Presentation of Specification to TSG or WG

Presentation to: TSG-RAN Meeting #13

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Abstract of document:

This technical report captures the results of the work on the work items “UMTS1800” and “UMTS1900”. The TR captures the simulation results, and analytical considerations of deploying WCDMA on adjacent to narrowband systems. In addition it captures the first drafts of the radio requirements to be considered further in next working group meetings. The document details the progress made so far on:

- Simulation results with 2x5MHz case with GSM, IS-95 and IS-136 technologies.
- Analytical studies of co-sating WCDMA and GSM.
- Deployment considerations.
- Proposal of methodology for deriving blocking, NB-IMD and cross-modulation requirements.
- Channel raster proposal to PCS1900 band to support single 5 MHz deployments.
- Draft radio requirement proposals for UE and BS for further discussions in RAN WG4.

Changes since last presentation to TSG-RAN Meeting:

This is the first presentation of the TR to RAN.

Outstanding Issues:

The outstanding issues and progress made is fully captured in the TR.

Contentious Issues:

3GPP TR 25.885 V1.0.0 (2001-09)

Technical Report

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

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This document is a technical report of the UMTS1800/1900 work items. The purpose of these work items is to provide UMTS specification support for UTRA/FDD in the 1800 MHz (ITU region 1 and 3) and 1900 MHz bands (ITU region 2). In addition to the schedule and status of the work items, the report includes a description of the motivation, requirements, and methodology, study results and specification recommendations.

This document is a 'living' document, periodically updated and presented at all TSG-RAN meetings until all related CRs are agreed and approved.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

1) UMTS1800 and UMTS1900 in UTRAN Work Task Descriptions, TSGRP#10(99)836 and #12

2) TR25.942 "RF System Scenarios" (v2.3.0 and v2.3.1 are used)

3) 3GPP TS 05.05 v.8.7.1. 3rd Generation Partnership Project;Technical Specification Group GERAN; Digital cellular telecommunications system (Phase 2+);Radio transmission and reception (Release 1999)

4) ETSI TR 101 115 v.8.2.0 Digital cellular telecommunications system (phase 2+); Background for radio frequency (RF) requirements (GSM 05.50 version 8.2.0 release 1999.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

- WCDMA – Wideband Code Division Multiple Access, a type of cellular system meeting ITU-2000 requirement
- UMTS – Universal Mobile Telecommunications System, often used synonymously with WCDMA

- GSM – Mobile cellular system (throughout this document, this acronym is generally to also means the services GPRS and EDGE, both enhancements to GSM, unless not applicable to the discussion.)
- UE – User Equipment, also cellular terminal
- BS – Cellular system base station
- DL – Downlink, the RF path from BS to UE
- ACIR – Adjacent Channel Interference Rejection, can be translated to receiver selectivity when the emission mask of the interfering signal is accounted for.
- TX – Transmitter
- RX – Receiver

4 Introduction

UMTS in Release 99 is currently specified primarily for the 2100 MHz band (WARC IMT-2000 allocation). The 1800 and 1900 MHz bands are either not specified or are only partially specified. Deployment in these bands, unlike in the 2100 MHz band, is complicated by the comparatively limited spectrum per operator, interference due to the presence of other technologies (such as GSM, IS-136 and IS-95) and in the case of UTRA/FDD, the narrower TX-RX frequency separation. For these reasons, the UMTS specifications need to be updated to support deployment

4.1 Task Description

The purpose of these work items is to investigate and prepare radio performance and other necessary specifications to enable optimal, cost-effective UTRA/FDD operation in the 1800 and 1900 MHz bands.

The Work Item descriptions for UMTS1800 and UMTS1900 were approved at TSG-RAN#10 and TSG-RAN#11 respectively.

4.2 Rationale for UMTS1800/1900

This WI enables the introduction of UMTS1800 radio interface to the 1705…1780 and 1805…1880 MHz band. It also includes some new radio requirements for UMTS1900 band operation.

5 Requirements

This section detail high level requirements for the UMTS1800/1900 work items.

5.1 Deployment Scenarios

UMTS1800/1900 specifications shall support the following deployment scenarios:

- One WCDMA carrier in 2x10MHz with geographically coordinated WCDMA and GSM base stations in the same 2x10 MHz band. The WCDMA Uplink and Downlink carriers are surrounded by GSM carriers, noted as a "sandwich" concept (GSM/WCDMA/GSM).
- One WCDMA carrier in a 2x5MHz band with geographically uncoordinated deployment at both band edges.
- Two WCDMA carriers in 2x10MHz band with geographically uncoordinated base station deployments at both band edges.

5.2 Co-existence with other technologies

UMTS1800/1900 specifications shall support WCDMA co-existence with other technologies in neighboring frequency bands:

- In case of UMTS1800, existing UMTS band and GSM1800 co-existence;
- In case of UMTS1900, GSM1900, IS-95, or IS-136 co-existence.
- Requirements for co-existence with other technologies will also take into account the discussion and conclusions in section 7.6 concerning network deployment constraints resulting from the proposed specification requirements.

5.3 Regulatory Requirements

5.3.1 Region 2 Requirements

FCC requirements on out of licensed block emissions for PCS 1900 band (applicable for UMTS1900 only). These have been incorporated into the suggested Change Requests in Section 8 for both UE and BS.

5.3.2 Region 1 and 3 Requirements

Requirements for operation, predominantly in the 1800MHz band, is coordinated with the [ERC, PT1group] in [Europe].

5.4 Harmonization of UMTS1800/1900 specifications

In order to achieve the maximum economy of scale on UE complexity, matching UMTS1800 and UMTS1900 specifications shall be achieved as much as possible.

It is understood that the difference on RF related specs are necessary because of different frequency band and Tx/Rx spacing. The effort shall focus on making all the requirements (e.g., ACS, blocking and IMD specifications, etc.) identical between these two bands (to be called Band II and Band III in the future releases of TS25.101 and TS25.104.)

GSM is the narrowband system that must be accommodated in both of these bands. IS-136 simulations are helpful in more fully understanding the UMTS system performance in the 1900 MHz band. The IS-136 simulations results may not be directly used in the setting of requirements of the Technical Specifications. Any impact from an IS-95 system as identified through analytical and simulation work shall be considered in setting those requirements.

6 Methodology used in this technical report

This section explains the purpose of each of the following sections of this Technical Report.

- In Section 7.1, the simulation results are reviewed and analysed for their primary purpose of system performance in a 2x5MHz deployment scenario. The following subsections show both the overall system results from the simulations in terms of average numbers, and analyses that show both worst case conditions and typical conditions. Further discussion of how to reduce the impacts of the worst cases are covered in later sections [7.5.5 & 7.6].
    - The simulation methodology is covered in Section 7.1.2 and the results from all previous documents are compiled in a single spreadsheet (click on icon to open) for easy reference.
    - The interference to the WCDMA Downlink is analysed in Section 7.1.3. Capacity loss versus WCDMA UE ACIR is shown. Choosing an acceptable capacity loss leads to a UE ACIR requirement. Note the analysis showing the performance improvement (amounting to 5dB ACIR increase) when real filters with increasing stop band attenuation are studied. As large ACIR requirement would have a severe implementation impact, there is some constraint on the value to be chosen.

  - The WCDMA Uplink capacity loss versus WCDMA BS ACIR is shown in Section 7.1.4. Good performance and negligible performance impact appear to coexist at an ACIR of 50dB.
  - The impact of WCDMA Uplink on GSM Uplink performance, reviewed in Section 7.1.5, is shown to be small in terms of average impact on SINR
  - The impact of WCDMA Downlink on GSM Downlink performance, reviewed in Section 7.1.6, is shown to be small in terms of average impact on SINR. However, one sees that the potential for severe adverse impact to the GSM Downlink, when the GSM UE is close to the WCDMA BS and the WCDMA UE is close to the GSM BS, is just as bad as the impact to the WCDMA Downlink in those cases. (See further analysis in Sections 7.5.1 and 7.5.5.)
- Section 7.2 and its subsections mirrors the analysis of Section 7.1 but with the base stations co-sited as is possible with the 2x10MHz deployment sharing a single WCDMA carrier and multiple GSM carriers controlled by the same operator. With an assumed UE ACIR of 30dB and BS ACIR of 50dB, good margins are shown under all conditions for operation of GSM carriers as close as 2.7MHz from the WCDMA center frequency. Section 7.2.6 also analyses system performance for closer carrier separation.
- Two WCDMA carriers in a 2x10MHz band is shown in Section 7.3 to have better ACIR to the uncoordinated adjacent band interference and according performance better than 2x5MHz uncoordinated deployment scenario.
- WCMDA UE to GSM UE interference is revisited in Section 7.4. The case is made for reducing the WCDMA UE spurious emissions.
- Section 7.5 reviews the analytical results for the purpose of deriving the values needed for the Technical Specification requirements.
  - Section 7.5.1 shows the connection between WCDMA Downlink blocking analysis and UE ACIR. The case for a UE ACIR of 30dB is shown.
  - Section 7.5.2 shows how a properly written Narrowband Blocking requirement with simultaneous UE transmission will guarantee adequate protection against performance degradation due to cross-modulation. Up and Downlink are covered. Blocking signal level is derived.
  - Section 7.5.3 shows how a properly written Inter-modulation Distortion requirement will protect against degradation of performance due to in-band products of multiple strong signals outside the WCDMA channel. Blocking signal levels are derived.
  - Section 7.5.4 contains the analysis for the combined (UL and DL and second system) overall system outage versus ACIR. One sees that the range of variations shown makes it difficult to quantify the desired result.
  - Section 7.5.5 addresses a key operator concern about potential blocking that might occur with certain UE locations.
    - Section 7.5.5.1 shows how only a fraction of the WCDMA system outages are due to blocking when close to the interfering BS.
    - Section 7.5.5.2 shows how improving, for instance, the WCDMA Downlink with increased WCDMA UE ACIR will have the adverse impact on the GSM Uplink. The point is that the route of demanding increased UE ACIR should be considered cautiously, especially as other means to alleviate the apparent problem will be shown in a later section. This section also shows how the region of higher blocking probability (the so-called dead-zone) will not be constant over the system as ACIR increase rapidly with frequency offset from the WCDMA carrier.
    - Section 7.5.5.3 shows how the hard handoff capability of the WCDMA standard to other WCDMA carriers and to GSM carriers in the same band and other bands is a powerful tool in making the UMTS system robust to all interference and increasing the average level of performance as well. This is an important section to understand the other options to simply increasing UE ACIR, which has a much higher implementation impact.
- Section 7.6 contains a set of network deployment options that can be used to manage interference, particularly for the coordinated deployment scenario. It reflects several issues in section 7.4, the coordinated deployment analysis, which will increase the margins against interference. The use of some of these options

would permit the operation of GSM carriers at 2.5MHz frequency offset from the WCDMA carrier in the coordinated deployment.

- The output of this Technical Report is the appropriate values and conditions to put into the requirements for TS25.101 and 25.104. Section 8 brings all of this together for this purpose. The tables review the status of all the anticipated changes. Some of them are already agreed to in prior RAN4 meetings and are so noted in the tables. The wording for those agreed to sections is presumed to be available from the referenced documents and is not copied into this section. For the requirements that do not have agreed to contributions already, suggested CR wording is included in sections 8.1 and 8.2 using the values derived from this document for initiating the specification drafting work.

7 Study Areas

This section summarizes the studies and analyses that were necessary to complete the work item. In general, these issues were concerned with the presence of narrowband signals within the new bands, and the necessary changes required to the core specifications to eliminate, or minimize to acceptable levels, the impacts of those signals.

Since there are several deployment scenarios within the 1900 MHz band, we start with the one that is the most demanding in terms of radio performance. In the case of 1800 MHz, such limitations as 2x5MHz single channel band have not been identified, and hence the analysis of GSM interference for the 1900 MHz band should be adequate for the 1800 band.

In the section 7.1 the results of a pair of 5 MHz wide frequency bands (also noted as 2x5 MHz deployment case) are collected and analyzed. In such a deployment, the system will almost certainly have to coexist with various narrowband cellular services (GSM, IS-136, IS-95) in the adjacent bands. Note that all the simulations have been directed exclusively at this deployment scenario.

The deployment of a single WCDMA carrier within either 10 or 15 MHz band along with GSM service in the rest of the available spectrum will be analyzed in light of the previous 2x5 MHz analysis and simulation results, and conclusions are listed in the appropriate sections 7.2 and 7.3.

7.1 Support WCDMA 2x5Mhz Deployment

It was generally agreed that simulations would be used to determine the UE and BS receiver ACIR (Adjacent Channel Interference Rejection or selectivity) required for adequate performance of the WCDMA system when narrowband interference was present in an adjacent band. This is precisely the situation that must occur when a single WCDMA carrier in placed in a 2x5 MHz band, since the WCDMA signal fills the whole band. The following sections show the results of those simulations.

7.1.1 Summary of Simulation Results

The simulation results have been collected and condensed into a single spreadsheet. This spreadsheet is accessible by clicking on the icon at the end of section 7.1.2.

7.1.2 General Description of Approach

The purpose of the simulations is to help guide the choice of values for new requirements in the specifications related to the operation in 1800 MHz and 1900 MHz bands. The methodology and conditions of the simulation are described in references [7.1.2.1, 7.1.2.2, 7.1.2.3, 7.1.2.4]. In general it was decided that several of the conditions would be set at a worst case, the rationale being that the performance would be better than indicated in the results when the conditions were less severe. Some examples of this are the following:

- It was decided to place the interfering system at the edge of the WCDMA cells, thus causing the most possible interference to terminals when they are receiving the weakest level of desired signal.

- When the closest interfering signal is a base station, it is assumed to be at maximum power and transmitting continuously. For the case of a GSM BS, the signal represents a BCCH carrier. This is certainly possible but not a very likely design practice in real networks, where the object is to protect the signaling carriers from uncoordinated interference as much as possible.

- It was agreed to refer the capacity losses to the maximum load of the system or a fixed outage criterion. At this operating point, the system is most vulnerable to the external interference and small amounts of interference are more easily detected.

All of these examples make the simulation results representative of worst-case results.

It should be noted that the simulations involve averaging the results of multiple simulation runs, or snapshots, whereby variables such as the locations of the UE's, and the signal path fading, etc., are changed. For each snapshot, power control is invoked until the system reaches equilibrium. Statistics are assembled over the total set of simulations to determine the particular criterion being evaluated. In cases of interference to either a WCDMA UE or BS, the simulations are run with the parameter for ACIR (Adjacent Channel Interference Ratio) changed over a range of discrete values.

The key element of interest in all these simulations is the impact of interference caused to or caused by the WCDMA UE or BS. The four major groups of these simulations are addressed in the following sub-sections. These are:

- WCDMA DL victim case
- WCDMA UL victim case
- GSM DL victim case
- GSM UL victim case

A summary of these simulation results, as presented within RAN4 Working Group, can be viewed by clicking on the icon below. (Note that a very large amount of information is represented in all these simulations, as there are 57 separate results presented, and each of those results contains multiple results, such as values for 5 selectivity cases.)

"Selecitivity Summary Total.xls"

7.1.2.1 Assumptions for analytical approach

In the context of each simulation result, a short analysis of selected topics considered to be most critical is included in each section. For those analyses, the following assumptions are used:

Parameter	value	unit
WCDMA MCL micro	53	dB
WCDMA MCL macro	70	dB
MCL UE – UE (between systems)	40	dB
GSM BS sensitivity	-104	dBm
GSM BS TX power	43	dBm
WCDMA BS noise floor	-103	dBm
WCDMA BS TX power	43	dBm
GSM UE maximum TX power	30	dBm
GSM UE ACIR @ 2.7 MHz	-50	dBm
WCDMA UE maximum TX power	21	dBm

Additional issues to be noted:

- In the simulations, the MCL's for all systems in any given simulation are made equal to each other.
- Same propagation model used signal path calculations.
- Vertical antenna patterns are included in the MCL value.

References

[1] 7.1.2.1 – TR25.942 (v2.3.0 and v2.3.1 were used), "RF System Scenarios"

[2] 7.1.2.2 – R4-010076, "Proposed Simulation assumptions for UMTS (Revised)," Boston, MA, USA 23-26 January 2001.

[3] 7.1.2.3 – R4-1800ah-0122, "Ad hoc Minutes – Proposed Simulation Parameters for UMTS 1900 Co-existence with IS-136 and IS-95," Seattle, WA, USA 2-3 February 2001

[4] 7.1.2.4 – R4-010718, "Ad hoc Minutes – Proposed Simulation Parameters for UMTS 1900 Co-existence with IS-136 and IS-95," Gothenburg, Sweden 21-25 May 2001

7.1.3 Results for Downlink WCDMA Victim

7.1.3.1 Simulation results

This set of simulations was designed to give the WCDMA Downlink capacity loss as a parameter of UE Adjacent Channel Interference Rejection (ACIR) or channel selectivity. In February 2001, some additions to the RF System Scenarios were made to cover both small (577m) and large (2400m) cell sizes, both omni-directional and tri-sectored antenna systems, and IS-136 and IS95 adjacent band systems along with the GSM system. Thus, the following table [7.1.3.1] of results contains more variations than the original UE receiver ACIR (selectivity) at the closest interfering signal frequency. (The table is extracted from the Selectivity Summary Total.xls file in section 7.1.2.)

To review the methodology briefly, the simulation is first run without the interfering system operating in order to establish a baseline performance, i.e. set the criterion at 5% outage rate for the WCDMA UE's in the system. Many runs are made with WCDMA UE's in random locations. The number of WCDMA UE's is adjusted until the average outage over all the runs is 5%. Then the interfering system is turned on and the simulations run again, adjusting the number of terminals until the outage rate of the WCDMA UE's determined over a large number (thousands) of individual runs is again 5%. The difference in number of terminals before and after the interfering system is applied represents the capacity loss for the conditions of the simulation. The parameter that is varied across the simulations is the ACIR of interfering downlink signal. The ACIR value shown in the tables is the UE selectivity combined with base station emissions at the frequency offset of the first interfering channel. The slope of the UE selectivity at frequencies further away from the WCDMA carrier frequency was agreed in these simulations to be 0.8dB/200khz. In case of GSM and re-use pattern 4/12 the spacing of carriers is 800 kHz, which will mean that the next carrier at same interference level will increase the composite interference by 1.7 dB. When considering the fading this impact is further diminished.

Table 7.1.3.1 – Summary of simulation results for WCDMA Downlink. Values are WCDMA Downlink capacity loss as a function of WCMDA UE ACIR (selectivity).

source	ant type	Cell size	Interferer (# carriers)	ACIR -20	ACIR -25	ACIR -30	ACIR -35	ACIR -40
2	omni	small	GSM (1)	12.4	5.6	2.1	0.7	0.2
2	omni	small	GSM (3)	15.0	7.0	2.8	0.9	0.3
3	omni	small	GSM	8.8	4.2	2.9	1.1	1.1
5	tri	small	GSM (3)	18.0		5.0		1.0
4	omni	small	GSM (1)	10.0	4.3	1.7	0.6	0.2
4	omni	small	GSM (3)	12.0	5.5	2.2	0.8	0.2
6	tri	small	GSM	11.0	4.0	0.9	0.3	0.0
6	tri	large	GSM	15.4	9.8	4.2	2.2	0.6
3	tri	large	GSM	9.2	5.2	3.2	1.9	1.2
1	tri	large	GSM	10.5	5.3	3.5	1.8	1.2
2	tri	small	IS-136 (1)	7.8	3.1	1.1	0.4	0.1
2	tri	small	IS-136 (8)		6.5	2.5	0.9	0.3
2	tri	large	IS-136 (1)	10.8	6.1	3.4	1.8	0.8
2	Tri	large	IS-136 (8)		9.5	5.5	3.0	1.5
3	Tri	large	IS-136	11.3	4.5	2.8	1.9	1.3
3	Tri	Large	IS-136		9.5	4.0	2.5	1.7
2	Tri	small	IS-95	18.1	8.7	3.6	1.4	0.4
5	Tri	small	IS-95	35.0		6.0		1.5
2	Tri	Large	IS-95	20.5	11.7	6.5	3.5	2.0
3	Tri	Large	IS-95	22.1	11.7	7.6	4.1	2.1

The company numbers correspond to: 1 – Alcatel, 2 – Ericsson, 3 – Lucent, 4 – Motorola, 5 – Nokia, 6 – Nortel

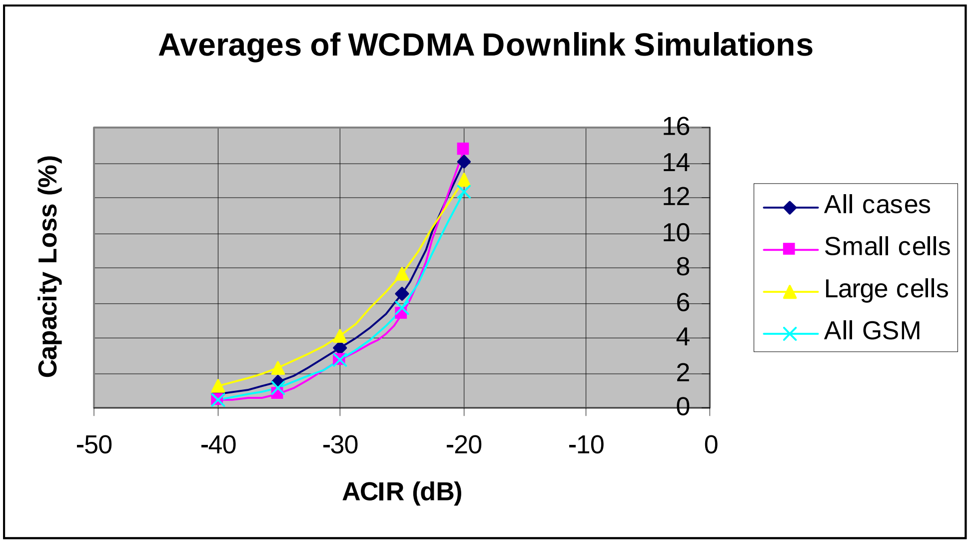
Small = 577-800m, Large = 2400-4800m, # carriers tells how many interfering signals are present in the adjacent band. Results are from references at the end of this section [7.1.3.1-7.1.3.8, 7.1.3.11]

Rather than display this table graphically, it is left as a consolidated table in order to make several observations. For instance, averages can be displayed as a function of various groupings. The table below shows some of the possible groupings.

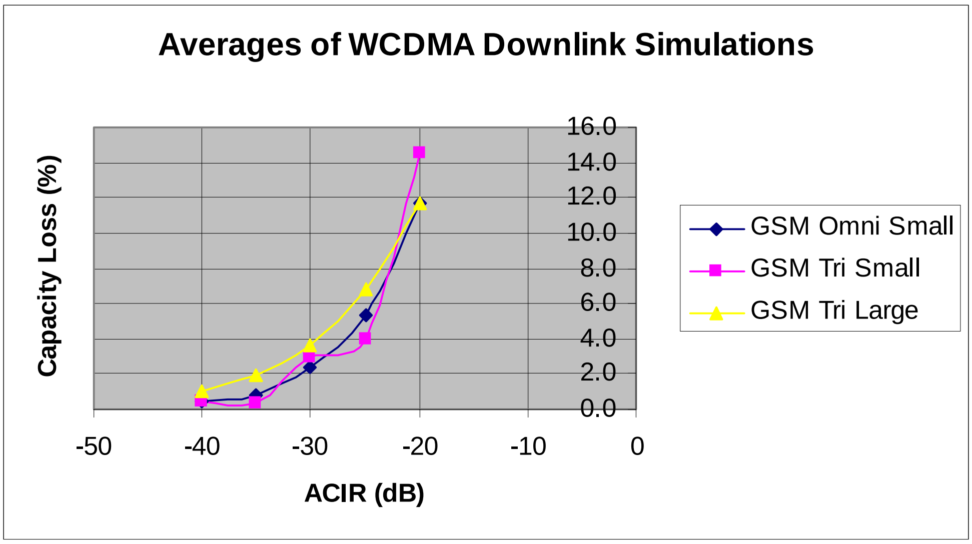
Table 7.1.3.2 – Average capacity loss versus WCDMA UE selectivity for various conditions

Group (average)	ACIR –20 dB	ACIR -25 dB	ACIR -30 dB	ACIR -35 dB	ACIR -40 dB
All cases	14.1	6.5	3.4	1.5	0.8
All small cells	14.8	5.4	2.8	0.8	0.5
All large cells	13.0	7.7	4.1	2.3	1.3
All GSM	12.4	5.7	2.8	1.1	0.5
GSM Omni Small	11.6	5.3	2.3	0.8	0.4
GSM Tri Small	14.5	4.0	3.0	0.3	0.5
GSM Tri Large	11.7	6.8	3.6	2.0	1.0

The first 4 rows of data from Table 7.1.3.2 are displayed in graphical format in the following figure.



The GSM (and EDGE) results are shown separately in the following Figure



From this summary, one can choose a WCMDA UE selectivity based on the WCDMA Downlink capacity loss that is acceptable. Furthermore, per section 5.6, the discussion should focus more on the All GSM case.

Other things to note:

a) There is not much difference between capacity loss with omni-directional and tri-sectored antennas.

b) The capacity loss with larger cells is higher than that for smaller cells (expected result).

c) IS-136 interferers have about the same impact as GSM interferers. This means that it is a reasonable assumption to focus on GSM performance and expect acceptable performance when a WCDMA channel happens to be adjacent to an IS-136 system.

7.1.3.2 Analytical considerations

An additional simulation result from reference [7.1.3.9] may be of some help to further understand the level of possible capacity loss that might be achieved with more realistic UE filters than that used in the simulations above. Reference [7.1.3.9] includes four simulations using a different filter characteristic. These simulations are not like the others whereby an ACIR is specified at the nearest interfering channel and has only a 0.8dB / channel increase in ACIR for increasing frequency offset. This example filter characteristic picked a particular ACIR versus frequency offset. This is shown in the following table from reference [7.1.3.9]:

$f - f_0$ (kHz)	0	200	400	600	800	1000	800 +200N
ACIR (dB)	**25**	28	32	36	**40**	40.8	40 + 0.8N

The notation of $f-f_0$ in this case means the distance from WCDMA band edge to the center of the interfering signal.

The four WCDMA Downlink cases having the following results, also copied from reference [7.1.3.9]:

Configuration/ Reuse of GSM system	Cell/sector radius (m)	Capacity loss (%)
36 omni cells GSM reuse 9	577 m	2.3
	2400 m	4.1
16 tri-sectored sites (48 sectors) GSM reuse 4/12	577 m (inter-site distance of 1731 m)	2.8
	2400 m (inter-site distance of 7200 m)	2.0

The interesting point to note is the capacity loss for this filter versus the simulation results shown in Table 7.1.3.1. This is done in the Table 7.1.3.3 below. (Drop in capacity loss for larger tri-sectored cell is not explained in the referenced document. It may be the finite number of runs in the simulation.)

Table 7.1.3.3 – Comparison of simulations with flat stop band attenuation to simulations with realistically sloped stop band attenuation

Ant type	Cell size	ACIR -20	ACIR -25	ACIR -30	ACIR -35	ACIR -40	Sloped ACIR starting at -25
omni	small	12.4	5.6	2.1	0.7	0.2	2.3
omni	small	15.0	7.0	2.8	0.9	0.3	2.3
omni	small	8.8	4.2	2.9	1.1	1.1	2.3
Tri	small	18.0		5.0	---	1.0	2.8

Tri	small	11.0	4.0	0.9	0.3	0.0	2.8
Tri	large	15.4	9.8	4.2	2.2	0.6	2.0
Tri	large	9.2	5.2	3.2	1.9	1.2	2.0

The agreed to simulation condition of a nearly flat stop band attenuation in the UE channel filter has simulation results (DL capacity loss) shown in ACIR (-25 to –40) columns. The simulation results (DL capacity loss) using the UE channel filter with a sloped attenuation starting at –25dB for the first interfering channel frequency is shown in the last column. The figures shaded in green are the closest match in capacity loss between the two different types of simulation.

The key conclusion here is that realistic filter assumptions, which have been used in this scenario, result in a DL performance against interference equal to the simulation results obtained with an ACIR 5dB better than the ACIR value for the nearest interfering channel. For instance, if we choose an ACIR of –30dB for the nearest interfering frequency, and it is a realistic filter, the DL capacity loss of the UMTS system is the simulation value obtained with an ACIR of –35dB, i.e. 1-2% over the whole system.

7.1.3.2.1 IS-95 interfering WCDMA DL

In this case we need to evaluate the emissions from IS-95 BS to WCDMA UE and the WCDMA UE selectivity.

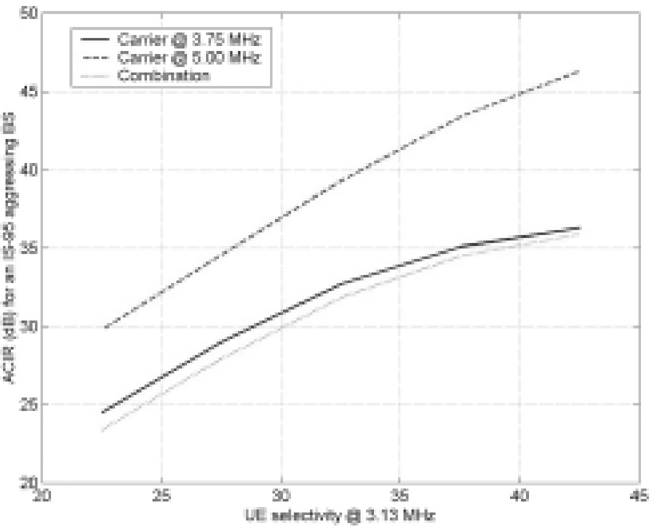
In discussions it has been agreed that carrier to carrier offset between these systems is 3.75 MHz.

From IS-97 specification for BS emissions following definition can be found:

Table 1 - Band Class 1 Transmitter Spurious Emission Limits

For |Δf| Greater Than	Emission Limit
885 kHz	-45 dBc / 30 kHz
1.98 MHz	-55 dBc/ 30 kHz: Pout ≥ 33 dBm -22 dBm / 30 kHz, 28 dBm ≤ Pout < 33 dBm -50 dBc / 30 kHz; Pout < 28 dBm
2.25 MHz	-13 dBm / 1 MHz

From this requirement it can be estimated that the worst-case emission power from BS falling into WCDMA DL channel is 5.9 dBm/3,84 MHz. With +43dBm power output, this results in an ACIR of 37.1dB. This is effectively with a very large WCDMA UE selectivity. In fact, this agrees well with the graph from reference [7.1.3.6] showing ACIR versus receiver selectivity at 3.13 MHz frequency offset, accounting for the IS-95 emissions. The graphs show 37dB ACIR for RX selectivity of –43dBc and 27dB ACIR for RX selectivity of –25dBc. This graph from reference [7.1.3.6] is reproduced here for convenience.



The effect of multi-carrier IS-95 scenario is included by ACIR shift as is done for GSM interference case.

Interference level to WCDMA RX = [IS-95 BS output power] – [BS ACIR] - [Path loss] = 43 dBm – 37.1 dBc – 70 dB = -64.1 dBm/ 3.84 MHz.

When considering this to the noise level at the UE sensitivity level:

WCDMA UE RX level = [thermal noise floor] + [noise figure] = -108 dBm + 11.5 dB = - 96.5 dBm.

Hence the worst-case desensitization is –64.1dB – 96.5 dB = 32.4 dB. Also the link budget can be estimated to be:

WCDMA DL Link budget = [max DPCH power in WCDMA BS] – [interference level to WCDMA RX] + [Processing gain] – {Eb/No] = 30 dBm –64.1 dBm + 25 dB – 7 dB = 112.1 dB.

It should be noted that calculations presented are based on specification values. In principle IS-95 and WCDMA has a 10log(1.228/3.84) = 4.95 dB difference in system noise, and a spreading factor gain of 6dB for a net difference of 1dB. All other aspects should be more or less same. Hence the emissions in real implementations of the networks are better, but this is impossible to show with requirements stated is specifications. *Real results will be better than the above calculations would indicate.*

7.1.3.3 Conclusions

We will see later in section 7.5.3.1 that this filter characteristic with more steeply sloped filter characteristic is realistic and, in fact, guaranteed by the way the Inter-modulation distortion requirement is specified.

In summary, the results of these simulations can be used to set the narrowband blocking requirements for the WCDMA UE based on an acceptable level of capacity loss. We should note that the nature of interfering signal would have an impact on the system performance. Hence IS-95 type CDMA signal does not represent the most stringent requirement for the UE, whereas the more narrowband GSM type of signal does. Furthermore, the performance in terms of DL capacity in the presence of interference will be in actual case better as if the ACIR is better than the ACIR value at the required for the first adjacent interfering channel. Thus, an ACIR of –30dB at 2.7MHz frequency offset from the WCDMA center frequency and filter stop band slope behavior as described in the example above, will only suffer a Downlink capacity loss of 1-2%.

References

[5] 7.1.3.1 - R4-1800ah-0102, "UMTS1800/1900 Simulation Results for WCDMA and GSM Interference" Seattle, WA, USA 2-3 May 2001

[6] 7.1.3.2 - R4-1800ah-0110, "UMTS1800/GSM Co-existence Simulation Results for Downlink Scenarios" Seattle, WA, USA 2-3 May 2001

[7] 7.1.3.3 - R4-1800ah-0114, "UMTS/GSM Co-existence Simulation Results" Seattle, WA, USA 2-3 May 2001

[8] 7.1.3.4 - R4-010629, "UMTS1800/GSM Co-existence Simulation Results for Downlink and 3

Sector Configuration (revised)", Seattle, WA, USA 2-3 May 2001

[9] 7.1.3.5 - R4-010719, "Simulation Results on UMTS1800 Coexistence in a Large Cell Environment (Downlink and Uplink)", Gothenburg, Sweden 21-25 May 2001

[10] 7.1.3.6 - R4-010602, "Results of UMTS 1900 Co-existence Simulations (Downlink)" Gothenburg, Sweden 21-25 May 2001

[11] 7.1.3.7 - R4-010993, "UMTS1900/IS-136 Co-existence Simulation Results for Downlink" Berlin, Germany 9-12 July 2001

[12] 7.1.3.8 - R4-010960, "IS-95 -- WCDMA DL interference simulation results" Berlin, Germany 9-12 July 2001

[13] 7.1.3.9 – R4-1800ah0104, "On defining UE narrowband blocking requirements for UMTS 1800/1900" Seattle, WA, USA 2-3 May 2001

[14] 7.1.3.10 – R4-010576, "Signal strength analysis to derive NB blocking and NB IMD requirement" Gothenburg, Sweden 21st to 25th of May 2001.

[15] 7.1.3.11 R4-011257 "UMTS1900/IS-95 Co-existence Simulation Results" Edinburgh, Scotland, September 3 2001

7.1.4 Results for Uplink WCDMA Victim

7.1.4.1 Simulation results

This set of simulations was designed to give the WCDMA Uplink capacity loss as a parameter of BS selectivity. In February 2001, some additions to the RF System Scenarios were made to cover both small (577m) and large (2400m) cell sizes, both omni-directional and tri-sectored antenna systems, and IS-136 and IS95 adjacent band systems along with the GSM system. Thus, the following Table [7.1.4.1] contains results for more variations than the original UE receiver selectivity at the closest interfering signal frequency. (The table is extracted from the Selectivity Summary Total.xls file in section 7.1.2.)

To review the methodology briefly, the simulation is first run without the interfering system operating in order to establish a baseline performance of a 6dB increase in noise floor at the WCDMA BS receiver. Many runs with random WCDMA UE positions are used to get an accurate average of the noise floor increase. The number of terminals is adjusted until this average increase in noise floor is equal to 6dB. Then the interfering system is activated and the simulations were run again, adjusting the number of terminals until the noise floor increase is again 6dB. The layout of the system was the same as DL case, e.g. interfering base stations were located at the UMTS cell edge. The decrease in number of terminals from before to after the interfering system is turned on represents the capacity loss for these conditions. The parameter that is varied across the simulations is the ACIR or selectivity of the WCDMA BS. The value shown in the tables is the ACIR at the frequency offset of the first interfering channel. In these simulations the slope of the BS selectivity at frequencies further away from the WCDMA carrier frequency is 0.8dB/200khz.

Table 7.1.4.1 – Summary of simulation results for WCDMA Uplink. Values are WCDMA Uplink capacity loss as a function of WCDMA BS ACIR (WCDMA BS selectivity+ GSM UE transmitted emissions).

Company	ant type	Cell size	interferer	# carrs	ACIR -25	ACIR -30	ACIR -35	ACIR -40	ACIR -45	ACIR -50	ACIR -55	ACIR -60	Pwr Cntr
2	omni	Small	GSM	1		17.1	5.3	1.8		0.2		0.1	Yes
2	omni	Small	GSM	4			10.0	3.0		0.4		0.1	Yes
5	Tri	Small	GSM			41.0	11.0	3.0	0.1				Yes
5	Tri	Small	GSM			100		80.0		1.0			No
4	omni	Small	GSM	1			30.2	8.9	2.7	1.1			Yes
4	omni	small	GSM	4			35.0	12.0	3.5	2.0			Yes
6	Tri	small	GSM		5.4	2.1	0.8	0.4					Yes

6	Tri	large	GSM		7.0	4.3	2.0	0.4					Yes
3	Tri	large	GSM	1	25.8	10.6	5.3	2.3	0.8	0.0			Yes
3	Tri	large	IS-95	1	18.2	9.8	3.0	0.8	0.0				Yes
1	Tri	large	GSM	1		41.5	11.3	5.7	1.9	0.9			No

The company numbers correspond to: 1 – Alcatel, 2 – Ericsson, 3 – Lucent, 4 – Motorola, 5 – Nokia, 6 – Nortel

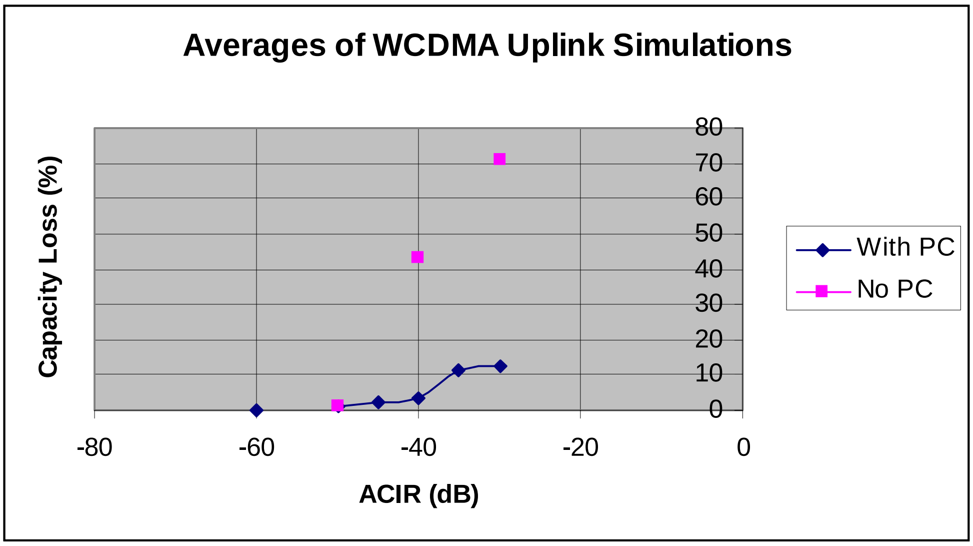
Small = 577-800m, Large = 2400-4800m. Results are from references at the end of this section [7.1.4.1-7.1.4.6, 7.1.4.8]

Rather than display this table graphically, it is left as a consolidated table in order to make several observations. For instance, averages can be displayed as a function of various groupings. The table below shows some of the possible groupings.

Table 7.2.3.2 – Average capacity loss versus WCDMA BS selectivity for various conditions

Group (average)	ACIR -30 dB	ACIR -35 dB	ACIR -40 dB	ACIR -45 dB	ACIR -50 dB	ACIR -55 dB	ACIR -60 dB
With power control	12.6	11.1	3.5	2.1	0.9		0.1
No power control	70.8		42.9		1.0		

Table 7.2.3.2 is displayed in graphical format in the following figure.



Regardless of the conditions of small cell or large cell, omni-directional antenna or tri-sectored antenna, power control or no power control, 1 interfering GSM carrier or 4 interfering GSM carriers, choosing an ACIR value of –50dB ensures a very small loss in Uplink capacity.

7.1.4.2 Analytical considerations:

a) The worst case signal level into the WCDMA base station receiver from a nearby GSM terminal is*:*

BS RX signal level = [GSM UE TX power] - [Coupling loss] - [BS RX selectivity] + [fading margin] = +30 dBm –70 dB –50 dB +6 dB = - 84 dBm/3.84 MHz

b) Impact of co-channel interference due GSM UE TX emissions:

From TS 05.05 we can roughly estimate that the impact of the GSM UE TX emission in form of ACIR for WCDMA BS is 50 dBc when the GSM UE signal is placed at 2.7 MHz offset from the WCDMA channel center frequency. This will mean in practice that one half of the composite interference is originated from GSM UE transmitter emission masks, and the other half from BS receiver filter.

The key point is that increasing the BS ACIR past –50dB would not result in any benefit as the GSM UE TX emission mask into the WCDMA channel would then dominate.

c) Impact of slotted interference (GSM TCH or RACH transmission) and radio frame interleaving:

In practice the interleaving over frame(s) will allow some slots to be destroyed in WCDMA reception, and still maintain the quality of service. Hence this will further diminish the impact since it's not very likely of having several uncoordinated UE's at close proximity of victim base station. Actual performance of how many slots can be lost due interference is dependent on the radio frame structure used and TTI length. In the case of GSM the RACH burst length is less than 577 us, and in IS-136 case the length is 6.67 ms.

As a conclusion of the analysis it can be noted that the performance with –50dB ACIR seems adequate for the WCDMA BS. It will mean that the composite interference power to WCDMA BS receiver is, worst case, –84 dBm during the active slots (e.g. TCH or RACH). The simulation results indicate that the probability of the worst case occuring is quite low, as the area with low MCL is quite small. Further tightening of WCDMA BS selectivity will not improve the performance very much due to the GSM UE TX emission mask. Hence, if further protection from close by interfering signals is deemed absolutely necessary, then more coupling loss (80-90 dB) is needed. This is especially the case if the interference is being caused by non-power controlled RACH transmission. For this type of interference, also smaller UMTS cell sizes should be considered.

For an MCL of 90 dB the impact to the WCDMA BS received signal level from GSM UE is then –104 dBm, and if the target noise rise is 3 dB, then the total impact is:

BS RX signal level = [Thermal noise] + [BS Noise figure] + [Noise rise] + [interference] = -108 dBm + 5 dB + 3 dB - 104 dBm = -98.5 dBm.

This represents 1.5 dB increase in the target noise level of –100dBm at the WCDMA BS receiver due to worst case interference power when the MCL is 90dB. This is quite moderate taking into account the rare nature, and by using the higher MCL, the system now has a higher interference margin.

7.1.4.2.1 IS-95 impact to WCDMA UL

In this case we need to evaluate the emissions from IS-95 UE to WCDMA BS and the WCDMA BS selectivity.

In discussions it has been agreed that carrier to carrier offset between these systems is 3.75 MHz.

Calculation has same analogy as is the case in DL, but now the emissions are based on the requirement in following table:

For |Δf| Greater Than	**Emission Limit**
1.25 MHz	Less stringent of -42 dBc / 30 kHz or –54 dBm / 1.23 MHz
1.98 MHz	Less stringent of -50 dBc / 30 kHz or –54 dBm / 1.23 MHz
2.25 MHz	-13 dBm / 1 MHz

From this requirement it can be estimated that the worst-case emission power from UE falling into WCDMA UL channel, assuming +23 dBm output power from terminal, is –6.1 dBm/3,84 MHz. (Again, this is with very high receiver selectivity assumed as well.)

Interference level to WCDMA RX = [IS-95 UE output power] – [UE ACLR] - [Path loss] = 23 dBm – 29.1dBc – 70 dB = -76.1 dBm/ 3.84 MHz.

When considering this to the noise level at the BS sensitivity level:

WCDMA BS RX level = [thermal noise floor] + [noise figure] + [noise rise due traffic]= -108 dBm + 5 dB + 3dB= -100 dBm.

Hence the worst-case desensisation is 23.9dB. This is consistent with the result in table 7.1.4.1 with ACIR limited to –30 dB. However the large outage indicated for –30 dB ACIR is not actually real, because the reverse path interference situation needs to be considered at the same time as well. Also the link budget can be estimated to be:

WCDMA UL Link budget = [Noise floor at BS] – [UE processing gain]+ [Eb/No] - [UE max power] = -100dBm - 25 dB + 7dB dBm –21 dBm = -139 dB.

Hence the link budget with IS-95 interference is 115.1 dB.

7.1.4.3 Conclusions

Both GSM and IS-95 cases indicates that with lower MCL assumptions the BS blocking could be possible. In addition for GSM case more than 50 dBc BS selectivity will not improve the situation much. In case of IS-95 the interference is dominated by co-channel emission, where the filter steepness does not help at all past approximately –40dBc.

In that the WCDMA BS can have more adjacent channel selectivity than a WCDMA terminal by virtue of its fixed location with adequate space, the choice of this value of selectivity is both feasible and desirable. The Berlin Ad hoc, reference [7.1.4.7] tentatively agreed on –50 dB ACIR as a working value for the 25.104 change request requirements.

References

[16] 7.1.4.1 - R4-010344, “Results of UMTS1800/GSM Co-existence Simulations (Uplink)” Vienna, Austria 19-23 February 2001

[17] 7.1.4.2 - R4-1800ah-0102, "UMTS1800/1900 Simulation Results for WCDMA and GSM Interference” Seattle, WA, USA 2-3 May 2001

[18] 7.1.4.3 - R4-010658, "UMTS1800-1900/GSM Simulation Results for the Uplink Scenarios” Gothenburg, Sweden 21-25 May 2001

[19] 7.1.4.4 - R4-010692, "UMTS/GSM Co-existence: WCDMA as a victim in the Uplink” Gothenburg, Sweden 21-25 May 2001

[20] 7.1.4.5 - R4-010994, "UMTS1800/GSM Co-existence Simulation Results for Uplink” Berlin, Germany July 9-12 2001

[21] 7.1.4.6 - R4-010719, "Simulation Results on UMTS1800 Coexistence in a Large Cell Environment (Downlink and Uplink)”, Gothenburg, Sweden 21-25 May 2001

[22] 7.1.4.7 – R4-011TBD, “RAN4 #18 report” Berlin, Germany 9-12 July 2001

[23] 7.1.4.8- R4-011258, “UMTS1800/GSM Co-existence Simulation Results for Uplink (Revised)”, Edinburgh, Scotland 3rd-7th of September 2001

7.1.5 Results for Uplink GSM Victim

7.1.5.1 Simulation results

This set of simulations was designed to measure the impact of the WCDMA Uplink on the GSM Uplink performance. The WCDMA parameter that affects the adjacent system is the out-of-band emissions of the WCDMA UE transmitter. This parameter is already agreed to be aligned according to the FCC out-of-band requirements.

In February 2001, some additions to the RF System Scenarios were made to cover both small (577m) and large (2400m) cell sizes, both omni-directional and tri-sectored antenna systems. (The table is extracted from the Selectivity Summary Total.xls file in section 7.1.2.)

To review the methodology briefly, the simulation is first performed without the WCDMA interfering system operating in order to establish a baseline performance. For this set of simulations, a cdf (cumulative distribution function) of users versus SINR is obtained. The number of terminals is adjusted until the cdf value matches a target value at a critical SINR value. Then the interfering system is turned on and the simulations run again, obtaining a new cdf versus SINR with the interference present. The change in cdf (%) is then indicative of the impact of the WCDMA system on the GSM Uplink.

Table 7.1.5.1 – Summary of simulation results for GSM Uplink. Values are GSM Uplink change in cdf from with the WCDMA system off to with the WCMDA system on.

Company	ant type	cell size	nearest carrier	cdf % delta	ACIR (dB)
2	omni	small	2.7	0	29.8
5	tri	large		4% outage*	
4	omni	small		0	50
3	tri	large	2.7	0	29.8

The company numbers correspond to: 1 – Alcatel, 2 – Ericsson, 3 – Lucent, 4 – Motorola, 5 – Nokia, 6 – Nortel

Small = 577-800m, Large = 2400-4800m. Results are from references at the end of this section [7.2.4.1-7.2.4.4]

* results were given in terms of increased outage (4%)

There are not a large number of results for this series of simulations. However, the nearly unanimous result of negligible impact appears to be reasonable, given the implied signal levels.

7.1.5.2 Analytical considerations

The ACIR is totally due to the emission mask of the WCDMA UE. Following table has been presented in reference [7.1.5.5], and from there we can note the calculated UE TX ACIR values vs. Carrier spacing (last column.)

Carrier spacing (MHz)	ACIR in downlink (dB) due spectrum emission mask of WCDMA BS (measured in a 200 kHz bandwidth).	**ACIR in uplink (dB) due to spectrum emission mask of WCDMA UE (measured in a 200 kHz bandwidth).**
2.6	48.8	**28.3**
2.8	50.0	**31.3**
3.0	53.0	**34.3**
3.2	56.0	**37.3**
3.4	59.0	**40.3**
3.6	60.8	**42.1**
3.8	60.8	**42.3**
4.0	63.0	**42.5**
7.4	63.0	**45.9**
7.6	63.0	**47.0**
8.4	63.0	**55.0**
8.6	63.0	**56.0**

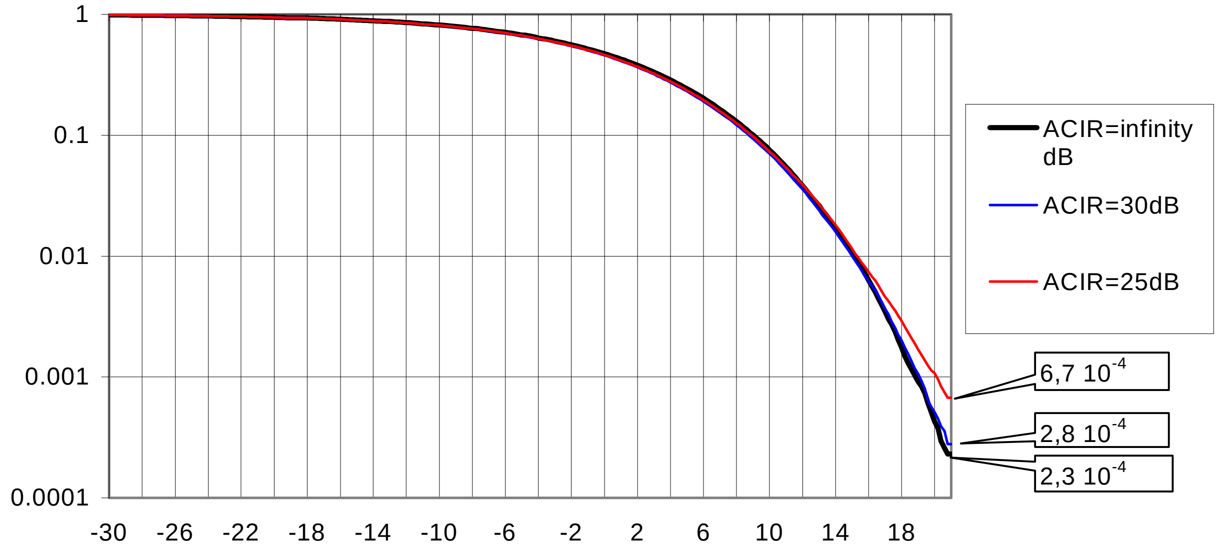
From the table we can note that at 2.7 MHz frequency offset from the WCDMA center frequency, an ACIR of 30dB is calculated. Thus, the +21dBm UE power is reduced by 30dB to a radiated power level of –9dBm from the WCDMA UE into the GSM channel closest in frequency to the WCDMA carrier. The worst-case interference from the WCDMA UE TX emissions into the GSM BS receiver is:

GSM BS RX level = [UE TX power] – [ACIR@2.7 MHz] – [coupling loss] = +21 dBm – 30 dB -70 dB = –79dBm.

Again introducing more coupling loss would improve the situation, as was discussed in case of WCDMA BS victim case, but this would be an option of the GSM system operator.

There will be instances of GSM UE's positioned such that the desired signal level at the GSM BS will be as low as –90 to –100 dBm. In this case the required WCDMA emission mask attenuation would be 60dB@2.7 MHz to produce only 3 dB degradation to the sensitivity. This would represent quite a considerable tightening of the implementation requirement, and is much tighter that FCC requirement of out of band emissions.

However, it is very important to notice that the combined probability is quite small that there is a WCDMA terminal, operating near maximum power output, within the MCL radius of the GSM BS communicating with a GSM UE at the cell boundary. This is evidenced by the results shown in the reference [7.1.5.6], where the WCDMA UE TX power probabilities are recorded in **large cell size** (inter WCDMA site distance 4 km) scenario.



Probability that the UMTS terminal transmit power is greater than value in x axis [dBm]

The ACIR in the graph is that of the WCDMA BS receiver in the simulation. As we have concluded earlier, the value for BS selectivity is, in principal, agreed to be 50 dB, and hence the black curve should be used. From the graph we can see that over the whole WCDMA system there is less than 1% of the WCDMA UE's are using more than +15 dBm power, and less than 0.1% the UE's are using more than +19 dBm output power.

In cases where the cell size is smaller, e.g. 1000m, the behavior of the WCDMA UE output power can be noted in [7.1.5.5]. In this case, more than +5 dBm power levels are hardly ever used.

Thus, one can conclude that the GSM Uplink might suffer very slightly from an adjacent WCDMA carrier for a frequency offset of 2.7 to 7.7 MHz. However the statistical probability is very low, and even in that case only possible with scenarios where the interfering WCDMA BS is located at the GSM cell edge. The probability of the impact can be further reduced by applying higher coupling losses or considering other BS location of either of the systems.

Finally the WCDMA UE emission masks will always include implementation margins, which will further improve the situation.

References:

[24] 7.1.5.1 - R4-010344, "Results of UMTS1800/GSM Co-existence Simulations (Uplink)"

[25] Vienna, Austria 19-23 February 2001

[26] 7.1.5.2 - R4-1800ah-0102, "UMTS1800/1900 Simulation Results for WCDMA and GSM Interference"

[27] Seattle, WA, USA 2-3 May 2001

[28] 7.1.5.3 - R4-010658, "UMTS1800-1900/GSM Simulation Results for the Uplink Scenarios"

[29] Gothenburg, Sweden 21-25 May 2001

[30] 7.1.5.4 - R4-010994, "UMTS1800/GSM Co-existence Simulation Results for Uplink”

[31] Berlin, Germany July 9-12 2001

[32] 7.1.5.5 R4-010354, “ Considerations of WCDMA BS and UE TX emissions for UMTS1800” Vienna, Austria 19-23 February 2001.

[33] 7.1.5.6. R4-01692, “UMTS/GSM co-existence: WCDMA as a victim in the uplink.”Gothenburg, Sweden, 21-25 May 2001.

[34] 7.1.5.7. R4-1800ah-0113 “ UMTS emission mask compliance in the 1900 MHz PCS band” Seattle, WA, USA 2-3 May 2001

7.1.6 Results for Downlink GSM Victim

7.1.6.1 Simulation results

This set of simulations was designed to measure the impact of the WCDMA Downlink on the GSM Downlink performance. The WCDMA parameter that affects the adjacent system is the out-of-band emissions of the WCDMA BS transmitter. This parameter is already set by the FCC out-of-band requirements.

In February 2001, some additions to the RF System Scenarios were made to cover both small (577m) and large (2400m) cell sizes, both omni-directional and tri-sectored antenna systems. (The table is extracted from the Selectivity Summary Total.xls file in section 7.1.2.)

To review the methodology briefly, the simulation is first run without the WCDMA interfering system operating in order to establish a baseline performance. For this set of simulations, a cdf (cumulative distribution function) of users versus SINR is obtained. The number of terminals is adjusted until the cdf value matches a target value at a critical SINR value. Then the interfering system is turned on and the simulations run again, obtaining a new cdf versus SINR with the interference present. The change in cdf (%) is then indicative of the impact of the WCDMA system on the GSM Uplink.

Table 7.1.6.1 -- Summary of simulation results for GSM Downlink. Values are GSM Downlink change in cdf from with the WCDMA system off to with the WCMDA system on.

Company	ant type	cell size	Downlink mode	cdf % delta	ACIR (dB)	nearest carrier
2	omni	small	GSM	0.05	48.8	2.7
2	omni	small	GSM	0	48.8	2.7
5	Tri	large	GSM	0		
5	Tri	large	EDGE	0.7		
4		small	GSM	0.3		
6	Tri	small	GSM	0.2		
3	Tri	large	GSM	0.3		2.7
1	Tri	large	EDGE	0	50	2.8

The company numbers correspond to: 1 – Alcatel, 2 – Ericsson, 3 – Lucent, 4 – Motorola, 5 – Nokia, 6 – Nortel

Small = 577-800m, Large = 2400-4800m. Results are from references at the end of this section [7.1.6.1-7.1.6.6]

Again, there are not a large number of results for this series of simulations. However, the results show a very small change in the GSM system cdf going from no interference to one with the full WCDMA system operational.

7.1.6.2 Analytical considerations

The ACIR is totally due to the emission mask of the WCDMA BS transmission. The interference seen in the GSM terminal receiver is:

Maximum interference level in GSM UE RX = [WCDMA BS output power] – [ACIR at 2.7 MHz with 200kHz] – [coupling loss] = +43dBm - 48.8dB –70 dB = –75.8dBm.

Impact to the GSM DL link budget at 2.7 MHz offset is:

Link budget GSM DL = [GSM BS TX power] – [C/I] – [WCDMA BS interference level]

= 43 dBm – 9 dB + 75.8 dBm = 109.8 dB

This should be compared to a maximum Link budget of:

Maximum link budget GSM DL = [GSM BS TX power] – [GSM UE sensitivity]

= 43 dBm + 102 dBm = 145 dB

Again, the probability is low that there is a GSM terminal, at its cell boundary, that is also near to the WCDMA BS,. Naturally the WCDMA BS emission mask is reduced when the frequency offset from its center frequency is larger or transmitted power is reduced. The emission ACIR into a GSM channel improves to –58.0dB @3.4MHz, and –63dB @ 4.0 MHz, reducing the radiated emissions by 9.2 dB and 14.2 dB, respectively. Hence the impact can be further reduced by proper RRM design that would shift the GSM TCH to a channel further away in frequency from the WCDMA channel when the GSM UE is so close as to be interfered by the WCDMA BS. It also follows that Frequency Hopping will move the traffic channel varying amounts of frequency offset from the WCDMA interferer. Thus, the interleaving gain will effectively reduce this interference to the GSM downlink. Furthermore, these emission numbers represent the worst-case situation, since there will be implementation margins that improve the situation.

One minor observation about the results from Table 7.3.4.1, where we note that the impact on the GSM DL is higher than the impact on the GSM UL, when the WCDMA mask emissions into the nearby channel are equal for both DL and UL. The difference is that the DL results are only dependent on the probability of the location of one UE, the GSM UE, whereas the UL results are dependent on the probabilities of the locations of two UE's, both the WCDMA UE causing the interference (it must be close to the GSM BS) and the GSM UE (it must be at the cell edge with path loss high in order to be susceptible to the interference.) In the UL case, we would multiply the two small probabilities, obtaining an even smaller probability that both UE's are in locations to cause high interference. However, it does point to the fact that we should focus more on the GSM DL interference.

Thus, one can conclude that the GSM Downlink suffers little impact from an adjacent WCDMA carrier for a frequency offset of 2.7 MHz. The amount of impact is probably acceptable.

References:

[35] 7.1.6.1 - R4-0100071, "Results of UMTS1800/GSM Co-existence Simulations (Downlink)"

[36] Boston, MA, USA 23-26 January 2001

[37] 7.1.6.2 - R4-1800ah-0102, "UMTS1800/1900 Simulation Results for WCDMA and GSM Interference"

[38] Seattle, WA, USA 2-3 May 2001

[39] 7.1.6.3 - R4-1800ah-0110, "UMTS1800/GSM Co-existence Simulation Results for Downlink Scenarios"

[40] Seattle, WA, USA 2-3 May 2001

[41] 7.1.6.4 - R4-1800ah-0114, "UMTS/GSM Co-existence Simulation Results"

[42] Seattle, WA, USA 2-3 May 2001

[43] 7.1.6.5 - R4-010629, "UMTS1800/GSM Co-existence Simulation Results for Downlink and 3 Sector

[44] Configuration (revised)", Seattle, WA, USA 2-3 May 2001

[45] 7.1.6.6 - R4-010981, "Simulation results on UMTS1800. EDGE victim in downlink"

[46] Berlin, Germany 9-12 July 2001

7.1.7 Summary of WCDMA 2x5MHz Performance

The results and analysis of the previous 4 sections is summarized in the following Table [7.1.6.1] for convenient reference:

Table 7.1.6.1 – Summary of 4 interference cases between WCDMA and Narrowband systems

Interference Case	Simulation result	Worst case result	Behavior that reduces worst case impact
WCDMA Downlink	1-2% capacity loss (ACIR –30dB at 2.7Mhz and -43dB at 3.5MHz)	See sections 7.5.1 and 7.5.5 where this is discussed At 2.4km cell size, ~1/4 outages will be due to blocking	See section 7.5.5 where discussed in detail -RRM procedures for hard handoff -GSM system self-protection measures will also help UMTS system -Placement of WCDMA BS closer to interfering BS -Need to handle non-blocking outages (blocking may not be as special as first thought)
WCDMA Uplink	~0.1% capacity loss (ACIR –50dB at 2.7MHz)	WCDMA BS noise floor rises an additional 14dB over 6dB planned increase for interfering UE at max power at MCL	-Control UMTS cell size (e.g., 2.4km does not suffer even for worst case) -Raise MCL
GSM Uplink	Negligible capacity loss	GSM BS noise floor as much as 30dB higher for UE at max power at MCL	Very low probability helped even further if the WCDMA UE does not try to operate at high interference levels, as it will cause interference itself. (Argues against excessively high UE ACIR—see section 7.5.5.2, as well large cell size when this is likely to be a problem)
GSM Downlink	<1% capacity loss	GSM link margin degraded by 35dB	GSM RRM procedures can shift interfered UE's to other channels Coordination of WCDMA and GSM BS location as is the case for WCDMA DL

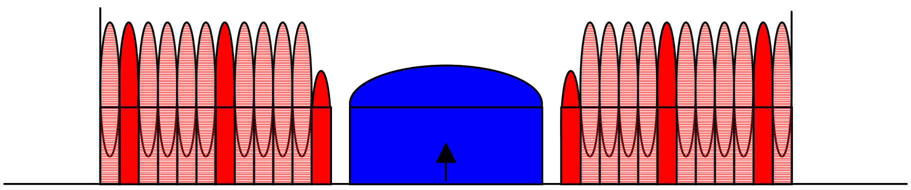
7.2 One WCDMA carrier in 2x10 MHz with coordinated GSM case

Coordinated Case with Co-sited WCDMA and GSM base stations means that both systems are deployed into the same sites in order to diminish the near-far effects. In this case it is recommended that UL of the GSM system is power controlled, if small coupling losses are applied. WCDMA UL is naturally power controlled.

There are 4 different cases that must be analyzed for this type of deployment with WCDMA and GSM base stations located at the same place and WCDMA and GSM terminals that may be in any location within the common cell size. At the moment, we will presume that the cell sizes of the two systems are approximately equal. This assumption is quite natural from a deployment point of view.

For purposes of discussing the different interference cases below, we use the following diagram of carrier configurations in a 10 MHz band with 1 WCDMA carrier and multiple GSM carriers on both sides of the WCDMA signal.

Figure 7.4.1



The frequency separation of the center frequency of the WCDMA carrier and the nearest GSM carrier frequency is f_{offset} or frequency offset.

7.2.1 CASE 1 WCDMA DL – GSM BS interferes with the WCDMA UE

In this instance, regardless of the location of the WCDMA UE, the path losses from either the WCDMA BS or the GSM BS are assumed to be nearly equal to within the fading margins.

For the 8kbps voice condition assumed in the uncoordinated simulations, the WCDMA UE can receive the desired signal down to 18dB below the noise floor of the receiver. Assuming a fading condition of [3dB] on the desired path relative to the interfering signal, the following will be true:

Interference level to WCDMA RX = [GSM BS output power] – [Path loss] – [WCDMA UE selectivity@2.7MHz]

Required WCDMA BS power = [Interference to WCDMA RX] – [processing gain] + [Path loss] + [fading]

Substituting the first equation into the second equation:

Required WCDMA BS power = [GSM BS output power] – [WCDMA UE selectivity] - [processing gain] + [fading] = +43 dBm [–30] dB –25 dB + 7 dB + [3] dB = -2 dBm

using the assumed –30dBc selectivity at 2.7 MHz from the uncoordinated case in section 7.1, and 3 dB fading margin. The -2dBm result is well below the lowest power control level (25 dB control range) of the WCDMA BS, and hence there will be always reasonable C/I conditions.

We can assume this DL interference case will be even better with reality in several ways:

a) The GSM BS's are cooperative and for the channels nearest the WCDMA carrier frequency, can be made to be non-BCCH carriers. They can also carry the lightest loading of all the channels sharing the total band. Thus, the +43dBm is a pessimistic and unnecessarily high value for a well-planned coordinated set of systems.

b) The differential path fading of [3dB] against the desired signal is assumed due close proximity of signal sources and small frequency difference. In fact, the differential fading is more likely to diminish the interfering signal level and not the desired WCDMA signal level as the diversity gain is larger for the WCDMA signal than the GSM signal in the downlink direction.

c) We can assume that the system operator will find the right balance between service on the nearest GSM channel to the WCDMA channel and the frequency offset of that channel.

The WCDMA BS power required to overcome the GSM interfering signal at 2.7MHz f_{offset} will be less than 0dBm most of the time. This will cause an insignificant increase in power transmitted to all WCDMA UE's

Conclusion from this analysis is that the WCDMA DL interference is under the control of the operator determining the usage of the nearest GSM carriers, and operation at a f_{offset} of 2.7 MHz in WCDMA DL is absolutely assured under the worst-case conditions.

7.2.2 CASE 2 GSM DL – WCDMA BS interferes with GSM UE

This interference situation is determined by the emission mask of the WCDMA BS, and interferes with the GSM UE's operating on the frequency channels closest to the WCDMA carrier. This emission level competes with the GSM BS signal directly in the GSM UE receiver. Again the path loss from interfering and serving BS is assumed to be the same within the fading margin. The location of the GSM UE should not affect the outcome of this analysis.

The analysis is based on the fact that the WCDMA BS emissions have to meet the Out-of-Band emissions required by the FCC, and at the same time the signal level from GSM BS has to be adequate to maintain the service. The ACIR of the WCDMA BS emissions at 2.7 MHz offset into a GSM channel is 48.8dB. The total output power from a WCDMA BS will be close to +43dBm most of the time. Therefore, the emissions of such a base station into the GSM UE receiver, and the received signal level from own BS will be:

Interference level to GSM UE RX = [WCMDA BS power] – [ACIR@2.7MHz] – [Path Loss],

GSM UE RX level = [GSM BS power] – [Path Loss] – [Fading]

The ratio of desired to undesired signal level denoted as C/I will be:

C/I = [GSM BS power] – [Path Loss] – [Fading] – [WCDMA BS power] + [ACIR] + [Path Loss] = +43dBm –[3dB] – 43dBm + 48.8dB = +45.8dB

Since a GSM voice signal only requires a +9dB C/I ratio, there is 36.8dB margin in this instance when the nearest GSM channel is operating 2.7MHz offset from the WCDMA carrier.

As a conclusion of the analysis the operation of the nearest GSM carrier at offset of 2.7MHz in GSM DL is assured with large margin.

7.2.3 CASE 3 WCDMA UL – GSM UE interferes with WCDMA BS

For this case, the location of GSM UE's will have a large effect on the system performance. Also, the number of GSM UE's in a given area, particularly close to the WCDMA BS will also affect the system performance. This latter effect will be very stochastic and somewhat difficult to account for.

In this analysis it should be analyzed about the impact of one or more GSM UE's transmission to the WCDMA BS. The worst case will be when the GSM UE's are in close proximity to the WCDMA BS. In this case, the coupling loss is assumed to be 70dB, reflecting the macro BS scenario. The micro BS case is also analyzed.

In this case when the GSM UE is closest to the base stations, the GSM UE power output will be commanded to its minimum value, 0 dBm + tolerance 5 dB = + 5 dBm. In addition the WCDMA BS selectivity at 2.7MHz offset is –50dBc (from section 7.2.3 of this report). Therefore, the GSM UE worst-case signal level into the WCDMA BS receiver will be:

Macro case:

GSM UE interference level into WCDMA BS = [Lowest GSM UE power] – [coupling loss] – [WCDMA BS selectivity] = +5dBm –70dB –50dB = -115dBm

The WCDMA BS RX noise floor is approximately –100 dBm (3 dB noise rise due the UL load). Therefore, -115 dBm of interference into the WCDMA BS RX will cause about 0.1dB rise in the RX noise level in the WCDMA BS. If this were the only effect, this would be an insignificant impact.

Micro case:

GSM UE interference level into WCDMA BS = [Lowest GSM UE power] – [coupling loss] – [WCDMA BS selectivity] = +5dBm –53dB –50dB = -98dBm

When micro BS cases have been discussed in RAN WG4, there has been an assumption that some level of desensitization is needed just due lower coupling loss, and the larger number of users in both the UMTS and interfering systems. A value of 14 dB desensitization has been commonly assumed as one option, and hence the WCDMA BS RX noise level, without interference, would be –83 dBm (6 dB noise rise due the UL load). Adding –98 dBm of interference would cause an additional 0.4 dB rise in the WCDMA BS RX noise level. In this micro case, the impact is slightly higher. This amount of impact could be reduced (eliminated, in fact) by either slight adjustments of appropriate coupling losses between BS and UE's.

Based on the above worst-case analysis, it is apparent that GSM or any other co-ordinated system would require UE transmitter power control in UL direction.

Furthermore, it is not anticipated that there is ever an instance where the GSM UE power output rises faster than the increase in Path Loss. Thus, the worst-case analysis is sufficient.

Other effects that might decrease or increase this margin:

1) RACH – This *must* be blocked by operator system planning, to prevent UE full power from occurring on the nearest GSM channels to the WCDMA carrier. In other words setting the system parameter in BCCH allowing UE to perform the RACH only in a more desirable frequency. If full UE power is broadcast into the WCDMA BS at close range, the signal level during the bursts will be (from macro equation above) = +30 dBm – 70 dB – 50 dB = -90 dBm. This level would desensitize the WCDMA BS by nearly 10dB and be very disruptive.

2) A single GSM UE will only be on 1/8 of the time, so there will be interleaving gain in the WCDMA channels, which will protect the service from short instantaneous interference.

3) A fully loaded GSM carrier will approach the worst-case result above. – Although it is statistically not very likely that all those UE's would be close to the WCDMA BS, the system operator may wish to distribute the loading on the nearest GSM channel in a manner that serves mostly GSM UE's at a greater distance. The interference from these UE's would then be greatly lessened. This should be a feature of proper RRM control.

As an final note, this analysis has not included fading, which would likely improve the situation. Other more typical behavior such as nominal UE TX output rather than the upper tolerance will increase operating margins. Assuming that the operator applies reasonable system parameters, the operation of the nearest GSM carrier at 2.7MHz in WCDMA UL is assured.

7.2.4 CASE 4 GSM UL– WCDMA UE interferes with GSM BS

In this case the out-of-band emissions of the WCDMA UE are the critical factor. This case also must take into account that the total power impinging on both (co-sited) base stations from all the WCDMA UE's needs to considered. WCDMA UE's will be under power control to output the minimum power needed to keep each WCDMA Uplink at about –18dB C/I for the 8kpbs voice service. Furthermore, the WCDMA system loading will be such that the WCDMA BS will see a modest rise of its noise floor.

WCDMA BS RX level at 6 dB noise rise = [thermal noise] + [BS NF] – [noise rise UL users] = -108 dBm + 5 dB + 6dB = -97 dBm

Since 6 dB load would mean quite considerable amount of user in the cell, it's approximated that it represents 40 users. For the sake of simplicity it's assumed that all users will have similar service, since otherwise the number of 40 users is neither justified.

WCDMA UE TX minimum power is limited to –50 dBm. Based on the transmitter emission mask definition in TS 25.101, the adjacent channels can be –50 dBm @ 3.84MHz. The impact of these values is that WCDMA UE's close to the base stations will have somewhat degraded ACIR in their emissions at 2.7MHz.

Macro case:

In the close proximity of macro base station the WCDMA UE will transmit at power:

WCDMA UE TX power = [WCDMA BS RX level at 6 dB noise rise] + [10log(1/ number of users in UL)] + [coupling loss] = -97 dBm –16 dB + 70 dB = -43 dBm.

Based on the requirement in TS 25.101, it's assumed that the interference at 2.7 MHz point is dominated by the wide band noise requirement –50dBm@3.84 MHz.

Interference level in GSM BS RX = [WCDMA UE TX noise floor] – [BW conversion] – [coupling loss] = -50 dBm@3.84MHz – 12.6 dB – 70 dB = -132.6dBm@200 kHz

As an extreme worst case, there would be 40 UE's, all close to the base stations. The total power into the GSM BS RX at all channels would then be –132.6 dBm + 16 dB (representing the to this number of users) = -116.6 dBm. Since the noise floor of the GSM BS RX is the sensitivity – the C/I = -104 dBm - 9 dB = -113 dBm, -116.6 dBm would have a noticeable impact of about 2 dB desensitization.

However, it is highly unlikely that all 40 UE's would be all that close. For a more even distribution, the emission mask would behavior more normally and reduce the –116.6 dBm worst case number considerably.

If the load is not 40 users, but something less, the UE should not change it's transmitted power more than 3 dB, since the load is also reduced. Naturally this assumes that the service remains the same.

Micro case:

In this case the UE minimum power is limited to –50 dBm and the power in the adjacent frequency range is also –50 dBm / 3.84 MHz.

Interference level in GSM BS RX = [WCDMA UE TX noise floor] – [BW conversion] – [coupling loss] = -50 dBm@3.84MHz – 12.6 dB – 53 dB = -115.6dBm@200 kHz.

If we consider the GSM BS sensitivity to be –104 dBm, this worst case interference by a single UE will impact the sensitivity by 1.9 being then –102.1 dB.

40 UE's at close proximity to the basestations would increase this number by 16 dB to –99.6 dBm. and approximately 13,4 dB desensitization to the BS reception. However, we must also be aware that the GSM micro cell plan rarely operates at these sensitivity levels.

From the above, we see that the worst-case analysis for the GSM UL would have some problems with impacts to UL sensitivity. However, we must recognize that the UE mask requirement probably does not represent reality very closely. Often, the emissions mask of a transmitter will get better as power output is reduced. It might be unrealistic to just assume that the emissions in the adjacent band will only be as good as the requirement in TS 25.101. Conclusion of this analysis is that WCDMA UE could effect the GSM UL if the performance of the UE emission mask is only as good as the requirements.

7.2.5 Summary of conditions that effect the coordinated operation of WCDMA and GSM in a shared band with co-sited base stations.

The above analysis shows that the proposed coordinated, co-sited base station deployment of a WCDMA system and a GSM system within the same band is also reasonably assured. The nearest GSM channel of 2.7MHz offset from the WCDMA carrier center frequency has been shown to have good margins for all interference conditions. All cases applying good network planning practices the possible interference scenarios can diminished in the level not having significant impact to the own system performance. Operation with a frequency offset of less than 2.7MHz is subject to many variables in system planning and different options of network deployment.

When considering this analysis in the context of the impact of uncoordinated interference, it can be concluded that the GSM portion of in this scenario acts as a "guard band" to other systems. In this case the offset to the nearest possible uncoordinated NB interferer is in the order of 5 MHz frequency offset from the WCDMA center frequency, and hence both the UE and BS ACIR as discussed in section 7.1.2.5 is significantly higher.

7.2.6 Operation of the first GSM channel closer than 2.7 MHz

WCMDA DL – Operation at smaller frequency offsets are certainly an option for the operator as the behavior of the nearest GSM channels can be controlled in many ways (as described in Section 7.2.1.) Operating GSM channels closer to the WCDMA center frequency will reduce the UE selectivity in the equation in Section 7.2.1. From there it can noted that when both systems have roughly the same BS transmitter power there is a positive processing gain with very reasonable filtering in WCDMA UE to suppress the total received signal power to reasonable level. The effect to be concerned about is that the interference may start to cause a noticeable increase in output power to all WCDMA UE's. Given that GSM BS power, traffic type, and RRM procedures can have a very large impact, operation at a frequency offset of 2.6MHz might be feasible as well. This WCDMA DL case should not be the limiting factor.

GSM DL – Here the key to operation closer than 2.7 MHz would be the behavior of the WCDMA BS emissions at the band edge. Given that there is a 36.8 dB margin, it is difficult to see how the 48.8 dB ACIR at 2.7 MHz could degrade to only 12 dB ACIR at 2.6 MHz. It should be also noted that due to the different deployment scenarios the WCDMA BS TX power would influence the emissions directly. Hence in lower BS power cases this could be possible. This needs to be checked with vendors to understand this behavior exactly. This GSM DL case will be a limiting factor.

WCDMA UL – The WCDMA BS selectivity is very high at 2.7 MHz. It is likely to have a very sharp slope versus frequency in this region. From the analysis above, the macro UL sensitivity would degrade 3 dB if the selectivity degraded 15 dB going to 2.6 MHz. However, either a combination of lightly loaded channel and /or restriction to operation on that channel with only distant GSM UE's with low RSSI at the GSM BS would open up the opportunity for operation on a more closely spaced frequency channel. This WCDMA UL case will be a limiting factor.

GSM UL – The WCDMA mask is the key factor in this case regardless of the frequency offset of the nearest GSM channel. Therefore, any operation closer than 2.7MHz would rely on RRM procedures and system design to utilize the nearest channel effectively.

Conclusion—Operation for coordinated deployment with carrier separation less than 2.7MHz between the WCDMA and GSM signals is dominated by the emissions of the WCDMA system. Successful operation in this domain requires careful RRM procedures.

7.3 2x10 MHz deployed with 2 WCDMA carriers

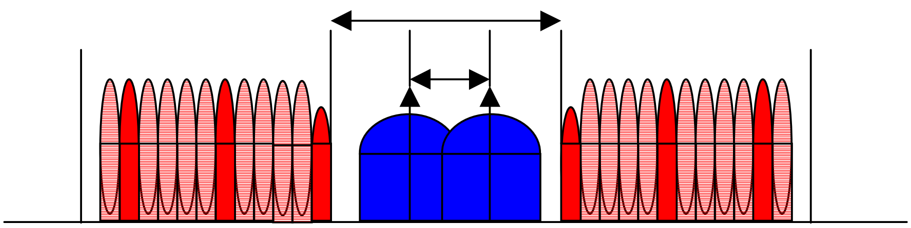
This is another possible deployment scenario for a 10 MHz frequency spectrum block. It consists of 2 coordinated WCDMA carriers, with approximately equal cell sizes. Since the power control balance is close to optimal neither DL nor UL WCDMA services interferes each other significantly. Hence it possible to place the WCDMA carriers closer than the 5 MHz channel allocation. If we consider the channel spacing to be 4.4 MHz as suggested in reference [7.3.1] for this case some more protection can be gained against the uncoordinated interference.

Hence this scenario can be divided into 2 different aspects:

1) In first case The capacity loss due closer than 5 MHz channel spacing in co-sited WCDMA carriers.
2) External interference from uncoordinated systems

the capacity in the WCDMA carriers is slightly reduced, up to approximately 3 %.

For purposes of discussing the different interference cases, we use the following diagram of carrier configurations in a 10 MHz band with 2 WCDMA carrier and NB carriers on both sides of the WCDMA signals.



The frequency separation of the center frequency of the WCDMA carrier and the nearest carrier frequency is f_{offset}.

The second case is a variation of interference scenarios handled in 2x5 MHz deployment section, but with somewhat better protection to the interference. Instead of the first interfering channel being at a frequency offset of 2.7 MHz, it will now be at 3.0 MHz. Since the emission ACIR's for both UE and BS do not change very fast with frequency from the WCDMA carrier, the GSM UL and DL performance will not improve significantly. However, the more impacted WCDMA DL performance will benefit from a possible increase in UE selectivity that would occur at the larger frequency offset. *IF* the UE selectivity of –30 dB at 2.7 MHz and –43 dB at 3.5 MHz is adopted, then one might infer that the selectivity for the first channel at 3.0 MHz would be in the range of 3/8 times 13 dB = 5 dB better than –30 dB or –35 dB. This 5 dB improvement would not be guaranteed by any specific part of the specification TS 25.101, but would be very probable with any realistic hardware implementation. This would improve the capacity loss and the blocking performance.

References:

[47] 7.3.1 – *RP-1800AH-0112* "Carrier to carrier spacing for UMTS-1800" RAN WG4 1800/1900 adhoc meeting, Seattle, USA, 2nd – 3rd May 2001

7.4 UE to UE interference considerations

7.4.1 CASE 1 – GSM UE interferes with WCDMA UE

In this case there is a specified spurious output requirement for the Band II (1900) and Band

III (1800) for GSM UE. This value is –71dBm@100kHz for the UE in active and idle mode into the receive band (measured at the antenna terminal), which is in this case common for both systems. The MCL (Minimum Coupling Loss) between UE's in the same band is assumed to be 40dB and the probability of more than one UE within the MCL is discounted. However, that UE could be a multislot capable UE—we assume two slots UE TX.

GSM UE power into WCDMA UE = [Receive band spurious level] – [duty cycle in GSM] – [UE to UE MCL] = -71dBm – 6 dB – 40dB = -117 dBm

WCDMA UE RX noise level = [thermal noise] + [NF] = -108 dBm + 11 dB = -97 dBm.

Hence the impact to the sensitivity is 0.1 dB, which not be a problem. Even an 8 slot UE would be of small consequence.

7.4.2 CASE 2 – WCDMA UE interferes with GSM UE

This is the reverse case to previous situation. In the WCDMA UE, the spurious requirement has already been set at –60dBm@3.84 MHz into the receive band. Again the MCL = 40dB makes the receive band power:

WCDMA UE power into GSM UE RX = [Receive band spurious requirement] –[BW conversion to 200 KHz] – [UE to UE MCL] = -60dBm –12.6 dB – 40dB = -112.6 dBm@200 kHz.

GSM UE RX noise floor = [UE sensitivity] – [C/I] = -102 dBm - 9 dB = -111 dBm. Hence the impact to the GSM sensitivity degradation is 2.3 dB.

Again, the worst case impact occurs only when both a GSM UE is operating at the sensitivity limit, at the same time that a WCDMA UE is at the minimum proximity distance. The probability for this is quite low. Hence no change is considered necessary to the requirements specification.

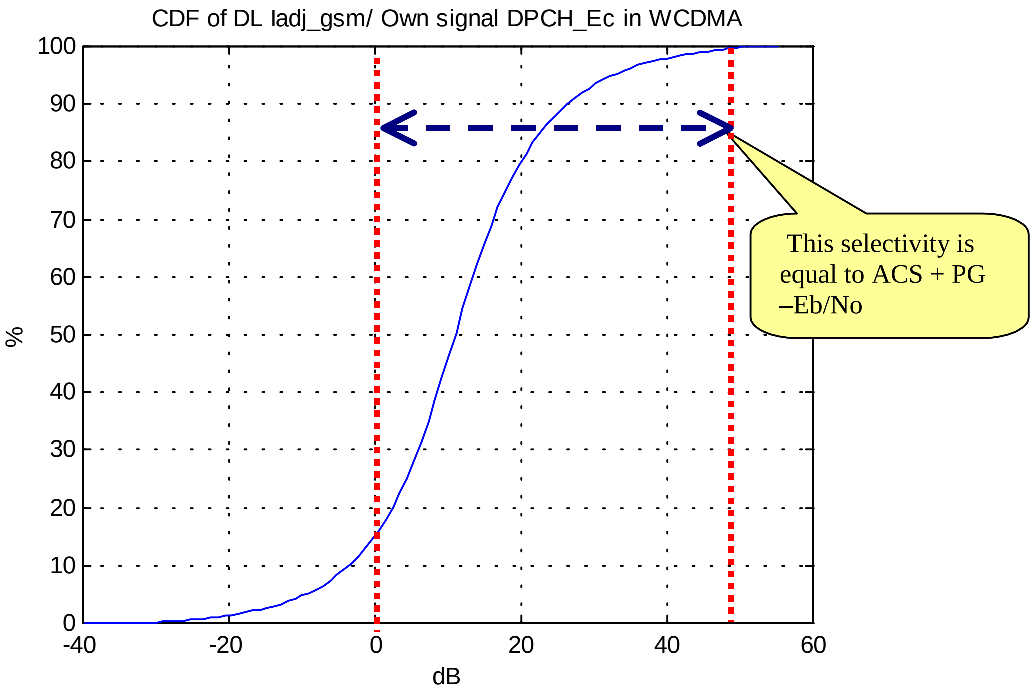
7.5 Summary of Analytical Results

7.5.1 Analytical results of WCDMA blocking in downlink

The simulation results and analysis in the section 7.1 for 2x5MHz case give us the desired ACIR (Adjacent Channel Interference Rejection) for both WCDMA Uplink and Downlink as a function of impact on system capacity for the worst-case deployment situation, which is purely generated for simulation purposes. It is relatively easy to agree upon a value of 50dB ACIR for the WCDMA Uplink (reference [7.5.1]), as that is a realistic implementation value and results in a very small capacity loss clearly less than 1%. This must be the case in practice as well; otherwise it would mean that the whole uplink would deteriorate, affecting all users in the cell. The Downlink ACIR is yet to be agreed upon, but one value of 30dB has been proposed (reference [7.5.2].) That value would result in a capacity loss of approximately 2% (see Section 7.1.3) in this worst-case 2x5 MHz deployment scenario case.

Other methods could be used to select an appropriate value for Downlink ACIR. Reference [7.5.2] uses one other method and shows the cdf of WCDMA UE's in the large cell simulation. The graph shows how much the interference signal is greater in dB's than the received own desired signal versus the cumulative density function of the UE population. For an ACIR of 30dB plus the 25dB processing gain minus 7dB Eb/No of the 8kbps service, less than 1% of the cases had an interfering signal exceed the original received signal by more than this amount. This is an important measure of the number of instances (about 1% for WCDMA cells with 2.4km radius) where the interfering signal is too large for –30dBc selectivity to suppress it sufficiently. When this happens the BS power control was not able to overcome the interference because of the +30dBm limit per UE.

One should bear in mind that, in this simulation, the interfering sources are all purposefully placed to cause the strongest interfering signals when the WCDMA system is attempting to receive the weakest BS signals. When the systems BS's will have any other location, that is more co-location than anti-location, this percentage of the UE population that is blocked will decrease further. That curve for worst-case situation from reference [7.5.2] is reproduced here for convenience.



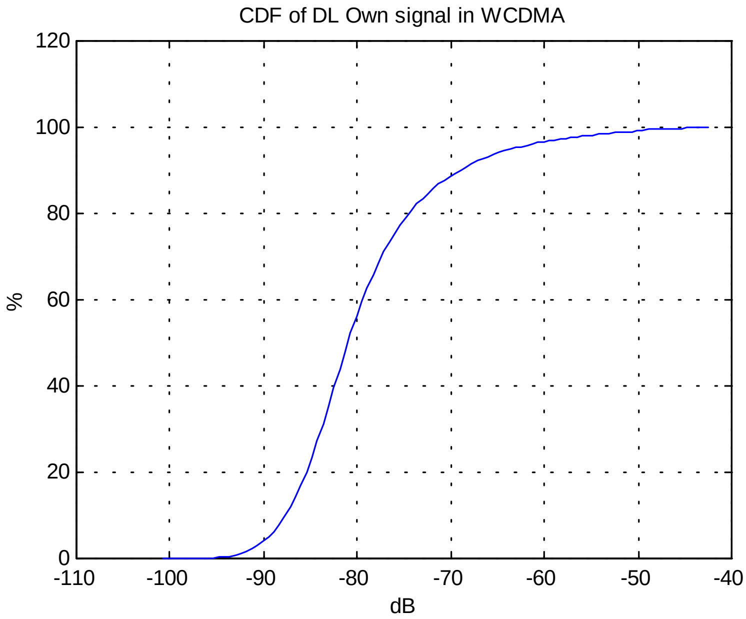
Note that this analysis above uses the simulation results in a different way than measuring capacity loss. It illustrates the impact of the interfering signals on individual WCDMA UE's. Whereas, the simulation results also respond to the interference with new power outputs and there is an additional capacity loss (4% versus the 1% implied by the above analysis) as the *Ior* noise level may rise to the point of causing the link to break, or there may not be sufficient power to keep a link going. Thus, additional links are broken for secondary reasons.

This also indicates that the capacity losses are not entirely located at the proximity of interfering BS's, but the majority of the UE outages (about ¾ of the total 4 % capacity loss) are spread elsewhere over the whole system.

In the section 7.1.3 there is additional analysis of the UE downlink selectivity issue. From the discussion there it can be noted that, since the filter has some slope to the stop band attenuation due practical implementation, the line between UE's that are being blocked and those that are not blocked will shift to the right on the cdf-curve as the selectivity increases. Hence the percentage of UE's that are blocked is reduced for the channels that are more than 2.7 MHz from the WCDMA center frequency. *The number of blocked UE's will be less than the above results suggest because of this realistic filter stop band attenuation slope.*

These results validate the choice of values of WCDMA BS and UE selectivity made for reasons of capacity loss. The frequency offsets for selectivity are the nearest possible GSM channels: in the case of Band II it is 2.7MHz and for Band III it is 2.8MHz. Since it is desired to have one requirement for both bands, the 2.7MHz point from channel center frequency is selected. Thus, the channel selectivity at 2.7MHz should be (for discussion purposes of this section) –30dBc for the UE and –50dBc for the BS.

The discussion above highlights the ratio of the desired signal and interfering signal. At what level of interference do we check the channel selectivity? This is an important value, as it influences several other performance parameters. One approach is to this is to use the cdf curve from reference [7.5.2] showing the desired signal behavior in the same simulation environment. The selectivity is needed to protect the desired signal, so this approach is felt very straightforward. For the convenience the graph is reproduced here.



From the plot it can be concluded that all users are having their own DPCH_Ec level higher than –95 dBm. In reference [7.5.2] the testing case was selected to be 10 dB above reference sensitivity level, e.g. DPCH_Ec = -105 dBm. This together with an ACIR of 30 dB will give following interfering level:

Interfering signal power = [Received signal level (DPCH_Ec)] + [selectivity] + [processing gain] –[Eb/No]= -105dBm + 30dB +25 dB -7dB = -57dBm

The graph would suggest that the range of DPCH_Ec values are well within this selected value for tri-sector WCDMA systems with 2.4km cell sizes.

7.5.1.1 Derivation of blocking condition and probability

In this section, a method is used to calculate the blocking condition from system parameters. As will be seen, a single result can then be extended to describe results with changed system parameters.

The blocking condition actually arises because of the limited power available from the BS -- +30dBm is the maximum permitted per user commonly used in these scenarios. From this value and knowledge of the system parameters, we can derive the interference level J(dBm) whereby:

1) interference levels less than J will have random outages, and

2) interference levels greater than J will have a high probability of systematic outage.

critical inteference level, J = [maximum BS power] – [path loss at cell boundary] + [selectivity] + [processing gain] – [Eb/No] = +30dBm –124dB (assuming antenna gains of 18 and 0 dB) + 30dB +25dB –7dB = -46dBm

We can then go the graph of interference cdf from reference [7.5.2] and determine that the percentage of interfering signals with levels higher than –46dBm is indeed about 2%.

We can also use this as a perturbation tool. What if the selectivity is higher? A selectivity of –43dB (to be required at 3.5 MHz frequency offset) indeed shows critical value J to be higher than the strongest interfering signal—thus, there should be no systematic blocking. This is the same as would be determined from the graphical method above. What if the cell size is larger such that the path loss is 5dB higher? The critical value J would be –51dBm. For such a larger cell the cdf of the interference signals would be predominantly unchanged in the regions close to the interfering base stations. Going to the cdf graph of the interfering signals, we would conclude that the incidence of systematic blocking would rise to about 4% of the UE population. The same technique would apply to the processing gain and Eb/No changes for other services as well. (Appendix A shows results plotted versus interference power level that clearly shows a break in the behavior of various parameters at this critical value J.)

7.5.2 Cross modulation

7.5.2.1 Cross modulation in the WCDMA downlink

It is shown here that the cross modulation effect is to be included in the “Narrowband Blocking Requirement” to be added to TS 25.101 (section 7.6.3) and TS 25.104 (section 7.5.2). This is done by further specifying the level at which the WCDMA UE transmitter is operating during the test for this requirement. Per prior approval Reference [R4-010???] all tests are to be made with the WCDMA UE transmitter operating at a level 3dB below the maximum power output for its class. For example, in the case of power class 4, the UE would be operating at +18dBm.

The Narrowband Blocking Requirement proposal in reference [7.5.2] suggests that it would be best to make the narrowband blocking measurement at a signal level elevated above the minimum signal level (defined as REFSENS in both documents and equal to –115dBm DPCH_Ec for the 1900MHz band). Reference [7.5.2] proposes that the measurement be made at:

Received signal measurement level = [REFSENS] + 10dB = –105dBm DPCH_Ec

for 1900 MHz band. For a effective processing gain of 18dB (25 dB-7 dB), the UE noise floor can rise to:

Maximum UE noise floor = [Received signal measurement level, dBm] + [Processing gain, dB] – [Eb/No]= -105dBm + 25 dB – 7 dB = -87dBm

From section 7.1.3, the WCDMA UE ACIR at 2.7MHz should be –30dB. Thus, we can determine the level at which the interference signal should be set by:

Interference level = [Maximum UE noise floor] + [ACIR at 2.7MHz frequency offset] = -87dBm + 30dB = -57dBm

This is the proposed value in reference [7.5.2] and thus, the complete Narrowband Blocking specification states that “The UE shall successfully receive a signal at –105 DPCH_Ec in the presence of an interfering GSM signal at a level of –57dBm and 2.7MHz offset from the WCDMA carrier center frequency while the UE is transmitting at 3dB less than maximum power output.”

Since the UE transmitter is also operating, there is also the possibility of an interference signal in the receiver due to cross-modulation between the transmitter signal and the interfering signal. The total noise floor due to:

Total noise floor = [Receiver NF] + [interference] – [ACIR at 2.7MHz] + [cross-modulation interference]

must be less than or equal to –87dBm. Thus, if the ACIR, or selectivity, at 2.7MHz is –30dB, then the cross-modulation component must be negligible. Alternatively, the UE could have an ACIR of –33dB. Then the direct interference component would be –90dBm, allowing a cross-modulation component of about –90dBm (assuming the receiver NF contributes nothing to this sum).

When the interfering signal level is greater than –57dBm, it can be shown that all of the components of the above equation increase linearly with the increase in the interfering signal level. *Therefore, there will be no degradation in sensitivity other than the linearly increasing noise level due to the higher interfering power level. This is important, as it means that any level of interfering signal level is as good as any other level for testing the impact any cross-modulation effect.*

The type of the interfering signal is considered to be a modulated GSM signal, actual modulation type tbd.[7.5.3]

Hence from the discussion above it can be concluded that by defining the appropriate transmitter level, also a reasonable cross modulation performance is then guaranteed. In the section 7.1.5.2 it was recorded that the probability of UE operating higher than +18 dBm power is less 0.1%, so this requirement should be quite well covered.

7.5.2.2 Cross modulation in the WCDMA Uplink

We will not repeat all of the analysis from section 7.5.2.1, but will summarize the new values that would be used in the appropriate section of TS 25.104. From section 7.1.4, the ACIR at 2.7MHz should be –50dB. A 6db increase in noise floor is an accepted criterion for testing the BS, so an appropriate interference test level would be:

Interfering signal level = [Thermal noise floor] + [WCDMA BS NF] + 6dB + [Selectivity]

= -108dBm + 5dB + 6dB + 50dBc = -47dBm

Again, the WCDMA BS should be simultaneously transmitting at full output power in order during this test, thus ensuring that the cross modulation performance of the BS is also tested at the same time.

The complete Narrowband Blocking specification states that “The BS shall successfully receive a signal at –115 dBm DPCH_Ec in the presence of an interfering GSM signal at a level of –47dBm and 2.7MHz offset from the WCDMA carrier center frequency while the UE is transmitting at maximum power output.”

The rationality of this figure can shown by an example; if we assume the GSM UE is transmitting at full power, the possible interfering level would be in this case:

Interfering signal level from GSM UE = [GSM UE transmitted power] + [coupling loss] + [duty cycle] = 30 dBm –70 dB –10log(1/8) = -49 dBm

7.5.3 Inter-modulation distortion

7.5.3.1 Narrow Band Inter-modulation in the WCDMA Downlink

It is recognized that the interfering signals in the band will be not just one, but several. For the GSM interfering system, the reuse pattern causes multiple signals at about the same power level (within fading variation) within the band. The appropriate specification requirement for this situation is a “Narrow Band Inter-modulation Distortion Requirement.”

The IMD requirement has many options. The first consideration is that the BCCH channels will be more problematic as they are transmitting continuously. In a rational deployment, these will not be placed at the band edges, but rather they are placed to ensure best protection against external interference. Therefore, it is sensible to place the IMD interference signals at some frequency offset further from the WCDMA carrier center frequency than the nearest possible channel.

Reference [7.5.2] suggests that the first frequency be 3.5MHz offset from the WCDMA carrier center frequency. A GSM system with 4/12 reuse would have a second BCCH carrier 2.4 MHz further offset or at 5.9MHz from the WCDMA carrier center frequency. This combination of interfering signals would generate a distortion product at 1.1 MHz offset from the WCDMA carrier center frequency. That distortion product would be in the pass band of the WCDMA receiver.

The IMD requirement should prevent the occurrence of interfering signals within the WCDMA receiver pass band caused by multiple interfering signals. Since these signals can separately interfere with the WCDMA UE receiver, via the selectivity of the channel filter, and create a cross-modulation product, the total increase in receiver noise floor would be:

Total UE noise floor = [Interfering signal at 3.5MHz] – [ACIR at 3.5MHz] + [Interfering signal at 5.9MHz] – [ACIR at 5.9MHz] + [IMD interference] + [cross-modulation interference]

The increase in UE receiver noise floor should be 10dB maximum or –87dBm for the 1900 MHz band. Since the ACIR at 5.9MHz offset is likely to be much greater than the ACIR at 3.5MHz, the direct interference component at 5.9MHz is neglected. The variable in the equation above with the most direct impact on the UE nose floor is the ACIR at 3.5MHz. From the discussion in section 7.1.3, realistic filters should improve by about 15dB in selectivity between 2.7 and 3.5MHz.

ACIR at 3.5MHz = [ACIR at 2.7MHz, dB] + 15dB = 30dB + 15dB = 45dB

Furthermore, we (arbitrarily) wish to restrict the product of the IMD and cross-modulation components to something smaller than the direct interference from the ACIR. If we select degradation due to both IMD and cross-modulation of 2dB, then the –87dBm noise floor target would become –89dBm for the direct interference component only.

Interference level at 3.5MHz = [UE noise floor target corrected for IMD and cross-modulation (2dB)] + [ACIR at 3.5MHz] = -89dBm + 45dB = -44dBm

as the power level of the two interfering signals for the IMD test.

The specification would require the receiver to operate with a desired input level of –105 dBm DPCH_Ec, in the presence of interfering signals at 3.5MHz and 5.9MHz with levels of –44dBm for both signals and the UE transmitter operating at 3dB less than maximum output power. One of the interfering signals should be GSM modulated. This is same methodology as is the case in current specification.

Note that the analysis above in both the Narrowband blocking and Inter-modulation Distortion requirements is based on ACIR values chosen by other means. The requirements developed above then ensure that the additional performance degradations due to cross-modulation and *inter-modulation are negligible in relation to the direct impacts of the ACIR (selectivity) on the receiver performance.*

7.5.3.2 Inter-modulation in the WCDMA Uplink

The WCDMA BS requirements for inter-modulation should mirror the analysis of section 7.5.3.1 for the UE.

Since the simulations show very good performance with an essentially flat stop band attenuation of –50 dB, we keep that selectivity value for the frequencies of the inter-modulation requirement. Therefore, the requirements in section 7.5.2.2 can be applied here. That is, the specification shall set the desired signal requirements at –115 dBm DPCH_Ec, which also means that the noise floor is allowed to rise 6 dB to –97 dBm. With –50 dBc selectivity, this means that the interfering signals must be –47 dBm to avoid any further direct desensitization of the receiver.

Both interfering signals will be at –47 dBm and be GSM modulated. This means that the inter-modulation distortion products must not contribute to any further desensitization. Generally this means that the implementation must have slightly more than the anticipated selectivity so that some level of distortion product can be tolerated.

The requirement would read – "The WCDMA BS shall receive a signal at –115dBm DPCH_Ec with 0.001 BER in the presence of two GSM modulated signals at 3.5 MHz and 5.9 MHz offset from the carrier center frequency with levels of –47 dBm." In reality, the selectivity will have to be slightly better than –50 dBc at 3.5 MHZ offset and significantly better at 5.9 MHz offset in order to reserve margin for all the contributing factors.

References:

[48] [7.5.1] RAN4 #18 report

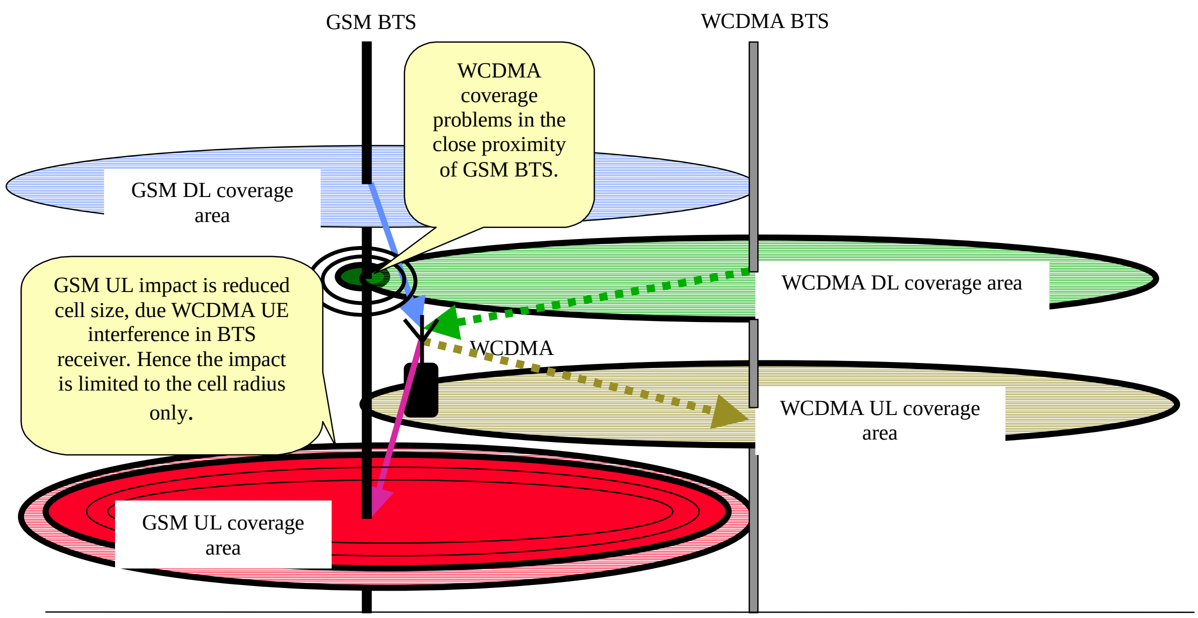
[49] [7.5.2] R4-010576 " Signal strength analysis to derive NB blocking and NB IMD requirement" Gothenburg, Sweden 21st-25th of May 2001.

[50] [7.5.3] R4-011227 "Signal characteristics for narrow band blocker UMTS 1800/1900" Edinburgh, Scotland, 3rd-7th of September 2001.

7.5.4 Analytical Results for Overall System Outage versus Simulated ACIR

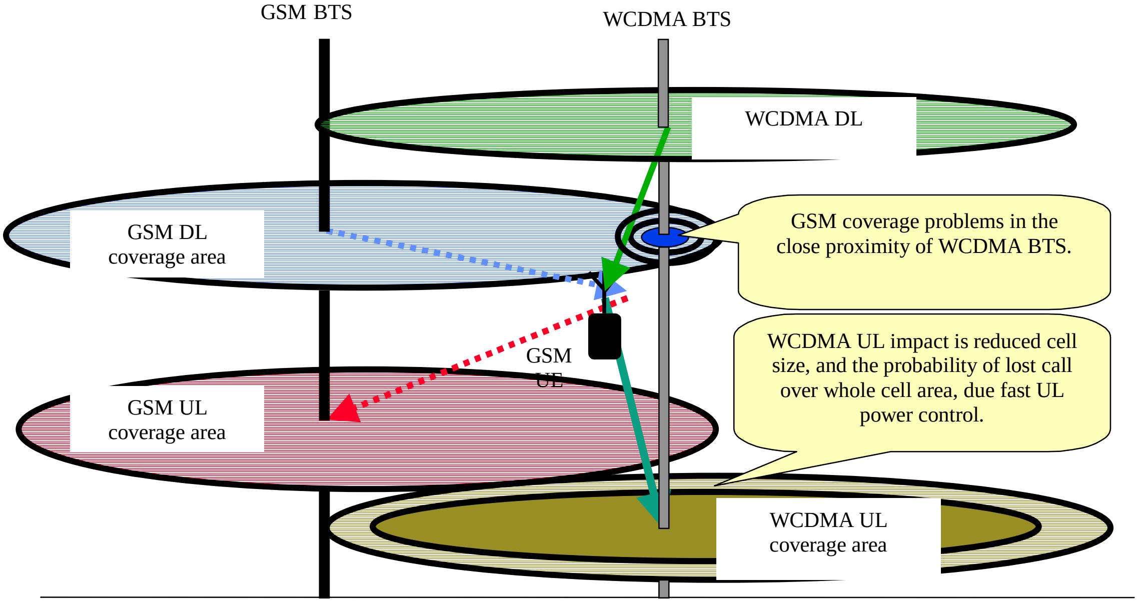
When considering the mutual impacts of both UL and DL capacity simulations, it is noted that such a simulations haven't been done, due mainly the complex nature of handling the location of all users in the simulation simultaneously for the UL and DL directions. Hence some observations are presented here about the mechanisms at work in both systems in order to better understand possible relations of both link directions.

In the pictures below are shown the interference mechanisms.



In the case illustrated in the above figure, the WCDMA DL is impacted due to limited UE ACIR, the WCDMA BS limitation on total transmission power, and interfering GSM BS power. At the same time, WCDMA UL capacity is not impacted. When the GSM interfering power increases (as would happen when the WCMDA UE moves closer to the GSM BS), at some critical point the WCDMA DL power control reliability degrades, and out of synchronization procedures will terminate the transmission of this single UE. The removal of this user does not harm other users of WCDMA system.

However, the WCDMA UE transmission in the above illustration could impact the GSM BS, degrading the C/I ratio in the GSM BS receiver across many of the channels adjacent to the WCDMA carrier frequency. Via this mechanism, the coverage radius in the GSM system would be reduced by an amount dependent of the user service class.



The case of a GSM UE that is in close proximity to the WCDMA BS is illustrated in the figure above. Since the GSM system is a narrow band system, the selectivity of its terminals will be very high relative to the signal from the wide band interfering system. This means that the selectivity of the GSM UE is not a dominant factor in the interactions illustrated in the figure above. In this case, the WCDMA BS emissions will cause co-channel interference to the GSM terminals. The impact to the GSM system will be an outage area for GSM terminals at close proximity to the WCDMA BS. The actual size of this outage area will depend on the C/I requirement of user service of GSM/EDGE and emission levels from WCDMA BS into the adjacent frequencies.

At the same time, the GSM UE signal might introduce interference into the WCDMA BS receiver. The impacts to the WCDMA UL is not at all straightforward, since all users in the WCDMA system are power controlled to operate basically at the C/I limit, and any interference to the system can potentially cause problems to any users anywhere in the coverage area. Hence the interference to the WCDMA UL is *not* limited to cell border areas.

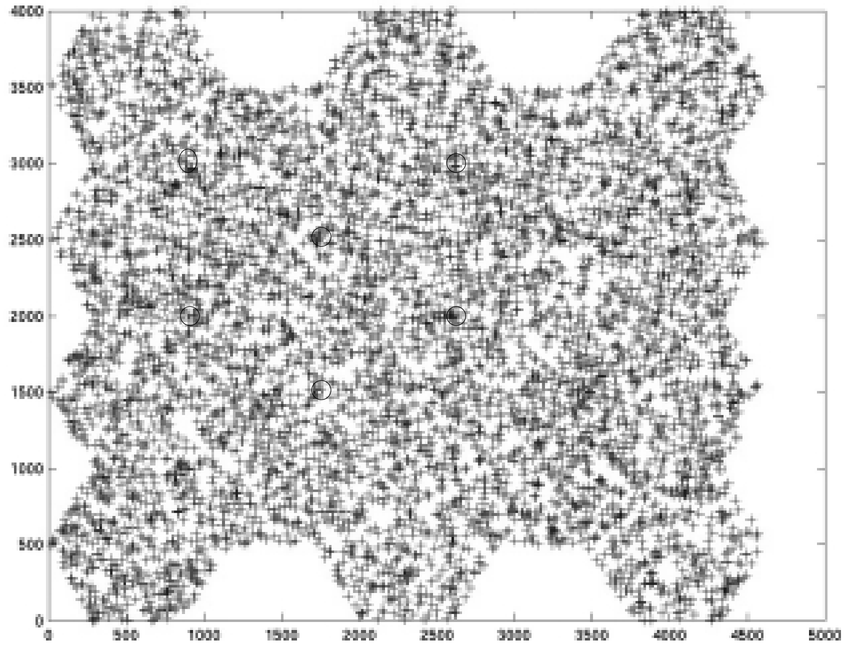
Based on the discussion above, it is apparent that there is not a simple answer to the composite capacity loss of both DL and UL of both systems. This is due the fact that the composite result is dependent on the desired system design parameters and the parameters of interfering system. One of these parameters that has a large impact is the minimum coupling losses in both systems UL.

Another parameter with a large impact on the two interacting systems is the cell sizes of each system. One case would be two interacting systems with approximately equal cell sizes. In that case, very large cell sizes means that the distribution of *both* desired and interfering signal levels into BS and UE receivers moves toward lower power levels. However, this generally means that the same *percentage* of connections will be forced into outage. As noted in the discussion in Section 7.5.1, most of the outages in the WCDMA system will be distributed across the whole WCDMA cell area. However, some of those outages in the WCDMA (and GSM) system will be direct blockages and be associated with locations around the interfering cell sites. The area of these particular outages due to blocking will change with cell size, even thought the percentages of terminals affected will not. The other case to consider is when the cell sizes are very different between the two interacting systems. Now the distributions of desired and interfering power levels do not move together, but apart from each other. Basically, this means that the C/I distributions discussed in section 7.5.1 will now move and the percentages of terminals in outage due to blocking will change. The system with the larger cell sizes, whose desired signal distribution has moved to lower power levels, will now be at a disadvantage as the interfering signal distribution is still toward the higher power levels. Hence, operation of two different systems with adjacent frequency bands and greatly different cell sizes will not probe to be effective for the system with the larger cell sizes.

7.5.5 Dead Zone Analysis for uncoordinated Deployment Cases

7.5.5.1 Simulation results

The topic of so-called "dead zones" is discussed in this section so that its consequences might be better understood. This topic has been addressed before in TSG RAN WG4#5 meeting, where the location of bad connections was discussed in case of WCDMA-WCDMA uncoordinated operation. In reference [7.5.1.1] these simulations were shown. For convenience some of the graphs are plotted again.

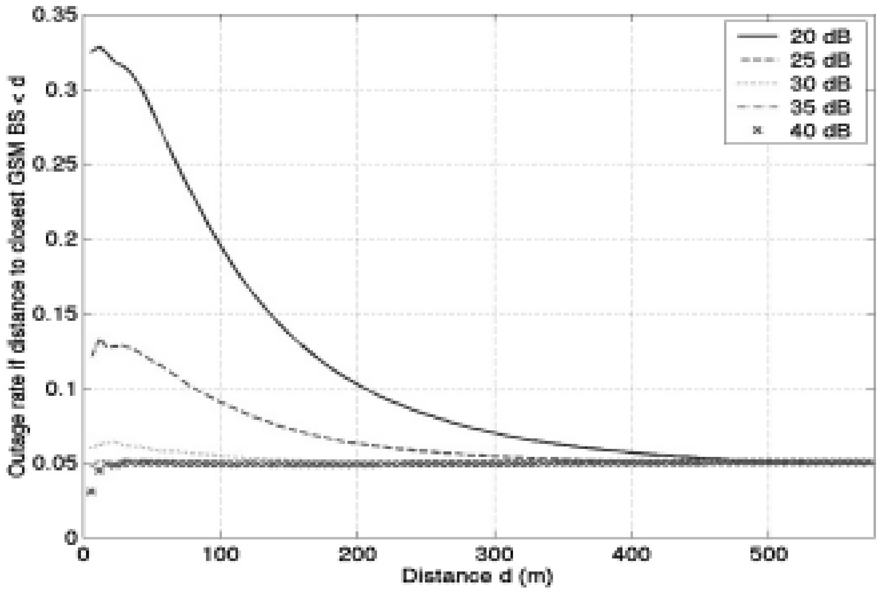


In the graph above the WCDMA UE ACIR was 35 dB.

From the above picture, the stochastic nature of the CDMA system can be better understood. In the picture above, the system loading has been set to a level that causes the outage in DL to be 5%. In other words even if a terminal is not experiencing an external interference from the other operator system, in fully loaded case, it has a probability of being in outage due the limitation of BS total power. In these simulations, it was agreed that the load and admission control is not modeled, and as such, is out of the scope of 3GPP specifications. Hence, there exists an equal probability of running out of DL power (in this example the power range was 0.020…1 W.)

It is especially important to note *that the capacity loss does not only occur in the proximity of other operator BS's, but the majority of this capacity loss is spread over whole area*. In the light of this, the simulations show that majority of the capacity loss is experienced elsewhere than in close proximity of interfering BS. The combined results presented in the Section 7.1, show capacity losses from 2.4…4.1 % depending cell sizes. Also in reference [7.5.2] it was concluded that less than 1 % of the cases UE will experience interference caused outage from outright blocking of the terminal where the BS power limitation is exceeded.

There is one document, reference [7.5.5.1], that has attempted to show the effects of interference on the area of the outages. A figure from that document is reproduced here.



The results in the figure above are from the simulation of GSM system interfering with the WCDMA DL with cell sizes of 577m and omni-directional antennas.

These results show the effects averaged over the simulation of an entire system. However, they do show the trend for at least some of the outages to be clustered closer to the interfering base stations when the UE ACIR is low. When the UE ACIR is sufficiently high, -30 dB in this case for 577m cell size, the distribution of outages becomes random as demonstrated above in another set of simulations. This is a fundamental characteristic of the WCDMA system behavior. (For a more detailed discussion relating UE ACIR to blocking refer to section [7.5.1].)

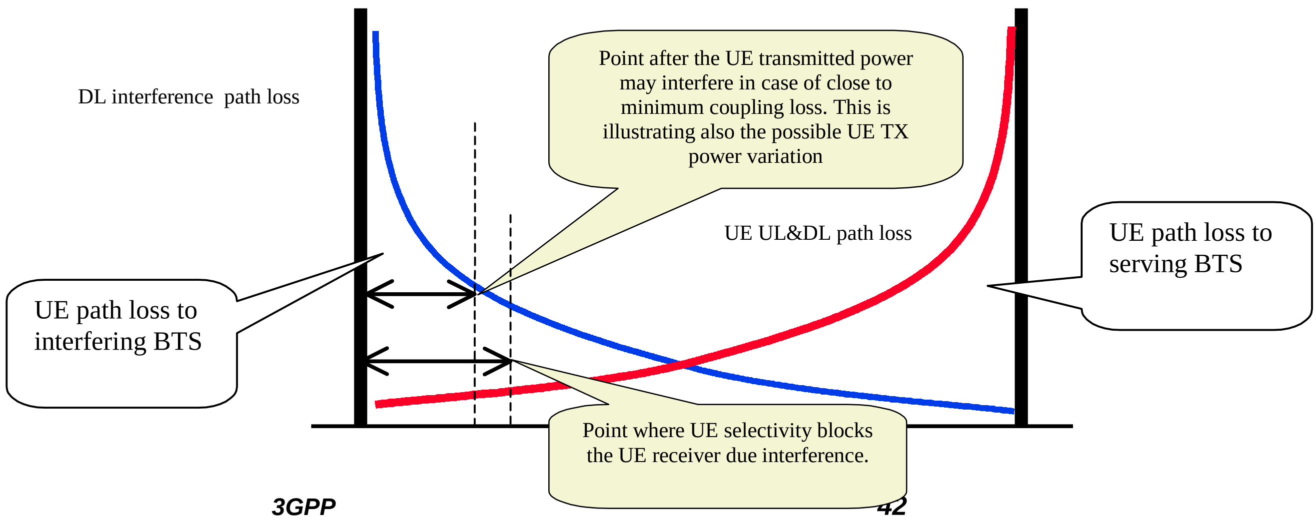
The admission control will probably limit the number of users to a level that would cause less than the 5% outage limit used in these simulations. It is important to remember that the high outage level was agreed to in order to *intentionally* make the simulations more sensitive to the effect of parameter changes, so that the effects due to those changes could be observed. This level was never intended to be indicative of good practice in the field. Therefore, with lower intentional outage, there would be BS power reserved to overcome temporary conditions due to interference of additional attenuation due to indoor coverage. (Note that the distinction between a user experiencing interference or having indoor losses is difficult if not impossible to determine.) Hence, whereas we can show trends in outages due to various system parameters, there is no deterministic answer to aspects of those outages—too many factors influence those probabilities.

References:

[51] 7.5.5.1 – R4-0100071,

7.5.5.2 DL and UL combined behavior

The analysis of combined DL and UL behavior can be approached from yet another way. If we consider how the close proximity WCDMA UE TX power control and interference in the GSM RX is behaving, the following figure will be helpful in its understanding.



This approach was adopted for WCDMA-WCDMA interference case to avoid a situation, where the uncoordinated UE is able to block the BS. In the picture above, the important issue to notice is that, when the UE is near the interfering BS, the path loss to the serving cell is almost unchanged versus distance from serving BS while path loss to the interfering BS is changing very rapidly. This implies that in cases of very close proximity of the UE to the interfering BS, the probability of TX emission blocking the BS increases. The calculations in the next section (7.5.5.2.1) will illustrate an important principle of behavior of two interacting systems:

whatever one does to improve the performance of the system being interferred by another, will likely caused an increased interference back to the interfering system.

It is important to remember this, so that we do not focus completely on fixing one local problem, only to cause a problem somewhere else. It is suggested here, for instance, that an aggressive solving of an apparent blocking problem, that may or may not occur very often in reality, by increasing UE ACIR significantly, will, in fact, cause more interference to the interfering system. Thus, rather than trigger an ever excalating situation, it might be better to recognize all the impacts, and choose other remedies (such as appropriate RRM procedures, appropriate cell size and BS location, appropriate MCL, etc.)

7.5.5.2.1 GSM/EDGE analysis

No frequency guard band case:

UL interference to GSM BS@3dB desen. = [WCDMA UE TX] – [UE emission ACIR, 2.7MHz] + [BS sensitivity level] – [C/I] = [coupling loss] = 21 dBm – 30 dB - 104 dBm + 9 dB = - 104 dB

DL interference to WCDMA UE@3dB desen. = [GSM BS TX] – [UE ACIR] –[processing gain] + [Eb/No] + [Io] = [coupling loss] = 43 dBm – 30 dB– 25 dB+ 7 dB – 97 dBm = -102 dB.

1 MHz guard band case:

UL interference to GSM BS@3dB desen. = [WCDMA UE TX] – [UE ACIR] - [BS sensitivity level] – [C/I] = [coupling loss] = 21 dBm – 41 dB + 104 dBm + 9 dB = - 93 dB

DL interference to WCDMA UE@3dB desen. = [GSM BS TX] – [UE ACIR] –[processing gain] + [Eb/No] - [Io] = [coupling loss] = 43 dBm – 43 dB– 25 dB+ 7 dB + 97 dBm = -79 dB.

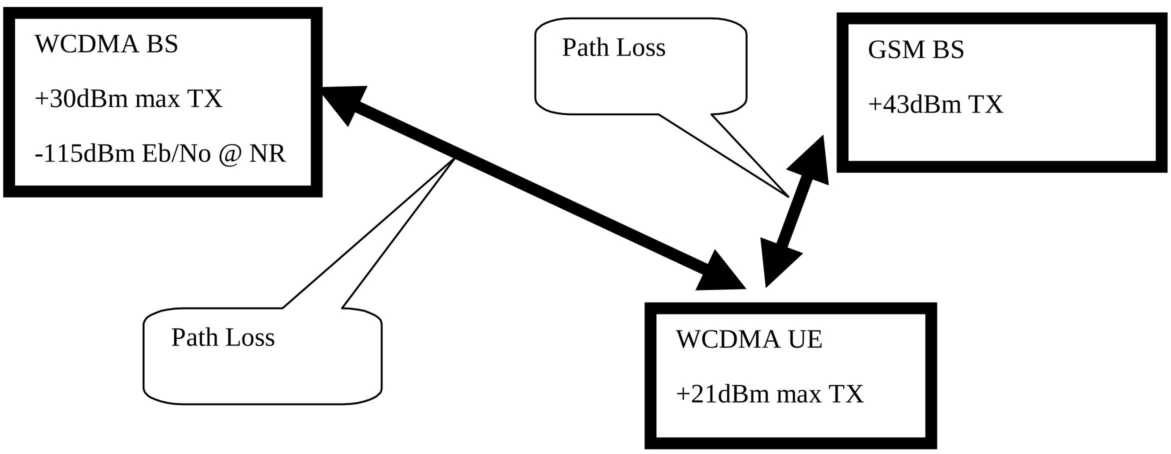
2.5 MHz guard band case:

UL interference to GSM BS@3dB desen. = [WCDMA UE TX] – [UE ACIR] - [BS sensitivity level] – [C/I] = [coupling loss] = 21 dBm – 43.5 dB + 104 dBm + 9 dB = - 90.5 dB

DL interference to WCDMA UE@3dB desen. = [GSM BS TX] – [UE ACIR] –[processing gain] + [Eb/No] - [Io] = [coupling loss] = 43 dBm – 55 dB– 25 dB+ 7 dB + 97 dBm = -67 dB.

Maximum Useable WCDMA UE ACIR.

The above analysis can be extended to show the *Maximum Useable WCDMA UE ACIR* as a function of some of other parameters. It makes use of the following diagram:



We assume that the Path Losses are reciprocal.

Again, we start at the interference to the GSM BS, but restated with the Path Loss, PL(GSM):

UL interference to GSM BS to cause 3dB desen. = -113dBm = [WCDMA UE TX] – [ACIR(WCDMA UE to GSM)] – [PL(GSM)].

Solving for [WCDMA UE TX]:

{1} WCDMA UE TX = -113dBm + [ACIR(WCDMA UE to GSM)] + [PL(GSM)]

We also know that the [WCDMA UE TX] is determined by the WCDMA system as it is under power control to hold the signal at the WCDMA BS to –115dBm when that system is loaded to 6dB noise floor rise.

{2} WCDMA UE TX = -115dBm + [PL(WCDMA)]

Combining equations {1} and {2} and solving for [PL(WCDMA)]:

{3} PL(WCDMA) = +2dBm + [ACIR(WCDMA UE to GSM)] + [PL(GSM)]

We can calculate the PL(WCDMA) in the downlink direction taking into account the interference from the GSM BS:

{4} PL(WCDMA) = [WCDMA BS Pout] + [Processing Gain] – [Eb/No] – [Interference to (WCDMA UE)]

= +30dBm + 25dB – 7dB – [Interference to (WCDMA UE)]

= +48dBm – [Interference to (WCDMA UE)]

Now the reverse path interference to the WCDMA UE is (also from above, but restated):

{5} Interfernce to (WCDMA UE) = [GSM BS TX] – [PL(GSM)] – [ACIR(GSM to WCDMA)]

= +43dBm – [PL(GSM)] – [ACIR(GSM to WCDMA)]

Substituting equation {5} for the interference at the WCDMA UE into equation {4}, we get:

{6} PL(WCDMA) = +48dBm – 43dBm + [PL(GSM)] + [ACIR(GSM to WCDMA)]

= +5dBm + [PL(GSM)] + [ACIR(GSM to WCDMA)]

Setting equations {3} and {6} equal to each other and solving for *ACIR(GSM to WCDMA):*

ACIR(GSM to WCDMA) = -3dBm + [ACIR(WCDMA UE to GSM)]

This is the maximum useable ACIR at the WCDMA UE when taking into consideration the interference to the GSM system. We can get the ACIR(WCDMA UE to GSM) values from the table in section 7.1.5.2. From this we see that:

2.7MHz offset – maximum useable ACIR = -3dB + 30dB = 27dB

3.5MHz offset – maximum useable ACIR = -3dB + 41.8dB = 38.8dB

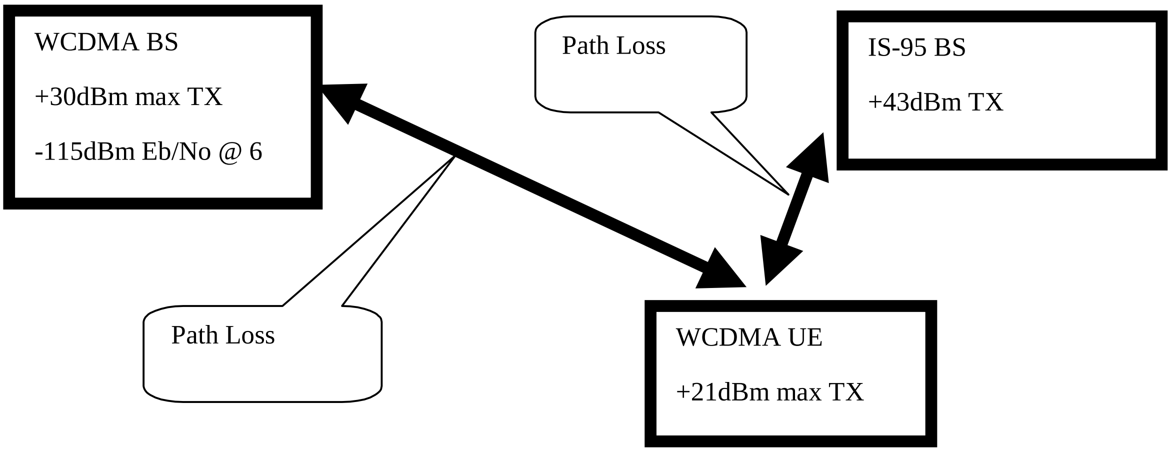
Values of 30dB and 43dB are used throughout this report, and are justified when considering the interference to the other system and that the actual emissions from the WCDMA UE will be somewhat better than the requirements.

7.5.5.2.2 IS-95 analysis:

The simulations of interference between IS95 systems and WCDMA in the 1900 MHz band have also been included. The interference to the IS95 system by the WCDMA 1900 Mhz system do not have very many results as yet. However, one result does show a rather startling outcome. Reference [7.5.1.4] shows a 4.6% capacity loss in the IS95 system for 577m cell size and a 59% capacity loss for 2.4km cell size. It can be shown here that this high capacity loss is an artifact of the simulation.

The simulation of interference of IS95 Uplink does not take into account the effects of reverse interference to the WCDMA UE by the IS95 BS. Because of that, WCDMA UE's are allowed to broadcast in the simulation, when in reality, they would be blocked by the IS95 BS and would not broadcast and cause the apparent interference. Therefore, this particular simulation, without taking into account the reverse interference, does not yield valid results.

For the following discussion, we refer to the following diagram:



We assume that the Path Losses are reciprocal.

The interference into the WCDMA UE from the IS95 BS is:

{1} *Interference at WCDMA UE* = [IS95 BS Pout] – [ACIR(IS95 to WCDMA)] – [PL(IS95)]

= +43dBm – [ACIR(IS95 to WCDMA UE)] – [PL(IS95)]

The path loss from the WCDMA BS can now be calculated as follows, using equation {1}:

{2} *PL(WCDMA)* = [WCDMA BS Pout] + [Processing gain] - [Eb/No] - [Interference at WCDMA UE]

= [WCDMA BS Pout] + 25dB - 7dB - 43dBm + [ACIR(IS95 to WCDMA UE)] + PL(IS95) +

= [WCDMA BS Pout] - 25dBm + [ACIR(IS95 to WCDMA UE)] + PL(IS95) +

The *reverse* interference into the IS95 BS from the WCDMA UE is:

{3} *Interference at the IS95 BS* = [Pout(WCDMA UE)] – [ACIR(WCDMA to IS95)] – [PL(IS95)]

Since the WCDMA UE is power controlled and we assume that the WCDMA system is loaded so that the WCDMA BS noise floor has increased by 6dB, then:

{4} *Pout(WCDMA UE)* = [PL(WCDMA)] – 115dBm

Substituting equation {4} for Pout(WCDMA UE) into equation {3} we now have:

{5} *Interference at the IS95 BS* = [PL(WCDMA)] –115dBm – [ACIR(WCDMA to IS95)] – [PL(IS95)]

Substituting equation {2} for the WCDMA path loss into equation {5} we now have:

{6} *Interference at the IS95 BS* = [WCDMA BS Pout] - 25dBm + [ACIR(IS95 to WCDMA UE)] + PL(IS95) –115dBm – [ACIR(WCDMA to IS95)] – PL(IS95)

=[WCDMA BS Pout] -140dBm + [ACIR(IS95 to WCDMA UE)] – [ACIR(WCDMA to IS95)]

From reference [7.5.1.4], the ACIR(WCDMA to IS95) is calculated from the current WCDMA UE emissions requirements to be 33.8dB. In that same document, we see that the ACIR(IS95 to IS95) is approximately 34dB over the three IS95 channels that would make up a single WCDMA channel. Therefore, using the ratio of the bandwidths as 5dB, the ACIR(IS95 to WCDMA) would be approximately 29dB. The maximum WCDMA BS Pout to a single WCDMA UE is +30dBm. From this we calculate that the maximum interference into a IS95 BS would be:

Maximum Interference at the IS95 BS = -140dBm + 29dB – 33.8dB + 30dBm = -113.8dBm

This will *not* cause significant desensitization of the IS95 BS receiver, as its noise floor is –107dBm. Furthermore, cell sizes at less than maximum range will cause WCMDA UE Pout to be less than maximum most of the time, reducing the interference to the IS95 system even more. Note that this result is independent of the actual path loss to the IS95 BS. Of course, at the MCL of 70dB for the path loss to the IS95 BS, the maximum Path loss in the WCDMA system will be significantly reduced from it maximum possible value. This can be calculated from equation {2}:

Maximum PL(WCDMA) at MCL of 70dB to IS95 BS = - 25dBm + [ACIR(IS95 to WCDMA UE)] + PL(IS95) + [WCDMA BS Pout] = -25dBm + 29dB + 70dB + 30dBm = 104dB

The maximum PL(WCDMA) without interference is 145dB.

7.5.5.2.3 IS-136 analysis

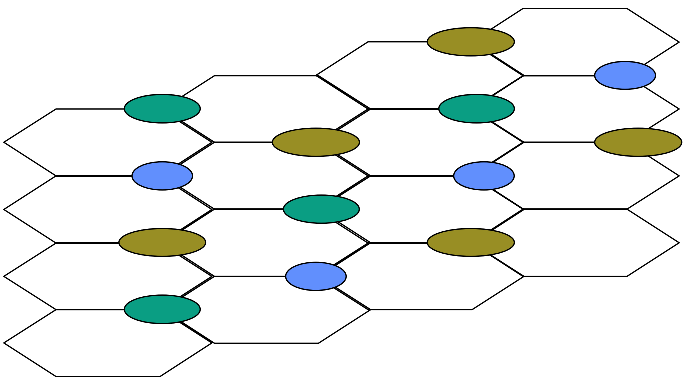
Tba.

Combined results for UL and DL analysis for dead zones.

Interfering system	ACIR 30 dBc @ 2.7 MHz		ACIR 43 dBc @ 3.5 MHz		ACIR 55 dBc @ 5 MHz	
GSM/EDGE 9 dB C/I service requirement	DL 102 dB UL 104 dB	WCDMA DL disables 7 dB before GSM UL.	DL 79 dB UL 93 dB	GSM UL disabled 3 dB before WCDMA DL	DL 67 dB UL 90.5 dB	GSM UL disables 14.5 dB before WCDMA DL.
IS-95	DL UL		DL UL		DL UL	
IS-136						

The table above suggests that the selection of the ACIR values shown above for each of the frequency offsets from the WCDMA center frequency has lead to a balanced behavior between the interfered and interfering systems.

We should also recognize that the real UE filter with sloping stop band attenuation, which is selected in the ACIR values shown above, will cause many different behaviors within a single multi-system deployment. For instance, the GSM system will be deployed with some reuse pattern. This means that the frequency offset between interfered and interfering systems is not fixed, but varies with location in the system. This means that some WCDMA UE's will see GSM interference in the first immediate adjacent channel, whereas other WCDMA UE's will see interference in channels further away. Within one deployment all of the cases in the above table will occur. The picture below shows how these apparent interference zones will actually have different apparent sizes for just this reason.



The above values are based on the mask requirements in TS 25.101, and in a real implementation, they will be better because of additional implementation margins.

7.5.5.3 Radio Resource Management impacts for dead zone management

In 3GPP/ UTRAN the RRM has been studied in TSG RAN WG4 as well, and mechanisms to perform measurements to other WCDMA carrier or GSM system has been fully standardized in rel-99. These RRM procedures enhance the usage of inter-frequency or inter-system handovers, which can be utilized to escape the interference.

The impact to the “dead zone” behavior between WCDMA – WCDMA has been also studied in reference [7.5.1.3]. This document shows clearly how efficient the inter-frequency handover (IFHO) is to first protect own users DL quality and at the same time also reduce the probability of UL interference to adjacent band operator. A set of pictures is included here to illustrate the results.

These results were performed with ACLR1 25 dBc and ACLR2 35 dBc to shorten the simulations, and show clearly the impact of moving users to the other frequency.

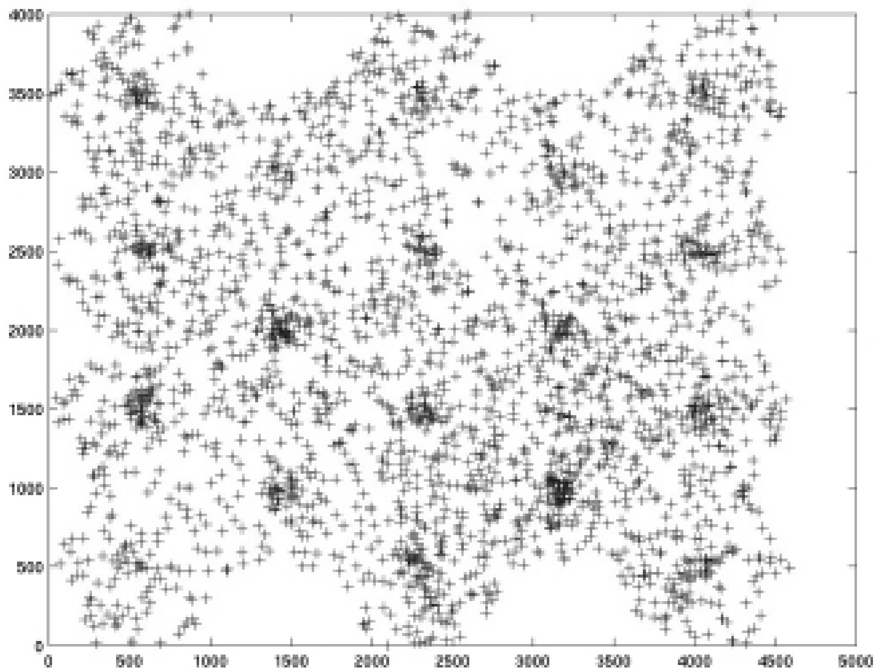


Figure 1. Geographical positions of bad quality calls in downlink when inter frequency handover is not used and ACLR is –25 dBc.

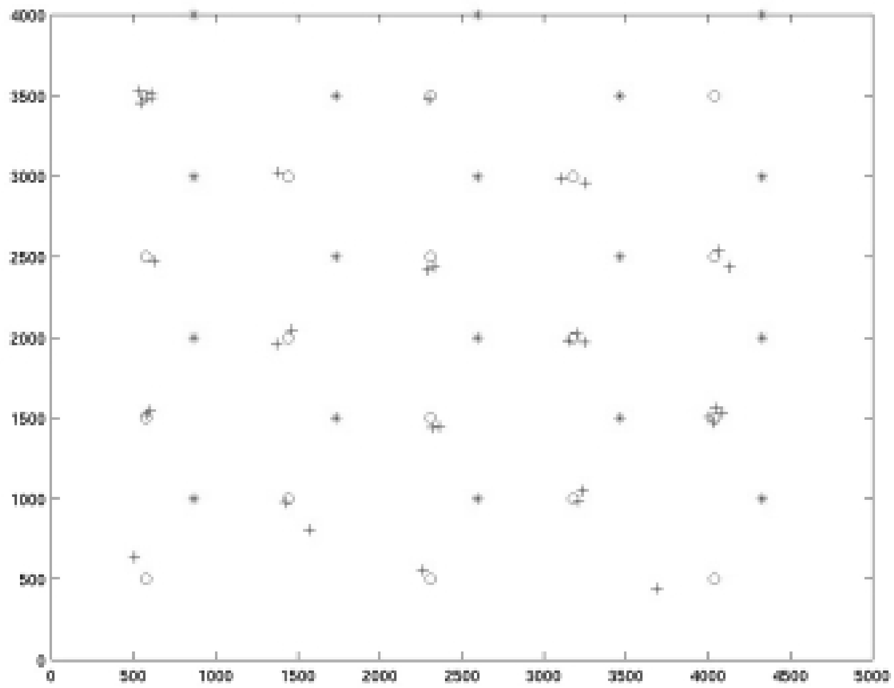


Figure 2. Geographical positions of bad quality calls in downlink when inter frequency handover is used and ACLR1 is –25 dBc.

In latter case, after IFHO the ACLR2 is –35 dBc, and hence the improvement is due 10 dB reduction of interference.

Key point – Inter-frequency handover is like adding 10 dB to the ACIR of both UE and BS without raising the interference into the interfering system.

This case is directly applicable for deployment case of 2x10MHz and 2 WCDMA carriers, and will reduce the dead zone significantly. It is also apparent that in deployment cases in 2x10 MHz with WCDMA + GSM mixed service or 2 separated 2x5 MHz blocks, and the service can be transferred to GSM, inter-frequency handover will also produce similar impacts. Because the services are not adjacent the results should be even better than those above.

7.5.5.4 Conclusions

The conclusion from the presentation above is that it is not obvious that tightening the UE selectivity is the only possibility for defending the system for dead zones. In that case, the impacts (Uplink interference) to other system BS starts to increase, especially if they are deployed with the assumed minimum coupling loss values

RRM procedures (inter-frequency and inter system handovers) provide an effective tool to improve the situation, to both systems's benefit, when it is possible to shift users to another frequency or system. This handoff capability is available already in WCDMA and all UE's will support these procedures.

In the case of a single 2x5 MHz deployment without any inter-frequency or inter-service handoff opportunity, the dead zone issue cannot be improved with RRM algorithms. In this case the cell size and radio network planning play a very important role to diminish the impact. It has been shown already that it is possible to diminish completely in case of coordinated use, e.g. the estimates discussed above are really indicating the worst possible situation of selected cells based on re-use pattern in GSM.

References:

[52] [7.5.1.1] R4-99311 " Downlink ACIR results with geographical data of bad quality calls", Miami, FL, 14th-16th of June 1999

[53] [7.5.1.3] R4-99640 "UTRA FDD to FDD Inter-frequency handover as an escape mechanism", Sophia Antipolis, France, 26th-29th of October, 2000.

[54] [7.5.1.4] R4-010857 "IS95 / UMTS1900 Uplink Simulations", Berlin, Germany, 9 July, 2001.

[55] [7.x.c] TR 25.942 RF system scenarios

7.6 Network Deployment Constrains from Proposed Specifications

The deployment scenarios set different limitations on how mixed operation of narrowband and wide band systems can be deployed. Hence these observations are divided as per deployment scenario:

7.6.1 2x5 MHz uncoordinated operation

As noted in the section 7.1 this is the most demanding scenario. In system simulations it can be noted that the probability of large problems regarding capacity losses can be avoided when the interfering system and the interfered system cell sizes are roughly the same and also cell radiuses are kept reasonable (in these cases below 2.4 km). In the case of very different cell sizes e.g. WCDMA cell clearly larger than interfering system, then capacity losses will increase. This can be seen also in the analysis which were indirectly indicating that large differences in MCL between desired and interfering system causes problems in both systems, which are not possible to overcome with tighter requirements on the equipment due implementation constraints.

In the case of larger cell radiuses, the outage areas against interfering system increases with fixed ACIR values in DL, but on the other hand also the UL blocking probability of interfering system increases due higher UE output powers.

Coordination and power control with interfering GSM system improves the situation, since then the probability of maximum interfering signal reduces.

Radio Recourse Management provides an effective tool in case there are other WCDMA or GSM frequencies available, and hence local outage problems of a system can be solved. Additionally, interference to the UL of the interfering system will be reduced.

7.6.2 10 MHz mixed GSM and WCDMA coordinated case

Analysis of this deployment scenario indicates that some issues exist and need to be taken care, but clearly this scenario is rather robust due to very good coordination, and minimal near-far problems.

Within both systems the minimum coupling losses in the case of micro deployment might cause some problems if non-power controlled access bursts in GSM are allowed to occur on any frequency. This problem is possible to control very effectively with RRM signalling to minimize these impacts from GSM system. Hence, it is recommended that at least the 4 GSM carriers closest to WCDMA channel not be allocated for BCCH transmission or RACH channels. These GSM carriers can, of course, use in normal TCH transmission. Capacity losses in both coordinated systems are negligible.

As shown in Section 7.2, many operator decisions will determine the usage and frequency placement of the closest (in frequency) GSM channels. It was shown that operation matching that of the uncoordinated case was reasonably assured. Operation, otherwise, requires knowledge of individual operator preferences.

This scenario also provides the best protection against uncoordinated interference, and hence is not as critical regarding unbalanced cell sizes. However it should be kept in mind that transmitter emission in UE and BTS have to be considered still.

7.6.3 10 MHz with 2 WCDMA carrier

This case is a variation 2x5 MHz case, with slightly improved protection against the interfering system. In this case it is also assumed that both WDMA carriers are coordinated so that possible less that 5 MHz channel spacing is possible. It would be beneficial also if the cell sizes of both WCDMA carriers are roughly the same.

In this case, the recommendation of interfering and own system cells sizes as in the case of 2x5 MHz deployment are valid as well. Also, RRM is a good tool for moving users to other carrier when they are locally suffering from very high interference levels.

8 Summary of prior contributions To set requirements for change requests

This section documents agreements that have been reached and makes reference to contributions agreed in RAN-WG4 with respect to this study item. This section covers both WCDMA Downlink and Uplink.

Operation of WCDMA within the 1800 and 1900MHz bands along with other Narrowband Systems, requires contributions from *both*:

1) Tighter requirements on WCDMA UE and BS

AND

2) Operational and deployment considerations

The simulation results show remarkably small capacity losses with only moderate increases in selectivity and linearity of the UE and BS hardware.

However, the analysis shows that it is possible for worst-case situations to occur, in both uncoordinated and coordinated deployment scenarios, where system performance can degrade. For example, the average system performance might be unaffected by an adjacent band interference, yet there might be small areas around the interfering base stations where the probability of outage would increase noticeably.

Of course, it is possible to consider increasing selectivity and linearity requirements to remove all such possible worst-case situations, but this would require very unreasonable implementation. Yet, it was demonstrated that doing so would often shift the problem elsewhere. In the example above, there would be an unacceptable increase in interference to the other system causing the original problem, in addition to an increase in the implementation costs of the WCDMA hardware.

The limitations of implementation are not discussed extensively in this document, but changing some key parameters will impact other parameters of the implementation and hence impact UE and BS performance. For example, increasing ACIR (selectivity) can be seen in sections 7.5.2 and 7.5.3 as an increase the linearity requirements via cross-modulation and inter-modulation. These increased linearity requirements lead directly to rapidly escalating impacts on current consumption, complexity and cost, and possible degradations of performance elsewhere (noise figure, filtering imperfections, etc). In light of these adverse impacts, one must evaluate the payback of these increases on performance. Referring to the figure in section 7.5.5.2, one sees that the steep slope on the path loss from the interfering BS versus distance would mean that an increase in ACIR of, for instance, 10 dB might only mean that the blocking radius (region of increased outage) would change by an amount that might not be considered as best trade-off.

As noted in the text, there are other ways to solve those problems associated with the worst-case situations. These range from use of RRM procedures for inter-frequency and inter-system handoffs for the few times that a UE is in hard-blocking, to adjustments of the system parameters such as admission control, MCL, cell size and cell location. In the case of a coordinated deployment with two systems, then the word “coordinate” becomes key. The operation and deployment of *both* systems must be controlled carefully. For instance, the traffic that is permitted on the frequencies close to the WCDMA carrier, not allowing RACH, using UL power control, adjusting the BS power on the closest channels, keeping cell sizes matched between the two systems, adjusting MCL, all become important in determining joint system capacity and behavior.

8.1 UMTS1800/1900 UE

A proposed restructure of 25.101 for the UE to include 1800 and 1900 MHz performance requirements has been put forth in Reference [8.1] and later in Reference [8.2]. The table in Reference [8.3] and is reproduced here (Table 8.1.1) and modified as required. The prior contributions that have been agreed to and set the requirements for each section are listed in the table. Sections addressed by this document are so noted.

This table also includes the status of the information for incorporation within the appropriate Change Request.

Later parts of this chapter include the suggested wording for the sections that are not already agreed to or need further modification. This wording, [if approved by approval of this document] can then be incorporated into the single Change Request for TS25.101.

Table 8.1.1 – Summary of Changes required for TS25.101 and their status

Clause	Description	CR Status	Description of change
3	Definitions	Agreed to in Ref [8.2]	New definitions added
5.2	Frequency band	Agreed to in Ref [8.2]	A new table for paired bands
5.3	TX-RX Bands	Agreed to in Ref [8.2]	A new table for frequency separation
5.4.2	Channel raster	Proposed in ref [8.13]	Add 12 new channels for Band II See below
5.4.3	Channel number	Proposed in ref [8.13]	Add 12 new channels for Band II See below
5.4.4	UARFCN	Agreed to in Ref [8.2]	Channel numbering for bands
6.2.1	Max Power	Proposed format agreed in Ref [8.5] – New power class 5 is withdrawn	New format to align with other tables in specification See below
6.6.2.1.1	Emission Mask	Proposed in Ref [8.6] and discussed in this document	See below
6.6.3.1	Tx Spurious	Agreed to in Ref [8.2]	New values for added bands
7.3	Reference sensitivity	Agreed to in Ref [8.2]	Separate requirements for each band **{Do we intend the UE TX to be at max power as stated in table?}**
7.6	Blocking	Agreed to in Ref [8.2]	Separation in "in-band" and "out of-band"
7.6.1	In band blocking	Agreed to in Ref [8.2]	The requirements should be relative to the variables <REFSENS> and <REFIor>
7.6.2	Out of band blocking	Agreed to in Ref [8.7] and Ref [8.2]	The requirements should be relative to the variables <REFSENS> and <REFIor>
7.6.3	Narrow band blocking	This document	See below
7.8.1	Intermodulation	Agreed to in Ref [8.2]	The requirements should be relative to the variables <REFSENS> and <REFIor>
7.8.2	Narrowband intermodulation	This document	See below
7.9	Rx spurious emission	Agreed to in Ref [8.2]	Separation into operating bands

Recommended wording of sections not already approved for incorporation into the Change Request for TS25.101 or sections needing modification per this document. The changes are marked in blue lettering. Sections of the CR that are already agreed to are not repeated here.

5.4.2 Channel raster

The channel raster is 200 kHz, which for all bands except Band II means that the centre frequency must be an integer multiple of 200 kHz. In Band II, 12 additional centre frequencies are specified according to the table in 5.4.3 and the centre frequencies for those channels are shifted 100 kHz relative to the normal raster.

5.4.3 Channel number

The carrier frequency is designated by the UTRA Absolute Radio Frequency Channel Number (UARFCN). The UARFCN values are defined as follows for all but the additional 12 channels in Band II:

Table 5.1: UARFCN definition

Uplink	$N_u = 5 * F_{uplink}$	$0.0 \text{ MHz} \leq F_{uplink} \leq 3276.6 \text{ MHz}$ where F_{uplink} is the uplink frequency in MHz
Downlink	$N_d = 5 * F_{downlink}$	$0.0 \text{ MHz} \leq F_{downlink} \leq 3276.6 \text{ MHz}$ where $F_{downlink}$ is the downlink frequency in MHz

Table 5.2: UARFCN definition (Band II Additional Channels)

Uplink	$N_u = 5 * ((F_{uplink} – 100khz) – 1850)$	1852.5, 1857.5, 1862.5, 1867.5, 1872.5, 1877.5, 1882.5, 1887.5, 1892.5, 1897.5, 1902.5, 1907.5
Downlink	$N_d = 5 * ((F_{downlink} – 100khz) – 1850)$	1932.5, 1937.5, 1942.5, 1947.5, 1952.5, 1957.5, 1962.5, 1967.5, 1972.5, 1977.5, 1982.5, 1987.5

6.2.1 UE maximum output power

The following Power Classes define the maximum output power.

Table 6.1: UE Power Classes

Frequency Band	Power Class 1		Power Class 2		Power Class 3		Power Class 4	
	Max Power (dBm)	Tol (dB)	Max Power (dBm)	Tol (dB)	Max Power (dBm)	Tol (dB)	Max Power (dBm)	Tol (dB)
Band I	+33	+1/-3	+27	+1/-3	+24	+1/-3	+21	+2/-2
Band II	-	-	-	-	+24	+1/-3	+21	+2/-2
Band III	-	-	-	-	+24	+1/-3	+21	+2/-2

NOTE: The tolerance of the maximum output power is below the prescribed value even for the multi-code transmission mode.

6.6.2.1.1 Minimum requirement

The power of any UE emission shall not exceed the levels specified in Table 6.10

Table 6.10: Spectrum Emission Mask Requirement

Frequency offset from carrier Δf	Minimum requirement	Additional Minimum requirement for operation in Band II	Measurement bandwidth
2.5 - 3.5 MHz	-35 -15*(Δf – 2.5) dBc	-15 dBm	30 kHz *
3.5 - 7.5 MHz	-35- 1*(Δf-3.5) dBc	-13 dBm	1 MHz **
7.5 - 8.5 MHz	-39 - 10*(Δf – 7.5) dBc	-13 dBm	1 MHz **
8.5 - 12.5 MHz	-49 dBc	-13 dBm	1 MHz **
* The first and last measurement position with a 30 kHz filter is 2.515 MHz and 3.485 MHz.			
** The first and last measurement position with a 1 MHz filter is 4 MHz and 12 MHz. As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth.			
The lower limit shall be –50 dBm/3.84 MHz or which ever is higher.			

7.6.3 Minimum requirement (Narrowband)

The BER shall not exceed 0.001 for the parameters specified in Table 7.x.x . This requirement is a measure of a receiver's ability to receive a W-CDMA signal at its assigned channel frequency in the presence of an unwanted narrow band interferer at a frequency, which is less than the nominal channel spacing

Table 7.x.x: Narrow band blocking characteristics

Parameter	Unit	Band II	Band III
DPCH_Ec	dBm/3.84 MHz	<REFSENS>+10 dB	<REFSENS>+10 dB
$\hat{I}_{or}$	dBm/3.84 MHz	<REF$\hat{I}_{or}$>+10 dB	<REF$\hat{I}_{or}$>+10 dB
I_{ouw}(Modulated)	dBm	-57	-56
F_{uw} (offset)	MHz	2.7	2.8
For Power class 3 the UE shall be transmitting continuously at an average power of +20 dBm. For Power class 4 the UE shall be transmitting continuously at an average power of +18 dBm			

7.8.2 Minimum requirement (Narrowband)

The BER shall not exceed 0.001 for the parameters specified in Table 7.9.

Table 7.9: Receive intermodulation characteristics

Parameter	Unit	Band II		Band III	
DPCH_Ec	DBm/3.84 MHz	<REFSENS>+10 dB		<REFSENS>+10 dB	
$\hat{I}_{or}$	DBm/3.84 MHz	<REF$\hat{I}_{or}$> + 10 dB		<REF$\hat{I}_{or}$> + 10 dB	
I_{ouw1} (CW)	dBm	-44		-43	
I_{ouw2} (modulated)	dBm	-44		-43	
F_{uw1} (offset)	MHz	3.5	-3.5	3.6	-3.6
F_{uw2} (offset)	MHz	5.9	-5.9	6.0	-6.0
For Power class 3 the UE shall transmit continuously at an average power of +20 dBm For Power class 4 the UE shall transmit continuously at an average power of +18 dBm					

8.2 UMTS1800/1900 BS

A proposed restructure of 25.104 for the BS to include 1800 and 1900 MHz performance requirements has been put forth in References [8.10], [8.11] and [8.12]. The table in Reference [8.3] and is reproduced here (Table 8.2.1) and modified as required. The prior contributions that have been agreed to and set the requirements for each section are listed in the table. Sections addressed by this document are so noted.

This table also includes the status of the information for incorporation within the appropriate Change Request.

Later parts of this chapter include the suggested wording for the sections that are not already agreed to or need further modification. This wording, [if approved by approval of this document] can then be incorporated into the Change Requests for TS25.104.

Table 8.2.1 -- Summary of Changes required for TS25.104 and their status

Clause	Description	CR Status	Description of change
5.2	Frequency band	Agreed to in Ref [8.10]	A new table for paired bands
5.3	TX-RX Bands	Agreed to in Ref [10]	A new table for frequency separation
5.4.2	Channel raster	Proposed in Ref [8.13]	12 additional channels added to Band II See below
5.4.3	Channel number	Proposed in Ref [8.13]	12 additional channels added to Band II See below
5.4.4	UARFCN	Could use that from Ref [8.2]	Channel numbering for bands
6.6.2.1	Emission mask	Proposed in Ref [8.6]	Required for regulatory
6.6.3.1	Tx Spurious emissions	Agreed to in Ref [8.11]	
6.6.3.2	Protection of BS receiver	Agreed to in Ref [8.11] (note 4)	
6.6.3.1-6.6.3.7	Co-existence requirements	Agreed to in Ref [8.11] (note 4)	
7.5	Blocking	Agreed to in Ref [8.12] (note 4)	One table needed for each frequency band. The WCDMA-1900 values need to be modified.
7.5.2	Narrow band blocking	This document	A new requirement is needed here for WCDMA-1800 and WCDMA-1900 as in TS 25.101.
7.5.3	Out of Band	Proposed in Ref [8.13]	

	Blocking	Pending approval	
7.6.2	Narrowband interm-odulation	This document	A new requirement is needed here for WCDMA-1800 and WCDMA-1900 as in TS 25.101.
7.7	Rx spurious emission	Agreed to in Ref [8.12]	Separation into operating bands as in TS 25.101.

(note 4) – The Band names must be changed to Band I, II, III at least here, and possibly elsewhere in this series of References [8.10], [8.11] and [8.12]

Recommended wording of sections not already approved for incorporation into the Change Request for TS25.101 or sections needing modification per this document. The changes are marked in blue lettering. Sections of the CR that area already agreed to are not repeated here.

5.4.2 Channel raster

The channel raster is 200 kHz, which for all bands except Band II means that the centre frequency must be an integer multiple of 200 kHz. In Band II, 12 additional centre frequencies are specified according to the table in 5.4.3 and the centre frequencies for those channels are shifted 100 kHz relative to the normal raster.

5.4.3 Channel number

The carrier frequency is designated by the UTRA Absolute Radio Frequency Channel Number (UARFCN). The UARFCN values are defined as follows for all but the additional 12 channels in Band II:

Table 5.1: UARFCN definition

Uplink	$N_u = 5 * F_{uplink}$	$0.0 \text{ MHz} \leq F_{uplink} \leq 3276.6 \text{ MHz}$ where F_{uplink} is the uplink frequency in MHz
Downlink	$N_d = 5 * F_{downlink}$	$0.0 \text{ MHz} \leq F_{downlink} \leq 3276.6 \text{ MHz}$ where $F_{downlink}$ is the downlink frequency in MHz

Table 5.2: UARFCN definition (Band II Additional Channels)

Uplink	$N_u = 5 * ((F_{uplink} - 100khz) - 1850)$	1852.5, 1857.5, 1862.5, 1867.5, 1872.5, 1877.5, 1882.5, 1887.5, 1892.5, 1897.5, 1902.5, 1907.5
Downlink	$N_d = 5 * ((F_{downlink} - 100khz) - 1850)$	1932.5, 1937.5, 1942.5, 1947.5, 1952.5, 1957.5, 1962.5, 1967.5, 1972.5, 1977.5, 1982.5, 1987.5

5.4.4 UARFCN

The following UARFCN range shall be supported for each paired band

Table 5.2: UTRA Absolute Radio Frequency Channel Number

Frequency Band	Uplink UE transmit, Node B receive	Downlink UE receive, Node B transmit
I	9612 to 9888	10562 to 10838
II	9262 to 9538 and 12, 37,62, 87, 112, 137, 162, 187, 212, 237, 262, 287	9662 to 9938 and 412, 437, 462, 487, 512, 537, 562, 587, 612, 637, 662, 687
III	8562 to 8913	9037 to 9388

6.6.2.1.1 Minimum requirement

The power of any BS emission shall not exceed the levels specified in Table 6.10

Table 6.10: Spectrum Emission Mask Requirement

Frequency offset from carrier Δf	Minimum requirement	Additional Minimum requirement for operation in Band II	Measurement bandwidth
2.5 - 3.5 MHz	-35 -15*(Δf – 2.5) dBc	-15 dBm	30 kHz *
3.5 - 7.5 MHz	-35- 1*(Δf-3.5) dBc	-13 dBm	1 MHz **
7.5 - 8.5 MHz	-39 - 10*(Δf – 7.5) dBc	-13 dBm	1 MHz **
8.5 - 12.5 MHz	-49 dBc	-13 dBm	1 MHz **
* The first and last measurement position with a 30 kHz filter is 2.515 MHz and 3.485 MHz.			
** The first and last measurement position with a 1 MHz filter is 4 MHz and 12 MHz. As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth.			
The lower limit shall be –50 dBm/3.84 MHz or which ever is higher.			

7.5.2 Minimum requirement (Narrowband)

The static reference performance as specified in clause 7.2.1 should be met with a wanted and an interfering signal coupled to BS antenna input using the following parameters.

Table 7.5 : Blocking performance requirement

Band	Center Frequency of Interfering Signal	Interfering Signal Level	Wanted Signal Level	Minimum Offset of Interfering Signal	Type of Interfering Signal
II	1850 - 1910 MHz	- 47 dBm	-115 dBm	2.7 MHz	GSM modulated carrier
III	1710 – 1785 MHz	- 47 dBm	-115 dBm	2.8 MHz	GSM modulated carrier

7.6.2 Minimum requirement (Narrowband)

The static reference performance as specified in clause 7.2.1 should be met when the following signals are coupled to BS antenna input:

- A wanted signal at the assigned channel frequency with a signal level of -115 dBm.

- Two interfering signals with the following parameters.

Table 7.6 : Intermodulation performance requirement

Interfering Signal Level	Offset	Type of Interfering Signal
- 47 dBm	3.5 MHz	CW signal
- 47 dBm	5.9 MHz	GSM modulated carrier

References

[56] [8.1] R4-010099, "TS25.101 REL 4 – Document re-structure"

[57] [8.2] R4-010657, "REL-5 frequency band restructure and essential corrections for UMTS-1800/1900"

[58] [8.3] R4-010349, "UMTS 1800 & 1900 radio requirements in TS 25.101 & TS 25.104".

[59] [8.4] R4-010603, "Channel Raster shift CR"

[60] [8.5] R4-010601, "UE UMTS 1800/1900 Power Output Classes for Band II and Band III" CR

[61] [8.6] R4-010600, "Rel 5 CR: UE UMTS 1900 regulatory impacts on spectrum mask (Clause 6.6.2)" CR

[62] [8.7] R4-010856, "UE Out-of-Band Blocking – A proposed change to 25.101 (for group CR)

[63] [8.8] R4-010576, "Signal Strength Analysis to dervice Narrowband blocking and Narrowband IMD requirements"

[64] [8.9] R4-010858, "Summary of UMTS 1800/1900 Simulation Results"

[65] [8.10] R4-010397, "TS25.104 REL4 – Section 5 modifications (UMTS 1800 WI)

[66] [8.11] R4-010398, "TS25.104 REL4 – Section 6.6.3 modifications (UMTS 1800 WI)

[67] [8.12] R4-010399, "TS25.104 REL4 – Section 7 modifications (UMTS 1800 WI)

[68] [8.13] R4-011218" Channel Raster Proposal for UMTS1900 2x5MHz Deployment" Edinburgh, Scotland, 3rd-7th of September 2001.

8.3 Change Request Plan

The above CR's are for Rel5 and enable UMTS systems for the 1800 and 1900 MHz bands. It is also noted that the TS 25.307 is designed to enable release independent UE's. However, it might be a good idea to consider if any of the above changes should also be made to any of the prior releases (Release 99 and Rel4). In this category of changes that might be considered to be "absolute" and better to be introduced into the prior releases rather than leaving them unchanged and possibly causing confusion even with the release independent strategy are:

1) The 1900 MHz frequency plan now that the raster is to be shifted in Rel5

2) The tighter spectrum mask (for regulatory requirements)

A third requirement to consider, due to performance impacts, would be:

3) Receiver sensitivities for the bands

9 Project Plan

9.1 Schedule

Date	Meeting	[expected] Input	[expected]Output
3rd-7th of September 2001	RAN WG4#19	- Technical report draft	Report approved

9.2 Work Task Status

	Planned Date	Milestone	Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

10 Open Issues

This section lists all open issues which has not reached agreement yet.

11 History

Document history		
V 1.0.0	2001-09	First version for information to RAN#13, Beijing, China

Rapporteur for 3GPP RAN TR 25.885 is: Jussi Numminen, Nokia Mobile Phones		
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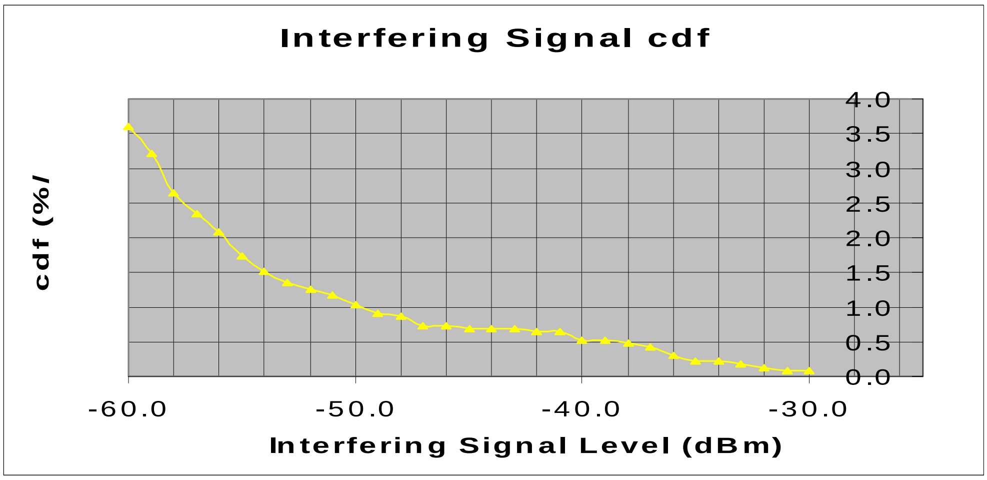
This document is written in Microsoft Word version 97 SR-2.		

A.1 Simulation assumptions

A.1.1 System behavior versus interference level

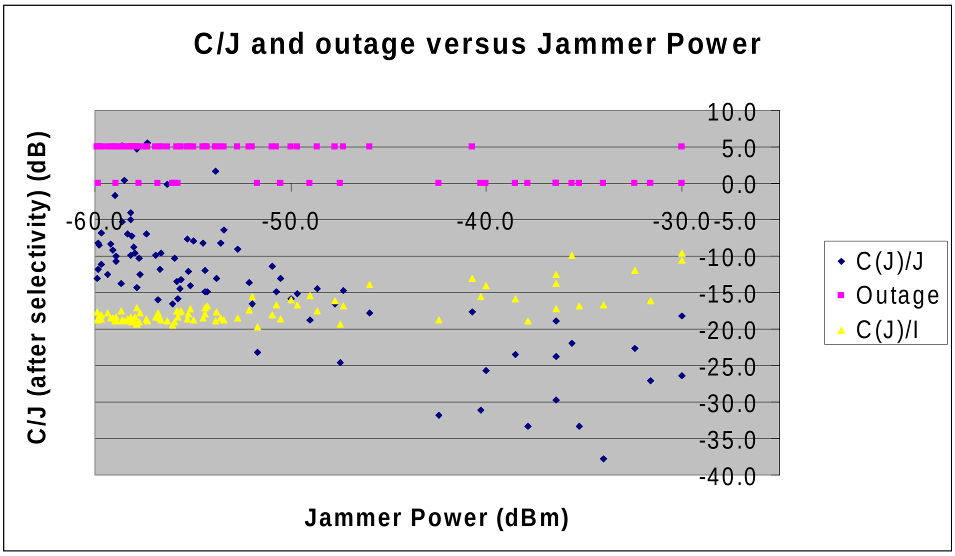
Included here is a single snapshot view of one simulation run, not the usual average over several thousand runs. As such, it is possible to gather data on individual WCDMA UE's and the level of interference at each, etc. The first graph shows the cdf of the interference level at the 3.5% of the UE's seeing the highest level of interference. This simulation was using 2.4km cells size and omni-directional antenna. Note the number of instances for the level of interference to compare with the next figure.



The following figure shows the situation for the 3.5% of UE's seeing the highest levels of interference. The values shown for each are: (1) in outage or not, a value of 0 denotes in outage and 5 denotes not in outage, (2) C/J for each UE, where J is jamming level of x-axis, and (3) C/I fo reach UE, where I is the WCDMA system noise level, excluding the value J. The path loss for this case was 131 dB. Using the formula in section 7.5.1.1, the critical jammer level would be –53dBm. (131dB path loss is derived from –142dB for 2.4km cell size, plus 11dB gain omni-directional antenna for this particular simulation.)

J = +30dBm[max BS power out] –131dB[path loss at cell edge] + 30dB[selectivity] +25dB[processing gain] –7dB[Eb/No]

This is seen to be where a major break occurs in the behavior of all three parameters in the graph below.


C/J and outage versus Jammer Power
C/J (after selectivity) (dB)
Jammer Power (dBm)
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-60.0
-50.0
-40.0
-30.0
C(J)/J
Outage
C(J)/I

A.1.2 Signal level distributions

Following pictures are derived from tri sectorized cell structures, with cell radius 2.4 km and 577. Both 30 and 40 dB ACIR are considered. [WCDMA VICTIM, GSM PC off, GSM 4/12 re-use, one carrier]

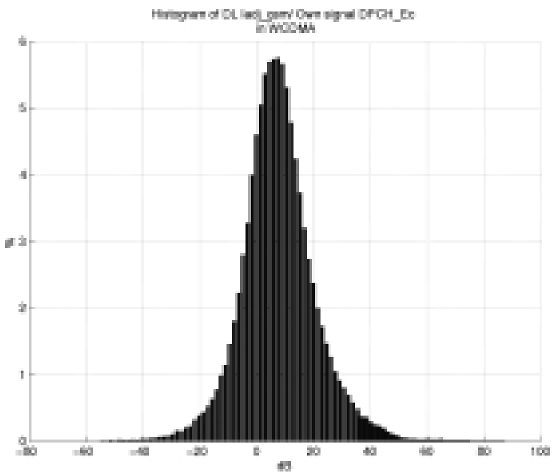
The important point to notice in each of these four cases is the percent of users in outage due to an interference level that exceeds the own signal by more than the selectivity plus the processing gain – Eb/No. This is best seen on the enlarged cdf plots for each case and the value of selectivity plus processing gain – Eb/No is drawn on these graphs. When one compares these graphs, it is apparent that very little additional performance is gained with significantly more selectivity

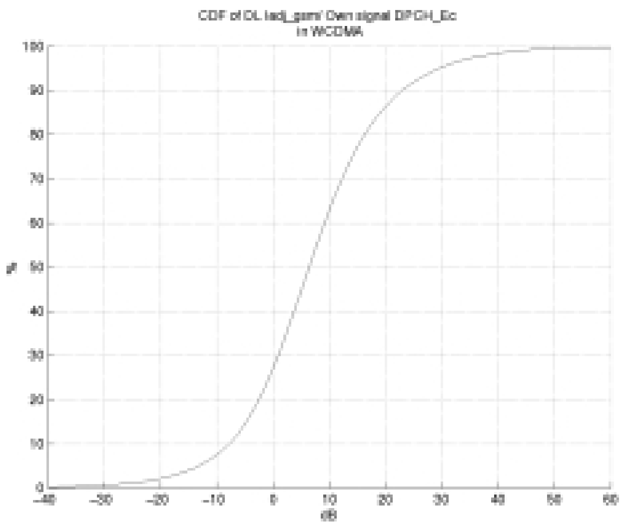
The additional graphs give one an indication of receive power level distributions for different cell sizes.

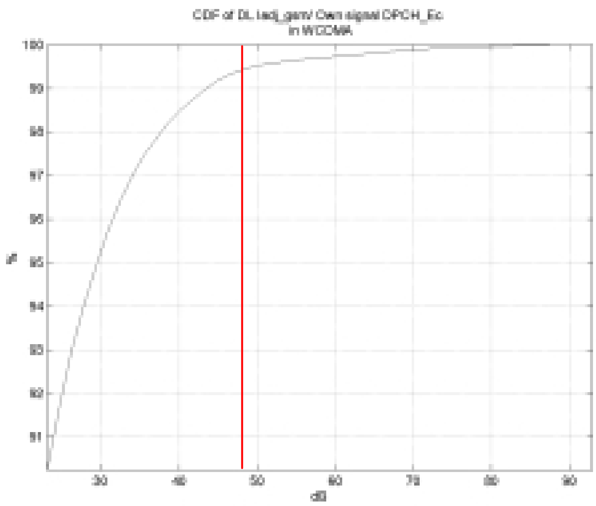
A.1.2.1 30 dB ACIR DL [2.4km cell radius, 1450 user]

WCDMA outage 5.4 %

DL adjacent channel interference/ own signal DPCH_Ec in WCDMA:

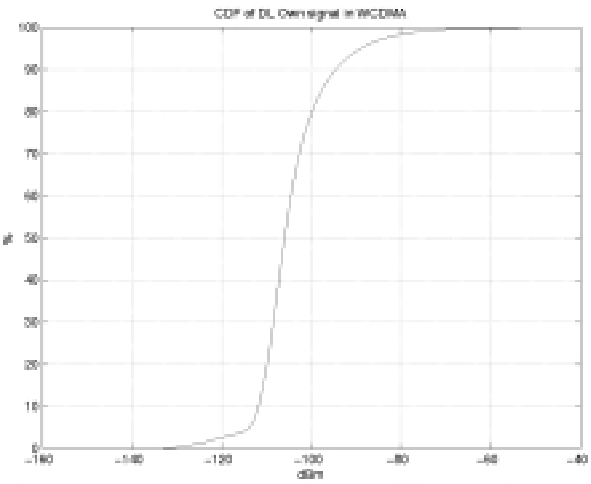






CDF of adjacent channel interference in WCDMA

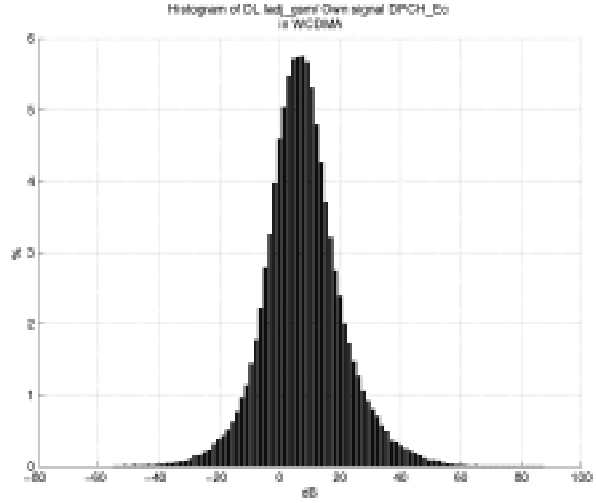
DL own signal DPCH_Ec in WCDMA

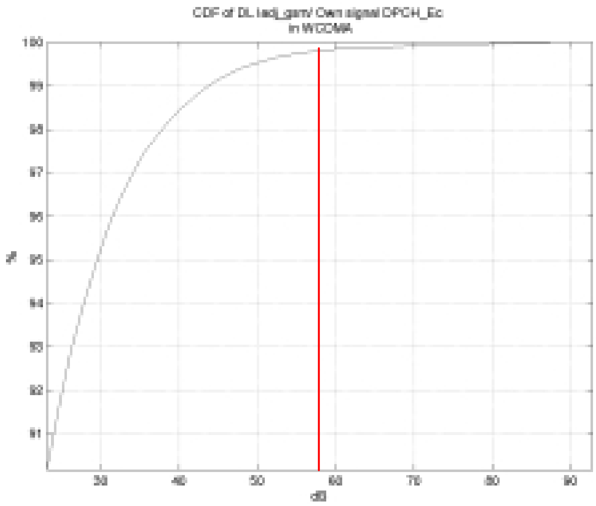


A.1.2.2 40 dB ACIR DL [2.4km cell radius]

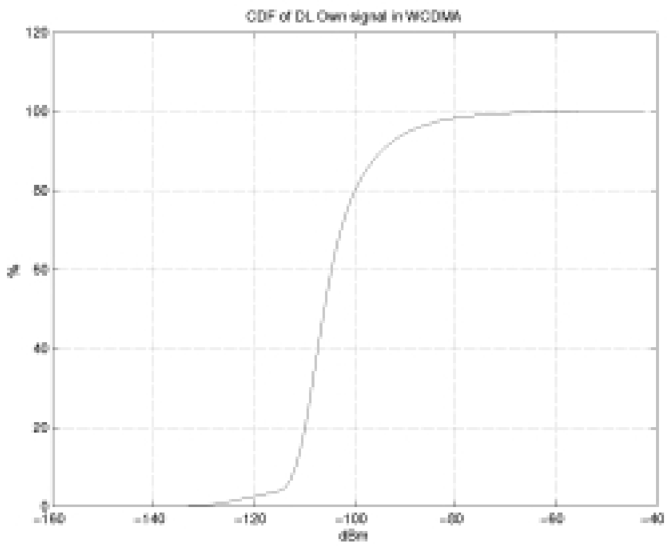
WCDMA outage 5.1%

DL adjacent channel interference/ own signal DPCH_Ec in WCDMA:





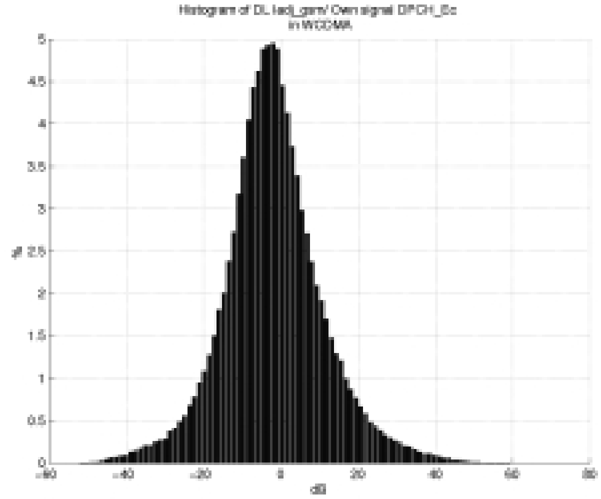
DL own signal DPCH_Ec in WCDMA

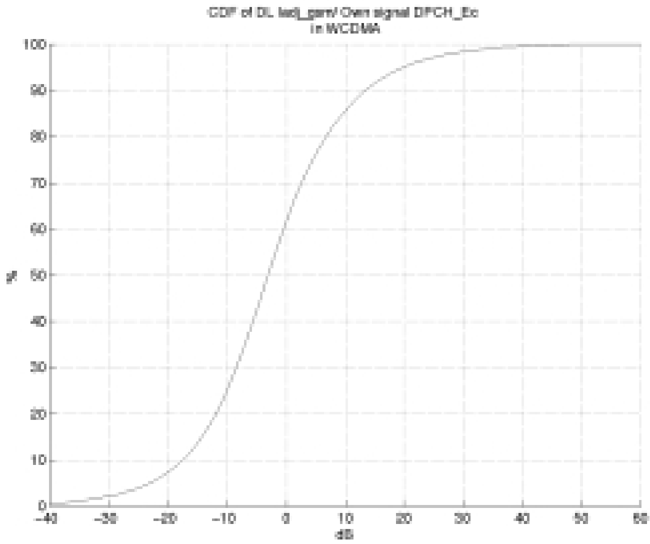


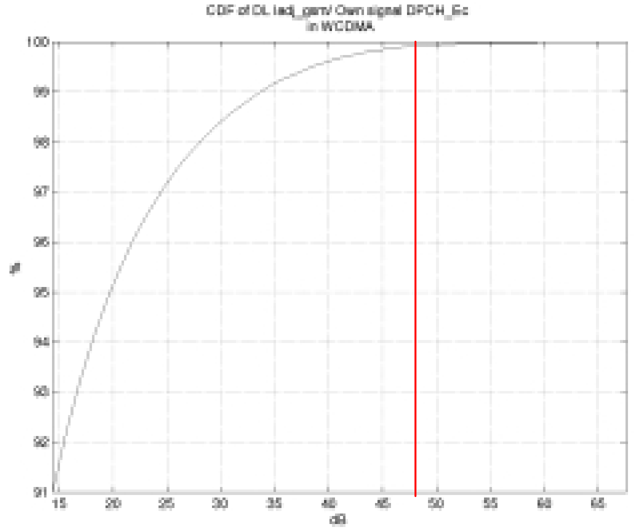
A.1.2.3 30 dB ACIR DL [577 m cell radius, 1838 users]

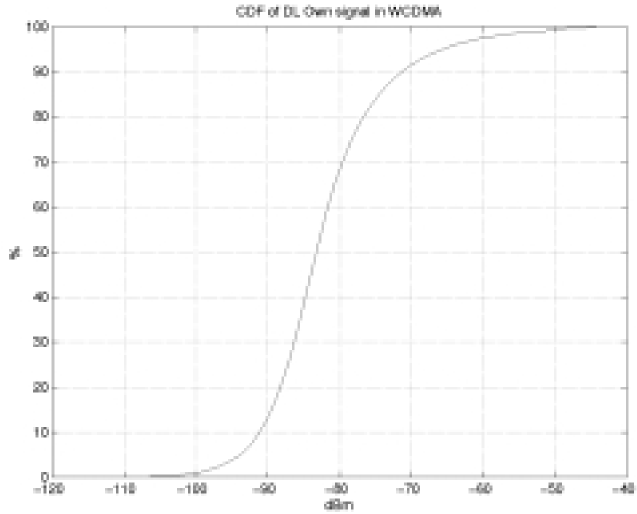
-30 dB ACIR
WCDMA outage 5.0%

DL adjacent channel interference/ own signal DPCH_Ec in WCDMA:





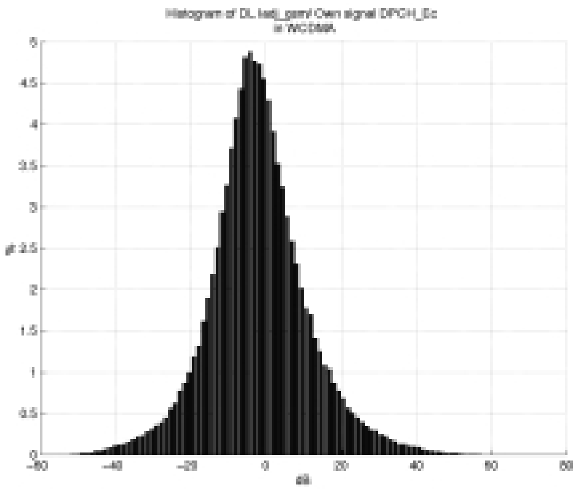

CDF of DL Iadj_gen/ Own signal DPCH_Ec
in WCDMA
%
dB

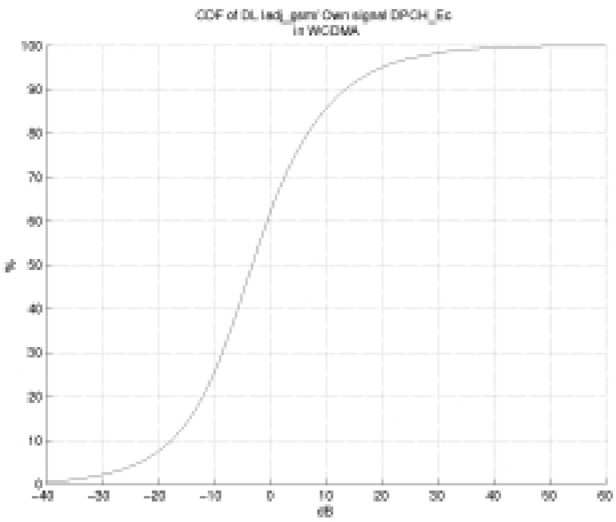

CDF of DL Own signal in WCDMA
%
dBm

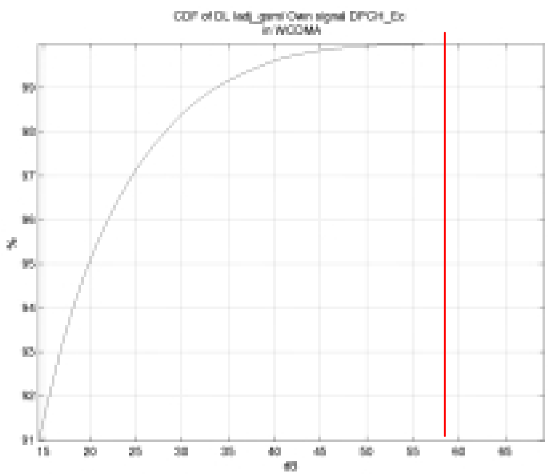
A.1.2.4. 40dB ACIR DL [577m cell radius]

WCDMA outage 4.9%

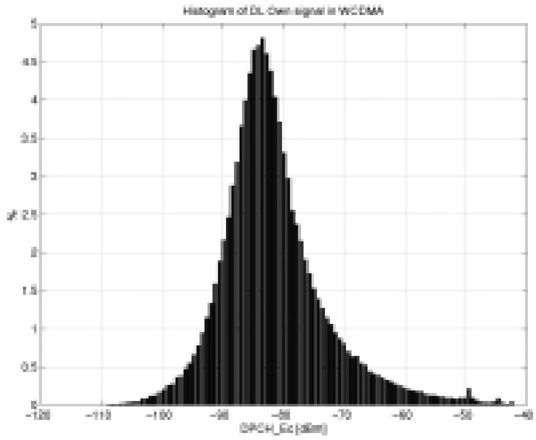
DL adjacent channel interference/ own signal DPCH_Ec in WCDMA

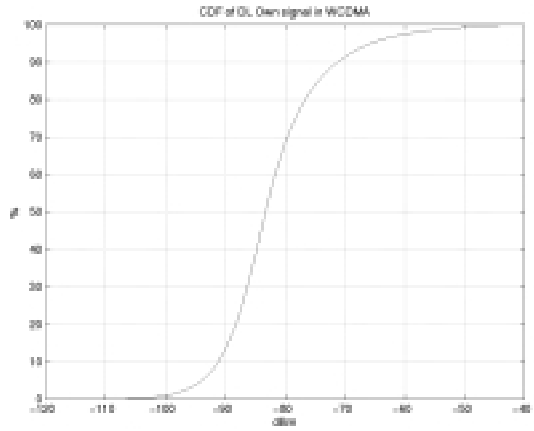






DL own signal DPCH_Ec in WCDMA


Histogram of DL Own signal in WCDMA
%
DPCH_Ec (dBm)


CDF of DL Own signal in WCDMA
%
dBm

Annex <X>: Change history

It is usual to include an annex (usually the final annex of the document) for reports under TSG change control which details the change history of the report using a table as follows:

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**