UMTS Optimization based on the minimization of the Detected Network Window

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Abstract:- UMTS planning tools based on theoric calculation of coverage and capacity offer the antenna configuration (tilt and orientation) and definition of neighbours according to the estimate traffic. However, the real coverage area of the cell does not always adjust to what was estimated, producing decreasing the quality of coverage. So that you requiered an optimization process following the start up. In this paper, we introduce an optimization method based on the study of the Detected Network window cells

Key-Words: - UMTS, neighbour, traffic, simulation, downtilt, users density, Detected Network.

1 Introduction

In UMTS it is possible that an UE (User Equipment) is connected to more than one cell at the same time. This type of HO (Handover) is called soft HO (when the cells belong to different sites) or softer HO (when the cells belong to the same site).

The mobile phone can measure the quality (Ec/No) or level of the signal (RSCP) of CPICH of the cells surrounding it. The group of cells that make up soft HO is called AS (Active Set). When the pilot of a surrounding cell is detected above threshold, defined as a window with respect to the best server called soft HO window, this new cell should be included in the AS. If the AS is full, it might be necessary to first cancel the one that already existed before introducing the new one. The most common value in 3G networks is three.

The rest of the neighbouring cells that are being measured, but are out of the AS window, can be found in the MS (monitored set) window.

But on some occasions, there are cells that are being received with similar levels to those of the AS or MS that were not defined as neighbouring. These cells are grouped inside the DN (detected network) window and generally are due to overreach or an incorrect neighbour definition.

When a DN cell has a RSCP level above an AS cell, plus a certain threshold, a call disconnection is produced. This threshold is a parameter defined by the telephone company, a typical value being 9dB.

In order to minimize the DN window with the aim of reducing the percentage of dropped calls, the cells that compose the window must be studied in depth. In some cases, it can be necessary to increase the tilt of the antennas to reduce the overreach factor [1][2]. But in other cases it may be neighbour definition. With the URANO tool it is possible to carry out various network capacity and coverage calculations, modifying in each step the traffic and antenna parameters. In this way, it is possible to adjust the initial design and reach a solution to empty the DN window.

Given the importance of the relationship between coverage and capacity in a 3G system, it is essential to carry out and estimation of the distribution of traffic that the system will support. In the context of mobile network system simulations, the traffic maps are patterns that determine in a probabilistic way the possible locations of the users in the study area.

In this paper the optimization process described is shown and the results obtained in the UMTS network of Telefónica in an urban scenario in Tenerife.

2 Scenario description

In order to classify the cells that have more dropped calls due to the DN window, a traced cell was activated and some specific events, that were triggered when the mobile phone reports that a neighbour does not have any cell of the Active Set defined as neighbouring, were analyzed. In this way a list of the cells in the DN window is obtained.

The test scenario chosen is the island of Tenerife (Canary Islands, Spain), and as a result a group of cells with high percentage of dropped calls was obtained, and among these were those that correspond to the base station TF/San Sebastian, shown in figure 1.

The simulations and results that are shown in the following section were carried out on the base station, that is located in a TDA (Traffic Demanding Area) [3] in an urban area, but the optimization process was applied to the group of cells.

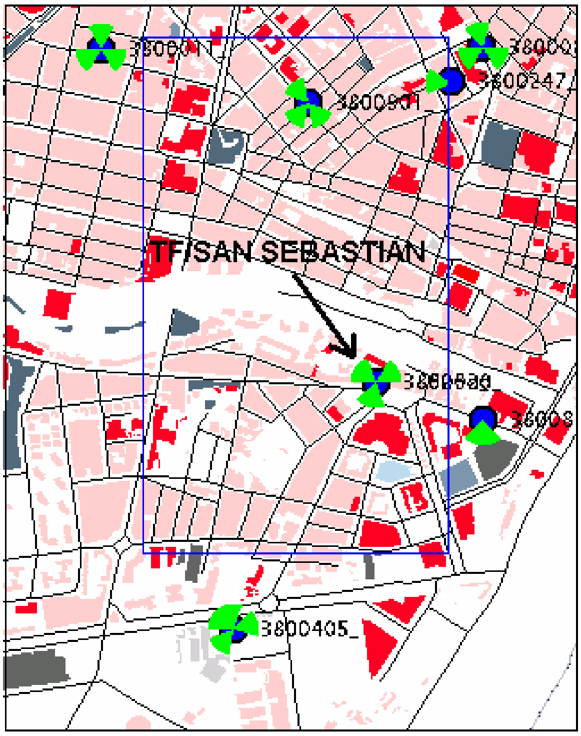

Fig. 1 Test scenario.

2.1 Coverage and capacity analysis

The aim of the simulations is the analysis of the evolution of the network capacity with relation to a possible traffic growth, comparing the present configuration of the base station (with certain dominance over the rest [4]) against another of lower range.

In order to determine what should be the area of the cell coverage, two distinct simulations were carried out. For the first group a downtilt antenna configuration was considered. For the second, the downtilt was increased.

The simulations were carried out using the URANO tool, developed by Telefónica R&D, for Telefónica España, and were based on traffic maps using real traffic statistics. The traffic maps are patterns that determining in a probabilistic way, the possible locations of the users in the area studied. This information is required for the network simulation, given that they condition the levels of interference, resources used in the cells, and to summarize, offered service quality.

The traffic map is a bidimensional pattern of weights that is used to calculate the positions of the users in the network, as is shown in figure 2.

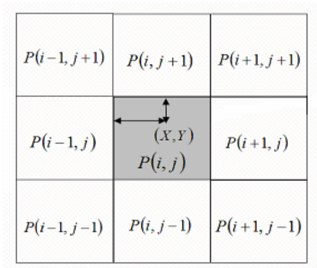

Fig. 2 Users position.

A probability of a user being located in this pixel (pixel probability) is defined, according to the weight relation between this pixel and the whole map, and inside this pixel, the position of the user is randomly chosen, according to the following equation. In this way URANO works with traffic maps using user values (weights) per pixel:

$$P_{ij} = \frac{P(i,j)}{\sum_{j} P(m,n)} \quad (1)$$

To carry out 3G network simulation in the scenarios defined by URANO, it is necessary to define the traffic values associated to the traffic distribution maps created according to the previous section. The values stored in the traffic distribution file are interpreted as relative weights by the simulation core, that is to say, the total traffic offered on each point of the map is calculated according to the following equation:

$$traffic_i = \frac{value_i}{\sum_{j} value_j} Tf \quad (2)$$

Therefore the equation is: the value (weight) of the point in question, divided by the total of the weights of the whole map, multiplied by the total traffic offered on the map (T), and at the same time, multiplied by the factor of scale (f) associated with simulation entry parameters. To carry out this planning, the user local service was defined in a specific simulation area. For these local services, based on global services designed for the tool, the traffic or users values are included in the scenario, and will determine the initial values of 3G simulation.

3 Results

The probability of service in downlink is defined as the probability of the users could decode any cell signal or pilot channel. If the air interface loading is allowed to increase excessively, the coverage area of the cell is reduced below the planned values, and the quality of service of the existing connections cannot be guaranteed [5][6].

To estimate the reduction in the capacity of offering a service according to an increase in demand, two simulations with different user densities were carried out. In figure 3, the probability of service in downlink in both cases is shown, with slight antenna downtilt. It can be seen that for larger density of users, the probability of service decreases due to an increase in mutual interference among the cells in the scenario.

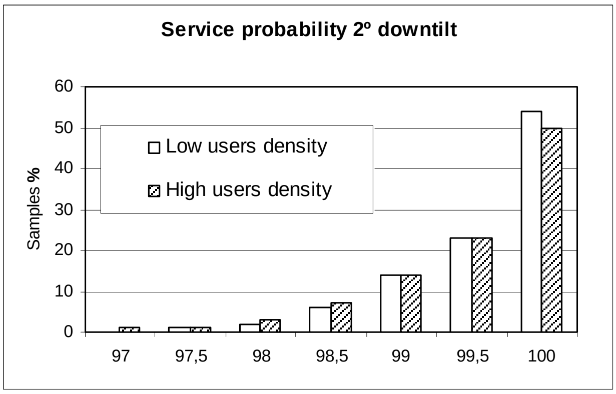

Fig. 3 Service probability in low downtiltl scenario.

In figure 4, the Ec/No values for slight antenna downtilt and high traffic density are shown, and the legend in figure 5.

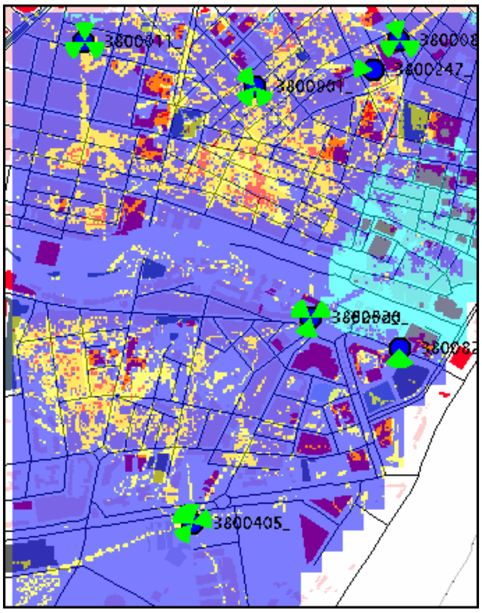

Fig. 4 Ec/No low downtilt and low users density scenario.

Fig. 5 Ec/No in dB.

The next test carried out consisted of decreasing the range of the cells of the TF/San Sebastián base station. To do this, the downtilt of the antennas was increased. The probability of service is shown in figure 6, and the Ec/No map for a high traffic density is shown in figure 7.

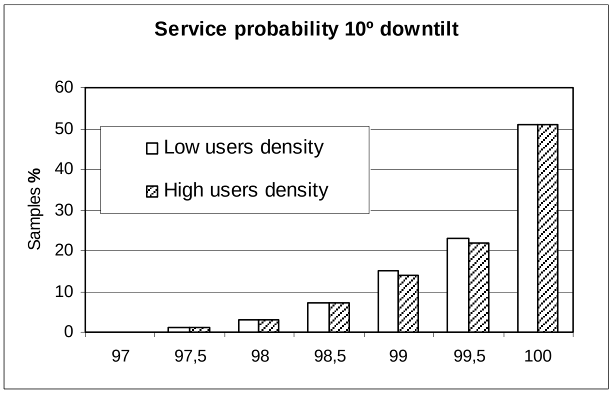

Fig. 6 Service probability in high downtilt scenario.

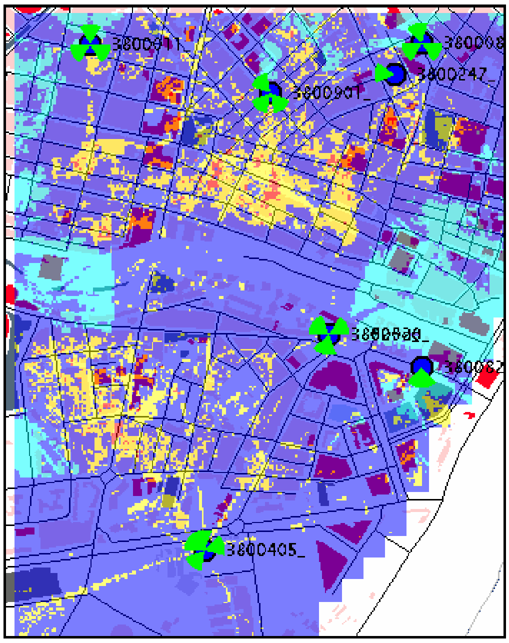

Fig. 7 Ec/No high downtilt and high users density scenario

If figures 3 and 6 are compared, it can be seen that the capacity to offer service decreases as the traffic increases for a slight antenna downtilt, but with high antenna downtilt, the capacity is constant and the range of the cells is reduced. Based on these results, we conclude that to minimize the DN dropped calls, it is better to reduce the cell range rather than maintaining overreach and defining new neighbours.

In figure 8, the evolution of the dropped calls for the three TF/San Sebastián cells is shown. The improvement is evident when the configuration of the antennas has been changed.

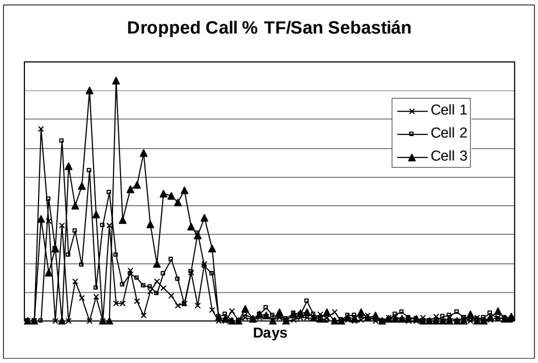

Fig. 8 Dropped calls in TF/San Sebastián.

The optimization method described was applied to the rest of the base stations on the island of Tenerife, and an improvement in the percentage of dropped calls was obtained. This evolution can be seen in figure 9.

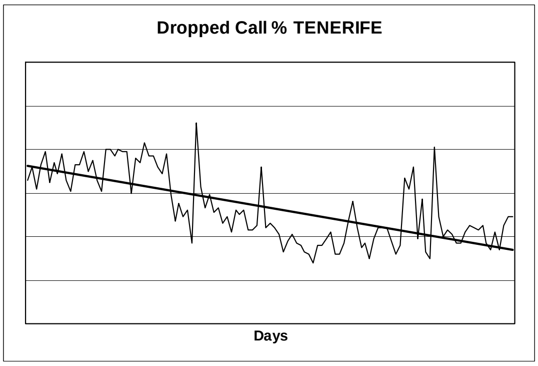

Fig. 9 Dropped calls in 3G network in Tenerife.

4 Conclusions

In this paper we introduce an optimization method for 3G networks for the reduction of dropped calls due to DN, based on coverage and capacity simulations.

These dropped calls are generally due to cell overreach because of slight antenna downtilt and the lack of neighbour definition. On some occasions the coverage area of the cell must be reduced in order not to produce an excessive interference increase as the users density rises. In other cases, it is possible to keep the planned configuration because the service demand will not spoil the quality offered.

Results in a specific urban scenario and in the rest of the 3G network in Tenerife have been shown.

In the state-of-the-art, there are some Automatic Cell Planning (ACP) tools. The main objective of these tools is to provide the best solution while considering a combination of coverage, quality, and capacity (interference) across the network coverage area. The optimization method described in this paper could be automated [7] adding a new module with capacity of importing trace call data.

Acknowledgments
The authors would like to thank Rosario Ortega Sicilia and John Michael Murray for helping with the translation of this paper.

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