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Digital cellular telecommunications system (Phase 2) (GSM); Transmission planning aspects of the speech service in the GSM Public Land Mobile Network (PLMN) system (GSM 03.50 version 4.4.1)

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**Digital cellular telecommunications system (Phase 2);
Transmission planning aspects of the speech service in the GSM
Public Land Mobile Network (PLMN) system
(GSM 03.50 version 4.4.1)**

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).

This ETS describes the transmission planning aspects pertaining to the speech service within the digital cellular telecommunications system (Phase 2).

Transposition dates	
Date of adoption of this ETS:	23 October 1998
Date of latest announcement of this ETS (doa):	31 January 1999
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 July 1999
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1 Scope

This European Telecommunication Standard (ETS) is concerned with the transmission planning aspects pertaining to the speech service in the pan-European PLMN system. Due to technical and economic factors, there cannot be full compliance with the general characteristics of international telephone connections and circuits recommended by CCITT.

This ETS gives guidance as to the precautions, measures and minimum requirements needed for successful interworking of the PLMN with the national and international PSTN. The Recommendation identifies a number of routing and network configurations. The objective is to reach a quality as close as possible to CCITT standards in order to safeguard the performance seen by PSTN customers.

1.1 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies. Unless otherwise stated, all references to CCITT Recommendations are from the Blue Book (1989).

- [1] GSM 01.04 (ETR 100): "Digital cellular telecommunication system (Phase 2); Abbreviations and acronyms".
- [2] GSM 03.04 (ETS 300 524): "Digital cellular telecommunication system (Phase 2); Signalling requirements relating to routing of calls to mobile subscribers".
- [3] GSM 06.01 (ETS 300 580-1): "Digital cellular telecommunication system (Phase 2); Full rate speech processing functions".
- [4] GSM 06.10 (ETS 300 580-2): "Digital cellular telecommunication system (Phase 2); Full rate speech transcoding".
- [5] GSM 06.11 (ETS 300 580-3): "Digital cellular telecommunication system (Phase 2); Substitution and muting of lost frames for full rate speech channels".
- [6] GSM 06.12 (ETS 300 580-4): "Digital cellular telecommunication system (Phase 2); Comfort noise aspect for full rate speech traffic channels".
- [7] GSM 06.31 (ETS 300 580-5): "Digital cellular telecommunication system (Phase 2); Discontinuous Transmission (DTX) for full rate speech traffic channel".
- [8] GSM 06.32 (ETS 300 580-6): "Digital cellular telecommunication system (Phase 2); Voice Activity Detection (VAD)".
- [9] GSM 06.02 (ETS 300 581-1): "Digital cellular telecommunication system (Phase 2); Half rate speech processing functions".
- [10] GSM 06.20 (ETS 300 581-2): "Digital cellular telecommunication system (Phase 2); Half rate speech transcoding".
- [11] GSM 06.21 (ETS 300 581-3): "Digital cellular telecommunication system (Phase 2); Substitution and muting of lost frames for half rate speech traffic channels".
- [12] GSM 06.22 (ETS 300 581-4): "Digital cellular telecommunication system (Phase 2); Comfort noise aspects for half rate speech traffic channels".

- [13] GSM 06.41 (ETS 300 581-5): "Digital cellular telecommunication system (Phase 2); Discontinuous Transmission (DTX) for half rate speech traffic channels".
- [14] GSM 06.42 (ETS 300 581-6): "Digital cellular telecommunication system (Phase 2); Voice Activity Detection (VAD) for half rate speech traffic channels".
- [15] ETS 300 085 (1990): "Integrated Services Digital Network (ISDN); 3,1 kHz telephony teleservice; Attachment requirements for handset terminals".
- [16] CCITT Recommendation G.103: "Hypothetical reference connections".
- [17] CCITT recommendation G.111: "Loudness ratings (LRs) in an international connections".
- [18] CCITT Recommendation G.113: "Transmission impairments".
- [19] CCITT Recommendation G.114: "Mean one-way propagation time".
- [20] CCITT Recommendation G.121: "Loudness ratings (LRs) of national systems".
- [21] CCITT Recommendation G.122: "Influence of national systems on stability, talker echo, and listener echo in international connections".
- [22] CCITT Recommendation G.131: "Stability and echo".
- [23] CCITT Recommendation G.165: "Echo cancellers".
- [24] CCITT Recommendation G.223: "Assumptions for the calculation of noise on hypothetical reference circuits for telephony".
- [25] CCITT Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
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- [26] CCITT Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".
- [27] CCITT Recommendations G.712: "Transmission performance characteristics of pulse code modulation".
- [28] CCITT Recommendations G.714: "Separate performance characteristics for the send and receive sides of PCM channels applicable to 4-wire voice frequency interfaces".
- [29] CCITT Recommendations M.1020: "Characteristics of special quality".
- [30] CCITT Recommendations M.1025: "Characteristics of special quality international leased circuits with basic bandwidth conditioning".
- [31] CCITT Recommendations M.1030: "Characteristics of ordinary quality international leased circuits forming part of private switched telephone networks".
- [32] CCITT Recommendations M.1040: "Characteristics of ordinary quality international leased circuits".
- [33] CCITT Recommendation O.132 (1988), "Specification for a quantizing distortion measuring apparatus using a sinusoidal test signal."
- [34] CCITT Recommendation P.11: "Effect of transmission impairments".

- [35] CCITT Recommendation P.34: "Transmission characteristics of hands-free telephones".
- [36] CCITT Recommendation P.38: "Transmission characteristics of operator telephone systems (OTS)".
- [37] CCITT Recommendation P.50: "Artificial voices".
- [38] CCITT Recommendation P.51 (1988), "Artificial mouths and artificial ears."
- [39] CCITT Recommendation P.64 (1988), "Determination of sensitivity/frequency characteristics of local telephone systems to permit calculation of their loudness ratings."
- [40] CCITT Recommendation P.76 (1988), "Determination of loudness ratings; fundamental principles."
- [41] CCITT Recommendation P.79 (1988), "Calculation of loudness ratings."
- [42] CCITT Recommendation Q.35: "Technical characteristics of tones for the telephone service".
- [43] CCITT Recommendation Q.551: "Transmission characteristics of digital exchanges".
- [44] CCITT Blue Book (1988), Volume V, Supplement 13, "Noise spectra."
- [45] ISO 3 - 1973: "Preferred numbers - series of preferred numbers."
- [46] ITU-T Recommendation P.57 (1993): "Artificial ears."

1.2 Definitions and abbreviations

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In addition to those below the definitions and abbreviations used in this specification are listed in GSM 01.04.

ADC	Analogue to Digital Converter
ADPCM	Adaptive Differential Pulse Code Modulation
AEC	Acoustic Echo Control
BSC'	Base Station Controller (excluding transmission systems)
BTS'	Base Transceiver Station (excluding transmission systems)
DAC	Digital to Analogue Converter
DMR	Digital Mobile Radio
DSI	Digital Speech Interpolation
EEC	Electric Echo Control
EL	Echo Loss
ERP	Ear Reference Point
FDM	Frequency Division Multiplex
LSTR	Listener Sidetone Rating
MRP	Mouth Reference Point
OLR	Overall Loudness Rating
PCM	Pulse Code Modulation
POI	Point of Interconnection (with PSTN)
RLR	Receiver Loudness Rating
SLR	Send Loudness Rating
STMR	Sidetone Masking Rating
UPCMI	13-bit Uniform PCM Interface

1.3 Introduction

Since the transmission quality and the conversational quality of the PLMN will in general be lower than the quality of the PSTN connection due to coding distortion, delay, etc, only some transmission aspects can

be brought in line with CCITT Recommendations. It is therefore necessary to improve the overall quality as much as possible by implementing proper routing and network configurations.

It should be recognised that the transmission plan for the pan-European PLMN cannot lead to major changes in the PSTN. However, it is important to use the improvements in the evolving PSTN (e.g. digitalization, introduction of echo cancellers) in an effective way.

The transmission requirements are in the first place based on international connections. When the quality is sufficient for international connections, it can be assumed that the national connections will have the same or better quality.

In order to obtain a sufficient quality in the connection, it is preferable to have digital connectivity between the Base Station System (BSS) and the international exchange. The PLMN requirements are based on this assumption. When this situation cannot be provided, a lower quality must temporarily be accepted.

This Recommendation consists of two parts: one will deal with network configurations, the other with transmission performance.

The part about network configurations gives information about the reference connections, on which the transmission plan is based. Furthermore, some guidelines are presented for improvement of the transmission quality in the evolving (digital) PSTN.

The part about transmission performance gives mainly characteristics of the transmission between MS acoustic interface (MRP/ERP) and the interface between the PLMN and the PSTN (POI). For transmission aspects where it is impossible to give overall characteristics, it is in some cases necessary to make recommendations for individual parts of the equipment.

Unless otherwise stated, all references to CCITT Recommendations are from the Blue Book (1989).

Annex A considers the effects of the type of acoustic interfaces of the MS.

2 Network configurations

2.1 General

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The basic configuration for the interworking with the PSTN is shown in figure 1.

2.2 Model of the PLMN

A more detailed model of the PLMN used for the consideration of transmission planning issues for speech is shown in figure 2. This model represents the main functions required and does not necessarily imply any particular physical realisation. Routing of calls is given in Recommendation GSM 03.04.

Any acoustic echo control is not specifically shown as it will be provided by analogue processing of digital processing or a combination of both techniques.

2.3 Interfaces

The main interfaces identified within the GSM Recommendations are shown in figure 1. For the purposes of this Recommendation, the Air Interface and the Point of Interconnect (POI) are identified along with two other interfaces, Interface Z and a 13-bit Uniform PCM Interface (UPCMI). These interfaces are needed to define the PLMN transmission characteristics and the overall system requirements.

The Air Interface is specified by GSM 05 series Recommendations and is required to achieve MS transportability. Analogue measurements can be made at this point by using the appropriate radio terminal equipment and speech transcoder. The losses and gains introduced by the test speech transcoder will need to be specified.

The POI with the PSTN will generally be at the 2048 kbits/s level at an interface, in accordance with CCITT Recommendation G.703. At the point, which is considered to have a relative level of 0 dBr, the analogue signals will be represented by 8-bit A-law, according to CCITT Recommendation G.711. Analogue measurements may be made at this point using a standard send and receive side, as defined in CCITT Recommendations G.714 and G.712.

Interface Z might be used in the case of direct MSC to MSC connections. Interface Z is of the same nature as the POI.

The UPCMI is introduced for design purposes in order to separate the speech transcoder impairments from the basic audio impairments of the MS.

2.4 Configurations of Connections

2.4.1 General Configurations of Connections

Figure 3 shows a variety of configurations of connections. There are a number of PSTN features which should be avoided from such connections. These include:

- echo control devices in the international network. If present, and not disabled, these devices will be in tandem with PLMN echo cancellers and may introduce degradation;
- satellite routings. The delay inherent in the connections when added to the PLMN delay, may result in conversational difficulties. Double satellite links are likely to cause severe difficulties and special precautions should be taken to avoid this situation under call forwarding arrangements;
- digital speech interpolation systems (DSI). There is likely to be an adverse interaction between DSI and DTX;
- ADPCM. The distortion introduced by ADPCM on routes where PSTN echo control is not provided is likely to reduce the echo cancellation provided by the PLMN electric echo canceller;
- significant differences in clock rates on non-synchronised digital network components. The resulting phase roll and slips are likely to degrade the performance of the PLMN echo canceller;
- those analogue FDM routings which exhibit phase roll. Any phase roll due to the absence of synchronisation between the carrier frequencies on the two directions of transmission is likely to degrade the performance of the PLMN echo canceller;
- tandem connections of sources of quantisation distortion. The PLMN speech transcoder is estimated to be equivalent to 7 QDUs between uniform PCM interfaces (see CCITT Recommendation G.113).