TSG-RAN Meeting #10 *RP-000524*
Bangkok, Thailand, 6 - 8 December 2000

(R4-000998, to TSG-RAN) Response to LS (R1-001321) on 1.28 Mcps TDD and 3.84 Mcps TDD co-existence studies in RAN4

Title: LS on 1.28 Mcps TDD and 3.84 Mcps TDD co-existence studies in RAN4 (answer to R1-00-1321)
Source: TSG-RAN4
To: TSG-RAN, TSG RAN1
Cc:

Document for:
Contact: **Daijun Zhang** **zhangdj@pub.tdscdma.com**

At the last TSG RAN #9 meeting in Hawaii, it was decided:

“WG4 was requested to study/continue studying the co-existence of the two TDD options in the unsynchronised case in adjacent bands, and to study to what extent requirements needed to be tightened.”

The following results have been achieved.

1. In accordance with the RAN 4 agreed simulation methodology on co-existence investigations, Monte Carlo based simulation results for unsynchronised operation in adjacent bands have been provided covering the following scenarios:
   a) 1.28 Mcps TDD MS ↔ 3.84 Mcps TDD BTS
   b) 1.28 Mcps TDD BTS ↔ 3.84 Mcps TDD MS
   c) 1.28 Mcps TDD MS ↔ 3.84 Mcps TDD MS
   In the additional RAN4 Ad-hoc meeting in Berlin it was concluded:
   “General consensus is that using the Monte Carlo based simulation method the MS to MS, MS to BTS and BTS to MS cases only produce a minor degradation in capacity (<2%).”
   The results on these co-existence studies will be included in the RAN4 technical report on 1.28 Mcps TDD (TR 25.945).
   The relevant documents are attached in Annex A.

2. A deterministic calculation for 1.28 Mcps TDD BTS ↔ 3.84 Mcps TDD BTS interference for the unsynchronised case in adjacent bands has been provided.
   In the additional RAN4 Ad-hoc meeting in Berlin it was noted:
   “The BTS to BTS case is of greatest concern, however the group need more time to study the assumptions. Given that operators will be willing to co-ordinate their planning there may be possibilities to improve the scenario. ”
   The relevant document is attached in Annex B.

3. Information on the system performance in case of co-siting of 1.28 Mcps and 3.84 Mcps TDD base stations and co-ordination between operators was provided during RAN4#14. Based on link level simulations the document concludes:
   “1.28 Mcps TDD and 3.84 Mcps TDD option can be synchronised. In the worst case of co-sited base stations, the overall cell capacity in the synchronised case is about 95 % of an ideal synchronised cell.“
   The relevant document is attached in Annex C.

Based on the provided results RAN4 concludes that for operation in adjacent bands a further alignment of the physical layer parameters / frame structure between 1.28 Mcps TDD and 3.84

Mcps TDD is not necessary, if operators co-ordinated to ensure both frame and switching point synchronisation.

RAN4 has finalised its simulation and study requested by RAN#9 on co-existence of the two TDD options in the unsynchronised case in adjacent bands. Based on the above listed results the work will be continued in order to complete the RAN4 technical report on 1.28 Mcps TDD, which includes to determine ACLR and ACS requirements.

Annex A:

R4-00COX002.doc R4-00COX003.doc

Annex B:

R4-00COX005.doc R4-000956.doc

Annex C:

R4-000972.doc

3GPP TSG RAN WG4 Meeting #14 **R4-000956**
Sophia, France 13th – 17th November 2000

TSG-RAN Working Group 4 (Radio) ad-hoc meeting R400COX006
November 9, 2000
Berlin, Germany

Title: Draft Meeting report from TDD Coexistence adhoc

Source: TSG-RAN WG4 adhoc chair

Introduction

A one day adhoc was held in Berlin on 9th November to discuss the wideband and narrowband TDD coexistence study. This meeting was requested by TSG RAN to answer if coordinated operators using adjacent channel wideband and narrowband TDD systems can coexist without synchronisation. This information is required to determine the need for a common frame structure for both options.

Detailed Notes

Tdoc 001 - Agenda was approved.

Tdoc 004 – LS from WG1 on LS on a proposal for a new frame structure for the 1.28 Mcps TDD option was presented by Telia.

Tdoc 002 - Coexistence Investigations related to 1.28Mcps TDD – 3.84Mcps TDD and 1.28Mcps TDD – 1.28Mcps TDD scenarios: simulation overview and assumptions was presented by Siemens.

Tdoc 003 - Coexistence Investigations related to 1.28Mcps TDD – 3.84Mcps TDD and 1.28Mcps TDD – 1.28Mcps TDD scenarios: simulation scenarios and results was presented by Siemens

Questions from Ericsson in Tdoc 2. on ACLR definitions, number of timeslot in up and down, these are the same.

Telia asked about the case of when the timeslots move relative to each other. When a sub-frame is errored how is this taken into account when the other sub-frame is studied, answer is that it is not. This means that different frame structures would not affect the result. However the simulation is worse case because it assumes that all the mobiles are transmitting when in reality they may not be.

Telia concerned about the UE to UE interference case which would be worse if the mobiles are co-located. RAN 4 have used a Monte-Carlo based approach for all parameters, so we should continue here.

Both systems have the same loading in the simulator.

C/I figures are based upon the ITU submission, this has power control enabled. These have been mapped from the 12kbps to 8 kbps. Was this based on the new chip rate, Siemens believe that it is the new chip rate but will check.

Nokia asked about the maximum BTS output power per user, and why are they different. This is because these were the figures used in the simulator and should not affect the results.

Ericsson concerned that it is too early to draw conclusion before the BS to BS interfernce has been analysied. The conclusions are for these studies.

Nokia asked about the BS grid layouts. The relation between the 2 systems move on a drop by drop basis.

CSELT asked about why the worse case cause changes from wideband to narrowband. It appears that this is may be because of the different transmit masks, but Siemens are not sure at this time.

Telia ask Siemens to study the situation where the BS to BS grids are fixed relative to each other. They agreed to look at this.
Tdoc 005 - Coexistence of 1.28Mcps TDD and 3.84 Mcps TDD was presented by Telia.

Siemens asked about the path loss and antenna gains. It appears that these are worse case scenario's where the antennas are pointing directly at each other and getting the full lobe gain. It would be interesting to compare these losses with the measured results presented by Algon in RAN 4.

Request made from Siemens to study this paper in more detail before the next RAN 4 meeting.

China Mobile commented that the Telia worse case would not happen in practice because the operators would coordinate to reduce these effects by antenna down titling, reduction in output power and allowing a greater increase in the noise floor.

Conclusion

General consensus is that using the Monte Carlo based simulation method the MS to MS, MS to BTS and BTS to MS cases only produce a minor degradation in capacity (<2%). Some concerns were expressed over the fact that worse case scenarios, especially the mobile to mobile case, have not been performed and ideally the group would like to see some form of simulation with more correlated mobiles, this could be difficult to perform. The concern is than in real life scenarios people make calls next to each other.

The BTS to BTS case is of greatest concern, however the group need more time to study the assumptions. Given that operators will be willing to coordinate their planning there may be possibilities to improve the scenario. The group will need more figures on the antenna to antenna path losses and output powers that coordinating operators would find acceptable.

This area will be addressed again during the RAN 4 plenary #14 to be held on Sophia Antipolis Nov 13 - 17.

Attendance list

Title	Family Name	Forename	Company
Mr.	Anand	Paul	Alcatel
Ms.	Badà	Anna Marina	Siemens ICN SpA
Mr. Dr.	Benn	Howard	Motorola
Mr.	Dick	Stephen	InterDigital Communications Corp.
Mr.	Edwards	Keith Russel	Nortel Networks
Mr. Dr.	Ernström	Per	Telia AB
Mr.	Fritze	Stefan	Siemens AG
Mr. Dr.	Gila	Janos	Siemens AG
Mr.	Höynck	Andreas	Siemens AG
Mr.	Ito	Makoto	NTT DoCoMo
Mr.	Kottkamp	Meik	Siemens AG
Mr. Dr.	Krause	Jörn	Siemens AG
Mr.	Patronen	Petri	Nokia
Ms.	Ronchini	Christina	CSELT
Mr.	Spaling	Gerke	LM Ericsson
Ms.	Zhang	Xiaoli	CATT/CWTS
Mr.	Zhou	Meng	CMCC/CWTS
Mr.	Dong	Chen	Siemens China

TSG-RAN Working Group 4 (Radio) meeting #14 ***TSGW#14(00)972***
Sophia-Antipolis, France, Nov. 13-17, 2000

Agenda Item: 6.1. 1

Source: CWTS

Title: System Performance of coordinated 1.28Mcps and 3.84Mcps TDD operation in case of co-siting

Document for: Information and Discussion

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1. Introduction

The co-existence studies for TDD within 3GPP TSG RAN WG 4 assume un-synchronised and un-coordinated operation between operators. The requirements in the standard are set in such a way that a proper operation for this general scenario is ensured.

In RP-000485 it was requested to study in addition the coordinated operation in case of co-siting of 1.28 Mcps and 3.84 Mcps TDD base stations. Even though it was decided at RAN#9 not to perform these kind of studies in WG 4, CWTS would like to provide WG 4 with information on the system performance in case of co-siting of 1.28 Mcps and 3.84 Mcps TDD base stations and co-ordination between operators.

2. Synchronisation between 1.28 Mcps and 3.84 Mcps TDD

Due to a common frame length of 1.28 Mcps and 3.84 Mcps TDD, it is possible to frame synchronise the two TDD options. To avoid interference between uplink and downlink on adjacent carriers in case of co-siting, the switching points for the two systems must be synchronised in addition. Figure 01 shows the frame structure of the two systems in case of synchronised frame timing and synchronised switching points and a symmetric UL/DL factor. It should be noted that it is still possible to vary the UL/DL factor.

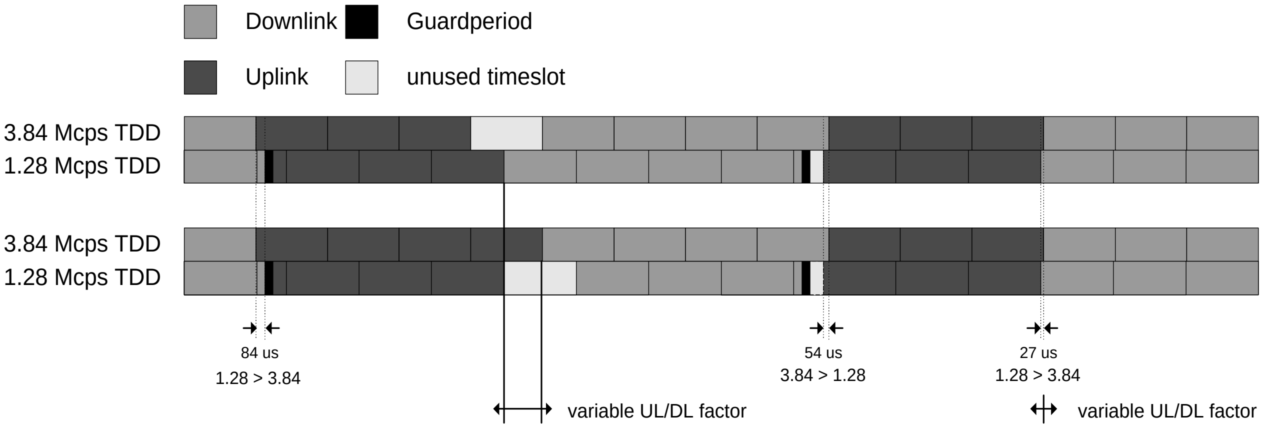

Figure 01 Frame structures of the coordinated scenario

In case that the DL and UL timeslots of the systems overlap by a significant amount at the switching points, it is assumed that the timeslot has to be unused in one of the systems. Consequently, one traffic timeslot either in 3.84Mcps TDD or 1.28Mcps TDD remains unused.

At the other switching points the UL and DL timeslots of the systems overlap slightly. This leads to a capacity loss for the interfered uplink timeslot. From Figure 01, it can observed that the longest period of 3.84Mcps TDD interfered by 1.28Mcps TDD is about 84 us. The longest period of 1.28Mpcs TDD interfered by 3.84Mcps TDD is about 54 us. The performance for these two cases with interfered timeslot is studied in the next chapter.

It can be seen from Figure 01 that the UpPCH in one of the two 1.28Mcps TDD slots cannot be detected by its node B since there is a transmission in parallel on the adjacent carrier. Nevertheless the system can still work well with the other UpPCH in the two frames although there is a reduced number of possible UpPCH. The scheduling on the FPACH will ensure that all random access resources can be used. This is the case since the FPACH can grant the UpPCHs of the past 4 sub-frames.

3. Link Performance in case of partly overlapping UL and DL timeslots

3.1. 3.84 Mcps TDD

3.1.1 Simulation assumptions

In the worst case the 3.84 Mcps TDD UL timeslot is interfered by a 1.28 Mcps DL timeslot for about 84 us (83.33 us exactly=320 chips for high chip rate TDD). This case was chosen for investigation of this co-siting situation.

For the simulated services two cases of receiving the data are compared.

Case1: No additional Interference (No adjacent low chip rate TDD downlink channel).

Case2: First 320 chips, additionally interfered by a low chip rate TDD downlink channel, considered as undetectable at the receiver.

Case 2 can be done based on the following General Simulation assumptions

- UTRA TDD release 99 compliant simulation environment
- Uplink
- JD-receiver (ZF-BLE)
- No oversampling
- chiprate 3.84 Mcps
- 15 TS per frame
- TS duration = 666.66 µs
- SF = 16
- Channel mode: vehicular A (120 km/h)
- Real channel estimation
- Antenna diversity (2 antennas)
- TFCI, TPC and DCCH bits are included, but not evaluated
- No power control

3.1.2. Service mapping

The service mapping for implementing the 8kbps speech are summarised in table 01.

Service	**Speech, 8 kbit/s, 20 ms delay**
User bit rate	8 kbit/s
Number of time slots per frame per user	1
Number of codes per time slot per user	1
Burst type	Burst type 1
Data modulation	QPSK
Convolutional code, coding rate	1/3
Total code rate	0.328
Interleaving depth	2 frames
User block size	160 bits

Table 01: Service mapping for the 8kbps service for 3.84 Mcps TDD

3.1.3. Simulation results

In Figure 02 the performance difference of the two cases are shown for the vehicular A environment.

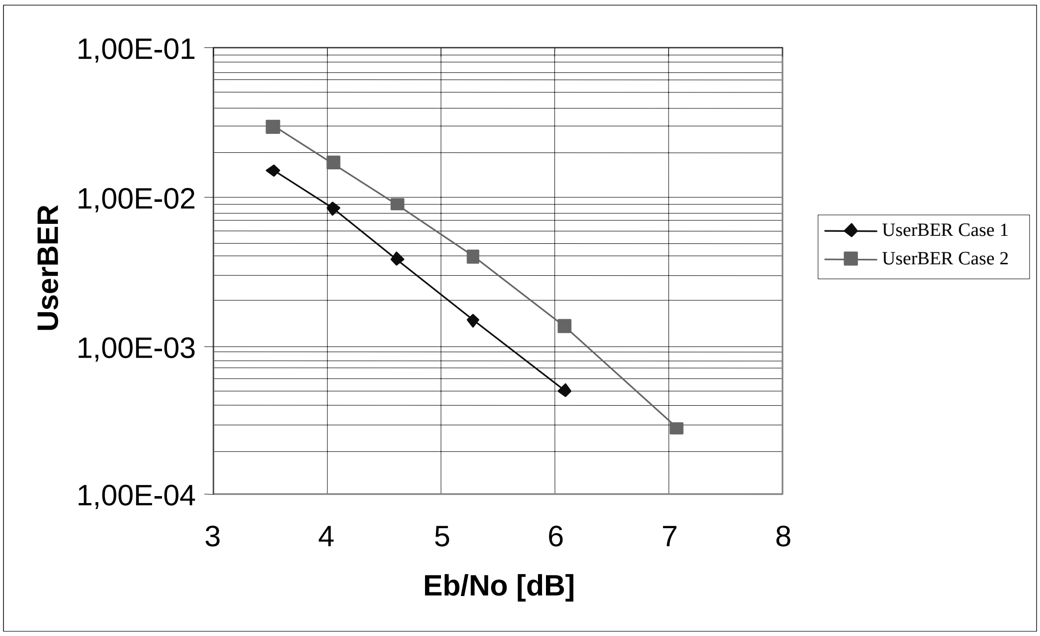

Fig. 02: 3.84 Mcps TDD, UserBER of the 8 kbps speech service, Vehicular A, uplink, JD, Antenna Diversity

The simulation results of Figure 02 show that the performance degradation between Case 1 and Case 2 is about 0.8 dB.

3.2 1.28Mcps TDD

3.2.1. Simulation assumptions

The worst interfering case for 1.28Mcps is that the longest overlapping of an uplink and downlink channel is about 54 us (70 chips for low chip rate TDD). And it was chosen for investigation.
For the simulated services two cases of receiving the data are compared.
Case1: No additional Interference (No adjacent high chip rate TDD downlink channel).
Case2: First 70 chips, additionally interfered by a low chip rate TDD downlink channel, considered as undetectable at the receiver in every sub-frame.

General Simulation assumptions for case 2 is

- Uplink
- JD-receiver (ZF-BLE)
- No oversampling
- chiprate 1.28 Mcps
- 7 TS per sub-frame
- TS duration = 675 µs
- SF = 16
- Channel mode: vehicular A (120 km/h)
- Real channel estimation
- Smart antenna (8 antennas)
- TFCI, TPC and DCCH bits are included, but not evaluated
- No power control

3.2..2. Service mapping

The service mapping for implementing the 12.2kbps are summarised in table 02.

Service	**Speech, 12.2k+2.4k, 20 ms delay**
User bit rate	12.2k+2.4k, but the results are from 12.2k only
Number of time slots per frame per user	1
Number of codes per time slot per user	2
Burst type	Burst type 1
Data modulation	QPSK
Convolutional code, coding rate	1/3, ½
Total code rate	See TR 25.928
Interleaving depth	4 sub-frames
User block size	See TR 25.928

Table 02: Service mapping for the 12.2kbps service

3.2.3. Simulation results

In Figure 03 the performance difference of the two cases are shown for the vehicular A environment.

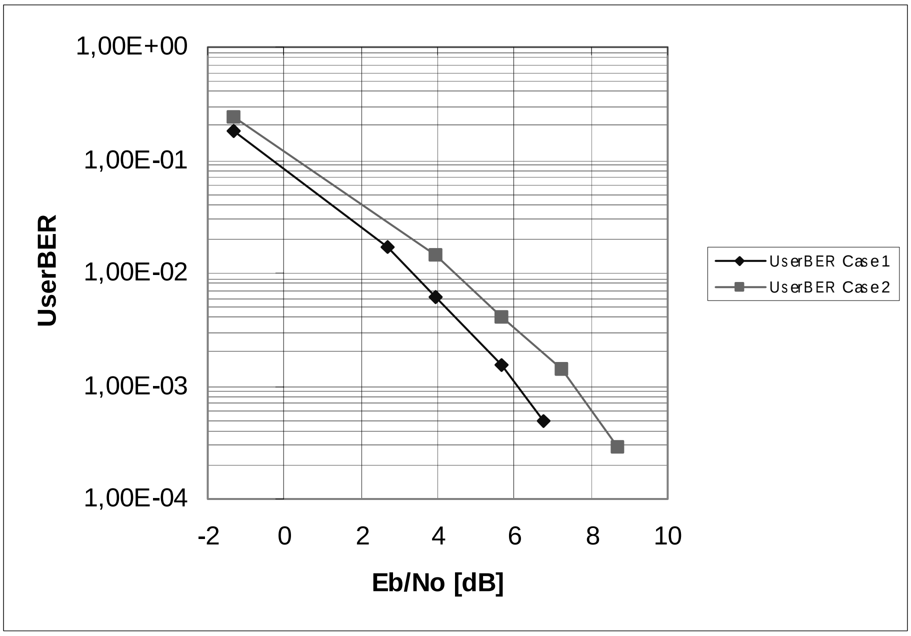

Fig. 03: 1.28 Mcps TDD, UserBER of the 12.2 kbps speech service, Vehicular A, uplink, JD, Smart Antenna

The simulation results of Figure 03 show, that the performance degradation between Case 1 and Case 2 is about 1.5 dB for the vehicular environment. If it is taken into account that only every second sub-frame is affected like this (see Figure 01), the performance degradation will only be about 0.8 dB as well. The simulations are giving a worst case result since every sub-frame is assumed to be interfered by the downlink of 3.84 Mcps TDD.

4. System Performance

For 3.84 Mcps TDD, the link performance was degraded by 0.8 dB at the most in case that 84 us of the timeslot were interfered by the DL on the adjacent carrier. A capacity loss of about 20 % in this timeslot is expected due to the performance degradation. At the other switching point only 27 us of the timeslot are interfered. A capacity loss of about 10 % is expected for this timeslot.

For 1.28 Mcps TDD, the link performance was degraded by 1.5 dB at the most in case that 54 us of the timeslot are interfered. A capacity loss of about 20 % is expected for this timeslot.

For the unused timeslots a capacity loss of 100 % is assumed. This is a worst case assumption, because the unused timeslot reduces the interference level on the adjacent carrier and in neighboring cells. Therefore the capacity on the adjacent carrier and in neighboring cells is higher during the unused timeslot.

Due to the 5 ms subframe structure of 1.28 Mcps TDD, one DL timeslot in the second sub-frame corresponds to the unused timeslot. The FPACH is a one burst message and uses only one sub-frame. Therefore, this timeslot is particularly suited for the FPACH and provides full capacity.

In Figure01 two scenarios were presented where either 1.28 Mcps TDD is preferable treated or 3.84 Mcps TDD is preferable treated. In the following the capacity for these scenarios is calculated.

3.84 Mcps TDD treated preferable:
3.84 Mcps DL capacity = 8 TS / 8 TS = 100%
3.84 Mcps UL capacity = 6,7 TS / 7 TS = 96 %
1.28 Mcps DL capacity = 7 TS / 8 TS = 88 %
1.28 Mcps UL capacity = 5,8 TS / 6 TS = 97 %
⇨ Overall average capacity = 95 %

1.28 Mcps TDD treated preferable:
3.84 Mcps DL capacity = 8 TS / 8 TS = 100%
3.84 Mcps UL capacity = 5,7 TS / 7 TS = 81 %
1.28 Mcps DL capacity = 8 TS / 8 TS = 100 %
1.28 Mcps UL capacity = 5,8 TS / 6 TS = 97 %
⇨ Overall average capacity = 95 %

In both cases the overall cell capacity loss of both systems is about 5 %. It should be noted that this loss only occurs in cells where the two systems are co-sited and coordinated on adjacent carriers and not in the complete network. The unused timeslot can be fully occupied in the neighboring cells.

5. Conclusion

1.28 Mcps TDD and 3.84 Mcps TDD option can be synchronised. In the worst case of co-sited base stations, the overall cell capacity in the synchronised case is about 95 % of an ideal synchronised cell. It has to be considered that operators have to align not only their frame timing but also their switching points to gain from synchronisation in case of co-sited operation. The difference in traffic asymmetry demands of the synchronised operators will lead to unoccupied timeslots. Therefore the actual capacity loss will be much lower than 5 %.

The two TDD options with its characteristic features are optimized for their individual application areas. An alignment of the two TDD options up to an extend where one of the options will have a significant degradation in their usual application area can not be justified by the small gain expected in the special coordinated co-sited case.

TSG-RAN Working Group 4 (Radio) ad-hoc meeting
November 9, 2000
Berlin, Germany

Title: Coexistence Investigations related to
1.28Mcps TDD – 3.84Mcps TDD and
1.28Mcps TDD – 1.28Mcps TDD scenarios:
simulation overview and assumptions

Source: Siemens
Agenda Item: 3
For: Discussion

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1 Introduction

In RAN meeting #13 simulation results for the coexistence of FDD and 1.28Mcps TDD systems were presented [7].
Here the investigations are continued by coexistence studies about 1.28Mcps and 3.84Mcps TDD systems.

This document gives a short overwiew of the Monte-Carlo snapshot simulation tool and a description of the rf-parameters of the 1.28Mcps and the 3.84Mcps TDD system used in the coexistence simulations.

The investigated scenarios and the relative capacity loss results of these coexistence studies are summarized in document [1].

2 Overwiew of the simulation

The focus of the simulations in the first step is on coexistence of macro cells considering a vehicular environment (case 3: 120km/h) with 8kbps speech users only.

The simulation is a Monte-Carlo based snapshot method calculating CDFs for C/I for large numbers ('trials') of stochastic mobile distributions over cells (including power control).
It should be pointed out that no kind of synchronisation or coordination between the different systems is assumed in the coexistence simulations presented here and before.
The goal of simulation procedure is to determine the relative capacity loss of a victim system for a considered link (uplink or downlink) due to the presence of a second system – the interfering system. The reference for the capacity loss is the capacity of the victim system alone without the interfering system.
The shift between the cell grid of the victim system and the cell grid interferer system is randomly chosen for each trial. For both systems a cell coverage radius of 500m is assumed.

The ***capacity of the system*** is defined as the mean number of mobile stations per cell (i.e. the load in different cells may be different while the mean load, i.e. the total number of users in the simulated scenario, remains constant) that can be active at a time while the probability that the C/I of a mobile station falls below a given threshold C/I_{min} is below 5% (i.e the percentage of users which do not satisfy the C/I criteria for the speech service is 5%).

This definition is different but strongly related to the so-called “satisfied user criterion” (i.e. 98% of all users have to be able to complete their call without being dropped due to interference). However the “satisfied user criterion” requires the mapping of C/I to BER/BLER values and time-continuous simulation techniques, while here a Monte Carlo snap shot method is used.

The simulation is done in two steps.
At first N_{single} the capacity of the ***single operator*** case (i.e. only the victim system is present) is determined which means that the capacity depends on the co-channel interference (i.e. there is no adjacent channel interference).
The co-channel interference power itself depends on a number of parameters, especially on the number of mobiles, their position and their power control behaviour.
N_{single} is the maximum mean number of mobiles per cell that can be active at a time in the single operator case.

The second step is the calculation of the ***multi operator*** capacity (i.e. victim and interferer system are present) which means the maximum mean number of mobiles per cell N_{multi} in the victim system that can be active at a time when considering co-channel and adjacent channel interference.
To determine N_{multi} the multi operator simulation is started with $N_{multi} = N_{single}$. Due to the additional adjacent channel interference the outage of users with C/I below the threshold C/I_{min} is increased compared to the single operator case (5%).
By decreasing N_{multi} until the outage of 5% is reached again the capacity loss due to adjacent channel interference can be determined.
(The number of users in the interfering system is chosen in that way that a single operator simulation with this system would result in an outage of 5%.)

Finally the relative capacity loss can be calculated as

$$C = 1 - \frac{N_{multi}}{N_{\sin gle}}$$

For further details about the simulator see also 25.942 [9] section 6.2, R4-99653 [2] and R4-00-0414 [3].

3 Simulation parameters

This section compares the different simulation parameters for 3.84Mcps TDD and 1.28Mcps TDD which are used to describe the ‚victim system‘ and the ‚interferer system‘ in the coexistence simulation scenarios.

General Parameters

No.	Parameter		a. 3.84Mcps TDD		b. 1.28Mcps TDD	
			MS	BS	MS	BS
P1	Chip rate	Mcps	3.84		1.28	
P2	Frame length	ms; chip	10ms; 38400		10ms; 12800	
P3	Slot length	ms;chip	666.666µs; 2560		675µs; 864	
P4	Slots per frame	1	15		14 (+ pilots and guard period)	
P5	Chip length	Ms	260.41666ns		781.25ns	
P6	Sfmax	1	16		16	
P7	Sfmin	1	1		1	
P8	Size of data symbol alphabet	1	4 (QPSK)		4 (QPSK)	
P9	No. of codes per TS	1	12		16	
P10	No. of codes used for an 8kbps speech service	1	UL: 1x SF=16 DL: 1x SF=16		UL: 1x SF=16 DL: 1x SF=16	
P11	User bandwidth	MHz	3.84		1.28	
P12	Channel spacing	MHz	5		1.6	
P13	Antenna position over ground	M	MS: 1.5m BS: antenna height (15m) + average roof top level (12m) =27m			
P14	Considered coverage area	Cell radius in m	Macro: 500m			
P15	Considered cluster size	1	-	1	-	1
P16	Minimum coupling loss (MCL)	DB	BS-MS: 70, MS-MS: 35		BS-MS: 70, MS-MS: 35	

Receiver Parameters

No.	Parameter		a. 3.84Mcps TDD		b. 1.28Mcps TDD	
			MS	BS	MS	BS
RX1	Sensitivity	DBm	-105	-109	-108	-110
RX2	Noise figure	DB	9	5	9	7
RX3	Antenna gain (incl. losses)	DBi	0	11	0	11
RX4	ACS	DB	33	45	33	45
RX5	Min. CIR for 8kbps speech	DB	-5.6	-8.1	-1.5	-6.7

Transmitter Parameters

No.	Parameter		a. 3.84Mcps TDD		b. 1.28Mcps TDD	
			MS	BS	MS	BS
TX1	Max. TX power	DBm	30	43 (36 per user)	30	43 (33 per user)
TX2	Min.Tx power per user	DBm	-44	36-30=6	-44	33-30=3
TX3	Antenna gain	DB	See RX3			
TX4	PC dynamic range (1 code considered)	DB	Max –(-44) = 74	30	Max –(-44) = 74	30
TX5	ACLR	DB	33 (43)	45 (50)	33 (43)	40 (50)

As a first step concerning the minimum C/I ratio values of the 1.28Mcps TDD system for the 8kbps speech service the results of R4-00TDD054 [5] and R4-00TDD055 [6] for a 12.2kbps service for case 3 were taken:
UL (i.e. receiving BS): C/Imin = -4.9dB
DL (i.e. receiving MS): C/Imin = 0.3dB.
Considering the mapping of the information data bits for the 12.2kbps service in UL and DL (see R4-00TDD051 [4]): 244 bits are mapped on 536 bits.
For an 8kbps speech service we assumed in a first approach that

244 x (8kbps / 12.2kbps) bits are mapped on 536bits

which results in a subtraction of 1.83dB for the both C/Imin values mentioned before which finally lead to the values in the table.
For the 3.84Mcps TDD system the minimum C/I requirements were taken from [8].

The ACLR and ACS values were taken from the specifications 25.102, 25.105 for 3.84Mcps TDD and the report 25.945 for 1.28Mcps TDD.

The cluster size of the 1.28Mcps TDD, i.e. the reuse of a frequency channel, may be chosen to be 1 (like for 3.84Mcps TDD) or 3 (since the 1.28Mcps TDD has one third of the bandwidth of the 3.84Mcps TDD). In our investigations we take cluster=1 as a first approach.

4 Scenarios and simulation results

For the investigated scenarios and the calculated relative capacity loss results please see document [1].

5 References

[1] RAN WG4 TDD ad-hoc, Nov. 9th, 2000, Berlin (Germany), Tdoc(00)xxx, Coexistence Investigations related to 1.28Mcps TDD – 3.84Mcps TDD and 1.28Mcps TDD – 1.28Mcps TDD scenarios: simulation scenarios and results
[2] RAN WG4 meeting #8, Oct. 26-29, 2000, Sophia Antipolis (France), Tdoc(99)653, Summary of results on FDD/TDD and TDD/TDD coexistence
[3] RAN WG4 meeting #11, May 22-26, 2000, Turku (Finland), Tdoc(00)0414, TDD capacity loss simulation results due to adjacent channel interference
[4] RAN WG4 TDD adhoc, Aug. 23-24, 2000, London (UK), Tdoc (00)TDD051, Reference measurement channels for 1.28Mcps chip rate TDD option
[5] RAN WG4 TDD adhoc, Aug. 23-24, 2000, London (UK), Tdoc (00)TDD054, Simulation assumptions for 1.28Mcps TDD performance requirements
[6] RAN WG4 TDD adhoc, Aug. 23-24, 2000, London (UK), Tdoc (00)TDD055, Simulation results for 1.28Mcps TDD performance requirements
[7] RAN WG4 meeting #13, Sep. 4-8, 2000, Turin (Italy), Tdoc (00) 0607, Coexistence scenarios related to 1.28Mcps TDD: First results
[8] Evaluation Report for ETSI UMTS Terrestrial Radio Access (UTRA) ITU-R RTT Candidate, (Sep. 1998), Attachment 5
[9] RAN WG4, 3G TR 25.942 v2.3.0, 2000-09, RF System Scenarios

TSG-RAN Working Group 4 (Radio) ad-hoc meeting
November 9, 2000
Berlin, Germany

Title:	Coexistence Investigations related to 1.28Mcps TDD – 3.84Mcps TDD and 1.28Mcps TDD – 1.28Mcps TDD scenarios: simulation scenarios and results
Source:	Siemens
Agenda Item:	3
For:	Discussion

1 Introduction

First simulation results for 1.28Mcps TDD and FDD coexistence scenarios were already presented in [1].

Based on the Monte-Carlo simulation method and the simulation assumptions explained in document [2] this document summarizes the considered coexistence scenarios and the calculated relative capacity loss values of a system A due to adjacent channel interference of another system B in the same geographic area. One of the systems A and B is 1.28Mcps TDD. The other one is a 1.28Mcps TDD or a 3.84Mcps TDD system.

For 1.28Mcps TDD a system with cluster=1 is assumed for the coexistence simulations, i.e. the reuse of the considered frequency band is 1, which means that the same band is used in the neighbour cell. Compared to systems with cluster=3 this system with cluster=1 corresponds to the worst case of adjacent channel interference.

It has to be pointed out that no kind of synchronisation or coordination is used between system A and system B in these coexistence simulations.

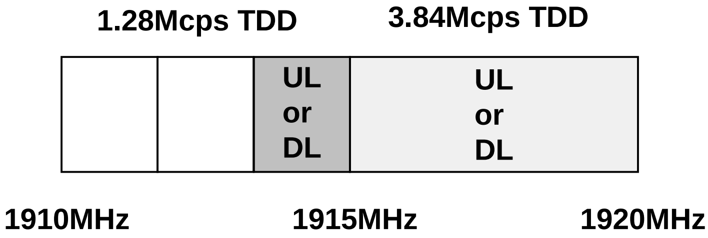
For all the simulations frequency bands adjacent to 1915MHz are considered. However the results can also be applied for other frequencies where 1.28Mcps TDD and 3.84Mcps TDD systems can use adjacent frequency bands.

The focus of these investigations is on speech users in macro cells for a vehicular propagation environment.

Due to the Monte-Carlo snapshot character of this simulation method BS to BS investigations are not part of this document.

2 1.28Mcps TDD – 3.84Mcps TDD

2.1 Considered coexistence scenarios



The scenarios considered in this section refer to the frequency 1915MHz where 1.28Mcps TDD and 3.84Mcps TDD may be allocated in adjacent frequency bands.

In a first step the 1.28Mcps TDD system is assumed to be a victim for ajacent channel interference of a 3.84Mcps TDD system.
Since the TDD band may be used for uplink (UL) or downlink (DL) communication 3 different scenarios are of interest depending on which station (MS or BS) is receiving (RX) or transmitting (TX):

1. 3.84Mcps TDD MS (UL TX) causes interference to 1.28Mcps TDD BS (RX of UL)
2. 3.84Mcps TDD MS (UL TX) causes interference to 1.28Mcps TDD MS (RX of DL)
3. 3.84Mcps TDD BS (DL TX) causes interference to 1.28Mcps TDD MS (RX of DL)

In a second step the 3.84Mcps TDD system is the victim system suffering from adjacent channel interference of the 1.28Mcps TDD system. Here 3 further cases need to be investigated:

4. 1.28Mcps TDD MS (UL TX) causes interference to 3.84Mcps TDD BS (RX of UL)
5. 1.28Mcps TDD MS (UL TX) causes interference to 3.84Mcps TDD MS (RX of DL)
6. 1.28Mcps TDD BS (DL TX) causes interference to 3.84Mcps TDD MS (RX of DL)

2.2 Relative capacity loss results

The reason for the adjacent channel interference is the non-ideal rise of transmit and receive filter flanks so that a leakage of transmitted power in the adjacent frequency band and a reception from adjacent frequency bands can not entirely be prevented.
To limit this interaction between different frequency bands ACLR (adjacent channel leakage power ratio) requirements for the transmitter and ACS (adjacent channel selectivity) requirements for the receiver are specified (see [2]).
In the simulations of the 1.28Mcps TDD and the 3.84Mcps TDD system spectrum emission masks fulfilling these ACLR requirements are used.

Due to adjacent channel interference (i.e. from the interferer system) superimposed by co-channel interference contributions (i.e. from the victim system) received in the used frequency band it might happen that at the considered receiver station the C/I ratio is below a minimum C/I ratio (see section before) which is necessary for the considered service. The percentage of these users is called ‘outage’.

The used Monte-Carlo based snapshot simulator determines at first for a given outage of 5% the mean maximum number of mobiles per cell which can be active without adjacent channel interference (single operator case).

Afterwards the mean number of users for the same outage (as in the single operator case) is calculated taking into account the co-channel and the additional adjacent interference of the interferer system (multi operator case).

Depending on the adjacent channel interference of the interferer system in the multi operator case the capacity of the victim system may be reduced compared to the single operator case. This is called ‘relative capacity loss’.
The results for the relative capacity loss are summarized in the tables below.

For the case that the 1.28Mcps TDD system suffers from adjacent channel interference from a 3.84Mcps TDD system:

Victim (receiver)	**interferer (transmitter)**	**Relative capacity loss**
1.28Mcps TDD BS (cluster=1)	3.84Mcps TDD MS	< 1%
1.28Mcps TDD MS (cluster=1)	3.84Mcps TDD MS	< 2%
1.28Mcps TDD MS (cluster=1)	3.84Mcps TDD BS	< 2%

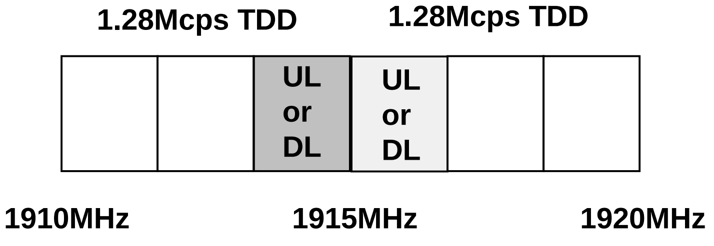
For the case that the 3.84Mcps TDD system suffers from adjacent channel interference from a 1.28Mcps TDD system:

Victim (receiver)	**interferer (transmitter)**	**Relative capacity loss**
3.84Mcps TDD BS	1.28Mcps TDD MS (cluster=1)	(*)
3.84Mcps TDD MS	1.28Mcps TDD MS (cluster=1)	< 1%
3.84Mcps TDD MS	1.28Mcps TDD BS (cluster=1)	< 2%

(*): simulation not yet terminated

3 1.28Mcps TDD – 1.28 Mcps TDD

3.1 Considered coexistence scenarios



In this section a scenario of two 1.28Mcps TDD operators in the same geographic area is investigated. For both systems apart from the frequency bands the same rf parameters and again no synchronisation or coordination is assumed.

Since the TDD band may be used for uplink (UL) or downlink (DL) communication 3 different scenarios are of interest depending on which station (MS or BS) is receiving (RX) or transmitting (TX):

1. 1.28Mcps TDD MS (UL TX) causes interference to 1.28Mcps TDD BS (RX of UL)
2. 1.28Mcps TDD MS (UL TX) causes interference to 1.28Mcps TDD MS (RX of DL)
3. 1.28Mcps TDD BS (DL TX) causes interference to 1.28Mcps TDD MS (RX of DL)

3.2 Relative capacity loss results

The relative capacity loss for the 3 cases mentioned in section 3.1 can be determined analogically to section 2.1.
The results for the relative capacity loss are summarized in the tables below.

Victim (receiver)	**interferer (transmitter)**	**relative capacity loss**
1.28Mcps TDD BS of operator A (cluster=1)	1.28Mcps TDD MS of operator B (cluster=1)	< 2%
1.28Mcps TDD MS of operator A (cluster=1)	1.28Mcps TDD MS of operator B (cluster=1)	< 2%
1.28Mcps TDD MS of operator A (cluster=1)	1.28Mcps TDD BS of operator B (cluster=1)	< 1%

4 Conclusion

This contribution describes the simulation scenarios and the relative capacity loss results achieved by the coexistence investigations of a 1.28 Mcps TDD system on the one hand and on the other hand in a different frequency band a 3.84Mcps TDD system or another 1.28Mcps TDD system.
The focus of these investigations is on speech users in macro cells for a vehicular propagation environment.

The results show reasonable capacity loss values, even without coordination or time alignment between the victim and the interferer system.

5 References

[1] RAN WG4 meeting #13, Sep. 4-8, 2000, Turin (Italy), Tdoc (00) 0607, Coexistence scenarios related to 1.28Mcps TDD: First results

[2] RAN WG4 TDD ad-hoc, Nov. 9th, 2000, Berlin (Germany), Tdoc(00)xxx,
Coexistence Investigations related to 1.28Mcps TDD – 3.84Mcps TDD and 1.28Mcps TDD – 1.28Mcps TDD scenarios:
simulation overview and assumptions

TSG-RAN Working Group 4 (Radio) adhoc on 1.28 Mcps TDD co-existence studies
November 9, 2000
Berlin, Germany

Title: Coexistence of 1.28Mcps TDD and 3.84 Mcps TDD
Source: Telia AB
Agenda Item: ?
For: Discussion

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1 Introduction

A large number of operators have expressed sincere worry [1][2][3] concerning the coexistence of 1.28Mcps TDD and 3.84 Mcps TDD. The reason is that the frame structure proposed for 1.28Mcps TDD in 25.945 does not allow synchronisation with 3.84 Mcps TDD, and thus severe problems with BS to BS and UE to UE interference can be expected.

Here we study BS to BS adjacent channel interference between 1.28Mcps TDD and 3.84 Mcps TDD. The site locations for base stations in a radio access network are highly constrained by an operators network planning and negotiations with landlord's etc. It is therefore extremely difficult, not to say impossible, to achieve co-ordination of site locations for different operators. Systems coexisting on adjacent channels in the same geographical region must therefore be tailored for situations where a receiving BS antenna is victim to line of sight interference from the front lobe of another operator's antenna. BS separation distances of about 100m should be expected to be abundant.

We will study the robustness of 1.28Mcps TDD and 3.84 Mcps TDD to such situations.

2 Calculations

We will perform two simple types of calculations.

- Given the distance between the two base stations and the maximum acceptable sensitivity degradation due to BS to BS interference, we calculate the required ACIR value. We will do that for all combinations of the following separation distances and acceptable sensitivity degradation values:

Separation distance (m)	Accepted sensitivity degradation (dB)
100	0.40
200	1
1000	3

- Given the maximum acceptable sensitivity degradation values due to BS to BS interference, and using ACLR and ACS values as given in the specifications, we calculate the minimum allowed separation distance. This will be done for the same values for the acceptable sensitivity degradation as given above.

The assumptions made for output powers, antenna gains, noise figures, pathloss, etc, are given in section 2.1 to 2.4, while the results for 1.28 Mcps TDD to 3.84 Mcps TDD, BS to BS interference and 3.84 Mcps TDD to 1.28 Mcps TDD, BS to BS interference are given in section 2.5 and 2.6 respectively. Note that for the antenna gains, and also for the noise figure for 1.28 Mcps TDD, two alternative values are used.

2.1 Transmitter characteristics

The same transmitter characteristics have been used as in [5]. For the antenna gain we use 11dBi as in [5], but also the alternative value 15dBi, which is a realistic value for the front lobe of a three sector antenna.

Technology	Output power (dBm)	Antenna gain (dBi)		ACLR (dB)
1.28 Mcps TDD	43	11	15	40
3.84 Mcps TDD	43	11	15	45

2.2 Receiver characteristics

The same transmitter characteristics have been used as in [5]. For the antenna gain we use 11dBi as in [5], but also the alternative value 15dBi, which is a realistic value for a three sector antenna.

Technology	Antenna gain (dBi)		ACS (dB)
1.28 Mcps TDD	11	15	45,00
3.84 Mcps TDD	11	15	45,00

For the noise figure for 1.28 Mcps TDD we use 7dB as in [5], but also the alternative value 5dBi, which is the value assumed for 3.84 Mcps TDD.

Technology	Noise figure (dB)	Noise floor (dBm)
1.28 Mcps TDD	7	-105.77
1.28 Mcps TDD	5	-107.77
3.84 Mcps TDD	5	-103.00

2.3 Resulting ACIR

From the ACLR and ACS values given above the resulting ACIR values are easily calculated for the interference scenarios studied.

BS to BS interference scenario	ACIR
1.28 Mcps TDD to 3.84 Mcps TDD	38.81
3.84 Mcps TDD to 1.28 Mcps TDD	41.99

2.4 Pathloss modell

A simple two-slope model [6] with free space propagation up to a distance of 1200m is used.

$$G = \begin{cases} 40.4 + 20 \cdot \log(d) & d < 1200 \\ -21.18 + 40 \cdot \log(d) & d >= 1200 \end{cases}$$

2.5 Results for 1.28 Mcps TDD to 3.84 Mcps TDD, BS to BS interference

Given the distance between the two base stations and the maximum acceptable sensitivity degradation due to BS to BS interference, we calculate the required ACIR value. We perform the calculation both for 11dB and 15dB antenna gain.

Separation distance (m)	Accepted sensitivity degradation (dB)	Required ACIR (dB) 11dB antenna gain	Required ACIR (dB) 15dB antenna gain
100	0.40	97.76	105.76
100	1	93.47	101.47
100	3	87.62	95.62
200	0.40	91.74	99.74

200	1	87.45	95.45
200	3	81.60	89.60
1000	0.40	77.76	85.76
1000	1	73.47	81.47
1000	3	67.62	75.62

The ACIR values required are very high.

Given the maximum acceptable sensitivity degradation values due to BS to BS interference, and using ACLR and ACS values as given in the specifications, we calculate the minimum allowed separation distance. We perform the calculation both for 11dB and 15dB antenna gain. The resulting minimum separation distances speak for themselves.

Accepted sensitivity degradation (dB)	Minimum separation distance (km) 11dB antenna gain	Minimum separation distance (km) 15dB antenna gain
0.40	10.31	16.34
1	8.06	12.77
3	5.75	9.12

2.6 Results for 3.84 Mcps TDD to 1.28 Mcps TDD, BS to BS interference

Given the distance between the two base stations and the maximum acceptable sensitivity degradation due to BS to BS interference, we calculate the required ACIR value. We perform the calculation both for 11dB and 15dB antenna gain, and for 5dB and 7dB 1.28 Mcps TDD noise figure (the 3.84 Mcps TDD noise figure is always 5dB).

Separation distance (m)	Accepted sensitivity degradation (dB)	Required ACIR (dB) 11dB antenna gain 7dB noise figure	Required ACIR (dB) 15dB antenna gain 7dB noise figure	Required ACIR (dB) 11dB antenna gain 5dB noise figure	Required ACIR (dB) 15dB antenna gain 5dB noise figure
100	0.40	100.53	108.53	102.53	110.53
100	1	96.24	104.24	98.24	106.24
100	3	90.39	98.39	92.39	100.39
200	0.40	94.51	102.51	96.51	104.51
200	1	90.22	98.22	92.22	100.22
200	3	84.37	92.37	86.37	94.37
1000	0.40	80.53	88.53	82.53	90.53
1000	1	76.24	84.24	78.24	86.24
1000	3	70.39	78.39	72.39	80.39

The ACIR values required are again very high.

Given the maximum acceptable sensitivity degradation values due to BS to BS interference, and using ACLR and ACS values as given in the specifications, we calculate the minimum allowed separation distance. We perform the calculation both for 11dB and 15dB antenna gain, and for 5dB and 7dB 1.28 Mcps TDD noise figure (the 3.84 Mcps TDD noise figure is always 5dB). The resulting minimum separation distances speak for themselves.

Accepted sensitivity degradation (dB)	Minimum separation distance (km) 11dB antenna gain 7dB noise figure	Minimum separation distance (km) 15dB antenna gain 7dB noise figure	Minimum separation distance (km) 11dB antenna gain 5dB noise figure	Minimum separation distance (km) 15dB antenna gain 5dB noise figure

0.40	10.07	15.96	11.30	17.91
1	7.87	12.47	8.83	13.99
3	5.62	8.91	6.30	9.99

3 Conclusion

The 1.28Mcps TDD technique described in 25.945 does not live up to the requirements on co-existence with 3.84 Mcps TDD.

The options for 3GPP that we can see are either to change the requirements and clearly state that 1.28Mcps TDD and 3.84 Mcps TDD are non inter-working “geographical options”, or to change the frame structure so that synchronisation is possible e.g. by adopting the frame structure proposed in [4].

We believe that a change of frame structure so that synchronisation is possible would yield a much more flexible and useful standard.

A change of the requirements would obviously have to be taken by TSG RAN.

We propose that these conclusions are included in the report from the adhoc meeting.

4 References

[1] R1-001131, TSG RAN WG1 meeting #15, Coexistence between the 3.84 Mcps TDD option and the 1.28 Mcps TDD option, Telia, Vodafone Group, BT, Mannesmann Mobilfunk, Telenor,

[2] R4-000633, TSG RAN WG 4 meeting # 13, Coexistence between the 3.84 Mcps TDD option and the 1.28 Mcps TDD option, Telia, NTT DoCoMo, Telenor, BT

[3] RP-000485, TSG RAN meeting #9, On the 3.84 Mcps TDD and 1.28 Mcps TDD coexistence study, BT, France Telecom, Mannesmann, NTT DoCoMo, Omnitel, Sonera, Telefonica,Telenor, Telia, Vodafone group.

[4] R1-001282, TSG RAN WG1 meeting #16, New frame structure proposal for the 1.28 Mcps TDD option, Telia

[5] R4-000607, Coexistence Investigations related to 1.28Mcps TDD: First Results, Siemens

[6] DOC PM12, ERC preporatory meeting for WP 8F, Helsinki, 18 September 2000, TDD and FDD Interference: Considering UMTS in the 2.5GHz band, Ericsson,