TSG-RAN Working Group 1 *TSGR1#8(99)f23*
New York, U.S.A., 12 – 15 October 1999

ERC TG1
London,
1-3 September:

Liaison statement from ERC TG1 to 3GPP

From: **ERC TG1**

To: **3GPP TSG RAN WGs 1 and 4**
Copy: **3GPP TSG RAN**

Title: **Acceptable interference level from third generation systems into a UMTS MS receiver for the purpose of the cross border co-ordination of UMTS systems.**

1. Introduction

Working Group 1 of ERC TG1 is currently preparing a recommendation on the cross-border coordination of UMTS systems. To ensure the efficient use of the spectrum at border areas, and to maintain equitable access to the spectrum for operators in neighbouring countries, innovative and flexible solutions must be developed.

The group is currently developing proposals based on UMTS code-sharing, in conjunction with a maximum level of acceptable interference into an UMTS MS receiver at the border between two countries. The proposals under development in TG1 are outlined in detail at Annex A to this document. These proposals are based on a number of assumptions. ERC TG1 requests 3GPP's TSG's guidance on the validity of these.

2. Interference criterion.

The proposed level of maximum interference to a UMTS MS receiver (*37.1 dB(µV/m) in a 5MHz BW*) is calculated on the basis of an interference criteria equivalent to a 50% increase of noise at the MS receiver. This has been retained from ERC/REC T/R 22-08, which deals with the cross-border coordination of DCS1800 systems.

2.1 The maximum interference level was calculated as follows:

If the coverage without interference is D_0 and the coverage with an interference level of I is D, provided that the propagation law is in power 4, then

$(1+I/N_T)=(D_0/D)^4$

A 50% increase of noise is therefore equivalent to a loss of coverage of 10%.

Provided that:
N_0 (Thermal noise) = -174 dBm/Hz
NF (Noise factor for MS) = 5 dB
BW (Receiver Bandwidth) = 3.84 MHz
the UMTS™ noise level is $N+N_0+NF+10.\log_{10}(BW)=-103.2$ dBm.

The maximum acceptable interference level is therefore
$I_{MAX}=N+10\log_{10}(50\%)=-106.2$ dBm

For a MS omnidirectional antenna, the maximum interfering acceptable electromagnetic field level is therefore
$E_{MAX}=I_{MAX}+77.3+20*\log_{10}(2000\text{ MHz})=$**37.1 dB(µV/m) in a 5 MHz BW.**

2.2 Validity of Interference Criterion.

TG1 would welcome clarification of the following issues from 3GPP TSG:

(a) Is the maximum level of acceptable interference to a UMTS MS receiver (37.1 dB(μV/m) in a 5 MHz BW) valid, both for FDD and TDD UMTS systems.
(b) TG1 has assumed that interference at a UMTS receiver from any non-UMTS system will be de-spread to Gaussian noise. Is this a reasonable assumption on which to base interference limits.

3. Code Co-ordination.

TSG1 would also wish to draw the groups attention to the liaison statement from ERC TG1 to 3GPP TSG RAN produced at its June meeting (15-16th June, Mainz, Germany). Answers to the issues raised in this liaison statement are required to develop successful coordination mechanisms for third generation networks and thus aid the rapid completion of the licensing of these systems in Europe.

In addition to the information requested in the June liaison statement TG1 would welcome clarification of the following issue:

(a) What is the impact on the success of the code sharing proposals of other codes in the UMTS system (e.g. PRACH, SCH) ?

4. Conclusion.

TG1 require this information to take forward its work on efficient cross-border co-ordination of UMTS services. The next meeting of TG1 takes place on the 2/11/99. We would greatly appreciate a response in time for that meeting.

Attachment : Document TG1(99)136 “UMTS Cross-border co-ordination”.

ERC TG1 TG1(99)136
London, 1-3 September 1999
Source : France

UMTS™ Cross-border coordination

1. Introduction

The subject of cross-border coordination methods is under study in TG1. The aim of this contribution is to investigate different proposed coordination methods, to propose acceptable field strength at the border, and to formulate a first draft of the ERC Recommendation that should be the basis for bilateral agreements between Administrations and possibly operators.

2. Proposed coordination methods

Two techniques of division of the band allocated to the system UMTS in border zones have been proposed. The first technique is the division by preferential frequency and the second is the division by distribution of scrambling codes to the base station. However, the adjustment of these two techniques can be improved by introducing new criteria such as the density of population in the zone considered. This work is indispensable as much that Vienna agreements 99 do not apply to the UMTS system frequency bands.

2.1. Preferential frequency

The technique of division by preferential frequency has already been used for GSM 900 or 1800. The installation of this technique is perfectly mastered and administrations can easily plan the frequency usage. The realisation of a recommendation can be established on the basis of ERC Recommendations T/R 20-08 or T/R 22-07. The division by preferential frequency limits interference and jamming problems. A document presented to ERC TG1 WG1 in April by Switzerland can serve as basis, but this document shows disadvantages of the division by preferential frequency, the spectrum is not used efficiently. In the case of a co-ordination between two countries 50% only of the spectrum is used, as well as about 33% for a co-ordination between three countries. Furthermore, the reduction of the number of frequencies for an operator decreases the capacity drastically.

2.2. Coordination of scrambling codes

Different types of codes are used in W-CDMA:

– Channelisation codes have good auto-correlation properties, and they are needed for synchronisation, they have one unique generator;

- Scrambling codes are characteristic of the base station, they have cross-correlation properties that turn interference from different codes into white noise, they are grouped in 32 groups of 16 codes;
- Spreading codes are characteristic of the mobile station, they are orthogonal if synchronised, they are generated in tree depending on the service bit rate.

From this, it appears it would not be useful to coordinate the use of spreading codes, as they would not be synchronised, and that would imply a drastic reduction of the service provision capability. It seems also impossible to share channelisation codes, as they are uniquely generated.
The division of scrambling codes appears as a useful solution, as it would turn the cross-border interference into noise, thus allowing to add the interference to the noise (N→N+I).

The division of resources in border zones with this new technique would be a new process. A number of code groups would be assigned to one country and the other part attributed to the neighbouring country. The advantage of this technique is to use all the spectrum is the concerned country even if the coverage and capacity may be reduced.

2.3. Preferential frequency or coordination of scrambling codes according to the area population density

In a detailed cross-border co-ordination, a supplementary criterion could be taken into account such as the served geographical zone and more particularly the density of population in the area. In the case of preferential frequency if a country has a zone of population denser than the other, one could have attribute supplementary canals, while respecting conditions of segmentation, by decreasing the number of canals allocated to the other country. The introduction of the criterion of the served zone improves appreciably the utilisation of the spectrum in the division by preferential frequency but without great efficiency especially in a co-ordination between three countries. In the case of a co-ordination by distribution of scrambling codes, the supplementary code attribution could be improved by taking into account the density of population.
The introduction of this criterion concerning the density of population is difficult to implement between administrations, but could serve in the framework of multilateral or bilateral agreements between operators, where Administrations allow it. An example of density of population could be 100 persons/km2 that would serve as a basis for the frequencies or scrambling codes to increase the assigning number.
In any case, it is indispensable to define the maximum electromagnetic field.

3. Electromagnetic field accepted at the border

The interference criterion that has been retained in ERC/REC T/R 22-08 is equivalent a 50% increase of noise at the MS receiver.

If the coverage without interference is D_0 and the coverage with an interference level of I is D, provided that the propagation law is in power 4, then

$(1+I/N_T)=(D_0/D)^4$

A 50% increase of noise is therefore equivalent to a loss of coverage of 10%.

Provided that:

N_0 (Thermal noise) = -174 dBm/Hz @ 25°C

NF (Noise factor for MS) = 5 dB

BW (Receiver Bandwidth) = 3.84 MHz

the UMTS™ noise level is $N+N_0+NF+10.\log_{10}(BW)=-103.2$ dBm.

The maximum acceptable interference level is therefore

$I_{MAX}=N+10\log_{10}(50\%)=-106.2$ dBm

For a MS omnidirectional antenna, the maximum interfering acceptable electromagnetic field level is therefore

$E_{MAX}=I_{MAX}+77.3+20*\log_{10}(2000\text{ MHz})=$**37.1 dB(μV/m)**

4. Minimum electromagnetic field to provide service

The signal to interference ratio depends on the service bit rate and E_b/N_0 for a given environment.

$(C/N+I)_{dB}=(E_b/N_0)_{dB}+10*\log10(Rb/W)$

For speech (R_b=8kbps), in a vehicular environment, E_b/N_0=8 dB, therefore

$C/N+I_{speech,\ vehicular}=-18.8$ dB

And the minimum signal strength is therefore

E_{MIN}(speech, vehicular)= **21.3 dB(μV/m)**

A 15.8 dB margin is therefore available at the boundary between the minimum level to provide service and the maximum to cause no unacceptable interference. With a D^4 propagation law, this implies a 2.5 ratio between the distance to border and cell size.

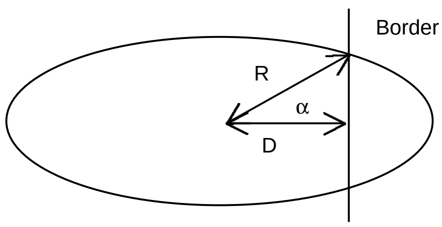

Figure 1 – Margin between distance to border and cell size

In the case depicted in Figure 1 of a straight border, the opening angle α is 66°, which allows omnidirectional base stations to be deployed not too densely.

For LCD384 (R_b=384 kbps), E_b/N_0=0.3 dB for a vehicular environment, and thus

$C/N+I_{LCD384,\ vehicular}$=-9.7 dB

And the minimum signal strength is therefore

E_{MIN}(speech, vehicular)= **30.4 dB(μV/m)**

The corresponding α angle for a straight border is 47°.

5. Propagation model

A review of available ITU-R P Series Recommendations indicates that the most appropriate propagation model is given in ITU-R Rec. P.1146. This model is valid in the frequency range 1-3 GHz, and includes propagation over sea.

6. Conclusion

The interest of this document is to review the different techniques of division to the level of the frontier by indicating advantages and disadvantages of one or the other technique. From a feasibility viewpoint, the distribution by preferential frequency no longer is to demonstrate having already served for the introduction of the GSM. This technique is perfectly mastered what is not the case of the distribution by scrambling codes. The distribution by scrambling codes is judicious, because it uses all the spectrum. The spectral resource is limited and the cohabitation in the even bands systems is sometimes difficult. The particularity, that is left to operators in the framework of multilateral or bilateral agreements, to modulate the division following a dense zone or not will be more interesting in the framework of a division by scrambling codes. The introduction of this criterion is as feasible for the distribution by preferential frequency but the former brings only little interest.

Attached is a framework for a new ERC Recommendation that should serve as the basis for bilateral agreements between Administrations and/or between operators.

Two additional points would require investigation:

- Is the addition of interference to noise still valid if the same scrambling code is used on each side of the border? The effect may be more complex to modelise, with effects on the link level E_b/N_0, but the overall result may be similar. The value not to be exceeded at the border in the case of using non-preferential scrambling codes needs to be defined;
- Is the maximum field level proposed sufficient to protect reception of channelisation codes, which is necessary in the case of cell selection/reselection?
- Is this scheme sufficient for the TDD mode?

A liaison with 3GPP™ TSG RAN and with ETSI EP UMTS™ would be necessary to clarify these and other points.

Recommendation T/R

FREQUENCY BANDS, PLANNING AND CO-ORDINATION FOR UMTS

Recommendation proposed by Working Group TG1 "Preparation of UMTS system introduction in Europe and CMR 2000"

Text of the Recommendation adopted by the "Telecommunications" Commission:

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that the UMTS system will use the frequency bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz in accordance with CEPT Decision ERC/DEC/(97)07,

b) that these frequency bands are allocated to the Mobile Service and the Fixed Service on a co-primary basis

c) that in the implementation of the UMTS system it is necessary to take account of national policies for the use of the frequency bands in question,.

d) that national frequency planning for the UMTS system is carried out by the operators and approved by the Radioregulatory Administrations or carried out by such Administrations in cooperation with the operators,

e) that frequency planning in border areas will be based on coordination between Radioregulatory Administrations.

noting

a) that in many CEPT member countries multiple operators for the UMTS system are expected,

b) that frequency coordination procedure and interservice sharing is necessary both between countries operating the UMTS system and between those countries and countries operating other services in accordance with the Radio Regulations,

recommends

1. That frequency co-ordination between UMTS systems in border areas shall be based on the concept of preferential codes;

2. That frequency co-ordination between UMTS and other systems in neighbouring countries shall be based on bilateral agreements.

3. that the national UMTS systems should use all or parts of the frequency bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz in accordance with the relevant ETSI standards.

4. That frequency coordination in border areas is based on the following concept:

4.1 Code co-ordination shall be agreed between Administrations concerned. Frequencies using preferential codes may be used without coordination with a neighbouring country if the field strength of each carrier produced by the base station does not exceed a value of 37 dBμV/m at a height of 3 m above ground at the border line between two countries.

4.2 Frequencies using preferential codes may be used without coordination with a neighbouring country if the field strength of each carrier produced by the base station does not exceed a value of [TBD] dBμV/m at a height of 3 m above ground at the border line between two countries.

4.3 All other frequencies are subject to coordination between Administrations.

4.4 Frequency planning in coastal areas is based on the concept of code co-ordination and coordinated codes assuming a middleline between the countries involved. Other principles for code planning and code coordination in coastal areas may be agreed between the Administrations concerned.

4.5 Propagation criteria for calculating the interfering fieldstrength is described in Annex 1

4.6 For adding multiple interferers the simplified algorithm described in Annex 2 can be used.

5. That the distribution of frequencies and/or codes between operators of different countries may take the population density into account;

6. That the technical parameters described in Annex 3 is used in the frequency co-ordination for the UMTS system.

7. That the following frequency co-ordination procedure is used:

7.1. When requesting coordination the relevant characteristics of the base station shall be forwarded using the co-ordination form indicated in Recommendation T/R 25-08 E [Note: the scrambling code group should be added to this form]. Administrations may diverge from the use of this form by common agreement but at least the following characteristics should be forwarded to the Administration affected:

a) frequency in MHz
b) name of transmitter station
c) country of location of transmitter station
d) geographical coordinates
e) effective antenna height
f) antenna polarisation
g) antenna azimuth
h) directivity in antenna systems
i) effective radiated power
j) expected coverage zone
k) date of entry into service.
l) scrambling code used

6.2. The Administration affected shall evaluate the request for coordination and shall within 30 days notify the result of the evaluation to the Administration requesting coordination.

6.3. If in the course of the coordination procedure the Administration affected requires additional information, it may request such information.

6.4. If no reply is received by the Administration requesting coordination within 30 days it may send a reminder to the Administration affected. An Administration not having responded within 30 days following communication of the reminder shall be deemed to have given its consent and the code co-ordination may be put into use with the characteristics given in the request for coordination.

6.5. The periods mentioned above may be extended by common consent.

7. In general Administrations may diverge from the technical parameters and procedures described in this
Recommendation subject to bilateral agreements."

Annex 1
Propagation model

[Derived from ITU-R Rec. P.1146, for 2 GHz]
.

Annex 2
SIMPLIFIED ALGORITHM FOR FREQUENCY COORDINATION

1. Notation

P = e.i.r.p. of wanted transmitter in direction of receiver (dBm).
L = Isotropic path loss from wanted transmitter to receiver (dB).
P_i = c.i.r.p. of interfering transmitter i in directiou of receiver (dBm).
1_i = Isotropic path loss from interfering transmitter i to receiver (dB).
a = Receiver antenna gain towards wanted transmitter (dBi).
a_i = Receiver antenna gain towards interfering transmitter i (dBi).
β_i = Gain due to receiver filter selectivity on interference from transmitter i (dB).
γ = Estimated shadowing margin to be allowed on C/I value (dB).
C = Total wanted carrier power at receiver input (dBm).
I_i = Effective interfering power due to transmitter i at receiver input (allowing for the effect of receiver filtering) (dBm).
I = Total effective interfering power at receiver input (allowing for shadowing margin) (dBm).
λ =.C/I threshold value.

2 Base-mobile Path Algorithm

(a) For each cell in question, take one or more "worst case" mobile station MS locations. These are locations at which the C/I is known, or believed to be, lowest.
(b) Calculate the wanted carrier power at the receiver input:
$C = P - L + a$
(c) Calculate the effective interfering power due to each potentially interfering transmitter (whether co-channel or adjacent channel) at the receiver input (allowing for the effect of receiver filtering): $I_i = P_i - L_i + a_i + \beta_i$
(d) Sum the interfering powers at the receiver and allow for the shadowing margin:
$I = 10 \log_{10} \Sigma \ 10^{(Ii/10)} + \gamma$
(e) Cheek the effective C/I ratio (C -I) against the threshold value λ.

1.3 Mobile-base Path Algorithm

(a) Take each cell that has a potentially interfering mobile station (MS). If N is the number of carrier frequencies allocated to that cell that can cause potential interference to the base station (BS), assume there are N MS's, one radiating each carrier, in that cell.

A proportion of the total number of MS's so identified (e.g. 20%) should be assumed to be the worst case locations of their cells and the rest at the mid-point of their cells.

Alternatively a "Monte Carlo" simulation can be undertaken in which a number of "snapshots" of the interference scenario are taken. In each snapshot, the interfering MS's are placed at random locations (uniformly distributed) within their cells. To find for example the 90% C/I value. 100 snapshots could be taken, and the C/I which is exceeded by 90 of the snapshots used.

(b) Perform steps (b) to (e) of the base-mobile path algorithm.

1.4 Notes on Calculation of Parameters

(a) P, P_i—These should be supplied by the UMTS™ operators.
(b) L, L_i —These can either be calculated using appropriate terrain modelling, or some simplified power distance law, e.g. $d^{-3.3}$.

(c) a, a_i — These should be supplied by the UMTS™ operators.

(d) β_i—These can be read off Figure A2-1 (T/R 20-08).

(e) If shadowing effects have been allowed for in the calculation of L and L_i, ϒ can be set to 0. Otherwise a value of 7 dB could be used (this assumes the wanted and unwanted signals each have a 5 dB shadowing margin (log normal distribution) and the composite shadowing margin is $\sqrt{2}$ x 5 dB, i.e. 7 d B).

(f) λ can be taken as follows:

UMTS LCD384 receiver = -9.7 dB

Note. The calculation must take into account all interfering transmitters from the wanted UMTS™ network as well as those from the neighbouring UMTS™ network.

Annex 3
UMTS™ technical parameters

[To be developped]