Annex E: Summary document on GSM-TDMA interference

Summary Document
On
GSM-TDMA INTERFERENCE

PROJECT: 60
Support to R2/MTS2

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1. Summary of Requirement.

In the course of a meeting to discuss the potential interference [1] problems associated with the introduction of GSM and other transmission systems employing TDMA techniques, Mr Williams of the Radio Technology Laboratory was tasked with producing a summary document covering all of the work carried out to date.

The minutes of that meeting are reproduced in annex 5, it should be noted that the chairman stated that the summary report should aim to concern itself with the direct breakthrough problem only, and not the TV image problem which may affect the UK only.

[1] Interference to TV, radio, audio and information technology equipment, including personal stereo equipment and hearing aids.

2. Summary of Findings.

2.1 Domestic Equipments.

Television receivers and portable radios/cassette players etc. proved to be the most susceptible domestic equipments with mean immunities of 4.0 and 5.6 V/m respectively. Ignoring all receiver spurious responses, these equipments would only suffer interference from a 20 W GSM mobile at distances of less than about 8 metres (worse case assuming 100% efficiency and free space path loss).

This means that in practice, due to building attenuation etc., interference will not occur unless the transmitter and victim equipment are very close, and within the same room.

It can therefore be concluded that GSM interference is unlikely to cause any serious problems to domestic equipment, being used in a domestic environment.

2.2 Hearing Aids.

Hearing aids also proved fairly susceptible, having a mean immunity of 4.1 V/m. Interference to hearing aids (and portable cassette players etc.) outside the domestic environment is likely to prove more problematic since the interfering GSM transmission is unlikely to be under the control of the user of the victim equipment.

Work conducted by the RTL and Racal Research Ltd. suggests that the immunity of small behind the ear hearing aids can be improved at reasonable cost (by about 10 dB) by applying conductive paint to the inside of the hearing aids plastic case. This would reduce the interfering range of a 5 W portable GSM transceiver to about 0.5 metres which is considered acceptable.

It can therefore be concluded that users of current hearing aid equipment are likely to experience some interference from GSM mobiles in close proximity. It is difficult to predict whether this will be a serious problem, but since the immunity of hearing aids can be improved at reasonable cost, and bearing in mind that the use of personal communications equipment will increase, it would be seem prudent for hearing aid manufacturers to investigate this course of action.

It is unlikely that the users of hearing aid equipment will be able to use any TDMA communications systems themselves (even if the low cost improvements described have been incorporated).

2.3 Higher Frequency Systems, DECT, DCS1800 etc.

The hearing aids tested proved more susceptible to 1900 MHz than 900 MHz (mean immunity 7 dB worse). This has obvious implications regarding the introduction of DECT etc.

3. Immunity Data.

3.1 Sources of Data.

Reports from the following laboratories were analysed to produce this summary document;

Radio Technology Laboratory Reports KJ109, KJ132, KJ132a, KJ181 Part1, KJ181 Part2.

British Telecom Research Laboratories Report RT4123

Netherlands PTT (hoofddirectie telecommunicatie en post) Report

Radio Frequency Investigations Report RFI\TR2\2294

3.2 Normalisation of Data.

The above laboratories presented their findings in a variety of forms. In producing this summary report it was necessary to unify the various abstract results and findings, by calculation and extrapolation, to a common form - the field intensity at which the impairment was on the limit of acceptability.

CCIR grade 3.5 impairment was considered an appropriate limit of acceptability for GSM interference since it falls halfway between the impairment that is considered acceptable, by the CCIR, for continuous interference (CCIR grade 4), and that which is only considered acceptable for a very small percentage of the time (CCIR grade 3).

The approximate field intensities that would result in CCIR grade 3 or 4 impairments can be obtained by adding or subtracting 5 dB audio impairment respectively (since a 1 dB change in the field intensity results in approximately a 2 dB change in the audio impairment (square law), multiplying or dividing the grade 3.5 field intensity by 1.33 will produce the approximate grade 3 and 4 field intensities respectively).

A description of the impairment associated with each of the standard CCIR impairment grades is given in Annex 1.

3.3 Analysis of the Data.

The original laboratories data and its conversion to field intensity for grade 3.5 impairment is given in Annex 2.

The Mean and Standard Deviation of the extrapolated data is given in Annex 3, and Summarised in Annex 4.

4. Observations.

4.1 Earlier work at the RTL has shown that the magnitude of AM or pulse[2] interference is related to the peak envelope power of the transmission. i.e. A victim equipment demonstrating immunity to 3 V/m (carrier) with 1kHz, 80% amplitude modulation, is also demonstrating immunity to 5.4 V/m peak i.e. a TDMA immunity of 5.4 V/m. This is supported by the recent tests conducted on hearing aids by RFI.

[2] 1:24< duty cycle <24:1

4.2 The recent tests conducted by RFI shows that the majority of the hearing aids tested (the smaller ones) were more susceptible at 1900 MHz than at 900 MHz (the mean immunity was 7 dB worse). This finding has obvious implications regarding the introduction of DECT etc., and is supported by some (limited) earlier work conducted by the RTL (KJ132a).

4.3 *Intentionally blank for reports disseminated outside the Agency.*

5. Conclusions.

5.1 The extrapolated mean/median peak TDMA field intensities at which various equipments would suffer visible/audible, but not annoying interference (approximately CCIR grade 3.5) are listed below.

Type of Equipment	Field Intensity (V/m)
Hearing Aids	4.1
Television Receivers	4.0
Video Cassette Recorders	>13.9
Satellite Television Receivers	9.5
Tuners/amplifiers	>8.3
Cassette Decks	>2.9
CD Players	>13.9
Portable Radios & Cassette Players etc.	5.6
Telephones	>7.6
Computers	>8.5
Computers (Home/Games)	>13.5
General Electrical/Electronic Equipment.	>7.8

From the above generalisation it can be seen that the most susceptible equipments are hearing aids, television receivers, cassette decks and portable radios/cassette players etc. Ignoring all receiver spurious responses [4], these would only suffer interference from a 20 W mobile at distances of less than about 8 metres (worse case assuming 100% efficiency and free space path loss). This means that in practice, due to building attenuation etc., interference will not occur unless the transmitter and victim equipment are very close, and within the same room.

It can therefore be concluded that GSM interference is unlikely to cause any serious problems to domestic equipment, being used in a domestic environment. Interference to hearing aids and portable cassette players etc. being used outside the domestic environment is more likely. Earlier work conducted by the RTL and Racal Research Ltd. suggests that the immunity of small behind the ear hearing aids can be improved at reasonable cost (by about 10 dB) by applying conductive paint to the inside of the hearing aids plastic case. This would reduce the interfering range of a 5 W portable GSM to about 0.5 metres which is considered acceptable.

[4] Although it was requested that this summary report should aim to concern itself with the direct breakthrough problem only, and not the TV image problem which may affect the UK only, the following background information is included for completeness.

The image (spurious) response of television receivers is potentially quite problematic because, for some of the higher Band V channels, this response falls within the bands allocated to TACS and GSM. However, interference via this mechanism is no worse for GSM (or other TDMA systems) than it is for analogue systems e.g. TACS. As no cases of TV image interference from TACS have been recorded during several years of operation, major image interference problems from GSM are not anticipated.

5.2 The following pertinent information has been extracted from RFI's test report RFI\TR2\2494;

5.2.1 Generic Immunity Standards.
The draft generic immunity standard (prEN 50082-1) requires the EUT to be tested at 3 V/m from 27 MHz to 500 MHz, but since there is no requirement to modulate the field it is unlikely that any hearing aid equipment would fail this test.

The final version will almost certainly require that two further tests listed in the informative annex to be carried out:

1. Electromagnetic field at a severity level of 3 V/m 80% amplitude modulated with 1 kHz tone swept from 80 MHz to 1 GHz.

2. electromagnetic field at a severity level of 3 V/m pulse modulated with a 100 Hz square wave at a frequency of 1.89 GHz.

5.2.2 Field Strength Produced by Portable Transceivers.

Based on compliance with the generic standard RFI have calculated how closely the user of a piece of hearing aid equipment may approach a portable transceiver before the level of unwanted interference becomes unacceptable, and produced the following table;

System	Power (W)	Minimum Distance (m)
CT2	0.01	0.1
GSM	2.00	1.4
	5.00	2.2
	8.00	2.8
	20.00	4.5
DECT	0.25	0.5

RFI state that;

These figures only provide a rough guide as they make no allowance for the type of modulation employed or for the disturbance of the electromagnetic field caused by the person using the hearing aid.

and that;

The values calculated above would suggest that users of hearing aid equipment are likely to experience some interference from GSM mobiles in close proximity and that they will not be able to use any of the above systems themselves.