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Agenda Item:

Source: **ITALTEL**

Title: **ACIR simulation results for TDD mode: speech in UpLink and in DownLink**

Document for: **Discussion**

1. Introduction

Co-existence of either different layers or different operators on adjacent channels requires restrictions to the amount of power transmitted and received out of band. Out of band emission phenomena are described, from a system point of view, by three parameters: ACLR, ACS and ACIR. On the base of the definitions given in [1], [2] and [3], ACLR and ACS are indicators of the amount of adjacent channel interference power respectively allowed in transmission and in reception, while ACIR is a global parameter because it takes into account interference due to both transmitter and receiver imperfections. A higher ACIR value allows a greater adjacent channel interference protection and improves system capacity, requiring, on the other hand, more complex and expensive equipments.
Many studies have been carried out, either in a multi-operator or in a multi-layer environment, on the relationship between ACIR and system capacity loss as regards the single operator or single layer case for FDD systems (see [4] for a collection of results). Aim of this document is to analyse the previous relationship when TDD duplexing technique is used.

The simulations have been performed for speech in a macro-to-macro scenario and in accordance with [3]. Studies concerning data at 144 kbps in macro-to-macro scenario are actually in progress.
Changes made to [3] because of the different duplexing technique are illustrated in the following paragraph and collected in Table 1.

2. Description of Simulations

The simulations have been performed in a macro-to-macro scenario, with 36 hexagonal cells wrapped around. Intermediate and worst case have been analysed for speech at 8 Kbps. The results showed 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 both for uplink and downlink at the end of the power control loops.

The number of calls allowed for the multi-operator case is obtained applying the "6 dB noise rise" criterion in UL and the "satisfied user criterion" in DL, as illustrated in [3]. 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 perfect joint detection is assumed. 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 [5], where link level simulation results for TDD mode are produced.
In the following table a description of the parameters used in the simulations is given. Changes introduced because of the different transmission technology are reported in italic and in red.

Parameter	UL value	DL value
SIMULATION TYPE	Snapshot	Snapshot
PROPAGATION PARAMETERS		
MCL macro (including antenna gain)	70 dB	70 dB
MCL micro (including antenna gain)	53 dB	53 dB

Antenna gain (including losses)	11 dBi	0 dBi
	0 dBi	11 dBi
Log Normal fade margin	10 dB	10 dB
PC MODELLING		
# of snapshots	*800 for speech*	*800 for speech*
#PC steps per snapshot	> 150	> 150
step size PC	perfect PC	perfect PC
PC error	0 %	0 %
margin in respect with target C/I	0 dB	0 dB
Initial TX power	*Based on C/I target*	*Based on C/I target*
Outage condition	Eb/N0 target not reached due to lack of TX power	Eb/N0 target not reached due to lack of TX power
Satisfied user		measured Eb/N0 higher than Eb/N0 target - 0.5 dB
HANDOVER MODELING	*Not included*	*Not included*
NOISE PARAMETERS		
noise figure	5 dB	9 dB
Receiving bandwidth	4.096 MHz proposed	4.096 MHz proposed
noise power	-103 dBm proposed	- 99 dBm proposed
TX POWER		
Maximum BTS power		43 dBm macro 33 dBm micro
Common channel power		30 dBm macro 20 dBm micro
Average TX power speech	21 dBm	30 dBm macro 20 dBm micro
Average TX power data	21 dBm	30dBm macro 20dBm micro
Power control range	65 dB	25 dB
HANDLING of DOWNLINK maximum TX power		
		Problem identified, agreed to collect as a minimum statstical data A proposal from Nortel was made TBD
ADMISSION CONTROL	Not included	Not included
USER DISTRIBUTION		Random and uniform across the network
INTERFERENCE REDUCTION		
MUD	*On*	*On*
non orthogonality factor macrocells	*0*	*0*

COMMON CHANNEL ORTHOGONALITY		Orthogonal
DEPLOYMENT SCENARIO		
Macrocell		Hexagonal with BTS in the middle of the cell
microcell		Manhattan (from 30.03)
BTS type		Omnidirectional
Cell radius macro		577 macro
Inter-site single operator		1000 macro
Cell radius micro		block size = 75 m, road 15 m
Inter-site single micro		intersite between line of sight = 180 m
Intersite shifting macro		577 and 577/2 m
# of macro cells		*72* with wrap around technique
Intersite shifting macro-micro		see scenario
Number of cells per each operator		*36*
Wrap around technique		Used
SIMULATED SERVICES		
bit-rate speech	8 kbps	8 kbps
Activity factor speech	100 %	100 %
Multipath environment macro	Vehicular macro	Vehicular macro
Eb/N0 target	*5.8 dB* instead of 6.1 dB	*8.3 dB* instead of 7.9 dB
Multipath environment micro	Outdoor micro	Outdoor micro
Eb/N0 target	*3.7* dB instead of 3.3 dB	6.1 dB
Data rate	144 kbps	144 kbps
Activity factor speech	100 %	100 %
Multipath environment macro	Vehicular macro	Vehicular macro
Eb/N0 target	*4.1 dB* instead of 3.1 dB	*4.1 dB* instead of 4 dB
Multipath environment micro	Outdoor micro	Outdoor micro
Eb/N0 target	*2.2 dB*	*2.2 dB*

Table 1. Description of the parameters used in the simulations.

3. Simulation Results

In the following figures the results of our simulations are shown for uplink and downlink in the intermediate and in the worst case.

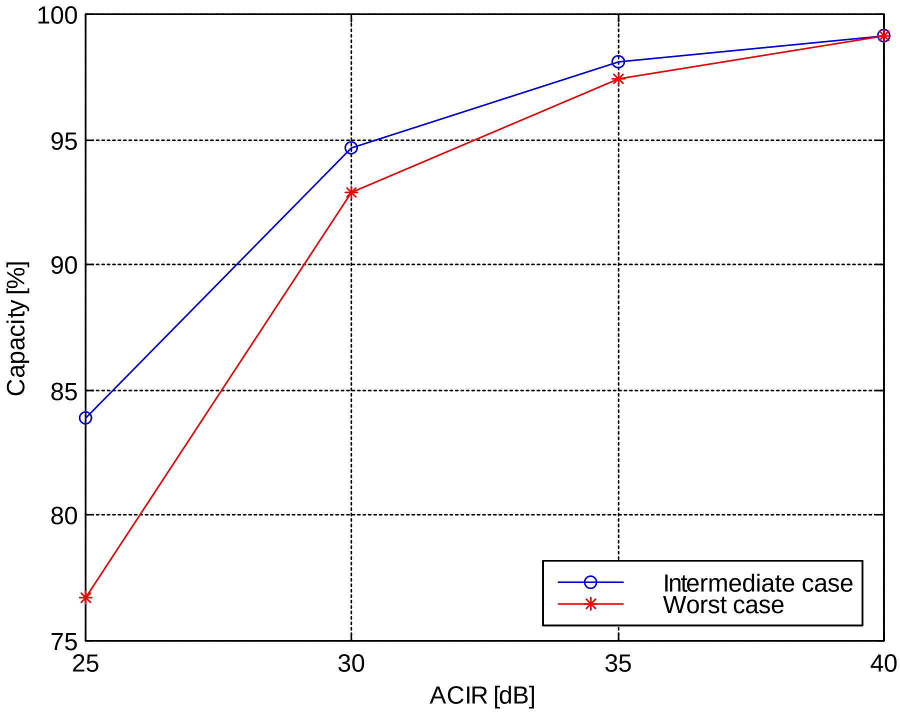

Figure 1. Relationship between ACIR and capacity loss for speech in UL in the intermediate and worst case.

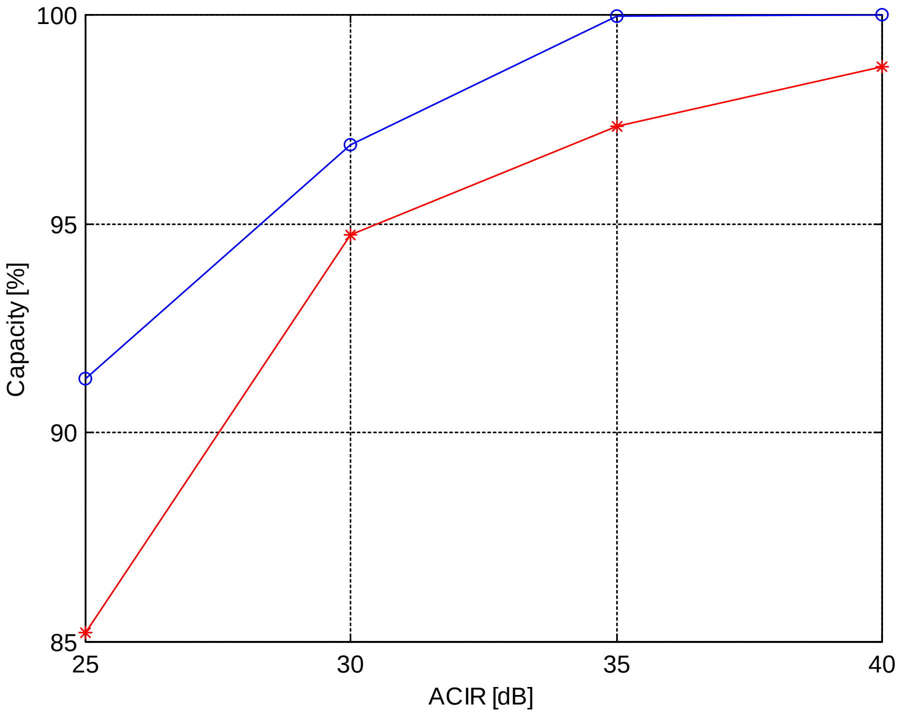

Figure 2. Relationship between ACIR and capacity loss for speech in DL in the intermediate and worst case

4. Conclusions

In the following tables a comparison between our simulation results and those presented in [4] for FDD mode has been made. Analysis of UL performances shows a different behaviour of the TDD system when ACIR is equal to 25-30 dB in UL, both in the intermediate and in the worst case. On the contrary in DL system performances are similar and we can conclude that in this case an ACIR value close to 30 dB could be a good arrangement between system capacity and equipment realization.

Differences in UL performances are due to the noise rise criterion that we think inadequate for systems that use JD technique. In fact in FDD systems the high number of users and the absence of JD imply that the total received power is almost equal to the overall disturbance. On the contrary, in TDD systems the total received power is mainly composed by intracell interference that can be eliminated by JD. Thus an high average noise rise does not imply a high outage probability in the network. An admission criterion based on C/I in UL also could be more appropriate for the TDD case.

ACIR [dB]	**FDD case**			**TDD case**
	Min	**Max**	**Average**	
25	90.69 %	91.82 %	91.15 %	83.89 %
30	96.85 %	97.40 %	97.09 %	94.70 %
35	98.89 %	99.07 %	98.98 %	98.10 %
40	99.53 %	99.70 %	99.65 %	99.15 %

Table 2. System capacity comparison between FDD mode and TDD mode for different ACIR values: speech UL in intermediate macro-to-macro case.

ACIR [dB]	**FDD case**			**TDD case**
	Min	**Max**	**Average**	
25	87.00 %	88.45 %	87.75 %	76.72 %
30	95.42 %	96.20 %	95.81 %	92.89 %
35	98.57 %	98.90 %	98.66 %	97.45 %
40	99.50 %	99.70 %	99.57 %	99.15 %

Table 3. System capacity comparison between FDD mode and TDD mode for different ACIR values: speech UL in worst macro-to-macro case.

ACIR [dB]	**FDD case**			**TDD case**
	Min	**Max**	**Average**	
25	86.54 %	93.50 %	89.12 %	91.28 %
30	94.16 %	97.40 %	95.30 %	96.88 %
35	97.73 %	99.00 %	98.21 %	99.95 %
40	99.09 %	99.90 %	99.41 %	100.00 %

Table 4. System capacity comparison between FDD mode and TDD mode for different ACIR values: speech DL in intermediate macro-to-macro case.

ACIR [dB]	FDD case			TDD case
	Min	**Max**	**Average**	
25	84.70 %	91.00 %	86.72 %	85.24 %
30	92.84 %	95.50 %	93.84 %	94.75 %
35	97.20 %	98.20 %	97.68 %	97.34 %
40	98.71 %	99.18 %	99.01 %	98.76 %

Table 5. System capacity comparison between FDD mode and TDD mode for different ACIR values: speech DL in worst macro-to-macro case.

5. References

[1] "UTRA (BS) TDD; Radio transmission and reception", TS 25.105 V1.2.0 (1999-07)

[2] "UTRA (UE) TDD; Radio transmission and reception", TS 25.102 V1.2.0 (1999-07)

[3] "RF System Scenarios", TS 25.942 V 0.1.3 (1999-05)

[4] "RF System Scenarios", TS 25.942 V 0.1.3 (1999-05), par. 8.1: Alcatel, Ericsson, Nokia, NTT DoCoMo and Motorola: UL and DL ACIR simulations results

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