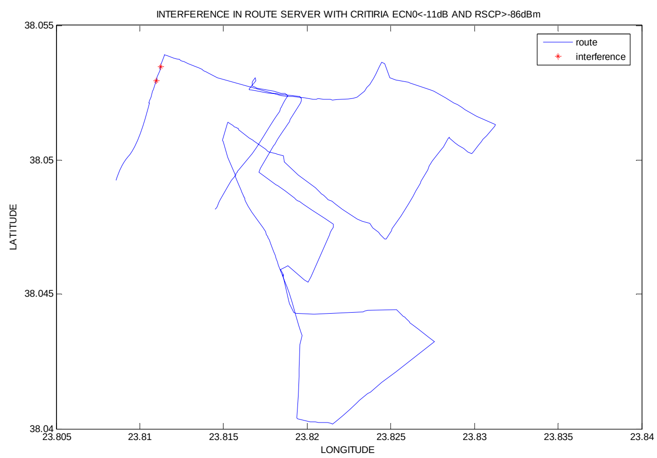

Fig. 6 shows with the red dots, the locations in the route, where interference is observed.

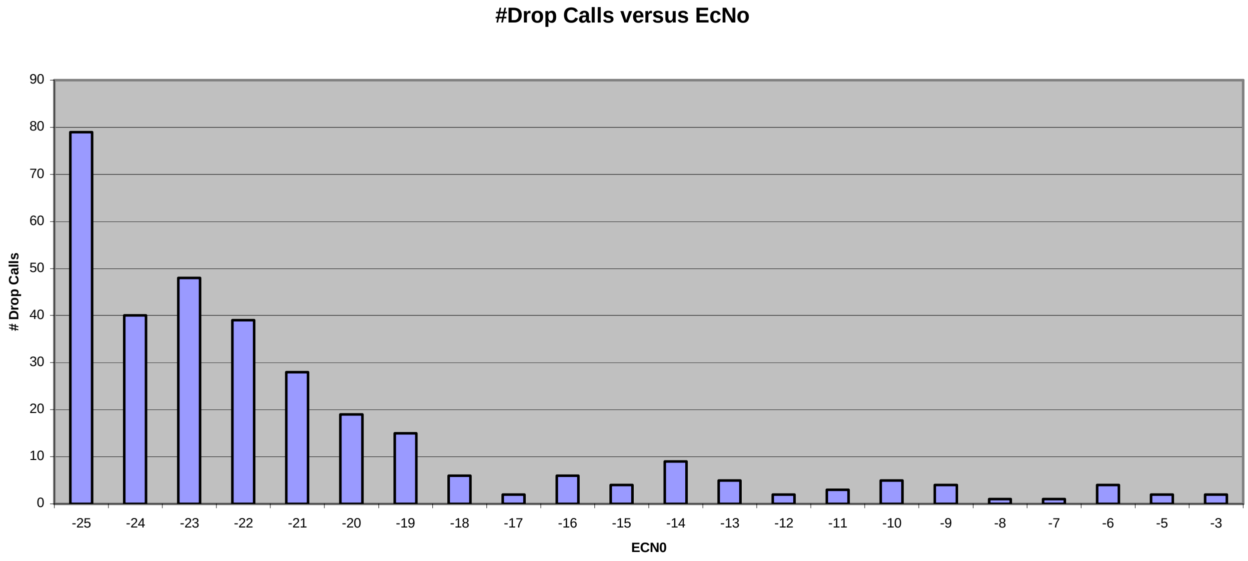

Fig. 7 shows a distribution of EcNo values versus the number of occurances of a specific EcNo value, a measurement before a drop call.

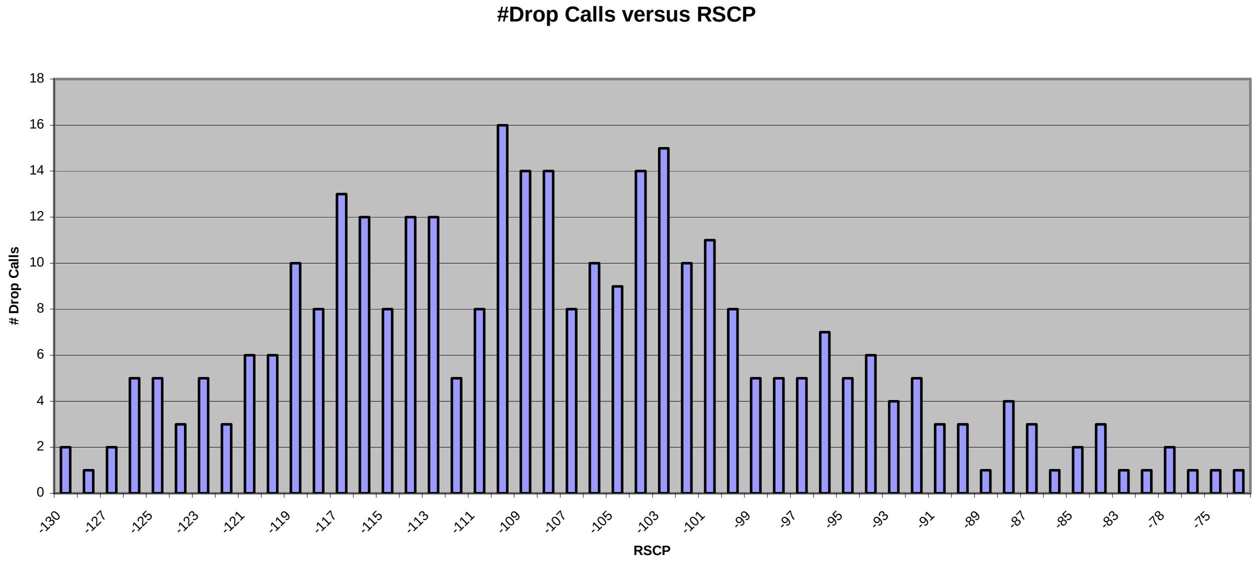

Fig. 8 shows a distribution of RSCP values versus the number of occurances of a specific RSCP value, a measurement before a drop call.

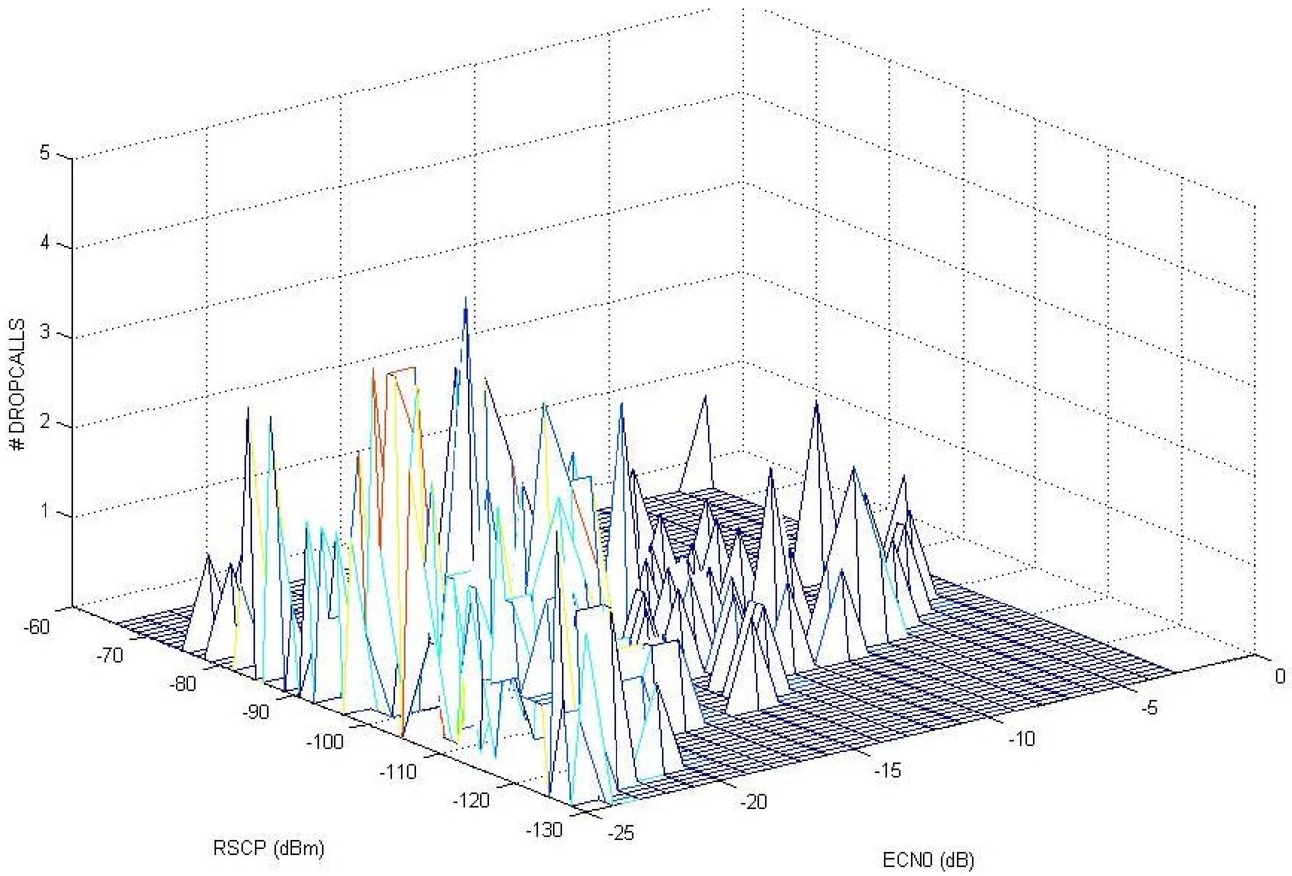

Fig. 9 shows the corresponding 3D distribution of RSCP and EcNo couple of values versus the number of occurances of that specific couple of values, a measurement before a drop call.

5 Investigation of EcNo and RSCP value before drop call

In the framework of co-operation with Cosmote, the case of drop calls was investigated further. The mobile operator was interested to know the values of EcNo and RSCP exactly before a drop call was occurred. An extra option was added to the software program (tool) in order to store the values of EcNo and RSCP in the data base, a meusurement before a drop call had occurred. A large number of measurement files of the operator was checked. Fig. 7 shows a distribution of EcNo values versus the number of occurances of a specific EcNo value, a measurement before a drop call. From this graph is observed that for values of EcNo smaller than -17 dB, the number of drop calls are increased steadily. Moreover, we notice that the most common value of EcNo before a drop call is -25dB. Fig. 8 shows a distribution of RSCP values versus the number of occurances of a specific RSCP value, a measurement before a drop call. The form of RSCP distribution is different from the form of EcNo distribution, although both are produced from the same large list of measurement files. In the EcNo distribution, the largest number of drop calls happent at the smallest value of EcNo = -25dB (left edge of the distribution) while in the RSCP distribution the largest number of drop calls happent at the value of -109 dBm which is not the smallest value of RSCP. Actually, at this level the RSCP is weak, although even weaker values of RSCP can be observed but those values are rather seldom. Fig. 9 shows the corresponding 3D distribution of RSCP and EcNo couple of values versus the number of occurances of that specific couple of values, a measurement before a drop call.
The above results will help the operator to tune the handover algorithm in order to reduce the drop call rate and thus to improve the overall quality of the WCDMA radio network.

6 Conclusions

In this work, a tool was developed for the post processing analysis of drive test measurement files. The tool can make a few basic plots, like the plots of the RSCP measurements on the map along the route of the car, using a color code. The RSCP measurement can be either the RSCP of the best server or the RSCP of a certain Cell, namely; only a specific SC is used in the second case. Another very useful plot is given, the plot which shows where are the measurement samples on the map, which are corrupted with interference. Moreover, an investigation of the EcNo and RSCP values exactly before drop call was done using a large list of measurement files, in order to optimise operator's parameters of the handover algorithm. This tool can be easily evolved further, to analyze more complex events according to the needs of the optimisation process. This tool fulfills both the research and educational interests of our laboratory.

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