

**TSG-RAN Meeting #12
Stockholm, Sweden, 12 - 15 June 2001**

RP-010357

Title: Agreed CR (Release '99) to TS 25.942

Source: TSG-RAN WG4

Agenda item: 8.4.3

WG4 doc	Status WG4	Spec	CR	Phase	Title	Cat	V old	V new
R4-010635	agreed	25.942	1	R99	Clarification to TDD pico - FDD macro interference simulation results	F	3.0.0	3.1.0

Gothenburg, Sweden 21st - 25th May 2001

CR-Form-v4

CHANGE REQUEST⌘ **25.942 CR 1** ⌘ ev **-** ⌘ Current version: **3.0.0** ⌘For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.Proposed change affects: ⌘ (U)SIM ME/UE Radio Access Network Core Network

Title:	⌘ Clarification to TDD pico - FDD macro interference simulation results		
Source:	⌘ RAN WG4		
Work item code:	⌘ TEI	Date:	⌘ 25.05.01
Category:	⌘ F	Release:	⌘ R99
	Use <u>one</u> of the following categories:		Use <u>one</u> of the following releases:
	F (correction)	2 (GSM Phase 2)	
	A (corresponds to a correction in an earlier release)	R96 (Release 1996)	
	B (addition of feature),	R97 (Release 1997)	
	C (functional modification of feature)	R98 (Release 1998)	
	D (editorial modification)	R99 (Release 1999)	
	Detailed explanations of the above categories can be found in 3GPP <u>TR 21.900</u> .	REL-4 (Release 4)	
		REL-5 (Release 5)	

Reason for change:	⌘ The results are more unambiguous when using dB as a reference for BS separation.
Summary of change:	⌘ Table 24 has changed and new figure 33 has added and part of the text has been chaged to align these changes.
Consequences if not approved:	⌘ The results are not unambiguous and lead to speculations about what propagation loss equation has been used.

Clauses affected:	⌘ 9.1.1, Figure 31, 9.1.5, Table 24
Other specs affected:	⌘ <input type="checkbox"/> Other core specifications ⌘ <input type="checkbox"/> Test specifications <input type="checkbox"/> O&M Specifications
Other comments:	⌘

How to create CRs using this form:Comprehensive information and tips about how to create CRs can be found at: http://www.3gpp.org/3G_Specs/CRs.htm. Below is a brief summary:

- 1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.
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9 Additional Coexistence studies

9.1 Simulation results on TDD local area BS and FDD wide area BS coexistence

9.1.1 Introduction

The present document investigates the possibility of UTRA TDD-UTRA FDD coexistence. There are several possible configurations in which the likelihood of intersystem interference to occur is anticipated. This paper describes only one such situation. There might be other scenarios too which might require similar consideration however they are beyond the scope of the present document.

In the present document, the interaction between UTRA TDD indoor and UTRA FDD macro systems is studied. Here it has been considered that UTRA TDD and UTRA FDD systems belong to two different operators and are operating in adjacent bands. For UTRA FDD only UL is modeled. ~~As the interference between UTRA TDD and UTRA FDD DL band experienced by the UTRA FDD DL may not be very predominant, significant (due to large frequency separation between UTRA FDD DL and UTRA TDD).~~ Owing to the frequency separation between UTRA TDD and UTRA FDD DL band, the interference between UTRA TDD and UTRA FDD DL may not be very predominant, significant (due to large frequency separation between UTRA FDD DL and UTRA TDD). The results are presented in terms of capacity losses.

9.1.2 Simulator Description

The simulator used for evaluation of UTRA TDD and UTRA FDD co-existence is a static system level simulator. Simulations are based on snapshots where users are randomly placed in a predefined deployment scenario. In each snapshot a power control loop is simulated until E_b/N_0 target is reached. Simulation is made of several snapshots. The simulations are so conducted that the first set of simulation statistics is collected for independent environments (TDD Alone or FDD alone) and the second round of simulations constitutes of placing the two systems TDD and FDD in adjacent bands and the simulation statistics is recollected. The simulation statistics collected in a standalone environment and in adjacent channel operation environment determines the impact of the intersystem interference between TDD and FDD operating in adjacent bands. This is expressed in terms of capacity losses, power distribution behaviour and interference levels in each system.

9.1.2.1 Simulation procedure overview

A simulation step (snapshot) consists of mobile placement, pathloss calculations, handover, and power control and statistics collection. At the beginning of each simulation, UE's are randomly distributed. After the placement, the path loss between each UE and the BS is calculated, adding the lognormal fading, and stored to so called *G-matrix* (Gain matrix). Distance attenuation and lognormal fading are kept constant during the execution of a snapshot. Then power control loop is started. During this the power control is executed till the used power will reach the level required by the required quality. During the power control loop, the Gain Matrix remains constant. Sufficient number of power control commands in each power control loop should be greater than 150.

At the end of a power control loop, statistical data is collected. UE's whose quality is below the target $E_b/N_0-0,5$ dB are considered to be in outage state and UE's whose quality is higher than the target $E_b/N_0-0,5$ dB are considered to be satisfied.

When a single step (snapshot) is finished, UE's are re-located to the system and the above process is executed again. Multiple snapshots are executed to achieve sufficient amount for local mean SIR values.

9.1.2.2 System Scenario

In the present document, hierarchical system with FDD in macro and TDD in pico environment has been chosen. The systems have been deployed as indicated in figure 31. The hexagonal cells represent the FDD macrocells and the TDD indoor system has been mapped on to the FDD middle cell. The TDD indoor layout has been adopted from [9].

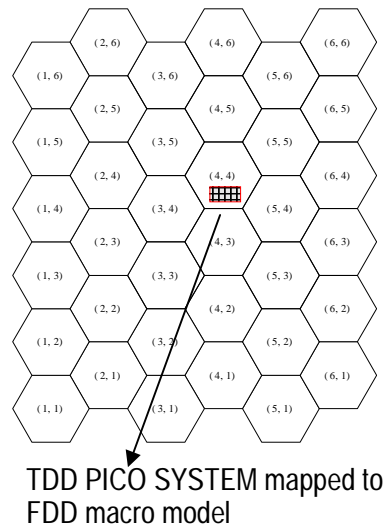


Figure 31: TDD pico and FDD Macro evaluation layout; Pico model chosen from [UMTS 30.03 - reference to be included.]

Here, it is assumed that TDD is operating inside the building hence the signals entering and exiting the building are attenuated because of the wall losses. In order to model the attenuation, an additional loss of 10 dB is added to the path loss of all signals crossing the TDD cell edge.

Statistics from FDD is collected from the central cell only. And this cell is the COI (Cell of Interest). The multiple FDD cells have been deployed to generate adequate FDD interference for the TDD system. The FDD macro cell range has been set to 500 m.

9.1.2.3 Propagation Model

9.1.2.3.1 TDD BS to TDD UE

This model is obtained from [9]. The indoor path loss model expressed in dB is in the following simplified form, which is derived from the COST 231 indoor model. This low increase of path loss versus distance is a worst-case from the interference point of view:

$$L_1 = 37 + 30\log_{10}(r) + 18.3n^{((n+2)/(n+1)-0.46)}$$

Where:

- r is the transmitter-receiver separation given in metres;
- n is the number of floors in the path.

NOTE: The UE-UE and BS-BS propagation model for the indoor environment are the same as BS-UE propagation model except that the antenna gains are different.

9.1.2.3.2 FDD UE to FDD BS

The FDD UE-FDD BS propagation model, obtained originally from [9], is applicable for the test scenarios in urban and suburban areas outside the high rise core where buildings are of nearly uniform height. Assuming, that the base station antenna height is fixed at 15 m above the rooftop, and a carrier frequency of 2 GHz is used, the FDD UE-FDD BS path loss L_2 can be expressed as [2]:

$$L_2 = 15.3 + 37.6\log_{10}(r)$$

Where:

- r is the transmitter-receiver separation in meters.

9.1.2.3.3 TDD UE to FDD BS

This is determined from L_2 described above by adding wall loss attenuation to the calculated value.

9.1.2.3.4 FDD UE to TDD UE

For this path, it depends where the FDD terminals are located if the FDD terminals are within the indoor system then the pathloss L_1 is chosen otherwise if the FDD Terminals are outside the indoor system then L_2 is chosen, to L_2 wall loss attenuation is added.

9.1.2.3.5 FDD UE to TDD BS

For this path, it depends where the FDD terminals are located if the FDD terminals are within the indoor system then the pathloss L_1 is chosen otherwise if the FDD Terminals are outside the indoor system then L_2 is chosen, to L_2 wall loss attenuation is added.

9.1.2.3.6 TDD BS to FDD BS

The TDD BS-FDD BS path loss is calculated with the help of L_2 and the wall loss attenuation is added to L_2 .

In the system simulations, a log-normally distributed shadowing component with standard deviation of 10 dB (macro cell) or 12 dB (pico cell) is added to calculated propagation path loss.

9.1.2.4 Power Control

Power control is a simple SIR based power control. Perfect power control is assumed. With the assumption of perfect power control, PC error is assumed equal to 0 %, and PC delay is assumed to be 0 s.

- TDD UL Power Control Range: 65 dB.
- TDD DL Power Control Range: 30 dB.
- FDD UL Power Control Range: 65 dB.

9.1.2.5 Interference Modelling Methodology

The interference calculations are done such that in each links (UL or DL) the total interference is the sum of intra system interference and inter system interference's). In calculations for the intersystem interference, the RF characteristics of transmitter and receiver are taken into account by weighting adjacent system signal with a parameter ACIR. The definition for ACIR and other related radio parameters is explained below.

ACLR: is a measure of transmitter performance. It is defined as the ratio of the transmitted power to the power measured after a receiver filter in the adjacent RF channel. Both the transmitted power and the received power are measured with a filter response that is root-raised cosine, with a noise power bandwidth equal to the chip rate.

ACS: is measure of receiver performance. It is defined as the ratio of the receiver filter attenuation on the assigned channel frequency to the receiver filter attenuation on the adjacent frequency.

ACIR: is a measure of over all system performance. It is defined as the ratio of the total power transmitted from a source (base station or UE) to the total interference power affecting a victim receiver, resulting from both transmitter and receiver imperfections. They have following relationship:

$$ACIR = \frac{1}{\frac{1}{ACLR} + \frac{1}{ACS}} .$$

For these simulations ACLR's and ACS's used are have been described in table 22.

Table 22: ACLR's and ACS's for TDD and FDD systems

	TDD				FDD	
	UE ACS	UE ACLR	BS ACS	BS ACLR	BS ACS	UE ACLR
dB	33	33	45	45	45	33

9.1.3 Capacity Calculations

9.1.3.1 Calculation of Single Operator Capacity for TDD and FDD

In order to study the impact of capacity due to adjacent channel interference between TDD and FDD the capacity evaluation of individual operators is done as follows. Single operator capacity designated by N_{Single} for each system is determined as follows:

- 1) generate BS's as per the selected environment (indoor case selected in these simulations);
- 2) reset the output data collection counters;
- 3) generate mobiles randomly;
- 4) calculate the path loss between each UE and the base station;
- 5) determine the best server;
- 6) calculate the co-channel interference;
- 7) control power till it stabilizes such that the used power will reach the level required by the required quality. This is the stabilization period;
- 8) execute sufficient number of power control commands in each power control loop;
- 9) collect the statistical data for outage and satisfied users .This is based on:
 - UE's whose SIR is lower than the target (in outage) and UEs whose SIR is higher than the target (satisfied);
- 10) increase or decrease the N_{Single} and start again till the satisfied user criterion is achieved.

The co-channel interference is modeled in the similar manner as described in [12]. Since in DL, the multiple transmitted signals are synchronously combined the intra operator interference is multiplied by orthogonality factor.

9.1.3.2 Calculation of Multi Operator Capacity

Mullet operator capacity designated by N_{Multi} is calculated as follows:

- 1) generate BS's as per the selected environment (option for pico,micro and macro.Pico considered here);
- 2) reset the output data collection counters;
- 3) generate mobiles randomly;
- 4) Calculate the path loss between each UE and the base station;
- 5) determine the best server;
- 6) calculate the co-channel interference and the adjacent channel interference at the victim station. (If the victim is TDD adjacent channel interference is from FDD system, if the victim is FDD adjacent channel interference is from TDD system);
- 7) control power till it stabilizes such that the used power will reach the level required by the required quality. This is the stabilization period;
- 8) a sufficient number of power control commands in each power control loop are executed;

9) collect the statistical data for outage and satisfied users for each operator .This is based on:

- UE's whose SIR is lower than the target (in outage) and UEs whose SIR is higher than the target (satisfied);

10) increase or decrease the N_{Multi} and start again till the satisfied user criterion is achieved.

9.1.3.3 Calculation of relative capacity loss

N_{Single} and N_{Multi} were determined above. The relative capacity loss in each system is calculated as follows:

$$C = 1 - \frac{N_{Single}}{N_{Multi}},$$

where C is the relative capacity loss of the system.

The *capacity criterion* is such that the UE's whose SIR at the end of the simulation is lower than the target Eb/N0 are in outage whereas UE's whose SIR is above the Eb/N0 are satisfied. At each simulation round it is assumed that 95 % of the users fulfil the satisfied user criterion.

9.1.4 Simulation Parameters

Table 23 represents the system parameters chosen for these simulations. Radio parameters are chosen from [12].

Table 23: Simulation Parameters

Parameter	FDD UL	TDD UL	TDD DL
Service parameters			
Bit rate (speech)	8 kbps	8 kbps	8 kbps
Eb/No target [dB]	6,1	3,7	6,1
Processing gain [dB]	26,3	13,9	13,9
SIR target [dB]	-20,2	-10,2	-7,8
Radio parameters			
Max Tx power [dBm]	21 (UE)	21 (UE)	33 (BS)
Power cntrl range [dB]	65	65	30
Frequency [MHz]	1 925	1 920	1 920
Other parameters			
Radio environment	macro	pico	pico
BS MUD	off	off	-
Channel non-orthogonality	-	-	0.06
MCL [dB] (Minimum coupling loss)	70 FDD BS -> FDD UE, TDD BS, TDD UE	40 TDD BS -> TDD UE, FDD UE	40 TDD UE-> FDD UE

9.1.5 Simulation results

The impact of TDD interference to FDD system was studied by locating the TDD indoor system in different locations in the FDD COI. The FDD and TDD system capacity losses were observed as function of ~~FDD BS - TDD system separation~~ coupling loss between TDD system and FDD macro BS. The results are summarised in table 24.

Table 24: Impact of ~~TDD-FDD system separation~~ coupling loss between TDD and FDD systems

Impact of TDD-FDD separationsystem coupling loss	40 m70.3	50 m90.8	100 m103.2	450 m130.0
TDD UL Capacity Loss	< 1 %	< 1 %	< 1 %	< 1 %
TDD DL Capacity Loss	< 1 %	< 1 %	< 1 %	< 1 %
FDD UL Capacity Loss	< 11 %	< 4 %	< 2 %	< 1 %

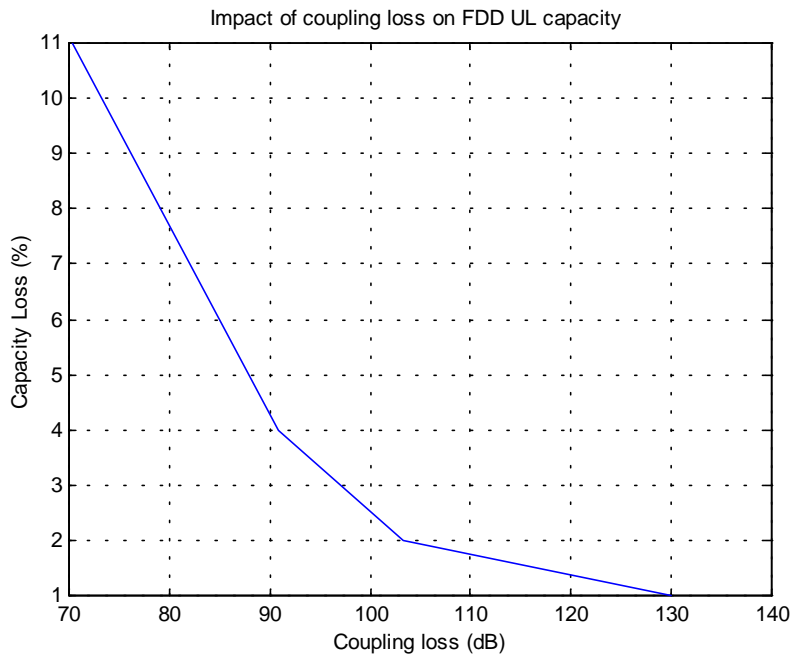


Figure 33. FDD capacity loss along the coupling loss between FDD macro BS and TDD pico system.

The results indicate that TDD indoor system capacity is not significantly affected by adjacent channel FDD interference. This is because there is adequate power available in TDD system to handle FDD interference.

9.1.6 Conclusions

Results indicate:

- no impact on TDD system capacity due to FDD operating in adjacent channel in this mode (FDD macro configuration);
- minor capacity losses are experienced by FDD UL if TDD system is too close to FDD BS (note however 10 m separation case is not valid from practical implementation point of view);
- adjacent channel operation of TDD and FDD system under stated conditions is possible;
- also, the TX powers of TDD entities in these simulations are very high. In practice, power levels in Local area TDD cells (in UL and DL) are obviously lower. Thus impact on FDD UL shall be reduced further.