

REPORT ITU-R M.2031

**Compatibility between WCDMA 1800 downlink
and GSM 1900 uplink**

(Question ITU-R 229/8)

(2003)

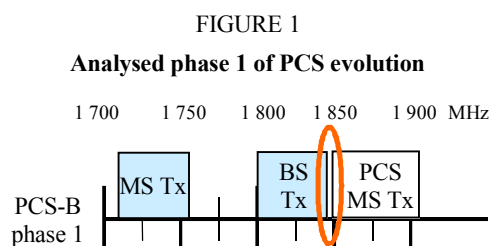
1 Introduction**1.1 Introduction and outline of the Report**

This Report discusses the compatibility analysis of radio coexistence between wideband CDMA deployed in the 1 800 MHz bands (WCDMA 1800) and GSM deployed in the PCS 1900 bands (GSM 1900) in adjacent bands and opposite duplex direction. The objective is to determine by means of deterministic calculations and Monte Carlo simulations the amount of guardband necessary to protect the two adjacent services against mutual interference. The deterministic calculations have been applied to the base station to base station (BS-BS) scenarios. Monte Carlo simulations have been used to investigate both the mobile station to mobile station (MS-MS) and BS-BS scenarios.

This Report is arranged as follows: in § 2, the assumptions pertaining to the BS-BS interference scenario are recalled. § 3 examines the impact of WCDMA 1800 BS interference on GSM 1900 uplinks by means of deterministic calculations, whereas § 4 presents the Monte Carlo simulation results of the BS-BS and MS-MS scenarios. The Appendix summarizes the methodology and assumptions specific to the Monte Carlo simulations.

1.2 Background

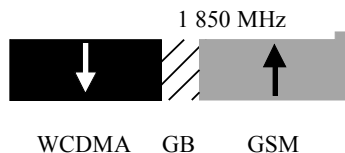
The analysed phase 1 of personal communication system (PCS) evolution is characterised by the introduction of IMT-2000 technologies in the 1 710-1 755/1 800-1 845 MHz bands. The proposed allocation is considering a 5 MHz guardband between the WCDMA 1800 downlink band and the PCS 1900 uplink band, as highlighted in Fig. 1.



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This Report considers interference from the WCDMA 1800 system (specifications not yet finalized) to an existing GSM 1900 system when considering various spectrum arrangements in the bands 1 710-1 990 MHz, e.g. on the spectrum border at 1 850 MHz, denoted guardband (GB) as depicted in Fig. 2.

FIGURE 2
WCDMA 1800 downlink and GSM 1900 uplink



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As an example, we are addressing here the GSM 1900 system but there are also other technologies in the PCS bands, such as IS-95 and TDMA (IS-136) where similar potential interference exists. This sharing situation will occur if portions of both the WCDMA 1800 and the PCS 1900 bands are allocated in the same geographical area. This causes potential mobile MS-MS as well as BS-BS interference.

The deterministic calculations (worst case analysis) and the Monte Carlo simulations are two methodologies that complement each other. While deterministic calculations consider worst-case values for the systems parameters, statistical approaches like Monte Carlo simulations give access to an estimate of the probability with which this worst case will occur.

The Monte Carlo methodology applied to the analysis of radio systems coexistence is now widely approved and recommended by the Electronic Communication Committee (ECC)¹, Report ITU-R SM.2028 and third generation partnership project (3GPP)². The 3GPP-based Monte Carlo methodology has been used to analyse the guardband needed between the WCDMA 1800 and PCS 1900 bands. Simulation results pertaining to the macro-cellular environment are reported and discussed in this document. The simulation methodology and assumptions are described in details in Appendix 1.

2 Assumptions for the BS-BS scenario

Table 1 aims at summarizing the assumptions adopted for the study. An objective of this section is also to clarify the relationship that exists between the carrier-to-carrier spacing and the guardband parameters.

¹ CEPT ECC Report 68, downloadable from ERO website <http://www.ero.dk/>.

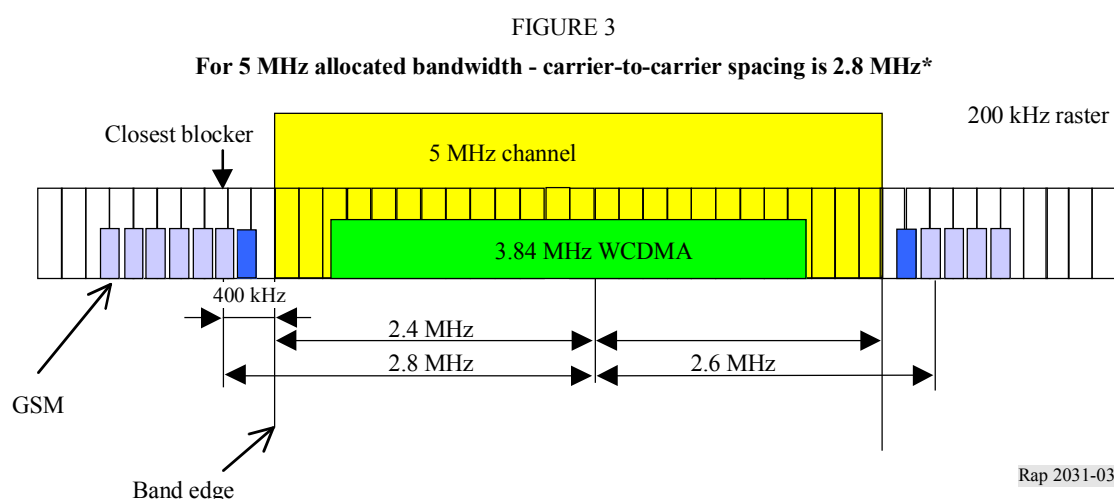
² RF System Scenarios – 3GPP TR 25.942 v2.3.1.

TABLE 1
Assumptions for the deterministic calculations
and the Monte Carlo simulations

	Deterministic calculations	Monte Carlo simulations
WCDMA 1800 BS transmitter power (dBm)	43	43
WCDMA 1800 BS adjacent channel leakage ratio (ACLR)	60 dB (carrier-to-carrier spacing = 5 MHz) ³	63,7 dB (guardband = 5 MHz) ³
	72 dB (carrier-to-carrier spacing = 10 MHz) ³	81 dB (guardband = 10 MHz) ³
WCDMA 1800 BS transmitter antenna gain (dBi)	14	11 ⁴
GSM 1900 BS receiver antenna gain (dBi)	12	11 ⁴
GSM 1900 base transceiver station (BTS) sensitivity (dBm)	−104	−107 ⁴
GSM receiver power (dBm)	−101	Not deterministic → simulated
C/I target (GSM 1900 uplink) (dB)	9	6 ⁴
BS-BS propagation model	Dual-slope line-of-sight LoS (see § 3)	Free space (see Appendix 1)

Figure 3 presents the WCDMA carrier-to-GSM carrier spacing when no guardband is introduced between the WCDMA and the GSM allocations. As a consequence there is the following linear relationship between carrier-to-carrier spacing and guardband:

$$\text{Guardband} = \text{Carrier-to-carrier spacing (MHz)} - 2.8 \quad \text{MHz}$$



* Carrier to carrier spacing for UMTS-1800 – Motorola – 3GPP TSG RAN WG4 R4-1800AH 0112 – 1800/1900 ad hoc meeting, Seattle, United States of America, 2-3 May 2001.

³ UTRA (BS) FDD; Radio Transmission and Reception – 3GPP TS 25.104 v3.4.0.

⁴ Results of UMTS1800/GSM Co-existence Simulations (Uplink) – 3GPP TSG RAN WG4 – Ericsson – TSG R4 No. 15 (01) 0344 [February 2001]. This contains the UMTS 1800 simulation assumptions agreed within 3GPP RAN WG4.

3 Deterministic calculations

The following study highlights the potential interference from the WCDMA downlink transmission to the GSM uplink reception in a base-to-base constellation when considering a rooftop installation scenario. In this section, only the WCDMA out-of-band transmission is considered, i.e. the WCDMA BS transmitter is suggested to be the limiting factor to the performance. It is noted that similar studies are also required in the opposite direction involving the terminals.

BSs are supposed to be located within LoS, and consequently, the dual-slope LoS propagation model is used. Assuming a carrier frequency of about 2 GHz, the path loss is calculated as:

$$L^{LoS} = \begin{cases} 38.5 + 20 \log_{10}(d) & \text{for } 1 \leq d \leq d_{break} \\ 38.5 - 20 \log_{10}(d_{break}) + 40 \log_{10}(d) & \text{for } d \geq d_{break} \end{cases}$$

With an effective BS height over the reflecting surface of 6 m (BS height = 30 m, average building height = 24 m), the breakpoint, d_{break} , is 960 m ($d_{break} = 4 \cdot h_{tx} \cdot h_{rx}/\lambda$).

3.1 Adjacent channel interference

The adjacent channel interference (ACI) is calculated as:

$$ACI = P_{tx} - ACLR + G_{A,tx} + G_{A,rx} - L - BW_{conv} \quad \text{dBm}$$

where:

- P_{tx} : WCDMA BS output power
- $ACLR$: adjacent channel leakage power ratio
- $G_{A,tx}$ and $G_{A,rx}$: transmitter and receiver antenna gain respectively
- L : path loss
- BW_{conv} : bandwidth conversion factor.

3.2 Minimum coupling loss

Given a maximum value of the adjacent channel interference, ACI_{max} , we can calculate the minimum required path loss, L_{min} , denoted as the minimum coupling loss (MCL).

$$L_{min} = P_{tx} - ACLR + G_{A,tx} + G_{A,rx} - BW_{conv} - ACI_{max} \quad \text{dB}$$

3.3 Minimum separation distance

The minimum required path loss is then transferred to a minimum separation distance (MSD) by means of the propagation model. Assuming that the ACI must not exceed the noise floor at the sensitivity level, ACI_{max} can be set to:

$$ACI_{max} = S_{rx} - \left. \frac{C}{I} \right|_{GSM} \quad \text{dBm}$$

where:

- S_{rx} : GSM sensitivity level
- $\left. \frac{C}{I} \right|_{GSM}$: required GSM C/I.

Given the parameter values below, the minimum required path loss and separation distance could be found in Table 2.

$$P_{tx} = 43 \text{ dBm}$$

$$\text{ACLR} = 46/58 \text{ dB for } 5/10 \text{ MHz carrier separation } (\Delta f)$$

$$G_{A,tx} = 14 \text{ dB}$$

$$G_{A,rx} = 12 \text{ dB}$$

$$S_{rx} = -104 \text{ dBm}$$

$$C/I_{GSM} = 9 \text{ dB}$$

$$\text{BW}_{\text{conv}} = 5 \text{ MHz}/200 \text{ kHz} = 14 \text{ dB}.$$

TABLE 2

**Minimum required path loss and separation distance between
WCDMA 1800 and GSM 1900 BSs**

$\Delta f/\text{guardband}$ (MHz)	5/2.2	10/7.2
Minimum path loss, L_{min} (dB)	122	110
MSD (m)	3 790	1 900

4 Monte Carlo simulations

4.1 BS-BS scenario

4.1.1 BSs co-siting

Monte Carlo simulations have been run using the 3GPP assumed BS-BS MCL value of 30 dB (including antenna gains²) and a level of unwanted emission from the WCDMA BS compliant with current 3GPP specifications³. Fig. 4 shows that WCDMA BS interference is causing more than 90% outage on the GSM uplink for a 5 MHz guardband.

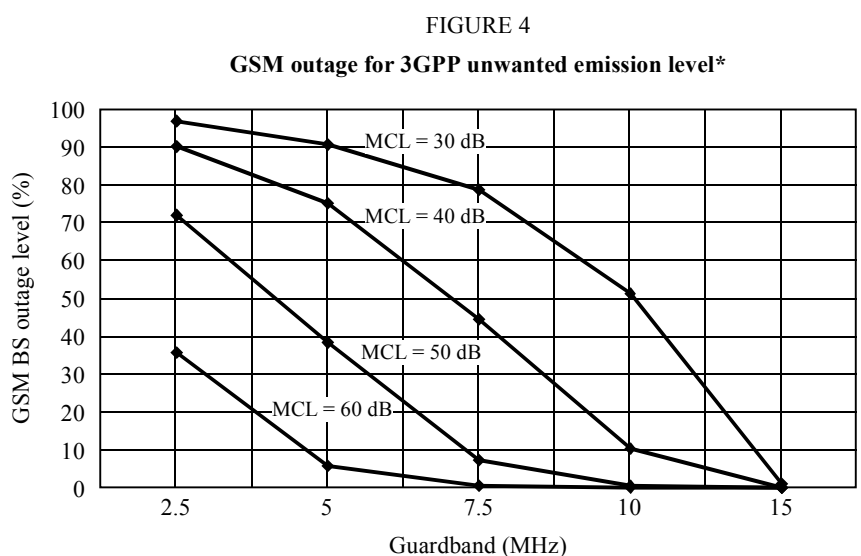
This degradation can be limited by taking into account more realistic values for the following parameters:

- The BS-BS minimum coupling loss.
- The WCDMA BS unwanted emissions level.
- The guardband value between the WCDMA 1800 and PCS 1900 bands.

The geographical shift of interfering BSs is also investigated (§ 4.1.2).

4.1.1.1 BS-BS minimum coupling loss impact on GSM outage

The influence of the minimum coupling loss between the WCDMA and GSM BSs antennas on the GSM capacity loss has been investigated. Since the MCL value of 30 dB specified in 3GPP TS 25.104 is a worst-case value, higher MCL values have been considered in this study⁵. Results for MCL of 40, 50 and 60 dB are presented in Fig. 4. It is found that when considering a guardband of 5 MHz, GSM capacity loss can be reduced down to around 6% by applying a MCL value of 60 dB.



* See footnote³.

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4.1.1.2 WCDMA BS unwanted emissions impact on GSM outage

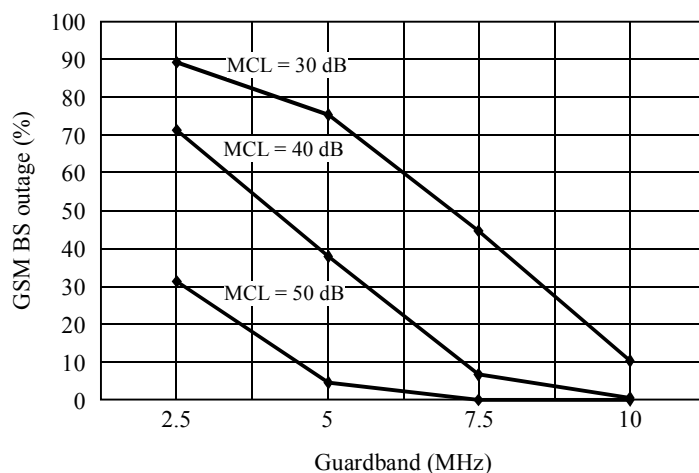
The same set of Monte Carlo simulations have been run under the assumption of a lower WCDMA BS unwanted emission level (margins of 10 dB and 20 dB have been added to the 3GPP unwanted emission level to take into account additional filtering at the WCDMA BS transmitter for frequency offset greater than 7.8 MHz).

Outage figures for MCL values of 30 dB (3GPP specifications), 40 dB and 50 dB are presented in Fig. 5 (10 dB margin) and in Fig. 6 (20 dB margin). The results show that for a guardband of 5 MHz between the GSM and WCDMA bands in opposite duplex direction, GSM outage level is less than 5% for the 10 dB margin and for MCL higher or equal to 50 dB. When considering the 20 dB margin case, an MCL value of 40 dB is sufficient to reduce GSM system outage below 5%.

⁵ Antenna-to-antenna Isolation Measurements – 3GPP TSG RAN WG4 – Allgon – TSG R4 No. 8 (99)631 [October 1999].

FIGURE 5

GSM outage for WCDMA BS unwanted emission level 10 dB lower than 3GPP specifications for frequency offsets greater than 7.8 MHz*



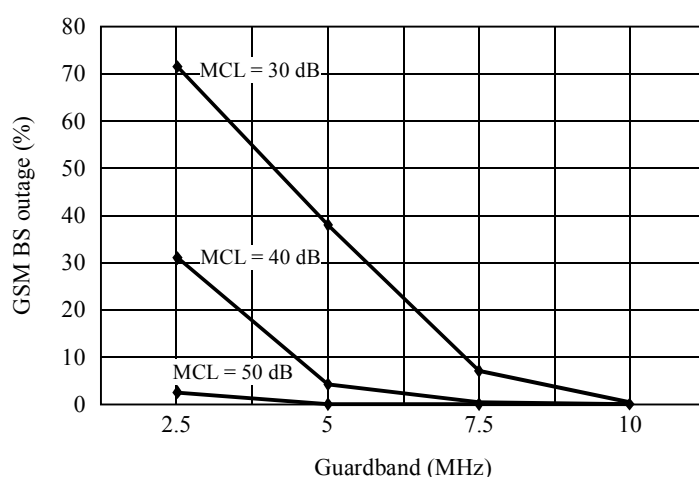
* See footnote³.

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Figures 5 and 6 when compared to Fig. 4 show that MCL and additional filtering at the WCDMA BS have an equivalent quantitative impact on the GSM system outage in uplink, so that a trade-off between these two mitigating factors is possible.

FIGURE 6

GSM outage for WCDMA BS unwanted emission level 20 dB lower than 3GPP specifications for frequency offsets greater than 7.8 MHz*



* See footnote³.

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4.1.1.3 Power levels statistics

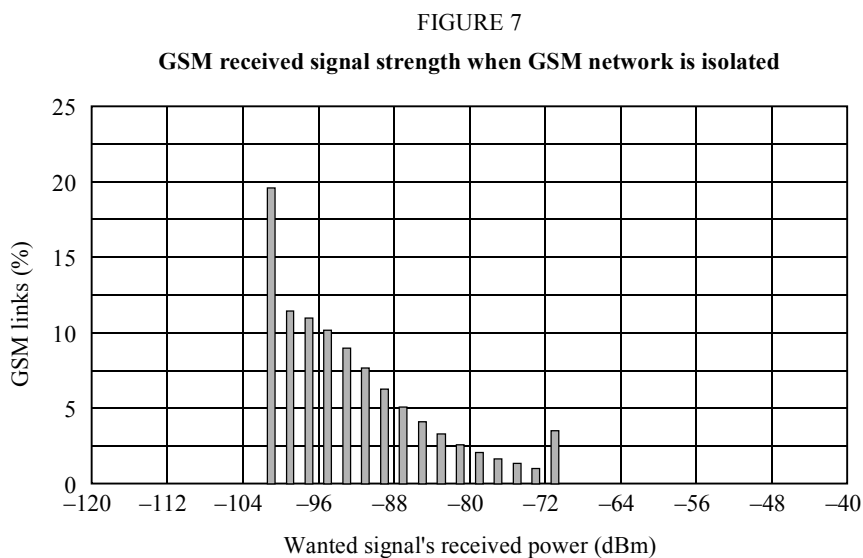
This section proposes to further investigate the BS-BS scenario in co-siting by analysing the GSM BTS received power statistics.

The victim GSM uplink signal and the interfering WCDMA BS signal levels have been computed from the simulations by considering various scenarios (varying the MCL, the additional filtering and the cell size). Their statistics are presented in this section. The objective was to further investigate the influence of the antenna isolation (modelled by the MCL parameter) and the WCDMA BTS additional filtering.

An understanding of these distributions will also help the comprehension of the role played by the GSM power control mechanism in the mitigation of the WCDMA interference.

GSM only (no WCDMA interference; cell radius = 577 m)

Figures 7 and 8 respectively show the distribution of GSM wanted power level and intra-system interference power received at the GSM BTS. The narrow distribution obtained for the intra-system interference power in Fig. 8 shows that the GSM system achieves an intra-system interference level between -114 dBm and -110 dBm for more than 85% of the uplinks.



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Figure 7 shows that when the GSM power control loop has terminated, all the GSM uplinks are experiencing received power higher than -102 dBm, which is 5 dB above sensitivity. Even when isolated from the WCDMA interference, the GSM system is interference-limited (intra-system interference).