TSG RAN Working Group 4 (Radio) meeting #8 **TSGR4#8(99)623**

Sophia Antipolis, France, 26. – 29. October 1999

Agenda Item:

Source: ITALTEL

Title: **Call admission criterion in UpLink for TDD mode**

Document for: Discussion

1. Introduction

In document [1], where relationship between ACIR and system capacity loss has been studied for a TDD system using a MUD (Multi User Detection) receiver and for speech service, the necessity to introduce a new call admission criterion in uplink has been stressed. Purpose of this document is to examine closely the problem. To reach this aim, simulations on data service at 144 kbps and on speech service in uplink have been performed applying two criteria: the "- noise rise criterion" and the "satisfied user criterion". The latter, applied in [2] to the downlink, has been applied in our simulations to the uplink in order to test a call admission criterion based on C/I calculations. This analysis leads to interesting conclusions concerning the optimisation of the radio resources in a TDD system.

2. Description of Simulations

Simulations have been performed in a macro-to-macro scenario with 36 hexagonal cells wrapped around. Intermediate and worst case have been analysed for data at 144 kbps and for speech service and for the uplink only. Results shown in the third paragraph have been obtained using a sequential simulator that has been "adapted" in order to reproduce different snapshots of the network. No DCA technique is used. Radio resource assignment is random.
The simulator executes the following steps several times (snapshots):

- loading of the system with a fixed number of users and mobile distribution uniformly across the network;
- execution of different power control loops to achieve system stability;
- evaluation of the total interference amount for uplink at the end of the power control loops.

The number of calls allowed for the multi-operator case is obtained applying two different call admission criteria: the "-noise rise" criterion and the "satisfied user criterion", both illustrated in [2]. The former involves the average noise rise in the network due to intracell interference, intercell interference and thermal noise, the latter is based on the signal to noise ratio at the user equipment and involves only intercell interference and thermal noise as a MUD receiver has been assumed (see [4] for a list of the simulation assumptions for the TDD mode).
System capacity loss is evaluated comparing, for different ACIR values, the number of calls allowed for the multi-operator case with the number of calls allowed for the single operator case. Uplink and downlink Eb/N0 targets have been derived from [3], where link level simulation results for TDD mode are produced. Simulations are made of one thousand of snapshots. A description of the parameters used in the simulations is given in [2], chapter 7.1.2.

3. Simulation results

Simulation results for the uplink channel are shown in the following figures respectively in the intermediate and in the worst case. Results that have been obtained applying the " noise rise criterion" and the "satisfied user criterion" are compared.

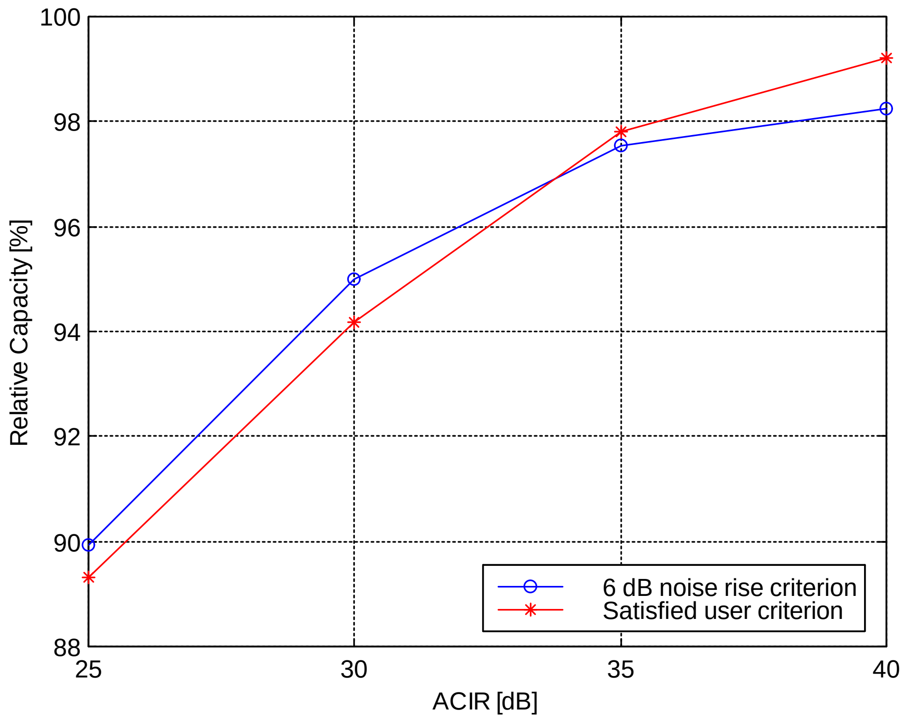

Figure 1. ACIR and capacity loss for UL 144 kbps data: intermediate case.

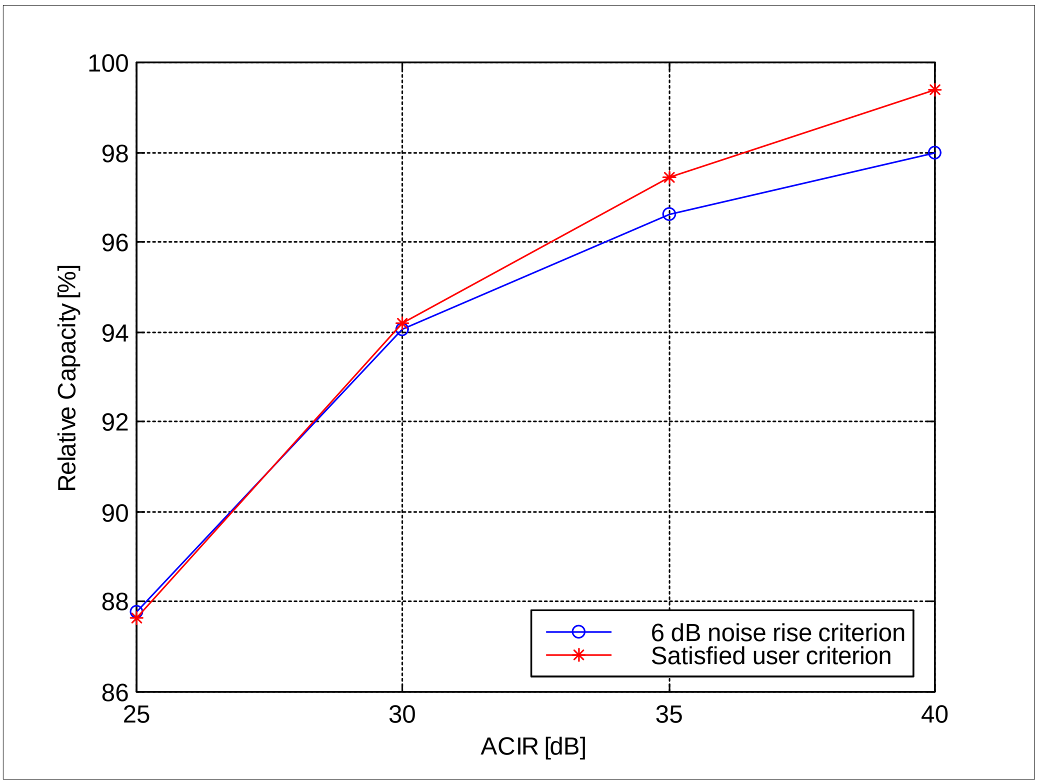

Figure 2. ACIR and capacity loss for UL 144 kbps data: worst case.

By comparing previous results, we can observe that system performances are almost the same for both the criteria. In a TDD system transmitting data at 144 kbps, each timeslot is dedicated to a single user. Then, in uplink, the power at the receiver is:

P = N*C+I, where:

- N is the number of codes per timeslot (N=9 in performed simulations);
- C is the single code power;
- I is the sum of the inter-cell interference and of the thermal noise.

Because of the ideal power control: $C/I = SIR_{Threshold}$, and $P = I*(1+N* SIR_{Threshold})$. As a consequence, in this case, the average noise rise is directly proportional to the non-orthogonal interference power and the similarity of the two capacity figures may be due to this relationship.

In case of speech service, the previous relationship is not valid and the received power is not directly proportional to the non-orthogonal interference power. In order to compare the two criteria for speech service, outage percentages have been calculated in the intermediate case. The obtained results show that, when the parameter ACIR is higher than 25 dB, the outage percentages are less than 5%, even if the maximum network loading. The relative capacity figure obtained is shown in Figure 3. The conclusion is that in uplink and for ACIR values higher than 25 dB the system is hard blocked, i.e. also when 9 speech services are allocated in each cell and timeslot, outage percentage is lower than 5%. Thus for values higher than 30 dB ACIR has no more influence on relative capacity.

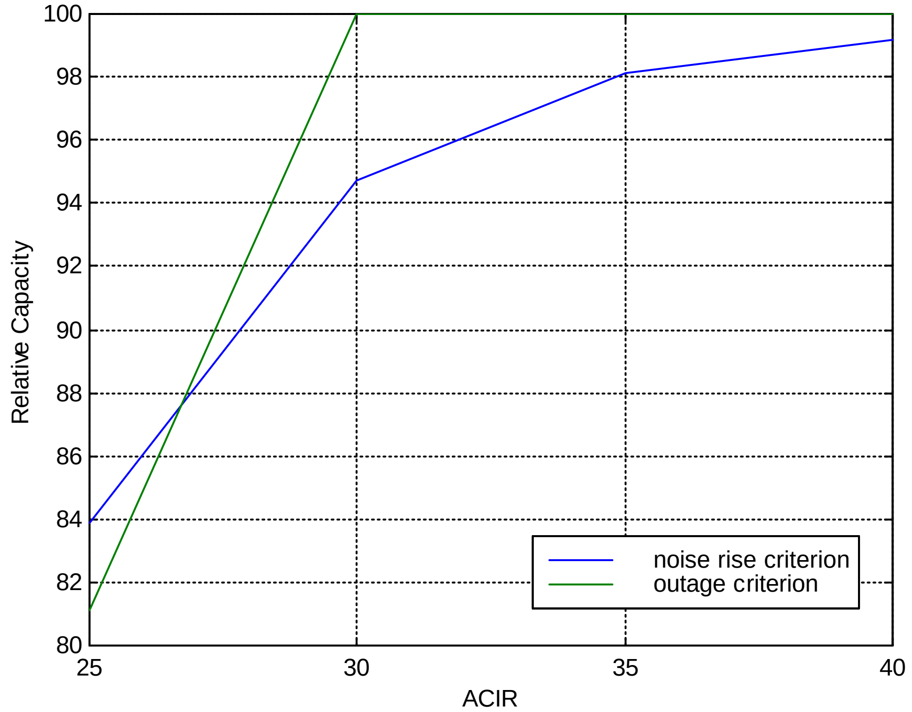

Figure 3. ACIR and capacity loss for UL speech service in the intermediate case applying the "satisfied user criterion"

4. Conclusions

The application of the "noise rise criterion" to evaluate UL system capacity is not generally correct for systems employing a MUD receiver because the RSSI (Radio Signal Strength Indication) is not proportional to the actually interfering power. A capacity evaluation criterion based on C/I can give more meaningful results.

In case of 144 kbps service, where a single user has all resources units in a timeslot, RSSI and interfering power are proportional and this brings to coherent results from both the outage and the noise rise criterion.

In case of speech service the outage criterion points out, in the ideal conditions used for simulations (regular layout, perfect power control as far as C/I estimation and power step), the system is hard blocked when ACIR $\geq$ 30 dB

Maybe in a more challenging scenario and with more real simulation conditions the system would be soft blocked in UL, however from currently available results we can draw that 30 dB of ACIR are sufficient to guarantee very little capacity degradation for operators on adjacent frequencies in the intermediate case.

We would also stress that a TDD system with asymmetric resource allocation, on a global basis, can efficiently manage the different UL and DL spectrum efficiency for a symmetric service like speech.
For example if the required outage percentage is guaranteed by a unitary timeslot reuse in UL and an average reuse of 2 for DL then the maximum capacity for speech can be obtained devoting to DL a number of resource doubled with respect to UL.

5. References

[1] " ACIR simulation results for TDD mode: speech in UpLink and in DownLink", TSG R4#6(99) 364 (July 1999)

[2] "RF System Scenarios", TS 25.942 V 2.0.0 (1999-09)

[3] "UTRA TDD Link Level and System Level Simulation Results for ITU Submission", SMG2 UMTS-ITU, Tdoc S298W61 (Septembe r 1998)

[4] " Simulation Assumptions for TDD mode ", TSG R4 (99)594, AH01 meeting (30th September-1st October 1999)