Up-Link/Down-Link capacity Unbalance analysis in UMTS using a GIS based Planning Tool and MATLAB simulation

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ABSTRACT

Capacity analysis using simulation is not a new thing in literature. Most of the development process of UMTS standardization have used simulation tools; however, we thing that the use of GIS planning tools and matrix manipulation capacity of MATLAB can show us different scenarios and make a more realistic analysis. Some work is been doing in COST 273 in order to have more realistic scenarios for UMTS planning. Our work initially was centered in uplink analysis, but we are now working in downlink analysis, specifically in two areas: capacity in number of users for RT and NRT services, and Node B power. In this work we will show results for up-link capacity and some results for downlink capacity and BS power consumption.

1. INTRODUCTION

Third generation is almost here. Two years ago, in 2000, most European telecommunication agencies bid licenses for third generation and now in 2003, many users are expecting that a dream becomes reality: possibility of data services like WWW using a mobile phone. However, it's hard to find planning tools that allow estimate capacity in some way. There exist some trials like STORMS project and eurescom project 921 or models like described in [8],[13],[14] and [15] that allow capacity estimation by means of simulations. These models, including ours, are very computing intensive and time consuming, but we think that shows some aspects of capacity that can not be obtained by analytical methods.

Planning process in any mobile system looks for a maximization of coverage area; with a minimum number of Base Stations that allow fulfill traffic requirements. With these goals in mind, many works have been done in the area of Base Station location and propagation models that predict better the coverage [11]. CDMA systems in general and WCDMA in particular have some different behavior than FDMA or TDMA systems, because of cell breathing effect and Multiple Access Interference; this particularities make the planning process a dynamic process and introduces more variables to take in consideration when a WCDMA system is being planned.

Additionally, a system being planned in an urban environment has irregular coverage maps and the best server map can be so much irregular too, as we will show later. This situation difficult capacity estimation using the traditional analytical models. Such models use hexagonal or circular grids, and the analytical solutions cannot be extended to systems with irregular coverage.

The objective of this paper is to show some results for up-link and downlink capacity in two particular scenarios, using a simulation model that permits us obtain capacity results from a best server map and coverage maps generated by a GIS based planning tool.

2. DYNAMIC SIMULATOR DESCRIPTION

We have previously described our tool in [13], but we have been refining and adding features to the tool in order to obtain additional information from simulations. We will make a short description of the simulator for information.

Simulator uses as inputs the best server map generated by Cell-View, a GIS based planning tool developed at Universidad Politecnica de Valencia, Spain, and coverage maps generated also by Cell-View. The best server map and the coverage maps are matrices, then we generate a matrix with a spatial distribution of users in the system, and each user can generate calls.

Using the coverage maps, we estimate the interference produced by each active call over each cell in the system, this includes intracell and intercell interference. We use a SIR based admission control for new calls in the system, and simulate also cell-breathing effect. **¡Error! No se encuentra el origen de la referencia.** illustrates the simulator model.

Using this simulator we can obtain information about active calls and Eb/No relation in any instant of the simulation in the uplink. Also we can generate a number of calls such the system goes to its capacity limit and analyze its behavior.

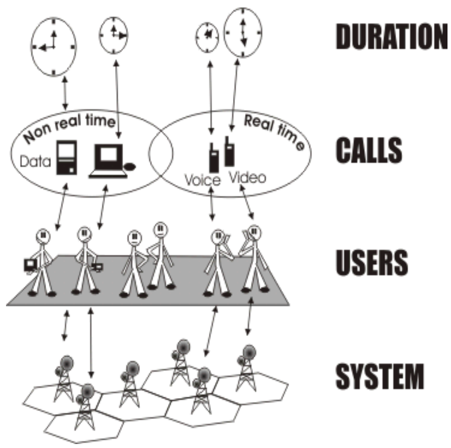

Figure 1 SIMULATOR MODEL

In downlink, we estimate the power required in EB for each user using the losses obtained from the coverage map. We use a SIR based power control in such way that the BS power for each user is raised or lowered according to Eb/No estimated in downlink. We estimate the Eb/No in downlink from the total power for each BS and propagation losses from each BS to each user obtained from coverage maps. We have established a power limit of 20 watts in each BS ,but the number of calls is limited by the Eb/No in up-link.

3. RESULTS

We will show result for two systems that are located in opposite extremes from the planning point of view. The first one is an ideal system, with hexagonal cells, and the second one is a system calculated with the same parameters as ideal one, but using the Walfisch-Bertoni propagation model. The result is a system extremely irregular. We will show also results for two cells in each system.

3.1 Ideal system

In Figure 2 we show the Eb/No perceived in downlink by users for cell No.1, and in Figure 3 we can see the Eb/No in base station, the power used by BS, and the evolution of calls in time. From those figures, it can be observed that exist a balance between the interference perceived by users in down-link and interference perceived by system in up-link. Most of users have an Eb/No better than 5 and Eb/No in up-link is near 5. We can also observe that the power consumed by base station is near 2 watts, when the power limit is 20 watts.

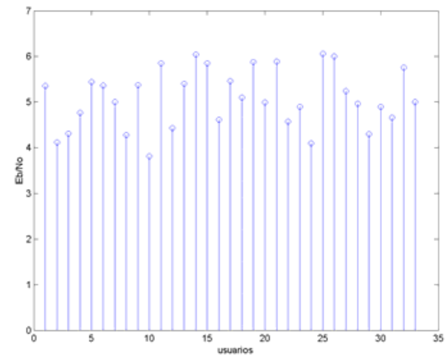

Figure 2 Eb/No perceived by users in cell No.1

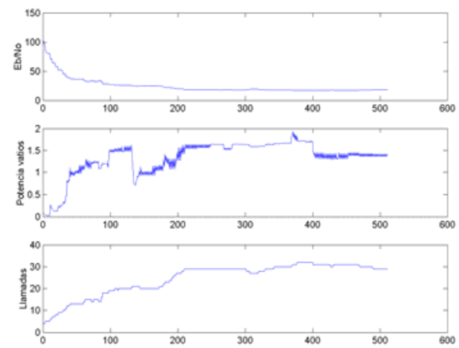

Figure 3 Eb/No, power of Node B and call in cell No.1

In Figure 4 we how the Eb/No perceived by users in cell No.7 and in Figure 5 we show Eb/No perceived by Node B, power of node B and number of calls in time. We can see that Node B is above 20 watts and the Eb/No perceived by most of users is below 5, which means that there is not enough power in node B to guarantee the quality needed by mobile terminals.

In this case, the downlink is more restrictive in cell capacity than up-link, probably because cell No.7 is located with many interferers around it.

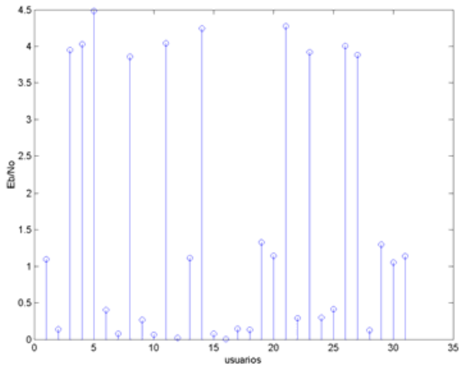

Figure 4 Eb/No perceived by users in cell No.7

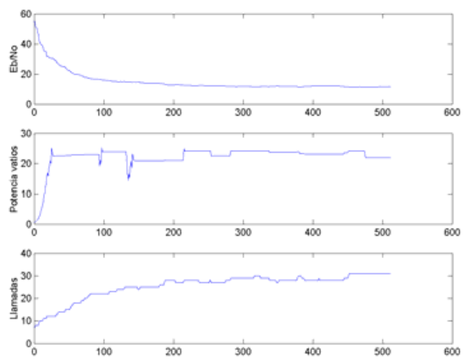

Figure 5 Eb/No, Node B power and calls in cell No.7

3.2 Non Ideal system

In Figure 6 we show the Eb/No perceived by users in cell No.1, and in Figure 7 we show the power of node B in time, and the number of calls in the cell. We can see that Node B is near 20 watts and number of calls is lower than ideal system. Also, we can see from Figure 6 that some users have an Eb/No near 1 and most of them have an Eb/No near 5. This behavior is because power for each user is allocated in as arrival basis. That means that when Node B is using all available power, there is no power for new users in the cell.

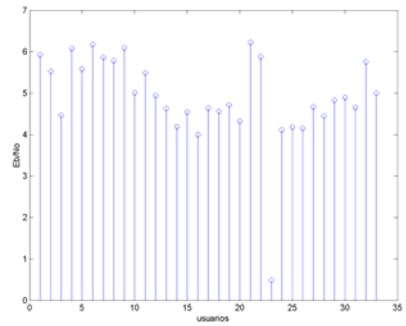

Figure 6 Eb/No for users in cell No.1

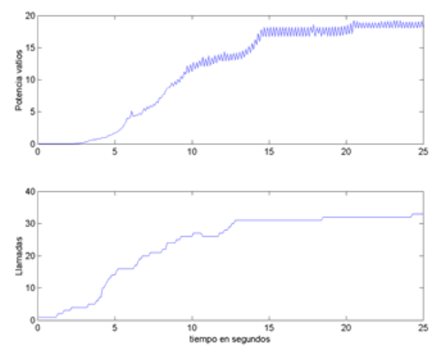

Figure 7 Node B power and number of calls in cell No.1

In Figure 8 we show Eb/No perceived by users in cell No.7. We can see that all users have an Eb/No below 5, and most of them have an Eb/No that is worst than 1. In Figure 9 we show power of node B and number of calls. It is clear that down-link is much more restrictive than up-link.

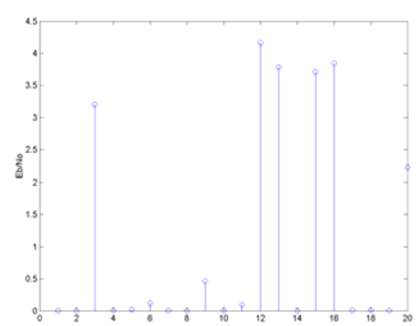

Figure 8 Eb/No for users in cell No.7

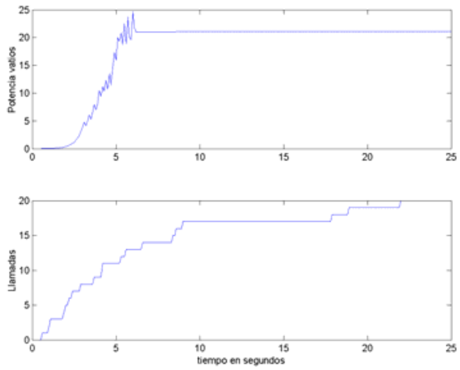

Figure 9 Node B power and calls in cell No.7

4. CONCLUSIONS

We have shown results from a simulation model that shown that in UMTS the downlink can be more restrictive than up-link, depending on propagation conditions, users location and other conditions not analyzed yet.

Results show were for voice services only, but it is clear that data services at higher rates will impose more restrictions to UMTS systems and probably a similar behavior could be found in CDMA-2000 systems. However, there are significant differences between the two technologies and is not possible to make such affirmation without making some tests or simulations.

5. REFERENCES

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