Technical Specification Group, Terminals
Meeting #2, Fort Lauderdale, 2-4 March 1999

TSGT#2(99)035

Source: **ERC TG1**

Title: **Liaison statement from CEPT ERC TG1 to 3GPP groups**

Document for: **Information**

Agenda Item: **12**

The liaison statement consists of:

- Liaison statement
- Attachment 1 to Liaison statement; ERC Report on adjacent band compatibility (including annexes A, B and C)
- Attachment 2 to Liaison statement; Draft future ERC TG1 contribution to ITU/R TG 8/1 on the Preliminary Draft New Recommendation on “Essential Technical and Operational Requirements for Mobile Stations”

Attachment 3 “Draft ERC Decision on the harmonised utilisation of spectrum for the terrestrial universal mobile telecommunications system (UMTS) operating within the bands 1900-1908 MHz, 2010-2025 MHz and 2110-2170 MHz” is not yet available.

This liaison statement is also presented to TSG RAN as TSGR #2 (99) 120

TSGR #2 (99) 120
TSGT #2 (99) 035

Liaison Statement from CEPT ERC TG1 to 3GPP TSG RAN WG4

To : **3GPP TSG RAN WG4**
cc : **3GPP TSG RAN**
3GPP TSG T
ETSI TC ERM

1.0 Introduction

This liaison statement deals specifically with -

- assumptions regarding the UTRA unwanted emissions transmit mask
- assumptions regarding the UTRA receiver blocking performance
- variable duplex spacing resulting from the draft ERC decision to allow TDD in the lower paired band
- the inclusion of unwanted emission limits in the document IMT.TERM - Essential Technical and Operational Requirements to ensure Radio Compatibility of IMT2000 Systems in Worldwide Use

The next meeting of TG1 is to be hosted between the (27th and 28th of April 1999) and initial replies to the points are requested in time for this meeting.

2.0 Background

Since its formation ERC Task Group 1 (TG1) has had the objective to interact as closely as possible with ETSI. In the case of Working Group 1 within ERC TG1, whose terms of reference include sharing and compatibility, this interaction has primarily been with the Layer 1 aspects group of ETSI SMG 2. TG1 recognises that the work of this group has now been transferred to 3GPP TSG RAN. The group is very keen to initiate and maintain interaction with 3GPP TSG RAN. In the case of the sharing and compatibility work TG1 believes it is TSG RAN Working Group 4 with whom the majority of the interaction should be.

3.0 Specific Issues for Liaison

One of the main work items under the mandate of TG1 is the generation of an adjacent band compatibility study. This study has now been completed and the draft report adopted by TG1. A copy of the report is attached - ERC REPORT [TG1/02]. The objective of this study is to conclude minimum carrier separation requirements between UMTS and adjacent services. In order to do so certain system assumptions have to be made. Two extremely important assumptions are those of transmitter unwanted emissions and receiver blocking performance (including ACP and ACS specifications). Both of these characteristics directly affect the minimum carrier separation requirement between systems. These characteristics are provided in Annex A of the attached adjacent band compatibility report and some of them are reproduced in the following sections. Now that the report is nearing final approval it is critical that if members of 3GPP believe any of the assumptions within the report are inaccurate, they communicate these concerns to TG1 as a matter of priority. Not doing so could result in a frequency plan which imposes impractical requirements upon both base station and mobile station transceiver design. TG1 is keen to maximise spectral efficiency and thus have relatively stringent limits but recognises that for UMTS to be a commercial success the limits need to be chosen accounting for technological and economic factors as well as spectral.

In the case of deploying TDD channels in the lower paired band there would consequently be a requirement for terminals operating in the FDD mode to have variable duplex spacing. This requirement has significant implications upon terminal design and needs to be discussed with care. The draft ERC decision as adopted by TG1 at its February meeting is attached.

3.1 UTRA Unwanted Emissions Specification

TG1 has based its assumptions for UTRA unwanted emissions on the initial SMG 2 alpha concept group UTRA proposal. This document provided the best information at the time of initiating the study, some 18 months ago. Since then TG1 has monitored the progress within ETSI and previously communicated its preliminary findings on a number of occasions. It is however apparent that there has been considerable debate within ETSI as to what the specified limits should be. This debate has prevented ETSI from being able to provide TG1 with any specific feedback. Instead the original assumptions have been maintained. The transmitter masks assumed by TG1 are illustrated in Figure 1.

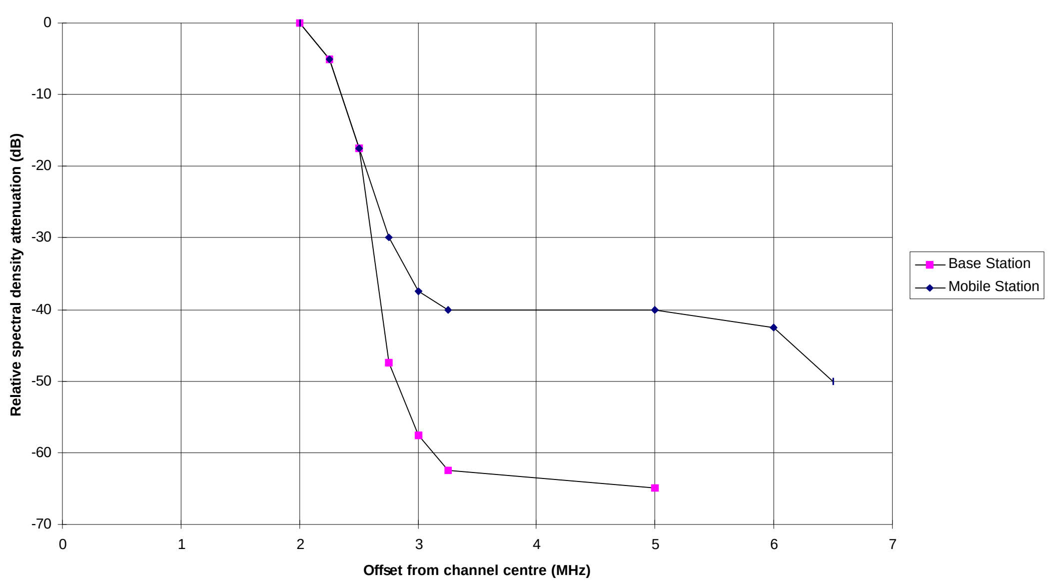

Figure 1 – TG1 Assumed Base and Mobile Transmit Masks

It should be noted from the masks above that the assumed mobile ACP is 40 dB and the base ACP more than 60 dB at a 5 MHz carrier spacing.

At its last meeting TG1 was provided with a list of provisional UTRA front end key characteristics. This document contains the latest information from TSG RAN WG4 regarding the RF parameters for UTRA which will be included in R.KEY. Within this document it is stated that the mobile ACP will lie in the range 30 - 40 dB and that base ACP will lie in the range 45 - 55 dB. It is noted by TG1 that ACP is termed ACLR within the WG4 document. However it is believed by TG1 that the two terms refer to virtually the same thing and can be compared directly.

Thus in the case of mobile station ACP, the current assumption within TG1 lies at the extreme limit of the RAN WG4 range. In the case of base station ACP the current assumption within TG1 lies outside the RAN WG4 range. Concerns have been expressed within TG1 that the current assumptions are too stringent relative to what is practical and what 3GPP is likely to conclude. TSG RAN WG4 is therefore requested to urgently provide TG1 with the latest information regarding UTRA unwanted emissions transmit mask. TG1 believes it would be of great value to receive a mask rather than ACP values.

TG1 has also received a document from the UKTAG group who are undertaking an extensive study into inter operator carrier separation requirements. This document illustrates transmit masks provided by two manufacturers. These masks are considerably more relaxed than the current TG1 assumptions.

In addition it should be noted that the draft ERC decision now adopted by TG1 regarding the harmonised utilisation of spectrum for terrestrial UMTS permits the use of TDD channels within the lower UMTS paired band i.e. between 1920 MHz and 1980 MHz. This deployment scenario should be taken into account when specifying UTRA transmitter characteristics.

3.2 UTRA Receiver Blocking Specification

TG1 has based its assumptions for UTRA receiver blocking on information provided by the layer 1 aspects group of ETSI SMG2. This information is based upon the GSM specification with a 12 dB relaxation. No frequency offset scaling has been made to account for channel bandwidth differences. Table 1 provides the current TG1 assumption.

Frequency Band	MS UMTS Blocking (dBm)	BTS UMTS Blocking (dBm)
in band		
1.6 MHz ≤ offset from channel edge < 3 MHz	- 45	- 37
3 MHz ≤ offset from channel edge	- 38	- 37
out-of-band		
20 - 80 MHz from band edge	- 24	- 12
> 80 MHz from band edge	- 12	- 12

Table 1 - TG1 Assumed UTRA Receiver Blocking Performance

As noted in Section 2.1, at its last meeting TG1 was provided with a list of provisional UTRA front end key characteristics. This document contains the latest information from TSG RAN WG4 regarding the RF parameters for UTRA which will be included in R.KEY. Within this document it is stated that the mobile in band blocking performance should be - 44 dBm over a 15 MHz frequency offset. No figure is quoted for the base station. Adjacent channel selectivity (ACS) figures are quoted as 48 dB for both the mobile and base station assuming a 12.2 kbs measurement channel. ACS as used here is the ratio of interfering received power to desired received power to obtain the specified reference sensitivity performance.

TG1 is aware of and recognises the importance of ongoing work within 3GPP regarding the balance of ACP and ACS specifications e.g. if a mobile station receiver provides 35 dB of filter selectivity then very little is gained by specifying the base ACP greater than 40 dB. Likewise if a mobile station transmitter has an ACP of 30 dB then there is very little gained by specifying the base filter selectivity greater than 35 dB.

In addition it should be noted that the draft ERC decision now adopted by TG1 regarding the harmonised utilisation of spectrum for terrestrial UMTS permits the use of TDD channels within the lower UMTS paired band i.e. between 1920 MHz and 1980 MHz. This deployment scenario should be taken into account when specifying UTRA receiver characteristics.

3.3 Variable Duplex Spacing

In the case of deploying TDD in the lower paired band, mobile stations and base stations operating in the FDD mode will require a variable duplex spacing to utilise the corresponding upper paired channel(s). TG1 recognises that the use of a variable duplex spacing has implications upon terminal design. At this point in time TG1 can advise 3GPP TSG RAN that the minimum regulatory requirement should be a variation of ± 5 MHz i.e. 185 MHz to 195 MHz.

3.4 IMT.TERM - Essential Technical and Operational Requirements to ensure Radio Compatibility of IMT2000 Systems in Worldwide Use

The IMT.TERM document (attached) forms a proposal from TG1 to specify essential technical and operational requirements to ensure radio compatibility of IMT2000 systems in worldwide use to facilitate global circulation. A first version has already been presented to ITU-R TG 8/1. Agreement was not achieved at this first presentation and the document was returned for further work. TG1 maintains its position regarding the need for such a document but has not reached a consensus on what should be included, and whether it should also be relevant to the satellite component.

Annex 1 includes a table of unwanted emissions - Table 2. TAG RAN is requested to comment on this table. In the first case there is an argument that this table is not required as it will be duplicating information provided in the R.KEY document being compiled by 3GPP. This could complicate and confuse matters without providing added value. In the case of its inclusion there is debate regarding what should be included. Whether it should be based upon Rec. ERC 74-01, or something else. The figures currently included in the table are based upon a mixture of the TG1 assumed UTRA transmit mask and the Rec. ERC 74-01 recommendation. It has been agreed by TG1 not to submit this to ITU-R TG8/1 at its next meeting in Brazil but at the China meeting being hosted between 31st of May and the 11th June 1999. This will allow time for the document to be refined subsequent to any comments received from TSG RAN WG4.

4.5 Contact Point

TG1 looks forward to receiving contributions from 3GPP and would like to point out that all correspondence should be sent to the ERC TG1 chairman, Pasi Toivonen (pasi.toivonen@thk.fi).

Attachments

1) ERC REPORT [TG1/02] - Adjacent Band Compatibility between UMTS and Other Services in the 2 GHz Band

2) Preliminary Draft New Recommendation ITU-R M. IMT.TERM. Essential Technical and Operational Requirements for Mobile Stations of IMT2000 Systems Operating in the Bands 1885 - 1980 MHz, 2010 - 2025 MHz and 2110 - 2170 MHz

3) DRAFT ERC Decision on the harmonised utilisation of spectrum for the terrestrial universal mobile telecommunications system (UMTS) operating within the bands 1900-1980 MHz, 2010 – 2025 MHz and 2110 – 2170 MHz.

Task Group 1
of the European
Radiocommunications
Committee

FINAL DRAFT (Rev 10)

Output from Edinburgh , 22-24 February 1999

ERC REPORT [TG1/02]

ADJACENT BAND COMPATIBILITY BETWEEN UMTS AND OTHER SERVICES IN THE 2 GHz BAND

1. Introduction

Decision ERC/DEC/(97)07 designated the frequency bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz to terrestrial UMTS applications. It decided to accommodate UMTS satellite component applications within the bands 1980-2010 MHz and 2170-2200 MHz. The frequency bands identified in ERC/DEC/(97)07 have co-primary allocations for fixed service. Compatibility studies between the fixed service and the terrestrial component of UMTS have been studied in ERC Report [TG1/01].

The band 1880-1900 MHz is currently used by DECT (ERC/DEC/(94)03). The bands 2025-2110 MHz and 2200-2290 MHz are currently allocated to several space services, the fixed service and the mobile service, as shown in Figure 1.

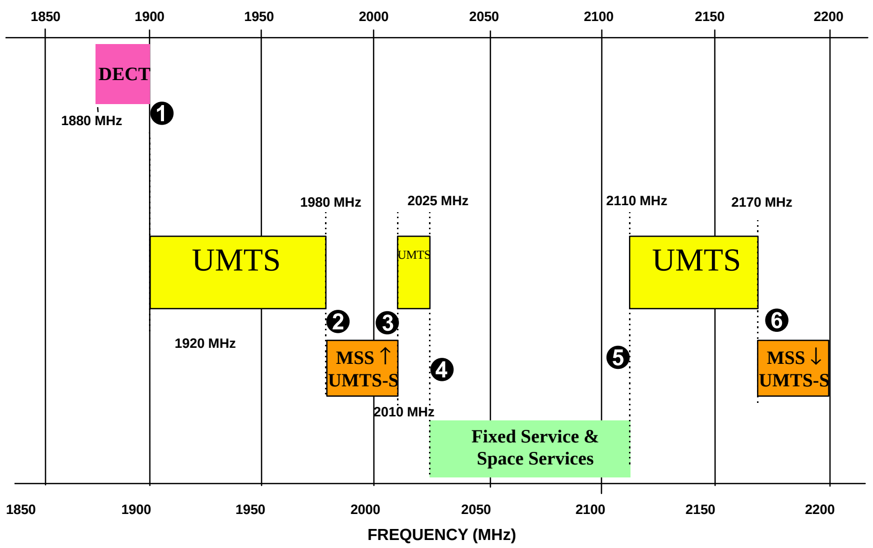

Figure 1 - European frequency plan for the 2 GHz band

This report gives the relevant parameters needed in interference studies for the systems identified in figure 1, at the date of publication. The interference problems are investigated by both deterministic and statistical approaches, for the different scenarios. This report gives initial recommendations on the necessary guard bands to use when introducing UMTS.

Because the UMTS carrier spacing can vary from 4.4 MHz up to more than 5 MHz, depending on the intra-system configuration, the results will be given in terms of “required carrier frequency separation”. This enables the derivation of the “extreme acceptable position of the UMTS carrier centre frequency”.

2. Compatibility study methods

The parameters for terrestrial UMTS, MSS, DECT and space services are provided in Annex A.

2.1 Scenarios for consideration

Based on the number of systems under consideration, a number of scenarios have to be considered. Table 1 lists these scenarios, which have been considered and makes reference to the relevant paragraphs in this report.

Bands	**Below 1900 MHz**	**1900-1920 MHz**	**1920-1980 MHz**	**1980-2010 MHz**	**2010-2025 MHz**	**2025-2110 MHz**	**2110-2170 MHz**	**2170-2200 MHz**	**Above 2200 MHz**
Assigned to ...	DECT	Terrestrial UMTS TDD	Terrestrial UMTS FDD/TDD	MSS/UMTS-S	Terrestrial UMTS TDD	Fixed service, space services (E-S/s-s)	Terrestrial UMTS FDD	MSS/UMTS-S	Fixed service, space services (s-E/s-s)
Co-channel band sharing		Fixed service [C]	Fixed service [C]	Fixed service [E]	Fixed service [C]		Fixed service [C]	Fixed service [E]	
Adjacent band sharing (lower band edge)		DECT [A]	Terrestrial UMTS TDD fixed service	Terrestrial UMTS FDD/TDD fixed service	Fixed service MSS/UMTS-S [D]		Fixed service space services (uplink) [B]	Terrestrial UMTS FDD fixed service	
Adjacent band sharing (upper band edge)		Terrestrial UMTS FDD/TDD fixed service	MSS/UMTS-S [D] fixed service	Terrestrial UMTS TDD fixed service	Fixed service space services (E-s/s-s) [B]		Fixed service satellite UMTS	Fixed service space services (downlink)	

Table 1 - UMTS sharing matrix

[A] See section 3.1
[B] See section 3.2
[C] See ERC Report [TG1/01]
[D] See section 3.3
[E] ITU-R Recommendation M.1141, M.1142, M.1143.

2.2 Minimum Coupling Loss (MCL) and Monte Carlo (MC) approaches

Within CEPT, two approaches have been used so far to assess interference between two systems.

The first one, the Minimum Coupling Loss (MCL), is now well-known, and gives for a given system the relationship between the separation distance and the guard band for a given set of transmitter and receiver parameters. The second and more recent one, Monte Carlo (MC) simulation, [3], is becoming more usual and gives a probability of interference for the given set of parameters and a deployment and power control model.

It is understood that only one of the approaches described above is not sufficient alone to describe in detail the interference problem, and to conclude on the problem of guard bands. The following points are relevant to this comparison of deterministic and statistical approaches :

- The MCL method is useful for an initial assessment of frequency sharing, and is suitable for fairly “static” interference situations (e.g. fixed links vs mobile base stations). It can however be pessimistic in some cases.
- The Monte-Carlo probabilistic method will generally give more realistic results. It is however complex to implement and will only give accurate results if the probability distributions of all the input parameters are well known.
- Because of the lack of agreed parameters for IMT-2000/UMTS in ETSI ETSs / TBRs and knowledge of deployment scenarios at the moment, the calculations must be done with approximate parameters for the transmitters and receivers. If the Monte-Carlo simulations are made with those approximate parameters, it is difficult to interpret the interference probability determined by the simulation to identify where the results are inaccurate.

2.3 Propagation models

When the distances considered in the MCL approach are small the free space propagation model can be used.For Monte Carlo simulations, the propagation model described in [3] is used.

It should be noted that Recommendation ITU-R M.1225 (REVAL) and UMTS 30.03 [1] give a set of propagation model that were used in the selection of the transmission technologies. These models differ slightly from the one in [3], but the results are expected to be similar.

2.4 Minimum Coupling Loss

The coupling loss between two interfering systems is a function of the scenarios under study.

The separation distance between the interferer and the victim are not the same if they are mobile or base stations.

The MCL between and interfering transmitter (Tx) and a victim receiver (Rx) is defined as

MCL = Tx Power (dBm) + Tx Out-of-band attenuation (dBHz^{-1}) + Tx antenna gain (dBi) + Rx antenna gain (dBi) - Rx interference threshold (dBmW.Hz^{-1})

2.5 Impact of interference

In UMTS the interference results in loss of capacity and/or of coverage, and the MCL may not be the best method to investigate this loss.

The acceptable interference probability used in Monte-Carlo studies will depend on the scenario under consideration. For example, the interference between DECT and UMTS, a probability of 2% is considered as a maximum.

Furthermore, the impact of interference on the loss of capacity needs to be the subject of further study.

2.6 Monte Carlo assumptions

The assumptions used in the Monte Carlo simulations are detailed in Annex C, and are based on work in ITU-R [5]. Additional information is also included alongside the results reported.

2.7 Interference mechanisms

This report has considered the effect of out-of-band emissions from one system falling into the receiver of another, and where the necessary technical information is available, the effects of receiver blocking have also been considered. Where the necessary receiver performance data is not available, blocking has not been considered and receivers will need to be designed taking into account the adjacent band systems and the guard bands available.

3. Compatibility study results

3.1 DECT

In the following sections, DECT BS is intended to mean DECT FWA (Fixed Wireless Access) terminal, whereas conventional DECT Mobile and Base Stations are equivalent and called MS.

The interference between DECT and UMTS has been evaluated for the UMTS TDD mode only, because it is expected that the band immediately above 1900 MHz will not be paired and therefore will be available for the TDD mode only.

This interference has been evaluated both by MCL and Monte-Carlo approaches, and section 3.1.3 provides an interpretation of the results.

3.1.1 MCL approach

Figures 2 and 3 present the required MCL for DECT to UMTS and UMTS to DECT interference as a function of the UMTS TDD carrier centre frequency.

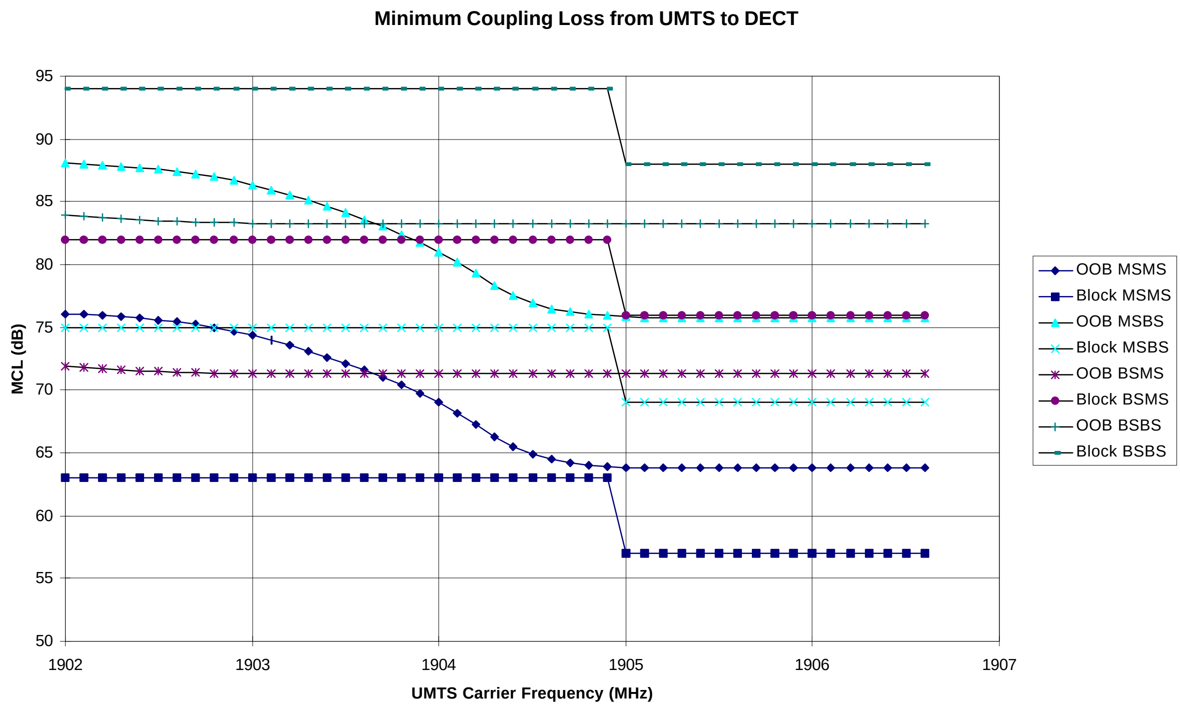

Figure 2 - MCL from UMTS to DECT due to blocking and out-of-band emissions as a function of UMTS carrier centre frequency

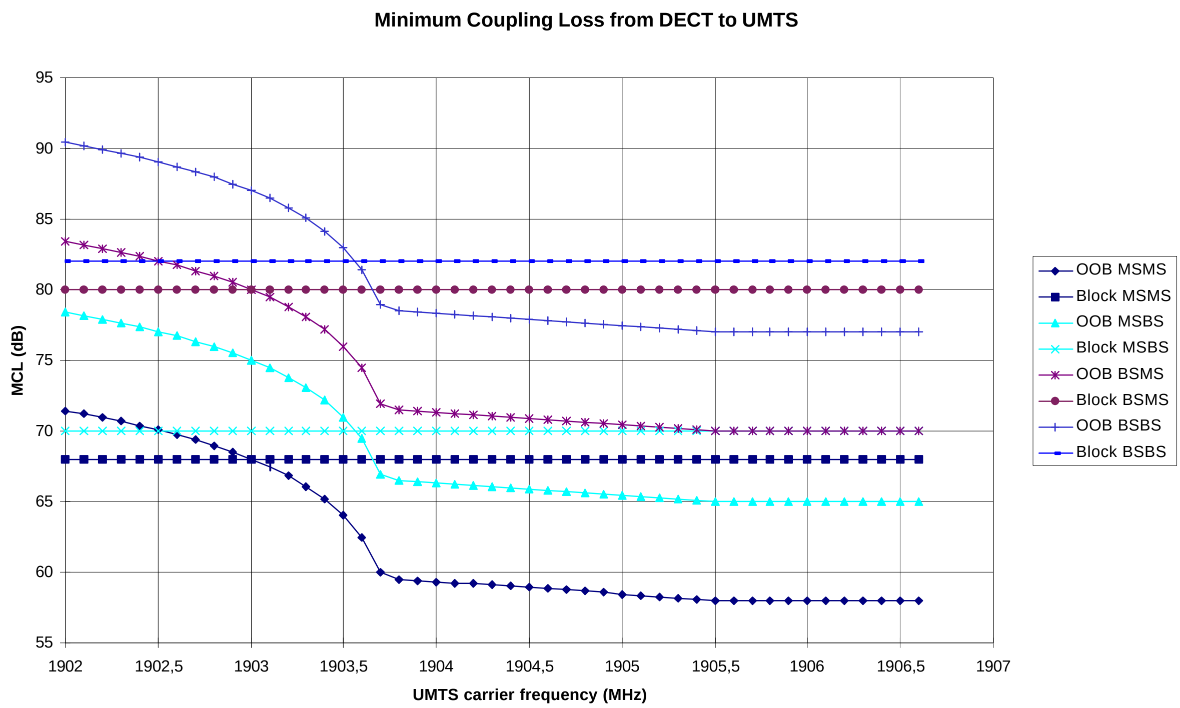

Figure 3 - MCL from DECT to UMTS due to blocking and out-of-band emissions as a function of UMTS carrier centre frequency

3.1.2 Monte Carlo approach

Monte Carlo simulations have been performed with a density of 500 mobiles (DECT and UMTS) per km², and perfect power control (as detailed in Annex A) is assumed for UMTS mobile stations. The results are shown in figures 4 and 5. It has to be noted, that these Monte Carlo simulations used a path loss model which is only valid for outdoor scenarios and not for indoor scenarios**.** More simulations are needed for the evaluation of indoor systems like public DECT systems, due to the propagation model, antenna heights, the operation at more than one floor, the building losses and the very short distances between interferer and victim (very high user densities). It has been said that, to avoid interference between UMTS MS and DECT MS the distance between MSs has to be greater than 5 m indoors. The equivalent MCL must be below 52 dB.

However, the SEAMCAT tool being developed within PT SE21 should, when enhanced, provide a usable methodology for both indoor and outdoor scenarios if careful consideration and choice of parameters and interferer densities is addressed.

In the case of UMTS MS to DECT BS interference, figure 4 also plots the probability of interference when the blocking phenomenon is ignored (“MSBS no blocking” curve).

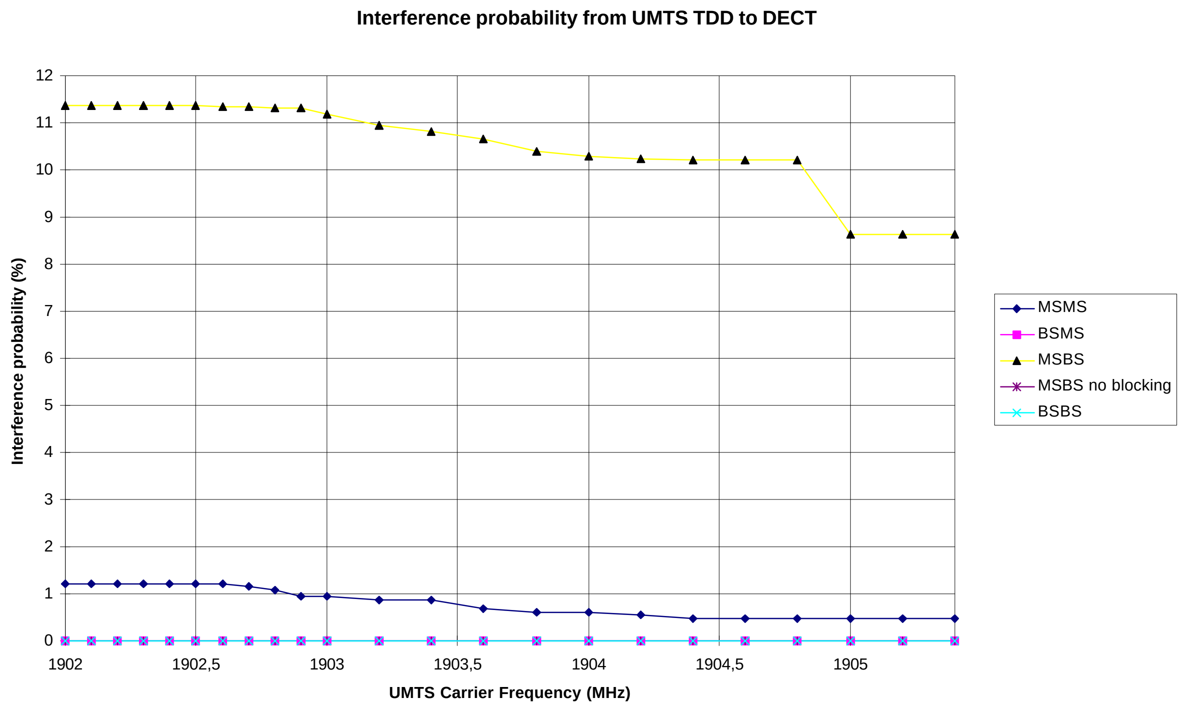

Figure 4 – Interference probability from UMTS to DECT as a function of UMTS carrier centre frequency

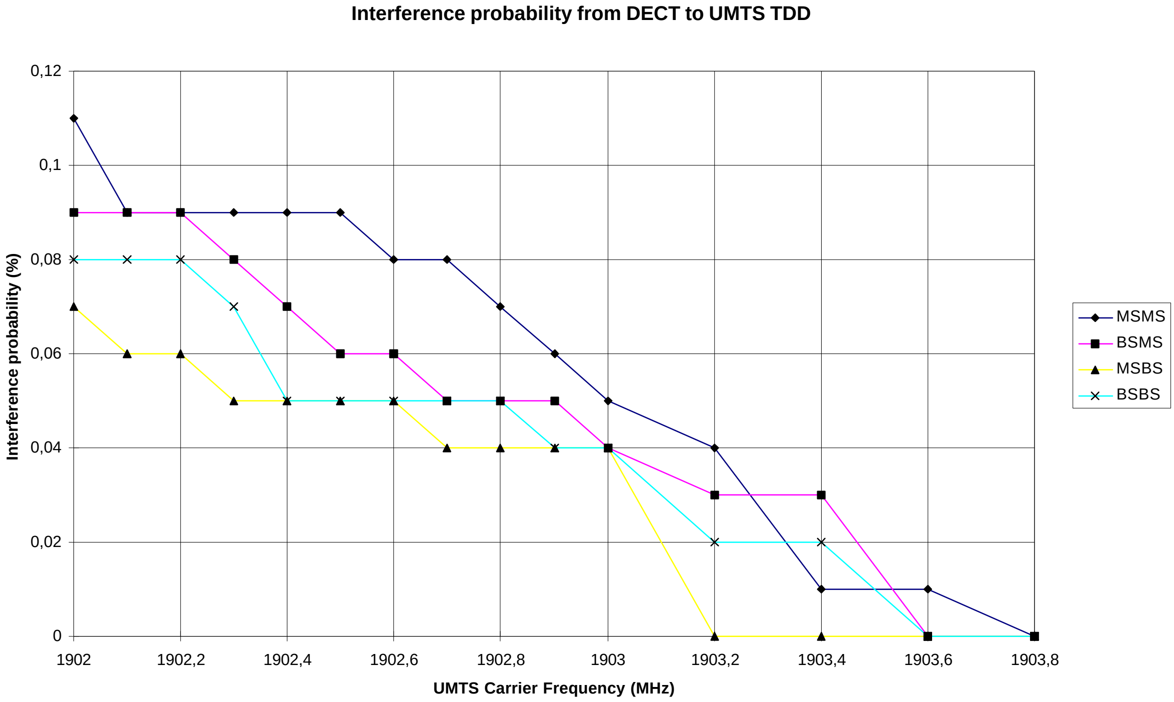

Figure 5 – Interference probability from DECT to UMTS as a function of UMTS carrier centre frequency

3.1.3 BS to BS scenarios

The only situation that needs to be studied with the MCL approach are the BS to BS scenario and the indoor use of public DECT systems and UMTS, because the distances are here fixed

Figure 2 shows that the spurious emission interference from UMTS to DECT is always less than the interference caused by blocking. Since parameters of the current DECT systems are not modifiable, this cannot be reduced easily. It has been explained in Annex A3 that the blocking performance with a modulated signal could be significantly better than with a CW signal. The out-of-band interference will be therefore considered primordial.

On the other hand, Figure 4 shows that interference between two Base Stations is very unlikely to occur. It means that the cases where two base stations are in too close vicinity are very rare and these cases could be overcome by DECT dynamic channel selection (DCS).

Figures 3 and 5 show that interference from DECT BS to UMTS BS is less important than from UMTS BS to DECT BS.

A solution might be to operate UMTS TDD channel at 1903.5 MHz or above, since the MCL curves for UMTS to DECT and DECT to UMTS cross at this point. The interference would then be equally split between the two systems.

This corresponds to a carrier separation of 1903.5-1897.344≈6.2 MHz.

3.1.4 MS scenarios

In scenarios involving at least one mobile station, the Monte Carlo approach is preferable.

Figures 4 and 5 show that for most of the scenarios, no guard band is necessary, because interference probability is below 2%, which is considered as the maximum acceptable probability for DECT. The operation of UMTS on the carrier centred on 1902 MHz is possible without interference. However further analysis of the mobile to mobile case using Monte Carlo with a much higher density of mobile stations is required (e.g. 2 interferers at 25 m² is equivalent to 80 000 interferers/km²).

The scenarios that need detailed consideration are the UMTS MS to DECT BS and the indoor use of DECT and UMTS in high density office environment. The high values of probability of interference are caused by DECT blocking, much more than by UMTS out-of-band emissions. When the blocking phenomenon is removed from the simulations, the interference probability falls to 0%, independent of the size of the guard band.

It has been expressed that the increase of noise level produced by UMTS broad band may block the DECT DCS in the adjacent parts of the DECT frequency bands.

3.1.5 Conclusions

When DECT is not operated for FWA, the DECT base station has approximately the same characteristics as the mobile station. For the densities used in the above studies, the conclusion is that no guard band is required.

When DECT is operating in FWA applications, the top DECT channel should not be available for FWA applications unless the UMTS channel centre frequency is above 1903.5 MHz.

3.2 Space services

Annex 1 to ITU-R Recommendation SA.1154 [7] provides a compatibility study of space services and high-density land mobile systems. The conclusion of this study is that high density mobile systems should not be introduced in the 2025-2110 MHz and 2200-2290 MHz bands (i.e. these bands cannot be identified as potential IMT-2000 extension bands).

[7] provides a methodology for calculation of the aggregate received power at a space station, based on the density of users on the Earth.

Figures for the penetration and peak traffic are given in [7]. However, it seems that the figures in table 2, derived from [4] for Multimedia services, are more applicable.

	CBD/Urban (in building)	Home (in building)	Suburban (in building or on street)	Urban (pedestrian)	Urban (vehicular)	Rural in-& out-door
Indoor/outdoor	indoor		Outdoor			
Mean active/passive rate (seconds/busy hour) for non speech services for one person	8		6.1			
Mean active/passive rate (seconds/busy hour) for all services for one person	59		111			

Table 2 - Penetration and traffic figures

The cumulative interfering power spectral density arriving at the satellite, on orbit heights between 250 and 36000 km, is given by

$$P_{\Sigma_i} = P_s \frac{n_a(h)c^2}{(4pf)^2 Rh}[\ln(d_m) - \ln(h)] = \mathrm{n_a}(h) P_s \mathrm{L}(h)$$

$$d_m = \sqrt{(R+h)^2 - R^2}$$

where :

P_s : mobile spurious power density (W)

f : transmission frequency (Hz)

$n_a(h)$: total number of mobiles in the interference area

c : speed of light (km/s)

d_m : maximum distance to interferer (mobile on the horizon) (km)

R : Earth radius (km)

h : orbit height (km)

$\mathrm{L}(h)$: mean path loss

The mean path loss *L(h)* for one transmitter is 158 dB for a 250 km height and 190 dB for 36000 km height.

3.2.1 At 2025 MHz

The band 2010-2025 MHz is unpaired and it is expected to be used in TDD mode. Based on the traffic density in table 2, maximum out-of-band levels for one UMTS transmitter are derived in table 3. It is assumed that the interfering transmitter are uniformly distributed in 7 channels of 5 MHz wide (i;e. 1900-1920 MHz and 2010-2025 MHz).

Table 3 is a summary of the calculations for two orbit heights. The value for “Max allowed received” (Maximum tolerable level of interference) is extracted from [7] and detailed in Annex A. The value for “Population” is taken from [7].

		Indoor		Outdoor	
Spacecraft height	Km	250	36000	250	36000
Mean path loss	dB	158	190	158	190
Environmental attenuation	dB	10	10	3	3
Max allowed received	dBW/Hz	-214	-214	-214	-214
Max transmitted	dBW/Hz	-46	-14	-53	-21
Population	Millions	600	4000	600	4000
Active/passive rate	S/h	8	8	6.1	6.1
Simultaneously active units		1333333	8888889	1016667	6777778
Number of channels		7	7	7	7
Active units in the last channel		190476	1269841	145238	968254
Max transmit/unit	dBW/Hz	-99.3	-74.8	-105.1	-80.6
Max transmit/unit	dBm/Hz	-69.3	-44.8	-75.1	-50.6

Table 3 - Interference scenario around 2025 MHz

The most stringent limit to the UMTS transmitter is around -75 dBm/Hz for the low orbit spacecraft. This value is reached with a frequency offset of 2.75 MHz for the transmitting mask given in Annex A. For the geostationary spacecraft, the -50.6 dBm/Hz value is reached for a 2.5 MHz frequency offset.

3.2.2 At 2110 MHz

The aggregate interference to the space science service satellite receiver from all the visible UMTS base stations can be calculated as shown in the table below.

Space craft height (km)	**250**
Average transmission loss (dB)	*154.2*
Polarisation loss (dB)	**3**
Downtilt (2.5°)	**-2**
Max received (dBW/Hz)	**-214**
Ratio in-band/out-band (dB)	**3**
Max transmitted (dBW/Hz)	*-59.8*
Average cell radius (km)	**6.8**
Visible Earth (km²)	*9689313*
No. of simultaneous Txs	*66700*
BS power (dBm)	**41**
Power control/remote areas (dB)	**-6**
Bandwidth (Hz)	**4.096 10^6**
BS e.i.r.p. (dBW/Hz)	*-61.1*
Total BS Tx (dBW/Hz)	*-12.9*
Required attenuation (dB)	***44.9***

Table 4 - Interference scenario around 2110 MHz

The assumptions made in the calculation are :

- The average transmission loss is defined as the average of the BS antenna gain in the direction of the satellite and the free space path loss for all visible cells.
- A polarisation loss up to 3 dB can be considered applicable between vertically polarised UMTS and circularly polarised space systems.
- An average down-tilt of 2.5° is assumed which reduces the antenna gain by 2 dB.
- Half of the interference budget is allowed for out-of-band interference from UMTS.
- Base sations are assumed to transmit at a power of 41 dBm, an estimated allowance of 6 dB is incorporated for power control and the low base station density in remote and sea areas. This is a provisional estimate.

The necessary carrier frequency offset corresponding to the attenuation required depends to a major extent on the UMTS BS transmitter mask. According to figure A1, the required attenuation would be met at a frequency offset of 2.75 MHz from the UMTS carrier centre.

It should be noted that there is an internationally agreed multiple access frequency at 2106.4 MHz with a bandwidth of ±2.5 MHz for sensitive space to space links.

3.2.3 Conclusions

Table 5 lists the frequency offset necessary to protect the space services.

	At 2025 MHz		At 2110 MHz	
Height (km)	250	36000	250	
Frequency offset from the carrier (MHz)	2.75	2.5	2.75	

Table 5 - guard bands to protect the space services

It is shown that an extremely small guard band is sufficient to protect the space services in the band 2025-2110 MHz.

3.3 Mobile satellite service

3.3.1 Interference to MSS satellites

The methodology employed to assess interference in to MSS satellites is given in Annex B. The input parameters required by this methodology are given in Annex A.

These calculations examine the interference due to the unwanted emissions from the terrestrial component of UMTS into the mobile satellite service (MSS) operating in an adjacent allocation. The general principle in radio design, and in relevant ITU-R documentation, is that, in establishing the overall interference budget, the interference from unwanted emissions of adjacent band radio systems is a small fraction of that from in-band, co-primary interference sources, e.g. 1%, 6%. The satellite systems are designed to tolerate typically a 20% increase of the thermal noise level. This 20% is then divided in an appropriate way between adjacent channel (and co-channel) systems and services.

There is no agreed ITU-R Recommendation on the percentage of increase of noise that is acceptable to a satellite, although it is noted that Working Parties 8D and 4A are currently working on this and related issues.

For the purpose of evaluation of the carrier separation between terrestrial UMTS and MSS in this report, two criteria are considered: 3% and 6% of increase of noise. The 6% criterion applies at the edge of the band allocated to MSS, while the 3% criterion is applied 100 kHz within the MSS band. The results below show that these two criteria result in the same value of the extreme position of the UMTS carrier.

3.3.1.1 FDD Mode of terrestrial UMTS at 1980 MHz

In this case the band below 1980 MHz is the transmitter frequency band for the FDD terrestrial UMTS MSs. Application of the methodology in Annex B with the parameters for the FDD mode given in Annex A (table A3) gives the intermediate results listed in table 6. The parameters assume that the FDD mode is used to provide wide area outdoor coverage.

Satellite beam:	*Sub-Satellite*	*Edge-of-coverage*
Cell radius: Average [A]	6.8 km	
EIRP per cell: Average [B]	13.3 dBm	
Interference power from Cells lying in 3dB beamwidth (0 Hz offset from the carrier)	-166.2 $dBmHz^{-1}$	-161.1 $dBmHz^{-1}$
Number of Cells in 3dB beamwidth	4,681	26,740
⇒ Approximate area on Earth's surface of 3 dB beamwidth	565,000 km^2	3,190,000 km^2
Field-of-view correction [C]	-3.0 dB	
C_{FOV} (see §B2)	+6.7 dB	+4.0 dB

A - Calculated using radii assumed typical for terrestrial FDD UMTS.
B - Calculated using average MS EIRP for each environment and traffic predictions.
C - The entire satellite's field-of-view will not be uniformly covered as implied by other assumptions. This factor takes into account, for example, that the terrestrial busy hour may extend across time zones over the visible area and there may be portions of the satellite beam over ocean.

Table 6 - Calculation of aggregate interference at satellite receiver from the FDD mode MSs of terrestrial UMTS

Figure 6 plots aggregate interference power at the satellite receiver from the FDD mode MSs of terrestrial UMTS against frequency offset from the terrestrial UMTS MS carrier frequency. The values in this figure are calculated using the information given in table 6. Note that only the outermost terrestrial UMTS carrier has been considered in this interference power calculation. Also the typical minimum wanted signal power from Mobile Earth Stations is shown in figure 6, to aid the comparison and discussion.

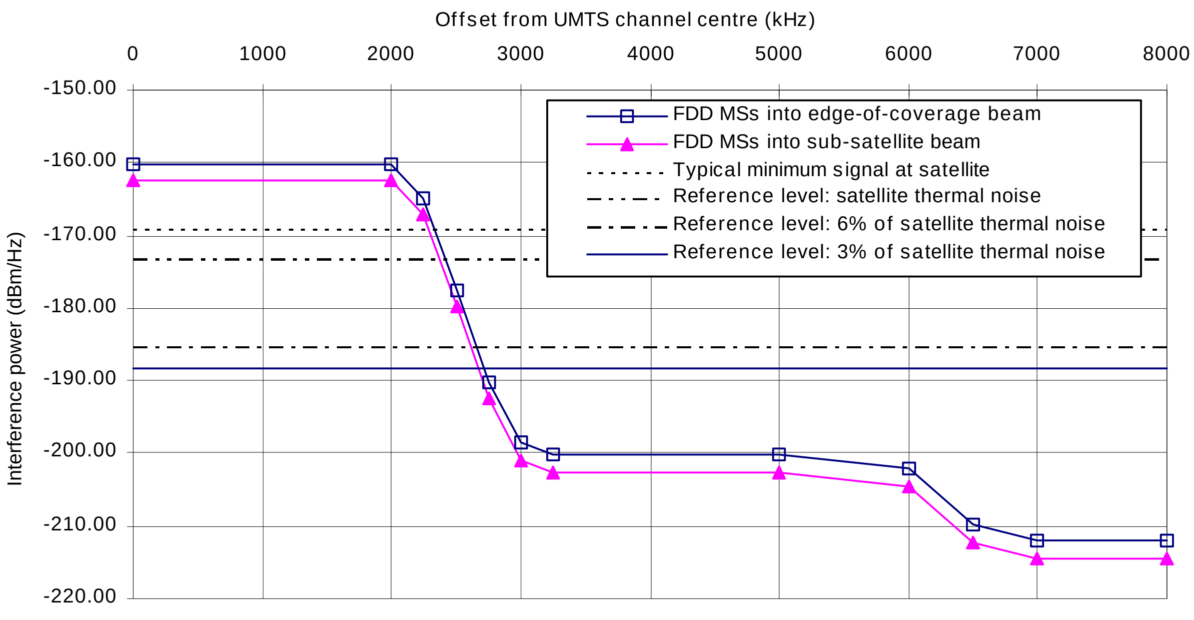

Figure 6 - Interference power at a satellite receiver from the FDD mode of terrestrial UMTS

3.3.1.2 TDD Mode of terrestrial UMTS at 1980 MHz and 2010 MHz

In this case the bands below 1980 MHz and above 2010 MHz are the transmitter frequency bands for the TDD terrestrial UMTS BSs and MSs. Application of the methodology in Annex

B with the parameters for the TDD mode given in Annex A (table A4) gives the intermediate results listed in table 7. Table 8 provides more detailed elements on the calculation of the total number of cells in 3 dB bandwidth. The parameters assume that the TDD mode is used to provide limited area indoor coverage.

Satellite beam:	*Sub-Satellite*	*Edge-of-coverage* [A]
Cell radius: Average	0.2 km	
Power into antenna per cell: Average [B]	MS: 3.5 dBm BS: 7.0 dBm [It has not yet been demonstrated whether these values are indeed applicable.]	
Interference power from Cells lying in 3 dB beamwidth (at 0 Hz offset from the carrier)	MS: -132.3 $dBmHz^{-1}$ BS: -141.9 $dBmHz^{-1}$	MS: -127.3 $dBmHz^{-1}$ BS: -131.9 $dBmHz^{-1}$
Total number of Cells in 3 dB beamwidth (before corrections)	5,414,977	30,650,355
⇒ Total number of Cells in 3 dB beamwidth (after corrections) [C]	77,976	441,365
⇒ Approximate area on Earth's surface of 3 dB beamwidth	565,000 km^2	3,190,000 km^2
Coverage correction [D]	-20.5 dB	
Indoor use	-12.0 dB [E]	-10 dB
Multiple floors [F]	+2.0 dB	
C_{FOV} (see §B2)	+6.7 dB	+4.0 dB

A - Further verification of EOC beam results is needed.
B - Calculated assuming 8 timeslots per channel and a 50% activity ratio.
C - See full calculation in Table 3 below.
D - $10\log_{10}$(30% of potential implementation area of 3%).
E - $10\log_{10}$(((30% of potential implementation area $\times 10^{14.7\ dB/10}$)+(70% of potential implementation area $\times 10^{10\ dB/10}$))/ total potential implementation area of 3%)).
F - $10\log_{10}$((3 floors over 30% of potential implementation area + 1 floor over 70% of potential implementation area)/(total potential implementation area of 3%)).

Table 7 - Calculation of aggregate interference at satellite receiver from the TDD mode of terrestrial UMTS below 1980 MHz and above 2010 MHz

Satellite beam:	*Sub-Satellite*	*Edge-of-coverage*
Total number of Cells in 3dB beamwidth (before corrections)	5,414,977	30,650,355
TDD potential implementation area: Area covered by 3 floors Area covered by 1 floor	 146,204 113,715	 827,560 643,657
TDD penetration in implementation area (30%): Area covered by 3 floors Area covered by 1 floor	 43,861 34,115	 248,268 193,097
Total number of Cells in 3dB beamwidth (after corrections)	77,976	441,365

Table 8 - Full calculation of values for 'Total number of Cells in 3 dB beamwidth (after corrections)' as presented in table 12

Figure 7 plots aggregate interference power at the satellite receiver from the TDD mode of terrestrial UMTS against the frequency offset from the terrestrial UMTS carrier frequency. The values in this figure are calculated using the information given in table 7. Note that only the outermost terrestrial UMTS carrier has been considered when calculating interference power. Also the typical minimum wanted signal power from Mobile Earth Stations is shown in the figure, to aid the comparison and discussion.

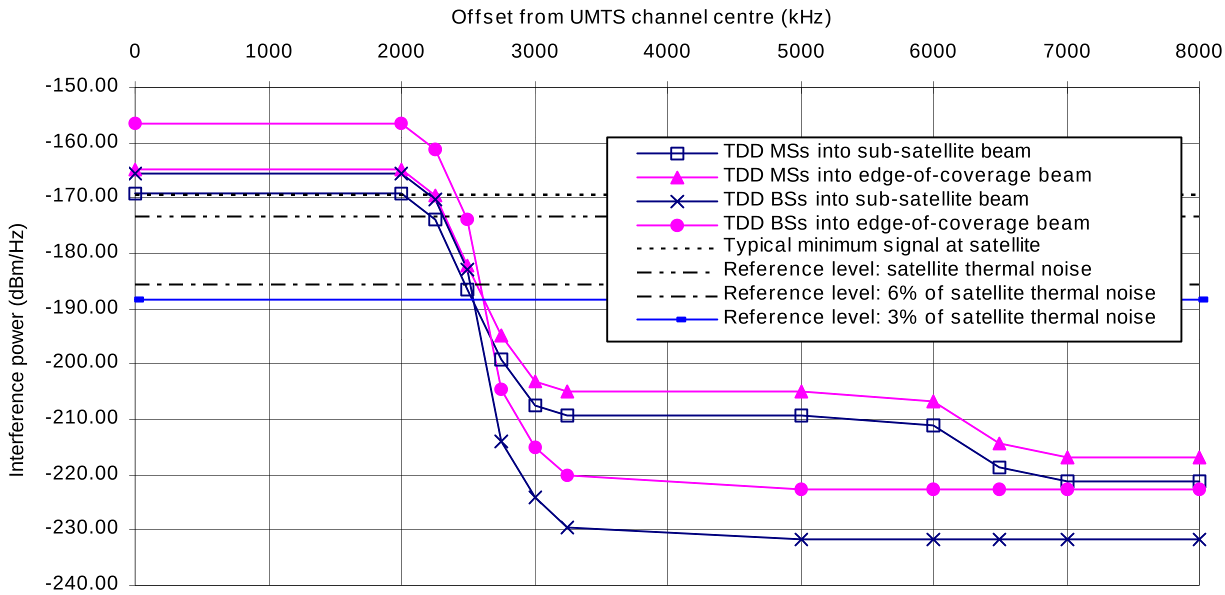

Figure 7 - Interference power at a satellite receiver from the TDD mode of terrestrial UMTS

3.3.1.3 Interpretation of results

Examination of the results presented above shows that, even though an edge-of-coverage spot beam covers a considerably larger area than the sub-satellite spot beam, the aggregate interference into both beams is generally similar. This is not the case for interference from TDD BSs though, where, amongst other things, the smaller BS antenna gain used when considering a sub-satellite beam results in a significantly reduced interference level.

Figures 6 and 7 show the interference power at the satellite receiver, as well as the reference levels of 6% and 3% increase of satellite thermal noise. Comparing these values in the figures, it can be seen that:

(i) for interference from FDD MSs, the interference power is less than the reference level beyond 2.655 MHz offset from carrier for the 6% reference and beyond 2.715 MHz offset from the 3% reference;

(ii) for interference from TDD BSs, the interference power is less than the reference level beyond around 2.595 MHz offset from carrier for the 6% reference and beyond around 2.618 MHz offset from the 3% reference;

(iii) for interference from TDD MSs, the interference power is less than the reference level beyond around 2.562 MHz offset from carrier for the 6% reference and beyond 2.625 MHz offset from the 3% reference.

3.3.1.4 Comments on the results

For the FDD calculation, it may be noted that if smaller cells had been assumed the interference would be lower since the power per mobile would be reduced (the total number of active mobiles remains fixed based on the given predicted amount of traffic per user). However, the current assumptions for FDD outdoor are consistent with information in the UMTS Forum documentation [4].

For the TDD calculation, if the cell size is smaller than the 0.2 km currently assumed (the Forum report mentions an example of 0.075 km), the impact on the calculated interference to the satellite would depend on the degree to which the average BS/MS power correspondingly reduces. There is currently insufficient information about the typical TDD power to make this assessment precisely, however consideration of the propagation model indicates that the effect of reduced BS/MS Tx power will dominate over the increase in the number of visible cells.

It should be noted that the calculations are highly sensitive to certain assumptions made when examining indoor/outdoor use (for example, EIRP and building attenuation). Figure 8 below shows how the effective average building attenuation varies with the percentage of transmitting stations indoors.

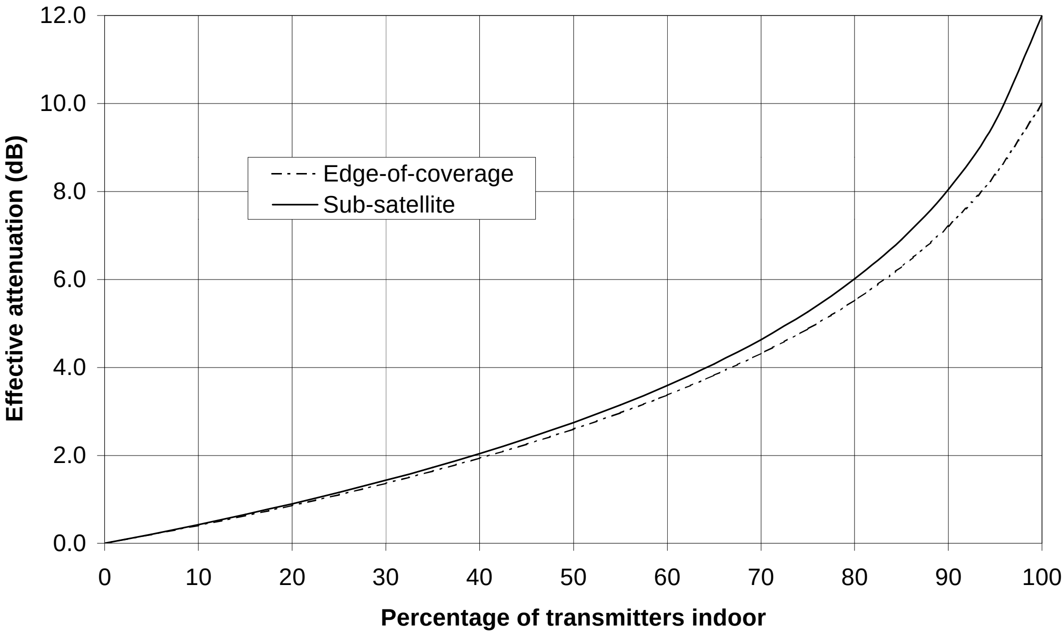

Figure 8 - Variation of effective attenuation with percentage of transmitters indoor

From Figure 8, it can be seen that:

(i) as the percentage of transmitters indoors is reduced from 100%, the effective attenuation falls quite quickly. For example, for the EOC case a reduction in the number of transmitters indoors from 100% to 90% implies a fall in effective attenuation of more than 3 dB.

(ii) as the percentage of transmitters is increased from 0%, the effective attenuation rises slowly. For example, an increase in the number of transmitters indoors from 0% to 20% implies an increase in effective attenuation of less than 1 dB.

This study assumes 100% indoor use for TDD and Figure 8 demonstrates that larger guard bands would be needed with any degree of outdoor use in order to achieve the same level of compatibility (e.g. 10% outdoor TDD would require an extra 0.1 MHz). The study also assumes 100% outdoor use for FDD, however it can be seen that a considerable percentage of FDD transmitters must ‘go indoors’ before any significant impact is felt.

Noting that the masks assumed result from simulation of the modulation only, filtering may reduce the interference effects, however the practical considerations of filter roll-off may still require guard-bands to adequately reduce interference into the adjacent satellite band. Examination of the results in §3.3.1.1 and §3.3.1.2 shows that, even though an edge-of-coverage spot beam covers a considerably larger area than the sub-satellite spot beam, the aggregate interference into both beams is generally similar.

3.3.2 Interference from MSS satellites to terrestrial UMTS

[8] and [9], which provides information on the MSS satellite systems expected to be operated in these bands, was examined.

[8] and [9] describe various systems that employ a variety of constellations (e.g. LEO, MEO, GEO) and access schemes (e.g. TDMA, CDMA). Based on this it was possible to calculate the maximum in-band spectral power flux densities (spfds) of these systems on the Earth’s surface. These maximum spfds are in the range -162.3 to -168.6 $dBWm^{-2}Hz^{-1}$. The level of -162.3 $dBWm^{-2}Hz^{-1}$ is used here, noting that this level is the highest in a range of maximum spfd values.

It is noted that ITU-R Task Group 1/5 is currently examining generic OOB emission limits for all services and document 1-5/TEMP/90 contains the current working proposals building up to the development of such limits. TG1-5 is far from concluding its work on these generic limits (the work is needed for WRC’03) and so considerable further work is expected.

Document 1-5/TEMP/90 includes proposals for masks from ITU-R WP4A based on worst-case OOB emission measurements Ku-band (which are expected to apply in C-band as well). These masks are currently being examined by various Study Groups, manufacturers and operators to check/ensure their validity with other systems and in other bands. It has not been possible to locate any other generic masks and so these masks have been used here on the assumption that they can be considered as relatively generic. At the point defined closest to the in-band emission (0.7 x the transponder bandwidth, measured from the centre of the transponder bandwidth) these masks indicate maximum OOB emission levels of -27 dBs (NB. dBs is defined as dB relative to the in-band spectral power density). The maximum interference at the UMTS MS receiver is calculated in table 9

Max in-band satellite spfd (on Earth’s surface) equivalent to	-162.3 $dBWm^{-2}Hz^{-1}$ -132.3 $dBm(m^{-2}Hz^{-1})$
OOB emission level	-27 dBs
UMTS Receiver bandwidth	+66.1 dBHz
UMTS MS effective antenna area	-26.3 $dB(m^2)$
Max interference power at UMTS MS receiver	-119.5 dBm

Table 9 - Interference from an MSS satellite to a terrestrial UMTS mobile station

The calculated value of maximum interference power at the MS receiver is -119.5 dBm. This is 20.6 dB below the receiver noise floor. It should be noted that the actual level of interference is expected to be less than this value since:

(i) maximum spfds, from the literature, are used; satellites are a power limited and will mostly operate at lower spfds than these maximums;

(ii) the OOB emission levels used assume the worst case scenario (i.e. fully loaded transponders); OOB emission levels in practical operation will generally be lower than this.

Terrestrial UMTS does therefore not require any guard band from the satellite downlink segment.

3.3.3 MSS Earth station interference

Interference from and to satellite UMTS Mobile Earth Stations has been investigated using a Monte Carlo analysis [6]. The results of the study are summarised in the following paragraphs.

The UMTS and MES technical parameters used in the study are given in Annex A (sections A1 and A2 respectively).

3.3.3.1 UMTS BS into MSS MES

The results of a Monte Carlo analysis of interference into the MSS MES from the UMTS Base Stations for three different environment types are shown in figures 9, 10 and 11 [6].

The method of calculation was to choose an MES location randomly and, assuming a given density of surrounding UMTS base stations (see legend), the distance to the nearest base station and the corresponding propagation loss is determined. Taking into account the interferer UMTS BS transmit power, antenna gains the sampled interference power is determined and compared to the maximum permitted level of an MSS MES. The permitted level can be either fixed, or if appropriate, set according to a probability distribution (eg. taking into account the probability of fading on the wanted link). The trial is then repeated a large number of times (over 1000 in the studies presented here) and the proportion of cases where the interference exceeds the permitted level is determined (i.e. the probability of interference occurring). It was assumed that the MES is operating on the carrier nearest to the UMTS band and that the UMTS channel is fully loaded (i.e. the BS transmit at maximum power).

The assumptions used in the Monte Carlo analysis (propagation model, antenna heights, UMTS BS density and MES interference criterion) are all indicated on the legend of the figures.

The results were calculated assuming transmitting UMTS base stations (FDD) which are located outdoors. The “guard band” shown in figures 9, 10, 11 and 12 is measured between the 3 dB bandwidth of the UMTS and MSS channels, assuming these to be 4.1 MHz and 25 kHz respectively.

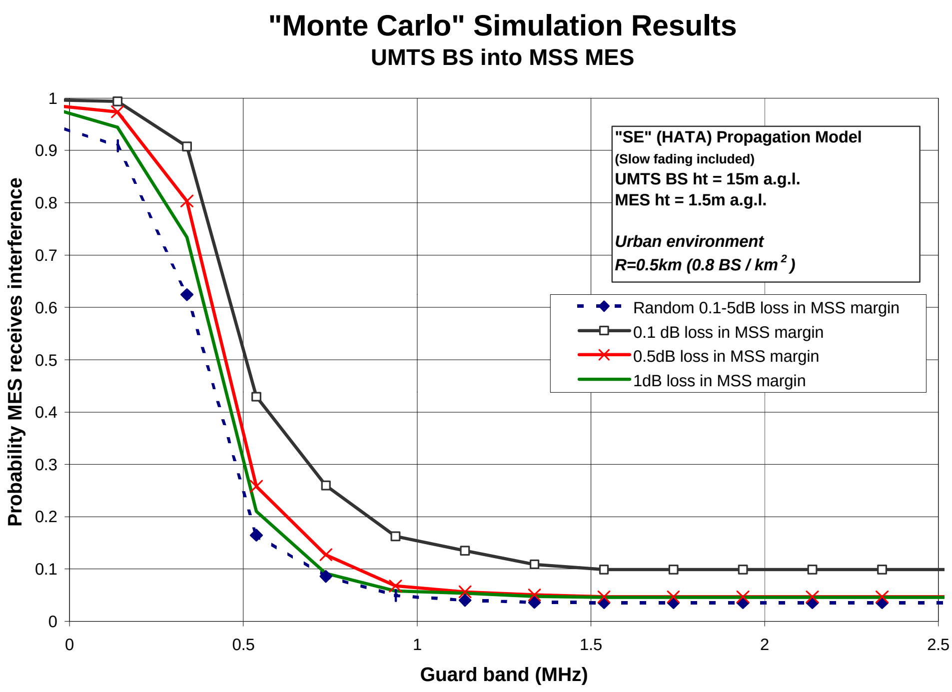

Figure 9 – Probability of MES receiver interference as a function of guard band in urban environment

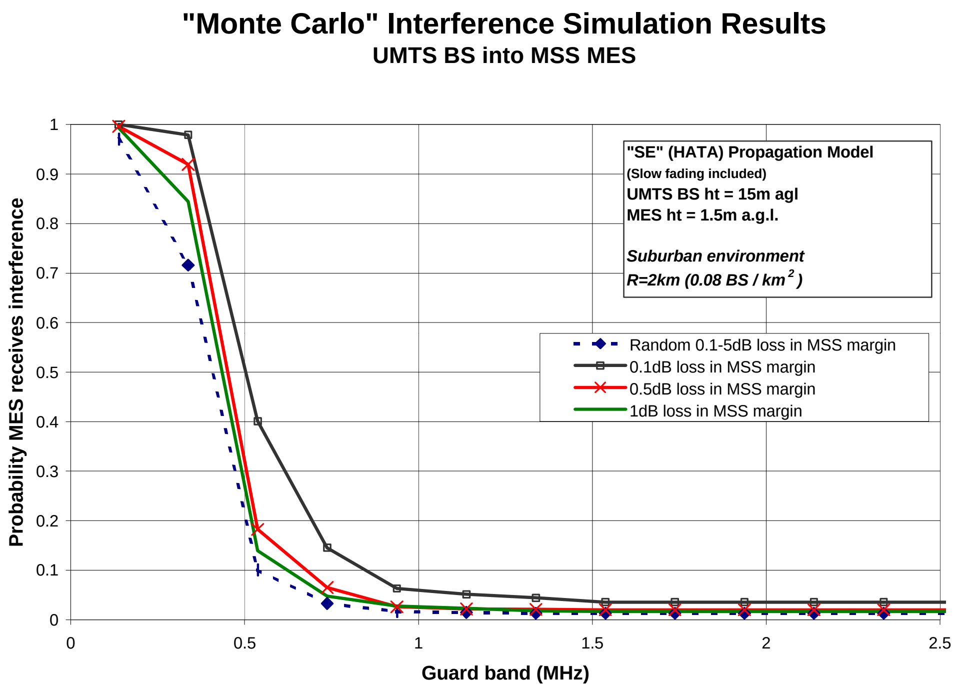

Figure 10 – Probability of MES receiver interference as a function of guard band in suburban environment

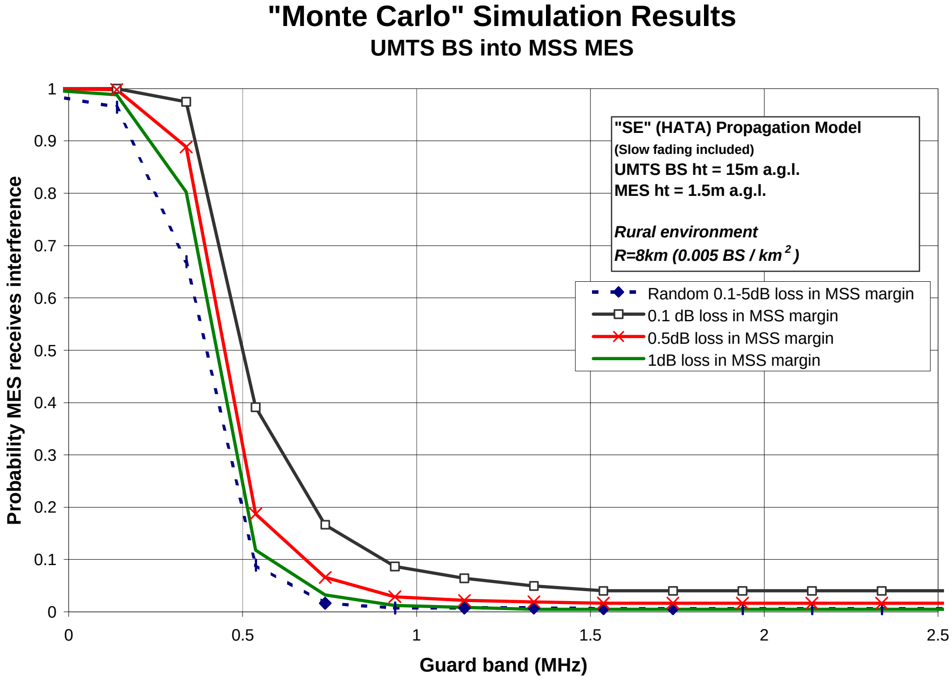

Figure 11 – Probability of MES receiver interference as a function of guard band in rural environment

3.3.3.2 MSS MES into UMTS BS

The results of a Monte Carlo analysis of interference from the MSS MES into the UMTS BS is shown in figure 12.

For a Monte Carlo analysis of interference from an MES to a UMTS BS a single UMTS base station could be considered with an MES located randomly. Such an analysis would however yield very low interference probability simply by virtue of the fact that the expected density of active MESs is very low. Instead it is considered more meaningful to study the probability that an MES would cause interference to <u>any</u> UMTS base station since these will probably be deployed to give ubiquitous coverage. The simulation process is basically then as for the previous case (UMTS BS to MES). Because the allowed interference level used for the UMTS base station already assumes a 3dB loss in margin, and since uplink power control for MES is likely to be used the permitted interference level at the base station is fixed in this case. The only variable in the simulation is the variable separation distance between interferer and victim defined by the random MES deployment. The study assumes that MES is in operation and using the channel closest to the UMTS band, which in themselves represent a low probability. Results for the different propagation environments (and assumed corresponding UMTS cell sizes and antenna gains) are presented.

The assumptions used in the Monte Carlo analysis (propagation model, antenna heights, UMTS BS density) are all indicated on the legend of the figures.

The results were calculated for receiving UMTS base stations (FDD) which are located outdoors. For the case of the MES interfering with UMTS **TDD**, the result below is also valid since the key parameters are the same. If the TDD base station were located indoors the required carrier separation would be even less. Since the dominant interference scenario will then almost certainly be the UMTS to the satellite anyway (see §3.3.1), this has not been studied in detail.

Similarly, interference from the MES to the UMTS TDD MS has not been studied since it is assumed that the UMTS mobile would be indoors and the MES outdoors and significant building attenuation would generally be available. If TDD were used extensively outdoors further study may be necessary to assess potential interference from the transmitting MES's.

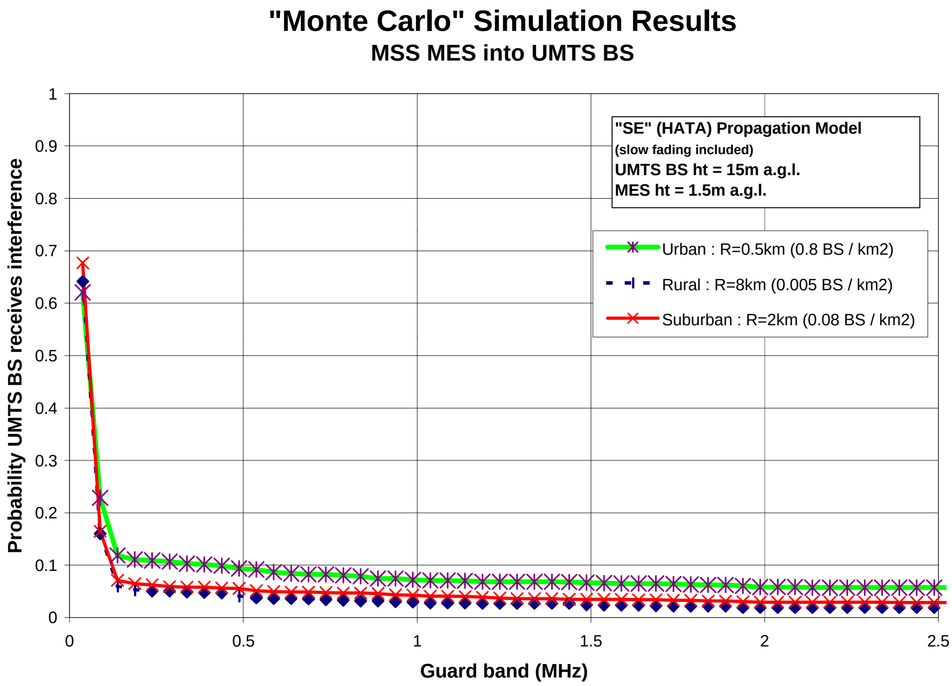

Figure 12

3.3.3.3 Discussion and conclusions

This study has focused on the analysis of unwanted emissions to determine the guard band requirements between UMTS BS and MSS MESs. Receiver blocking effects may require further investigation when more details of the receivers become available.

The "guard band" shown in the above figures is measured between the 3dB bandwidth of the UMTS and MSS channels, assuming these to be 4.1 MHz and 25 kHz respectively. Thus, the "Carrier frequency separation" will correspond to the "guard band" + 2.06MHz.

The Monte Carlo interference analysis results reveal that in this study the guard band requirements are similar for the different environments considered (urban, sub-urban and rural). This is because the effect of the greater propagation losses at a given distance in the urban environment are offset by the fact that the interference path lengths are shorter because of the higher density of base stations.

In carrying out the analysis it was noticed that the results are strongly affected by the standard deviation of the normal distribution which is added to the median propagation loss to model slow fading effects. The results obtained are of course dependent on the various input assumptions (e.g. cell size, powers, Tx masks) and would need to be recalculated if any of these change significantly.

In Figures 9 to 11 the probability of interference is plotted for different criteria for the loss in the MSS margin. Annex A mentions an 8 dB fade margin on the downlink, and therefore a 0.5 dB loss in the margin is seen as an acceptable criterion for interference, when coupled with the interference probability given below.

The interference probability plotted in these figures rapidly decreases with the guard band. The threshold for acceptable interference for both a mobile Earth station and a terrestrial UMTS terminal is set to 10% because the scenarios in consideration themselves have low probability to occur (the number of available satellite channels within the MSS satellite coverage mean that active MES will be sparsely distributed compared with terrestrial UMTS stations)..

The required guard band is therefore 0.8 MHz, equivalent to 2.86 MHz carrier frequency separation.

If the carrier frequency separation is set 2.86 MHz, then the probability that the MSS MES causes an 3 dB loss in the terrestrial UMTS uplink margin is about 9% in a urban area, 5% in a suburban area, and 4% in a rural area. This loss in margin is particularly detrimental in rural areas, where the coverage will be a limiting factor, and in particular the up link budget. Taking into account the very low probability that an MES is indeed located in a cell area due to the low expected densities of active MESs, this probability of interference is however considered to be acceptable.

Since the victim station is here a base station operating with CDMA, interference can cause not only a loss of coverage but also a loss of part of or all the uplink capacity. A 3 dB increase of noise is however not considered to cause a detrimental loss of capacity. More detailed simulations, taking into account both the wanted received signal and the interfering signal levels, would be necessary to study the loss of capacity and blocking effects. This is a topic for further study.

4. Conclusions and discussion

The compatibility studies in section 3 have resulted in either guard bands or carrier separations necessary to protect UMTS from other systems and other systems from UMTS. They are summarised in table 10 below.

This guard band can be taken either totally inside the UMTS band or be accommodated with the guard band provided by the particular spectrum utilisation of adjacent services and systems. Therefore table 10 summarises as well the "extreme position of the UMTS carrier centre frequency". This is calculated based on the following information :

- The last DECT channel centre frequency is 1897.344 MHz
- TBR 42 limits the operation of mobile Earth stations to the bands 1980.1-2109.9 MHz.
- The space science services operate in the whole band 2025-2110 MHz. In particular, there is an internationally agreed carrier frequency at 2106.4 MHz ± 2.5 MHz.

A working assumption for the UMTS channel frequencies is that it is based on a 200 kHz raster. This channel raster has not been taken into account in the figures for the extreme position.

Adjacent services	Minimum carrier separation (MHz)	Calculated Extreme position of the UMTS carrier centre frequency (MHz)	Comments
❶ DECT vs. UMTS (TDD) (see section 3.1)	6.2	1903.5	For FWA, BS-BS scenario, if the top DECT carrier is used
	4.7	1902.0	For “conventional” DECT
❷ UMTS (FDD) vs. MSS (E-s)	2.65	1977.35	Based on dominant interference mode of UMTS to satellite
UMTS (TDD) vs. MSS (E-s) (see section 3.3)	2.6	1977.4	
❸ MSS (E-s) vs. UMTS (TDD) (see section 3.3)	2.6	2012.6	Based on dominant interference mode of UMTS to satellite
❹ UMTS (TDD) vs FS/SSS (see section 3.2)	2.75	2022.25	Only considering SSS so far Based on the SSS requiring protection in the entire allocation
❺ FS/SSS vs. UMTS (FDD) (see section 3.2)	2.75	2112.75	Only considering SSS so far Based on the SSS requiring protection in the entire allocation
❻ UMTS (FDD) vs. MSS (s-E) (see section 3.3)	2.9	2167.2	Dominated by UMTS BS into MES considerations

Table 15 - Summary of the required carrier separations
(❶,❷, …, ❻ refer to figure 1)

If the adjacent systems’ assumed bandwidth changes, the carrier separation would be modified accordingly, but the extreme position of the UMTS carrier would not change.If the unwanted emission mask changes the extreme position of the UMTS carrier may need to be revised.

The studies in this Report have been based on the information available as of December 1998, which are detailed in annex A. In the case that this information is modified at a later stage, a careful investigation of the impact on the guard band would be necessary.

5. Glossary

MINIMUM CARRIER SEPARATION :

The minimum separation required between the nearest carriers of two adjacent band systems for them to co-exist.

MINIMUM FREQUENCY SEPARATION :

The minimum separation required between the band edges of two adjacent band systems for them to co-exist.

Minimum Frequency Separation is less than the Minimum Carrier Separation.

The difference is of the order of one half of the sum of the two systems channel spacings.

e.g. for two systems with channel spacings 200 kHz and 25 kHz a minimum frequency separation of x kHz equates to a minimum carrier separation of x + 112.5 kHz

CO-EXIST :

The systems will operate satisfactorily in adjacent bands.

i.e. the magnitude of the interference anticipated is considered acceptable.

6. References

[1] ETSI TR 101 112, Universal Mobile Telecommunications System (UMTS); Selection procedures for the choice of radio transmission technologies of the UMTS (UMTS 30.03 version 3.1.0)

[2] ETS 300 175-2, Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical layer (PHL)

[3] CEPT ERC SE, Monte Carlo Radio Compatibility Tool, Doc. SE(97)30, `http://www.ero.dk/eroweb/monte/SE973001.pdf`

[4] UMTS Forum, Spectrum for UMTS/IMT 2000, December 1998

[5] Document 8-1/45-E, Study period 1997-2000, Report of the expert meeting

[6] Compatibility between terrestrial UMTS and mobile-satellite services, Doc. ERC TG1 WG1 02, London 21 July 1998.

[7] Recommendation ITU-R SA.1154, 1995, Provisions to protect the space research (SR), space operations (SO) and Earth-exploration satellite services (EES) and to facilitate sharing with the mobile service in the 2025-2110 MHz and 2200-2290 MHz bands

[8] the IMT-2000 Satellite RTT Descriptions (as posted on the ITU website http://www.itu.int/imt);

[9] ITU-R Recommendation M.1184 "Technical Characteristics of Mobile Satellite Systems in the 1-3 GHz Range for Use in Developing Countries for Sharing between the Mobile-Satellite Service (MSS) and other Services using Common Frequencies".

ANNEX A

SYSTEM PARAMETERS

A1 Terrestrial UMTS Parameters

The values of the basic parameters are generally consistent with those defined in [1].

A1.1 Antenna gain characteristics

The antenna gain will be very dependent on the deployment of UMTS by individual operators. For typical deployments using 3 sectors, the value defined in [1] is a reasonable assumption :

13 dBi - 2 dB typical cable loss = 11 dBi

For deployments designed for maximum range, cellular antennas with a gain of up to 17 dBi are available for GSM 1800.

For most scenarios, a value of 14.5 dBi (including feeder loss) will be used.

A1.2. Receiver blocking

SMG 2 believes that the RF performance of the front end of a UMTS receiver can be made similar to that of a GSM 1800 receiver. This is dominated by the phase noise of the local oscillator.

UMTS will use higher order modulation than GSM to maximise system capacity in absence of interference. Therefore, in this case, there will be some system degradation at lower levels of blocking signal. This will result in some loss of system capacity, as a result of dynamic adaptation of the modulation.

A provisional value of 12 dB for this offset is proposed. This value will be reconsidered once the characteristics of UMTS are better defined. This results in the following values for blocking performance :

Frequency band	UMTS blocking	
	MS dBm	BTS dBm
in-band 1.6 MHz ≤ offset from channel edge < 3 MHz 3 MHz ≤ offset from channel edge	 - 45 - 38	 - 37 - 37
out-of-band 20-80 MHz from band edge >80 MHz from band edge	 - 24 -12	 -12 -12

Table A1 - UMTS blocking specification

A1.3 Other parameters

The following parameters have been used in interference calculations.

		BS	MS	
Rx noise floor (or Rx interference level)	dBm	-102.9	-98.9	
Rx sensitivity	dBm	-125.5	-118	
Rx bandwidth	MHz	4.096	4.096	
Peak Tx power	dBm	41	21	
Antenna gain + feeder loss	dBi	14.5 3 in microcells	0	
Tx spectrum mask		see figures below		
Channel spacing	MHz	5		
Power control		not used	FDD Rx Power + Tx Power = -83.5 dBm	TDD Rx Power + Tx Power = -66 dBm

Table A2 - Parameters used in interference evaluation

Power control should be applied on the downlink as well, in both systems. However, it is applied individually on each channel, and the total reduction of transmitting power is effective only when the cell is lightly loaded. Therefore power control is not generally applied in this report.

Figure A1 represents relative out of band attenuation for FDD and TDD, and figure A2 is a plot of the absolute unwanted emission levels, where the reference power spectral density is taken from table A2 transmitter power and bandwidth.

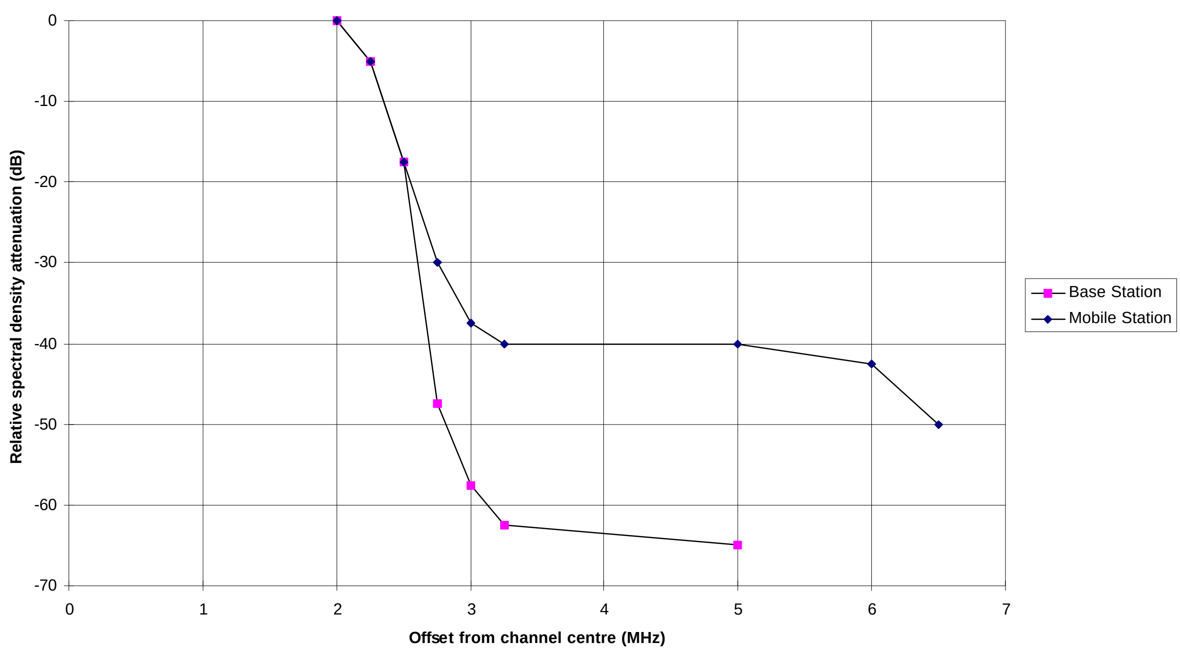

Figure A1 - Out-of-band attenuation

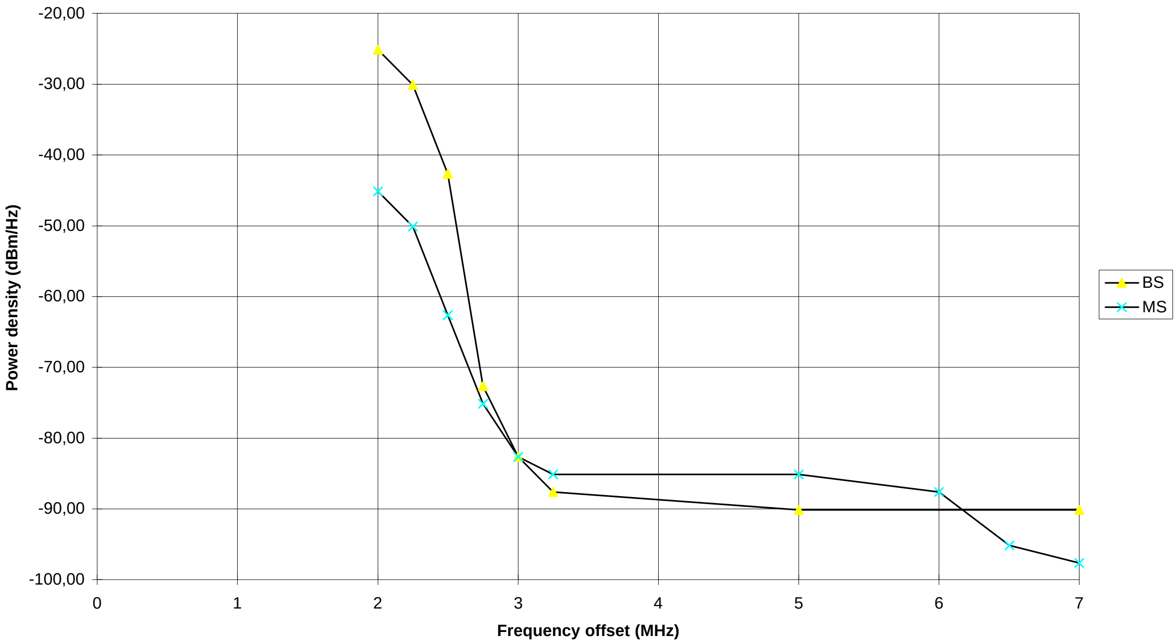

Figure A2 - TDD and FDD unwanted emissions

The parameters in table A3 and A4 have been used in addition in the study of interference to the satellites of the MSS.

The population density figures are based on the report Spectrum for IMT-2000,UMTS Forum, December 1998. It provides figures for High-density In-building (CBD), Urban Pedestrian and Urban Vehicular; here these have been assumed equivalent to Urban/CBD, Urban/Suburban and Rural. The cell sizes assumed below for FDD outdoor use are consistent with the information in the UMTS Forum report for the year 2010.

Percentage of land area [1]	No coverage	10 %
	Rural	87 %
	Urban/Suburban	2.98%
	Urban/CBD	0.02%
Typical cell radius [2]	Rural	8 km
	Urban/Suburban	2 km
	Urban/CBD	0.5 km
Average MS EIRP [3]	Rural	8.3 dBm
	Urban/Suburban	6.6 dBm
	Urban/CBD	-2.5 dBm
Active users per cell per channel [4]	Rural	0.3
	Urban/Suburban	12.5
	Urban/CBD	23.7

1 - Considered to be representative of land use in Europe (e.g. UK).
2 - Assumed typical of terrestrial FDD UMTS cell radii
3 - See ERC TG1 document (98) 152, Ericsson, October 1998
4 - Calculated using figures for Population Density, Penetration, Traffic (summed over all services) and Total Spectrum Requirement from the UMTS Forum report and assuming a 50% activity factor.

Table A3 - FDD mode parameters and traffic figures used in interference to the satellite

Typical cell radius		0.2 km
Coverage		30% of Urban/Suburban and Urban/CBD areas [1]
Multiple floors	In 70% of the coverage	1 floor
	In 30% of the coverage	3 floors
Indoor use		100%
Building Attenuation	Sub-satellite beam; single floor	10 dB
	Sub-satellite beam; aggregate over 3 floors	14.7 dB
	Edge-of-coverage beam	10 dB
Average power[3] (into antenna)	MS (per user)	-2.5 dBm
	BS (total per cell)	10 dBm
	BS (average with traffic per cell)	7 dBm
Antenna gain	MS	0 dBi
	BS (in sub-satellite beam)	0 dBi
	BS (in edge-of-coverage beam)	5 dBi
Number of active users per cell per channel [2]		4

1 - Areas as defined in FDD parameters above.
2 - Calculated assuming 8 speech carriers per cell with a 50% activity factor.
3 See ERC TG1 document (99)22, France Télécom, February 1999

Table A4 - TDD mode parameters and traffic figures used in interference to the satellite

A2 Satellite UMTS

A2.1 Mobile Earth Station

Transmitter characteristics for MSS in the 2 GHz band can be found in ETSI TBR 042. The unwanted emission mask, for the final carrier into an adjacent band, is plotted in figure A3.

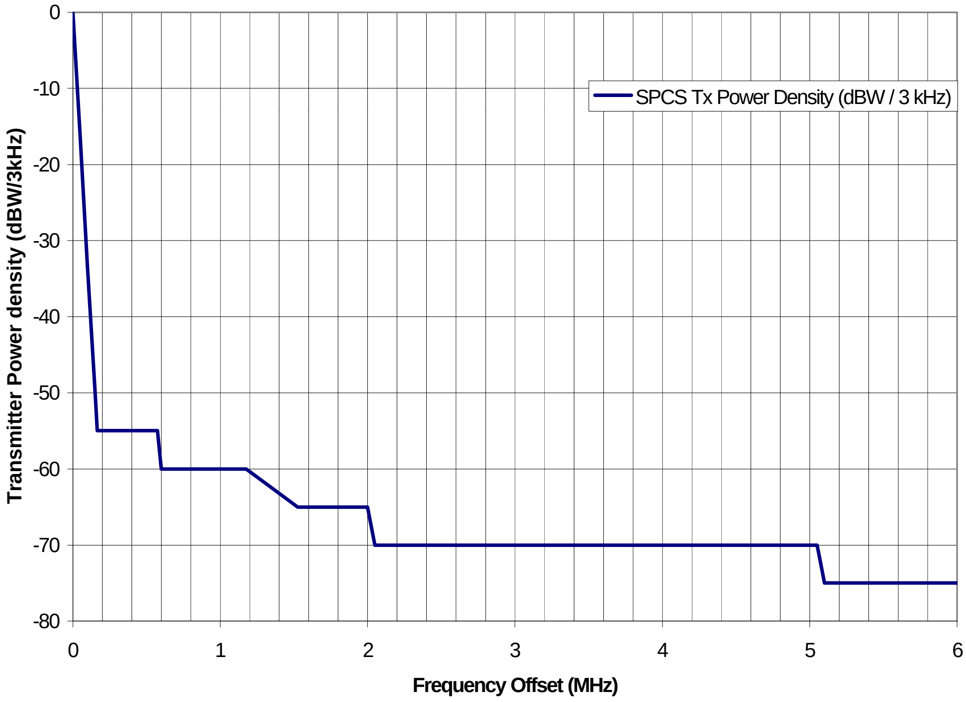

Figure A3 - 2 GHz S-PCN out-of-band mask

ETSI TBR 42 furthermore details that an MESs nominated bandwidth shall not fall in the 100 kHz bands located at either end of the allocated band.

One satellite system that intends to form part of the UMTS satellite component has [5]:

- 8 dB fade margin on the downlink
- 25 kHz channel bandwidth
- -154.8 dBW typical minimum signal level at MES receiver
- threshold C/N+I of 4 dB.

These values have been used for reference.

A2.2 Satellite (Space station)

Parameters below are representative of one satellite system which intends to form part of the UMTS satellite component. For the purposes of the interference studies of this Report, these parameters can be considered generically representative of any UMTS satellite system, since the key parameters are :

- the permissible interference level, which is calculated directly from the satellite noise level. However, the majority of noise captured by satellite antenna is due to the Earth and therefore satellite noise will not differ much between satellite systems;
- the spot beam size. However, spot beam sizes will generally be very similar since they are determined by, amongst other things, antenna diameter, satellite cost and hand-over signalling limitations. It should also be noted that differing orbit heights have very little effect on the study since, for the same spot beam size, any increase in path loss with increasing orbit altitude is directly cancelled by the increase in antenna gain required to develop the spot beam.

Satellite altitude		10,390 km
Beam nadir angle	Sub-satellite beam	0°
	Edge-of-coverage beam	20.2°
Receive antenna	Gain	30 dBi
	Pattern	See Figure A4
Typical minimum wanted signal level		-169 dBmHz^{-1}
Satellite G/T		4.5 dBK^{-1}
$\Rightarrow$ Satellite receiver noise power		-173 dBmHz^{-1}
Co-channel interference allowance (increase in noise due to adjacent band unwanted emissions)		1% [1]
$\Rightarrow$ Permissible interference level		-193.1 dBmHz^{-1}

Table A5 - Space station parameters

[1] See paragraph 3.3.1 for dicussion of this requirement.

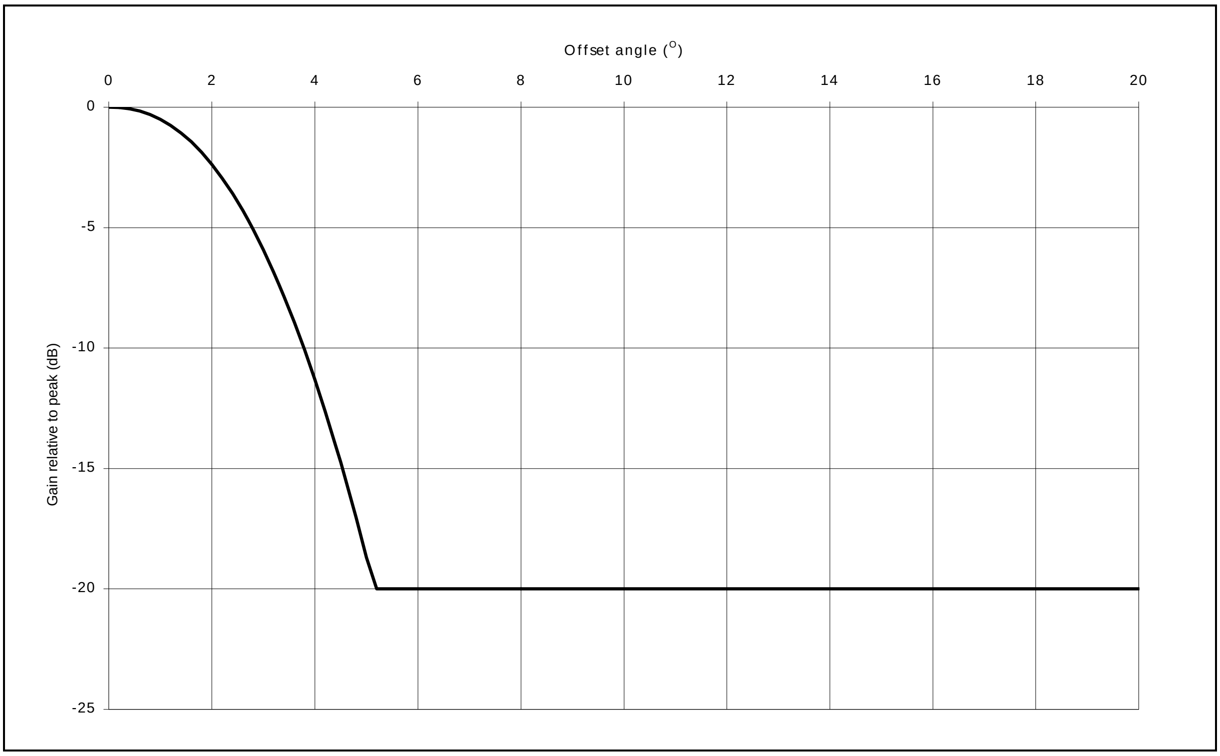

Figure A4; Satellite Beam Antenna Gain

A3 DECT

A3.1 General aspects

DECT is operating in the band 1880-1900 MHz, and the RF part complies with ETS 300 175-2 [2].

DECT systems are today gaining recognition as much more than only a system offering limited mobility at the customer premises level (home cordless telephone, wireless PBX, FWA).

One important condition for the acceptance and growth of DECT systems is a high service quality and availability. This is only guaranteed when the capacity in the DECT frequency band is not reduced by unwanted emissions from adjacent services, e.g. broad band noise of UMTS. Therefore Directive 91/287/EEC requires and CEPT Recommendation T/R22-02 recommends that : "DECT shall have priority over other services in the same band, and be protected in the designated band".

The relevant parameters for the study are given in table A6.

		Portable Part (PP) or Radio Fixed Part (RFP)
Tx power	mW	250
Tx antenna gain [1]	dBi	0 / 12
Rx bandwidth	kHz	1728
Rx sensitivity	dBm	-83
Rx C/I co-channel	dB	10
Last DECT channel centre frequency	MHz	1897.344
Blocking : 1900-1905 MHz [2]	dBm	-39
Blocking : 1905-2000 MHz [2]	dBm	-33

Table A6 - DECT transmitter and receiver parameters

1 - A 0 dBi antenna is applicable in most of the cases. However, for wireless local loop application, a 12 dBi antenna gain should be used instead, and both sets of results should be presented.
2 - The blocking level is not specified in [2] for frequency offsets smaller than 6 MHz, but the interference level for the second adjacent DECT channel is -39 dBm. Since the UMTS signal will be modulated and not CW, this value will be taken as blocking level.

DECT is a TDD system, operating with 24 slots in a frame of duration 10 ms. The effect of this active/passive rate is difficult to investigate, but some mitigating factor can be found from this phenomenon.

DECT uses Dynamic Channel Allocation (DCA) to combat interference. In case interference occurs on one channel, DECT has the ability to select another one, without loss of communication. This must also be taken into account in evaluating interference to the last DECT channel.

A3.2 Out-of-band emissions

With transmissions on physical channel "M" in successive frames, the power in physical channel "Y" shall be less than the values in table A7.

Emissions on RF channel "Y"	Maximum power level
Y = M ± 1	160 mW
Y = M ± 2	1 mW
Y = M ± 3	40 nW
Y = any other DECT channel	20 nW

Table A7 - DECT emissions due to modulation

NOTE: For Y = "any other DECT channel", the maximum power level shall be less than 20 nW except for one instance of a 500 nW signal.

The power in RF channel Y is defined by integration over a bandwidth of 1 MHz centred on the nominal centre frequency, Fy, averaged over at least 60 % but less than 80 % of the physical packet, and starting before 25 % of the physical packet has been transmitted but after the synchronisation word.

A3.3 Spurious emissions

The peak power level of any RF emissions outside the radio frequency band allocated to DECT, when a radio end point has an allocated physical channel, shall not exceed 250 nW at frequencies below 1 GHz and 1 µW at frequencies above 1 GHz. The power shall be defined in the bandwidths given in table A8. If a radio end point has more than one transceiver, any out of band transmitter intermodulation products shall also be within these limits.

Frequency offset, fo from edge of band	Measurement bandwidth
0 MHz ≤ fo < 5 MHz	30 kHz
5 MHz ≤ fo < 10 MHz	100 kHz
10 MHz ≤ fo < 20 MHz	300 kHz
20 MHz ≤ fo < 30 MHz	1 MHz
30 MHz ≤ fo < 12,75 GHz	3 MHz

Table A8 - Spurious emissions when allocated a channel

Measurements shall not be made for transmissions on the RF channel closest to the nearest band edge for frequency offsets of up to 2 MHz.

A3.4 Receiver intermodulation performance

If RF carrier number "d" is in use, a reference DECT interferer and a continuous wave interferer are introduced on DECT carriers "e" and "f" to produce an intermodulation product on carrier "d". Neither "e" nor "f" shall be adjacent to "d".

With "e" and "f" being received 33 dB greater than "d", and "d" being received at - 80 dBm, the receiver shall still operate with a BER of less than 0,001 in the D-field.

A4 Space Operation (SO), Space Research (SR) and Earth-Exploration Satellite (EES) services

The bands 2025-2110 MHz and 2200-2290 MHz are currently allocated on a primary basis to three of the space science services : space research, space operation, earth exploration-satellite (SR, SO, EES); the fixed service (FS) and the mobile service (MS), subject to footnote S5.391 of the RR.

The band 2025-2110 MHz is allocated to Earth-to-space and space-to-space links.

The band 2200-2290 MHz is allocated to space-to-Earth and space-to-space links.

The footnote S5.391 refers to ITU-R Recommendation SA.1154 (Provisions to protect the SR, SO and EES and to facilitate sharing with the mobile service in the 2025-2110 MHz and 2200-2290 MHz band), which recommends, *inter alia* :

1 *that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 025-2 110 MHz band:*

1.1 *that the aggregate interference at the input terminals of the spacecraft receiver, except in the case of a space-to-space link, should not exceed –210 dB(W/Hz) for more than 0.1% of the time;*

1.2 *that in the case of space-to-space links the aggregate interference at the input terminals of the spacecraft receiver should not exceed –214 dB(W/Hz) for more than 0.1% of the time;*

2 *that the following provisions are suitable to protect the SR, SO and EES services from aggregate interference from emissions of mobile systems in the 2 200-2 290 MHz band:*

2.1 *that the aggregate interference at the input terminals of the receiver in the earth station should not exceed –216 dB(W/Hz) for more than 0.1% of the time;*

2.2 *that the aggregate interference at the input terminals of the DRS spacecraft receiver should not exceed –214 dB(W/Hz) for more than 0.1% of the time.*

A5 Fixed service

Fixed service adjacent compatibility is considered in ERC Report [TG1/01]

ANNEX B

METHODOLOGY AND PARAMETERS FOR ASSESSING INTERFERENCE TO THE MSS SPACE SEGMENT

B1 Methodology

As shown in Figure B1, the centres of the terrestrial UMTS cells are modelled as lying on concentric rings centred on the sub-satellite point. This assumption simplifies the interference calculations since the elevation angle, the range and the Free Space Path Loss (FSPL) to the satellite are constant for each ring of cells. The radius of each ring of cells is a multiple of the single cell radius and is measured along the Earth's surface. The number of cells in a ring is calculated assuming a hexagonal cell pattern (i.e. 6 cells in the first ring, 12 in the next, 18 in the next, etc.).

The satellite forms a number of spot beams on the Earth, with a sub-satellite spot beam diameter, for current designs, of typically 600 - 700 km. It is therefore a requirement, in order to determine the worst case, to be able to undertake the interference calculations for any particular spot beam. A satellite spot beam is defined by its beam nadir angle and changing the value of this angle allows examination of any satellite beam (e.g. a sub-satellite or edge of coverage beam). Before any calculations are undertaken the spot beam to be examined, and its nadir angle, must be determined.

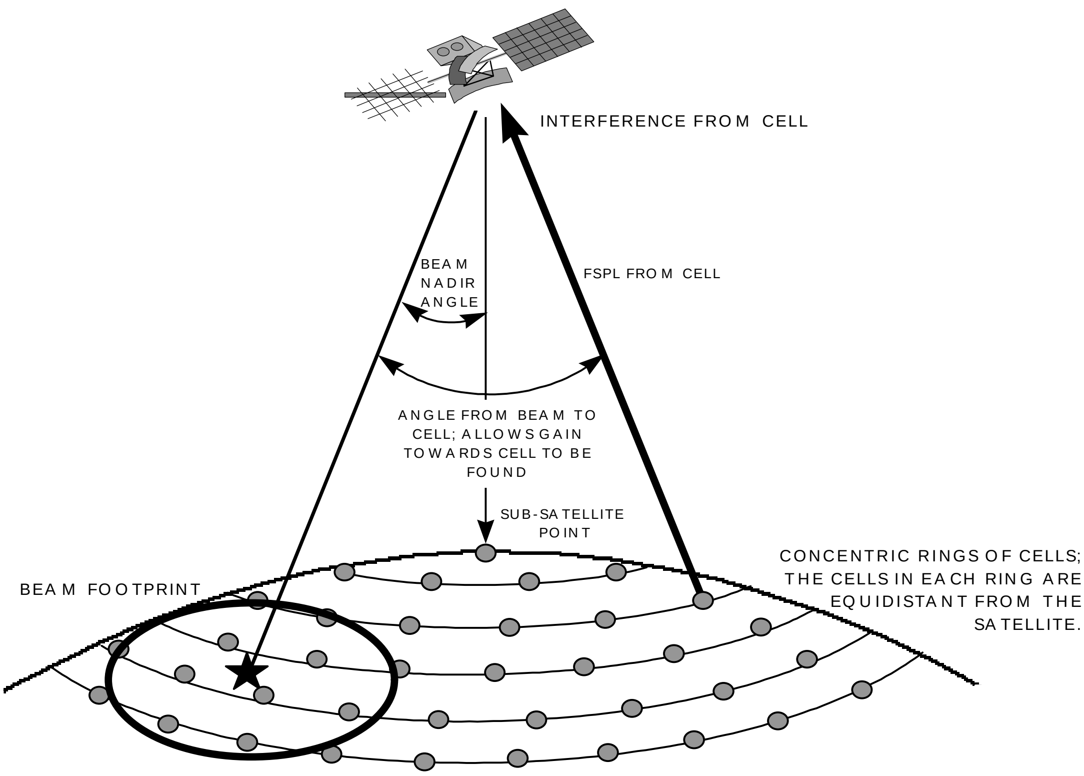

Figure B1 : Interference Calculation Methodology

For the n^{th} terrestrial cell, CELL-n, the interference contribution at the satellite is calculated from:

1. The cell's total interference power, I_{CELL-n}. This is calculated using transmit spectrum masks and making assumptions on the number of channels in use, the number of RF carriers in use, the use of power control, etc.;
2. The Free Space Path Loss, $FSPL_{CELL-n}$, to the satellite for the ring containing CELL-n. This is calculated using the distance between the cell and the satellite;
3. The receive gain, $G_{Rx\ CELL-N}$, of the satellite beam towards CELL-n. This is calculated using:
    - i) the angle between the centre of the beam and the cell (calculated using the beam nadir angle and the CELL-n nadir angle);
    - ii) a model of the satellite receive antenna gain pattern.

The total interference at the satellite is then calculated by summing up the contributions from each visible cell (i.e. cells on rings with an elevation angle to the satellite greater than 0°):

$$I = \sum_{\text{All Cells}} (\text{Contribution from each cell}) = \sum_{\text{All Cells}} (I_{CELL-n} - FSPL_{CELL-n} + G_{Rx\ CELL-n})$$

The interference from only those cells lying within the 3 dB beamwidth of the satellite spot beam can also be calculated using the same methodology by limiting the interference summation appropriately.

Calculation of Average Terrestrial Cell Size and Average EIRP per cell

Assuming:

1. land with an area, A, which is many orders of magnitude greater than the area of a terrestrial cell
2. that the area of land can be divided into four types of terrestrial UMTS coverage:

- No coverage
- Rural coverage
- Suburban coverage
- Urban coverage

3. that each type of coverage covers a proportion of the area, A:

- No coverage; P_N
- Rural coverage; P_R
- Suburban coverage; P_S
- Urban coverage; P_U

4. that these coverages do not overlap (i.e. $P_N + P_R + P_S + P_U = 1$);
5. that each of these coverage areas can be characterised by a typical hexagonal cell radius, an average MS EIRP and an average number of active users per cell:

	Cell radius (m)	Average MS EIRP (W)	Average number of active users per cell
No coverage	N/A	N/A	N/A
Rural	R_R	E_R	U_R
Suburban	R_S	E_S	U_S
Urban	R_U	E_U	U_U

and given:

1. that the area, A_{CELL}, of a hexagonal cell of radius R is given by:

$$A_{CELL} = F(R) = \frac{3\sqrt{3}}{2} R^2$$

then:

1. the total number of terrestrial cells of coverage type i in area A, N_i, can be found:

$$N_i = \frac{P_i A}{F(R_i)}$$

2. the total number of terrestrial cells in area A, $N_{CELLS\text{-}TOTAL}$, can be found:

$$N_{CELLS-TOTAL} = N_R + N_S + N_U$$

3. the average cell area, A_{AV}, can be found:

$$A_{AV} = \frac{A}{N_{CELLS-TOTAL}}$$

4. the corresponding ***average cell radius***, R_{AV}, can be found:

$$R_{AV} = F^{-1}(A_{AV})$$

5. the total EIRP from the MSs operating at the average EIRP in the cells of coverage type i can be found:

$$E_{Ti} = N_i E_i U_i$$

6. the ***average EIRP per cell*** (across all coverage types) can be found:

$$E_{AV} = \frac{\sum_i E_{Ti}}{\sum_i N_i}$$

B2 Simplifying the use of the methodology by examining the effect of interference outside the satellite beam

The methodology aggregates the interference power falling in to a satellite beam from all the terrestrial cells in the satellite's field-of-view. Noting that a key assumption of the methodology is uniform terrestrial cellular coverage over the satellite field-of-view, the calculations can be simplified considerably by examining only interference from terrestrial cells in the 3 dB beamwidth of the satellite's spot beam and adding a 'field-of-view correction factor', C_{FOV}. This correction factor accounts for the interference contribution from all terrestrial cells outside the 3 dB beamwidth of the satellite's spot beam. For the spot beams examined in this document, the full methodology has been employed to calculate this field-of-view correction factor, C_{FOV}:

- for the sub-satellite spot beam, C_{FOV} = 6.7 dB;
- for an edge-of-coverage spot beam, C_{FOV} = 4.0 dB.

Note that this factor would change with the inclusion of a more representative antenna pattern for BSs and with the use of different satellite system parameters (although any change here would be offset elsewhere in the calculations to provide similar interference results).

ANNEX C

ASSUMPTIONS FOR MONTE-CARLO SIMULATIONS

The following assumptions were agreed for use in Monte Carlo simulations :

Interference mechanisms :

- Unwanted emissions and blocking : normally included
- Spurious emissions : not included

Path loss models :

- Propagation above roofs for BS->BS, BS->MS, MS->BS
- Propagation below roofs for MS-> MS

Victim system

- Circular cells
- MS density depends on BS density and considered system spectrum efficiency
- Omnidirectionnal antennae
- Voice link
- Single (closest to interfering signal) or multiple channels to be considered
- Unwanted emissions integrated over receiver bandwidth

Interfering system

- Circular cells
- Omnidirectionnal antennae
- Voice link
- For an interfering base station, multiple channels are transmitted (see presentation of results)
- Uniform distribution of interferers
- Power control may be used even for base station
- 100 interferers are considered

Attachment to TG1 liaison to 3GPP TSG RAN WG4

DRAFT FUTURE ERC TG1 INPUT TO ITU-R TG8/1 ON THE

(Changes relative to the output of the nov. '99 TG8/1 meeting)

PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[IMT.TERM]

ESSENTIAL TECHNICAL AND OPERATIONAL REQUIREMENTS FOR MOBILE STATIONS ~~AND MOBILE EARTH STATIONS~~ OF IMT-2000 SYSTEMS OPERATING IN THE BANDS 1885-1980 MHz, 2010-2025 MHz AND 2110-2170 MHz

Summary

This Recommendation contains technical and operational requirements necessary to ensure radio compatibility of IMT-2000 systems for worldwide use. They are given in the form of guidelines to be used by the various administrations planning the regulatory approval of mobile stations~~and mobile earth stations~~ operating in IMT-2000 systems in their countries. It provides a basis for mutual recognition of conformity declaration and consequently assists the global circulation of these terminals.

Scope

This Recommendation contains the essential technical and operational requirements necessary to ensure the radio compatibility of IMT-2000 systems with other radio services, and consequently assists the global circulation of IMT-2000 terminals.

If IMT-2000 is an element in a multi-mode terminal, unless otherwise stated in this Recommendation, the requirements apply only to the IMT-2000 element of the terminal operating in the IMT-2000 frequency bands.

The ITU Radiocommunication Assembly

considering

a) that IMT-2000 systems are planned to begin operation from the year 2000, subject to market considerations;

b) that some Administrations have expressed a need to develop the necessary policies and regulations to facilitate the deployment of IMT-2000 systems;

c) that IMT-2000 systems are expected to provide IMT-2000 services on a global basis;

d) that IMT-2000 services will be provided over a variety of terminals including hand-held and vehicular as well as transportable IMT-2000 terminals;

e) that it is a basic objective for IMT-2000 terminals to operate in different countries and thus, the global circulation of IMT-2000 user terminals is an important aspect;

f) that the circulation of terminals among Administrations is usually dependant upon, amongst other things, some form of technical conformity declaration to agreed technical requirements;

g) that there is a need for identifying the essential technical requirements for the conformity declaration of IMT-2000 terminals on a global basis;

h) that the essential technical requirements should achieve an acceptable balance between equipment design and production cost and the need for effective use of the radio-frequency spectrum and should be impartial with respect to radio transmission technologies, subject to the protection of other radio systems;

[j) that the setting up of regulations for IMT-2000 systems will require the recognition of health and safety aspects;]

k) that the satellite component of IMT-2000 will operate between 1 and 3 GHz;

~~k) [Recommendation~~l) that Recommendation ITU-R M.1343 provides " Essential Technical Requirements of Mobile Earth Stations for Global Non-geostationary Mobile-satellite Service Systems in the Bands 1-3 GHz";~~]~~

m) that Recommendation ITU-R M.[8D/194 Att. 21] provides " Essential Technical Requirements of Land Mobile Earth Stations of Geostationary Mobile-satellite Service Systems in the Bands 1-3 GHz";

~~l)~~n) that regional bodies are also in the process of defining essential requirements for IMT-2000 terminals;

~~m)~~o) that the identification by the ITU-R of essential technical requirements for IMT-2000 terminals would provide a common technical basis for conformity declaration of IMT-2000 terminals by various national authorities and the development of arrangements for conformity declaration of IMT-2000 terminals and arrangements for circulation of IMT-2000 terminals among Administrations;

~~n)~~p) that the identification by the ITU-R of essential technical requirements for IMT-2000 terminals would help to ensure that unacceptable interference will not be caused to other radio services;

~~o)~~q) that the identification by the ITU-R of essential technical requirements for IMT-2000 terminals would help to ensure protection of the IMT-2000 systems;

~~p)~~r) that other relevant technical characteristics are prescribed by the Radio Regulations that pertain to the effective use of the radio-frequency spectrum;

~~q) that [draft new Recommendation ITU-R [*Document1A/52, 1996-97*]] contains a list of radio equipment parameters that are relevant to achieve spectrum efficiency and compatibility,~~

~~r)~~s) that IMT-2000 networks should be capable to the ~~extend~~extent practicable of preventing terminals causing interference to radio services,

considering further

~~a) [that it would be necessary for the satellite component of IMT-2000 to have the capability to determine the location of the MES terminals in order to fulfil the relevant requirements of Resolution 25 (WRC-95) and WTPF-96 Opinion No. 2;]~~

~~b)~~a) that essential technical requirements should be measurable and verifiable,

noting

a) that simple regulatory processes are necessary to facilitate fast and easy deployment of IMT-2000 systems;

b) [that mutual recognition of conformity declarations would facilitate global circulation of IMT-2000 terminals, and their use subject to network authorisation (Question ITU-R 39-5/8 (1997)

~~*further considering* b)],~~

recommends

1 that the essential technical and operational requirements of IMT-2000 terminals as specified in the Annex 1 should be used by Administrations for:

a) facilitating conformity declaration requirements for IMT-2000 terminals;

b) facilitating the development of arrangements of conformity declaration of IMT-2000 terminals;

c) facilitating the development of arrangements to facilitate the global circulation and use of IMT-2000 terminals;

~~[**2** that the satellite component of IMT-2000 should be capable of determining the location of its operating terminals.]~~

ANNEX 1 TO IMT.TERM

Requirements for IMT-2000 Terminals ~~(Mobile Stations and Mobile Earth Stations)~~

1 Purpose

The purpose of this Annex 1 is the protection of radio services and systems from uncontrolled RF transmissions from IMT-2000 terminals.

2 Definitions

For the purposes of this Annex 1, the following definitions apply:

carrier-off state: A terminal is in this state when either it is authorized by the Network Control Facility (NCF) to transmit but when it does not transmit any signal, or when it is not authorized by the NCF to transmit.

carrier-on state: A terminal is in this state when it is authorized by the NCF to transmit and when it transmits a signal.

~~**nominated bandwidth:** The bandwidth of the terminal radio frequency transmission. The nominated bandwidth is wide enough to encompass all spectral elements of the transmission necessary for communication and which have a level greater than the specified unwanted emissions limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. The nominated bandwidth is within the IMT-2000 transmit frequency band within which the terminal operates.~~

unwanted emissions: Unwanted emissions are those falling outside the ~~nominated~~necessary bandwidth**.**

3 Unwanted emissions

~~*(**Editor's note:** The text in this section is provided as an example.)*~~

~~3.1 Unwanted emissions outside the band [x MHz to y MHz]~~

~~Unwanted emissions from terminals outside the band [x MHz to y MHz] should be below the following limits.~~

~~1) The unwanted emissions over the frequency range 30 MHz to 1 000 MHz should not exceed the limits in Table 1.~~

~~TABLE 1~~

~~**Limits of unwanted emissions up to 1 000 MHz at a measuring distance of 10 m**~~

~~**Frequency (MHz)**~~	~~**Quasi-peak limits (dB(μV/m))**~~
~~30 to 230~~	~~[30]~~

~~230 to 1 000~~	~~[37]~~

~~The lower limit should apply at the transition frequency.~~

~~2) The e.i.r.p. of the unwanted emissions above 1 000 MHz in the measurement bandwidth and in all directions should not exceed the limits of Table 2:~~

~~TABLE 2~~

~~**Limits of unwanted emissions above 1 000 MHz and outside the band [x MHz to y MHz]**~~

~~**Frequency range (MHz)**~~	~~**Carrier-on**~~		~~**Carrier-off**~~	
	~~**e.i.r.p. limit (dBW)**~~	~~**Measurement bandwidth (kHz)**~~	~~**e.i.r.p. limit (dBW)**~~	~~**Measurement bandwidth (kHz)**~~
~~1 000 to x – a~~				
~~y+a to 40 000~~				
~~***Editor's note:*** *Expanatory notes will be added as required*~~				

~~**3.2 Maximum unwanted emissions within the [x MHz to y MHz] band**~~

Specification 1: ~~Carrier-on state~~

The following limits are defined with reference to f_c (MHz), the IMT-2000 mobile station transmit carrier centre frequency. The e.i.r.p. ~~of the unwanted emissions in any 3 kHz band within the [x MHz to y MHz] band, but outside the nominated bandwidth, should not exceed the limits of Table 3.~~should be measured in all directions at frequency *f* (MHz) in the measurement bandwidths defined below.

~~TABLE 3~~

~~*(**Editor's note:** The figures in this table are provided as examples.)*~~
~~**Limits for unwanted emissions within the [x MHz to y MHz] band**~~

~~**Offset from the edge of the band of the nominated bandwidth (kHz)**~~	~~**Maximum e.i.r.p. (dBW)**~~
~~[0 to 10]~~	~~[–5]~~
~~[10 to 20]~~	~~[–10]~~
~~[20 to 100]~~	~~[–15]~~
~~[100 to 200]~~	~~[–25]~~
~~[200 to 700]~~	~~[–35]~~
~~[greater than 700]~~	~~[–45]~~

~~The limits in Table 3 may be exceeded provided that the sum in watts of the spectrum components exceeding the limits of Table 3 does not exceeds [-16 dBW].~~

~~Specification 2:~~ ~~Carrier-off~~3.1 Receiving stations and carrier-off state

The [e.i.r.p./radiated power] of ~~any emission in any 3 kHz band within the [x MHz to y MHz] band~~unwanted emissions of receiving stations and of transmitting stations in carrier-off state should not exceed the limits of table 1.

~~[-63 DBW.]~~ TABLE 1

Maximum [e.i.r.p./radiated power] of unwanted emissions (Receiving stations and carrier-off state)

Frequency range (MHz)	e.i.r.p. limit (dBm)	Measurement bandwidth (kHz)
$0.009 < f \leq 0.150$	-57	1
$0.150 < f \leq 30$	-57	10
$30 < f \leq 1\,000$	-57	100
$1\,000 < f \leq 11\,000$	-47	1000

3.2 Carrier-on state

The [e.i.r.p./radiated power] of mobile station unwanted emissions should not exceed the limits of table 2 when the station is in carrier-on state.

TABLE 2

Maximum [e.i.r.p./radiated power] of unwanted emissions (Carrier-on state)

Frequency range	**e.i.r.p. limit (dBm)**	**Measurement bandwidth (kHz)**
$0.009 < f \le 0.150$	-36	1
$0.150 < f \le 30$	-36	10
$30 < f \le 1\,000$	-36	100
$1\,000 < f \le f_c-a$	-30	1000
$f_c-a < f \le f_c-b$	-45	30
$f_c-b < f \le f_c-c$	-55	3
$f_c-c < f \le f_c-d$	$-55+10\times(f-f_c+c)$	3
$f_c-d < f \le f_c-e$	$-53+3\times(f-f_c+d)$	3
$f_c-e < f \le f_c-g$	-50	3
$f_c-g < f \le f_c-h$	$-50+8\times(f-f_c+g)$	3
$f_c-h < f \le f_c-i$	$-48+28\times(f-f_c+h)$	3
$f_c-i < f \le f_c-j$	$-41+52\times(f-f_c+i)$	3
$f_c+j \le f < f_c+i$	$-41-52\times(f-f_c-i)$	3
$f_c+i \le f < f_c+h$	$-48-28\times(f-f_c-h)$	3
$f_c+h \le f < f_c+g$	$-50-8\times(f-f_c-g)$	3
$f_c+g \le f < f_c+e$	-50	3
$f_c+e \le f < f_c+d$	$-53-3\times(f-f_c-d)$	3
$f_c+d \le f < f_c+c$	$-55-10\times(f-f_c-c)$	3
$f_c+c \le f < f_c+b$	-55	3
$f_c+b \le f < f_c+a$	-45	30
$f_c+a \le f \le 11\,000$	-30	1000

Parameter	a	b	c	d	e	g	h	i	j
Value (MHz)	20	10	6.2	6	5	3.25	3	2.75	2.5

4 Terminal control and monitoring functions (CMF)

4.1 Self-monitoring functions

4.1.1 Processor monitoring

The terminal, to the extend practicable, should incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in CMF.

The processor monitoring function should detect failure of the processor hardware and software and take appropriate action in the minimum time practicable.

4.1.2 Transmit frequency generation sub-system monitoring

The terminal, to the extend practicable, should incorporate a transmit frequency generation sub-system monitoring function, which should take appropriate action in the minimum time practicable after any detectable failure of the transmit frequency generation sub-system occurs.

4.2 Network control authorisation and reception

This control can be achieved by the "receive-before-transmit" principle, which is described in 4.2.1 and 4.2.2. However, it is recognized that there are modes of operation which cannot implement the "receive-before-transmit" principle, such as direct mode terminals, -including the fellow mode, not dependant on a network, for which other means of achieving the goal of preventing terminals from unauthorized transmission are required. For terminals where the receive-before-transmit principle is used, the following requirements apply:

4.2.1 Network control authorisation

During POWER-ON, no transmissions should occur from the terminal.

Following POWER-ON, the terminal should enter a controlled, non-transmitting (carrier-off) state. This state should be maintained whilst the terminal is not synchronized with the appropriate network control channel(s).

Without synchronizing to the appropriate network control channel(s), it should not be possible to initiate carrier-on state.

Within a minimum time practicable of having lost the appropriate network control channel(s) the terminal should suppress transmissions (carrier-off).

4.2.2 Network control reception - transmit frequency control

On the command of the NCF the terminal should set accordingly the carrier frequency of its transmission. The carrier frequency should be controlled such, that the entire nominated bandwidth of the terminal falls completely within the operational frequency band(s).

4.3 Fellow radio stations in a dual-mode or multi-mode terminal

Any fellow radio station in a multi-mode terminal, in which IMT-2000 is one component, should not transmit without reception of a network control channel for the system for which it is designed. The requirements as under 4.2 apply accordingly.

5 Equipment identity

Each terminal should have a unique terminal identification code.

It should not be possible to alter the terminal identification code using any normally accessible procedure.

The terminal should be capable of transmitting its identification code upon reception of an appropriate NCF command addressed to it.