Technical Specification Group, RAN WG4 **TSGR4#2(99)125**

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Title: **The effect of outage from Adjacent Channel Interference on Quality of Service for moving users**

Document for: **Discussion**

Summary

This paper shows that the effects of outage on the quality of service experienced by a user can be much more severe when the user is moving than when stationary. As an illustration, a simple analysis has been made using results presented in 3GPP. For a motorway scenario, an area outage of 0.5% is shown to result in a average time before a call is dropped of approximately 6.2 minutes for cars travelling along the motorway; this would obviously be unacceptable. The cause of these dropped calls is Adjacent Channel Interference from basestations into nearby terminals which are using a different network.

It is necessary to ensure that all users receive a satisfactory quality of service in real networks, and not just the types of users and networks which can be easily simulated. This paper shows that the requirements for adjacent channel interference will probably be more stringent for moving users than for the static users which are usually assumed for simulation. It is essential that this is taken into account in defining the requirements for the parameter of UTRA which define the adjacent channel performance.

Background

Over the last year, there have been a large number of papers presented to SMG 2 L1 experts Group and TSG RAN WG4 on the subject of Adjacent Channel Interference[1] (ACI). These papers have generally used Monte-Carlo analysis to derive the reduction in capacity and the percentage of area outage caused by ACI. One limitation of Monte Carlo analysis is that it is a discrete time simulation; the simulations consist of a number of events or “snapshots”, each with a random distribution of users (who are effectively stationary).

Of course, real users do not behave in this way; they move in a continuous manner, and not in discontinuous jumps. Also, as in the example in this paper, they frequently do not move in a random manner, and this can also have an impact on the performance of the network.

At the last meeting of RAN WG4 (#2), a simulation methodology was agreed for more detailed Monte Carlo evaluation of ACI. However, this methodology still uses Monte-Carlo simulation, and will therefore not evaluate the dynamic effects discussed in this paper.

Analysis

The scenario used for the analysis (shown in fig.1) is a motorway where several operators have deployed basestations alongside the motorway, but not co-located; this deployment is widespread in the UK for GSM. It is expected that this deployment will also be used for UMTS, because operators will wish to re-use their existing cellsites.

The outage value is taken from an paper presented to TSG RAN WG4[2], which assumed a value of 40dB for the ACI; the cell radius was assumed to be 1000m, and the outage (for the ACI of 40dB) was evaluated to be approximately 0.5% of the cell area for 20% of mobiles.

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[1] Adjacent Channel Interference is the cumulative effect of Adjacent Channel Leakage (caused by a non-ideal transmitted spectrum; ACLR is the ratio of this to the in-channel power) and Adjacent Channel Selectivity (ACS; caused by a non-ideal receiver filter).

[2] Evaluation of up- and down-link adjacent channel performance, Annex B; TSGR#2 (99) 048; 15-19 Feb 1999; Ericsson

Percentage of cell with outage	0.5%
Radius of effective outage area, assuming cell radius of 1000m	70m
Mean length of motorway through outage area, assuming basestation is 35m from central reservation	120m
Time vehicle spends in outage area, at assumed vehicle speed of 25m/s	4.8s

This period of outage is long enough to cause users or the network to terminate the call, or at least cause considerable annoyance to the user.

Distance between interfering basestations along motorway	3km
Time taken between interfering basestations at 25m/s	120 seconds
“half life” of call (ie mean time for 50% of calls to drop, assuming 20% of calls drop for each interfering basestation passed	372 seconds

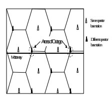

Fig 1: Motorway scenario with two operators both deploying basestations along the motorway.

The outage occurs in locations where it would be most annoying to users. GSM users have come to (reluctantly) accept dropped calls in areas of poor radio coverage, such as hollows and tunnels. By comparison, outage due to ACI in W-CDMA basestations would occur close to basestations (the user would not know that these are for different networks), which are generally where users would expect good service.

Conclusions

This paper presents a simple analysis of the effect of adjacent channel interference on users who are moving, using a motorway scenario as an example. It shows that the degradation of QoS can be more serious for moving users than might be suggested be the percentage of area outage for the cell. The reason for this is the geographic location of these outage areas within the cell. In the example given of a motorway, the average time before a call is dropped is only 6.2 minutes, which is unacceptably short.

To avoid this problem, it is will be necessary to select a value for ACLR for the basestation and ACS for the terminal which are high enough to achieve a good QoS for ***both*** static ***and*** moving scenarios.

It is recognised that the simple analysis presented in this paper makes a number of simplifying assumptions and approximations. Nevertheless, it is believed that a more detailed analysis will confirm that the effect of Adjacent Channel Interference on QoS for moving users is significant, and should be taken into account in determining appropriate values of ACLR and ACS.