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Digitalni celiļ ni telekomunikacijski sistem (faza 2+) ï Vidiki naļ rtovanja oddajanja govorne storitve v javnem kopenskem mobilnem omreģju (PLMN) sistema GSM (GSM 03.50, razliļ ica 8.1.1, izdaja 1999)

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 8.1.1 Release 1999)

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document describes the transmission planning aspects pertaining to the speech service within the digital cellular telecommunications system (Phase 2+).

The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document it will be re-released with an identifying change of release date and an increase in version number as follows:

Version 8.x.y

where:

8 indicates Release 1999 of GSM Phase 2+.

x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

y the third digit is incremented when editorial only changes have been incorporated in the specification.

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1 Scope

The present document describes the transmission planning aspects pertaining to the speech service in the GSM 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 the ITU-T.

The present document gives guidance as to the precautions, measures and minimum requirements needed for successful interworking of the PLMN with the national and international PSTN. The present document identifies a number of routeing and network configurations. The objective is to reach a quality as close as possible to ITU-T standards in order to safeguard the performance seen by PSTN customers.

1.1 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1999 document, references to GSM documents are for Release 1999 versions (version 8.x.y).

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 03.04: "Digital cellular telecommunications system (Phase 2+); Signalling requirements relating to routeing of calls to mobile subscribers".

[3] GSM 06.01: "Digital cellular telecommunications system (Phase 2+); Full rate speech processing functions".

[4] GSM 06.10: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Transcoding".

[5] GSM 06.11: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Substitution and muting of lost frames for full rate speech channels".

[6] GSM 06.12: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Comfort noise aspect for full rate speech traffic channels".

[7] GSM 06.31: "Digital cellular telecommunications system (Phase 2+); Full rate speech; Discontinuous Transmission (DTX) for full rate speech traffic channels".

[8] GSM 06.32: "Digital cellular telecommunications system (Phase 2+); Voice Activity Detection (VAD)".

[9] GSM 06.02: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech processing functions".

[10] GSM 06.20: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech transcoding".

[11] GSM 06.21: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Substitution and muting of lost frames for half rate speech traffic channels".

[12] GSM 06.22: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Comfort noise aspects for half rate speech traffic channels".

[13] GSM 06.41: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Discontinuous Transmission (DTX) for half rate speech traffic channels".

[14] GSM 06.42: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Voice Activity Detection (VAD) for half rate speech traffic channels".

[15] I-ETS 300 245-2: "Integrated Services Digital Network (ISDN): Technical characteristics of telephony terminals: Part 2: PCM A-Law handset telephony".

[16] ITU-T Recommendation G.103 (1998): "Hypothetical reference connections".

[17] ITU-T Recommendation G.111 (1993): "Loudness ratings (LRs) in an international connection".

[18] ITU-T Recommendation G.113 (1993): "Transmission impairments".

[19] ITU-T Recommendation G.114 (1993): "Mean one-way propagation time".

[20] ITU-T Recommendation G.121 (1993): "Loudness ratings (LRs) of national systems".

[21] ITU-T Recommendation G.122 (1993): "Influence of national systems on stability, talker echo, and listener echo in international connections".

[22] ITU-T Recommendation G.131 (1988): "Stability and echo".

[23] ITU-T Recommendation G.165 (1993): "Echo cancellers".

[24] ITU-T Recommendation G.223 (1988): "Assumptions for the calculation of noise on hypothetical reference circuits for telephony".

[25] ITU-T Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".

[26] ITU-T Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies".

[27] ITU-T Recommendation G.712 (1992): "Transmission performance characteristics of pulse code modulation".

[28] ITU-T Recommendation G.167 (1993): "Acoustic Echo Controllers".

[29] ITU-T Recommendation M.1020 (1993): "Characteristics of special quality international leased circuits with special bandwidth conditions".

[30] ITU-T Recommendation M.1025 (1993): "Characteristics of special quality international leased circuits with basic bandwidth conditioning".

[31] ITU-T Recommendation M.1030 (1988): "Characteristics of ordinary quality international leased circuits forming part of private switched telephone networks".

[32] ITU-T Recommendations M.1040 (1988): "Characteristics of ordinary quality international leased circuits".

[33] ITU-T Recommendation O.132 (1988): "Specification for a quantizing distortion measuring apparatus using a sinusoidal test signal".

[34] ITU-T Recommendation P.11 (1993): "Effect of transmission impairments".

[35] ITU-T Recommendation P.34 (1993): "Transmission characteristics of hands-free telephones".

[36] ITU-T Recommendation P.38 (1993): "Transmission characteristics of operator telephone systems (OTS)".

[37] ITU-T Recommendation P.50 (1993): "Artificial voices".

[38] ITU-T Recommendation P.51 (1993): "Artificial mouths".

[39] ITU-T Recommendation P.64 (1993): "Determination of sensitivity/frequency characteristics of local telephone".

[40] ITU-T Recommendation P.76 (1988): "Determination of loudness ratings; fundamental principles".

[41] ITU-T Recommendation P.79 (1993): "Calculation of loudness ratings".

[42] ITU-T Recommendation Q.35 (1988): "Technical characteristics of tones for the telephone service".

[43] ITU-T Recommendation Q.551 (1994): "Transmission characteristics of digital exchanges".

[44] ITU-T 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 (1996): "Artificial Ears".

[47] ITU-T Recommendation P.58 (1993): "Head and Torso Simulator for Telephonometry".

[48] I-ETS 300 245-3: "Integrated Services Digital Network (ISDN): Technical characteristics of telephony terminal: Part 3: PCM A-law loudspeaking and handsfree telephony".

1.2 Abbreviations

For the purposes of the present document, the abbreviations given in GSM 01.04 and the following apply.

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
ISC	International Switching
LE	Local Exchange
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 ITU-T Recommendations. It is therefore necessary to improve the overall quality as much as possible by implementing proper routeing and network configurations.

It should be recognized that the transmission plan for the GSM 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.

The present document 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.

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

2 Network configurations

2.1 General

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 realization. Routeing of calls is given in 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 specifications are shown in figure 1. For the purposes of the present document, 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 specifications 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 2 048 kbits/s level at an interface, in accordance with ITU-T Recommendation G.703. At the point, which is considered to have a relative level of O dBr, the analogue signals will be represented by 8-bit A-law, according to ITU-T Recommendation G.711. Analogue measurements may be made at this point using a standard send and receive side, as defined in ITU-T Recommendations.

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:

1) 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;

2) satellite routeings. 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;

3) Digital Speech Interpolation systems (DSI). There is likely to be an adverse interaction between DSI and DTX;

4) 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;

5) significant differences in clock rates on non-synchronized digital network components. The resulting phase roll and slips are likely to degrade the performance of the PLMN echo canceller;

6) those analogue FDM routeings which exhibit phase roll. Any phase roll due to the absence of synchronization between the carrier frequencies on the two directions of transmission is likely to degrade the performance of the PLMN echo canceller;

7) tandem connections of sources of quantization distortion. The PLMN speech transcoder is estimated to be equivalent to 7 QDUs between uniform PCM interfaces (see ITU-T Recommendation G.113).

It is recognized that on some connections it may not be feasible to avoid these features, but in many cases, especially if taken into account at the planning stage, this should be possible.

2.4.2 Reference configurations to illustrate delay and echo control issues

Three basic reference configuration types shown in figures 4 to 6 are defined to illustrate delay and echo control issues. Intermediate echo control devices as shown in the figures are disabled by appropriate signalling between the MSC and ISC or MSC and MSC.

Reference configurations A (see figure 4) represent national or international connections where there is no echo control device in the PSTN. These reference configurations include re-routeing configurations where the overall delay of the transmission path has not been extended.

Reference configurations B (see figure 5) represent national or international connections where echo control is provided in the PSTN. These reference configurations include re-routeing configurations where the overall delay of the transmission path has not been extended.

Reference configurations C (see figure 6) represent national or international connections where re-routeing has lead to an increase in the overall delay of the transmission path beyond recommended limits.

2.5 4-wire circuits in the PLMN

As shown in figure 2, the PLMN will usually contain transmission systems. Where present, they should provide 4-wire circuits.

In the case of digital circuits which do not include any speech processing devices, the overall system requirements of the PLMN will not be affected by the presence of the link.

In the case of analogue links, the transmission characteristics (e.g. attenuation, attenuation distortion, noise) will affect the overall system requirements of the PLMN. ITU-T Recommendations M.1020, M.1025, M.1030 and M.1040 describe several transmission characteristics for leased circuits. In cases where the analogue link introduces loss, provision will have to be made at the interface to restore the loss.

3 Transmission performance

The overall transmission performance of connections in alternate conversation mode can be considered as a summation of the effects of:

1) the audio part between the MRP/ERP and the UPCMI interface;

2) the speech transcoder part including the effects of radio transmission, and speech processing between the UPCMI and the POI;

3) the overall characteristics of the connection between POI and the other user.

There is not only a linear addition of these effects but there is also an influence from different parts of the connection on the performance of the speech transcoder and other speech processing devices.

Where possible, the transmission performance is specified between the MRP/ERP and the POI. Where this is not possible, the transmission aspects of the audio part mentioned above have been specified. The transmission aspects of the speech transcoder are specified in GSM 06 series specifications. In the following paragraphs, requirements are specified for the UPCMI, the Air Interface or the POI as appropriate.

The transmission requirements of the MS have been derived from the requirements of digital telephones stated in I-ETS 300 245-2 and 3.

MSs will have to work in a variety of environments ranging from quiet office locations to very noisy environments as found in moving cars. In noisy conditions, different values for the sending and receiving sensitivities relative to the nominal values can increase the performance of the terminal. Some guidance is given in annex E.

The overall transmission performance in full duplex conversation mode will also greatly depend on the performance of the echo control devices which may be included in the connection.

The handsfree requirements in the present document are designed to provide a basic level of performance and to avoid adverse interactions with other networks. Testing is carried out in one configuration in a vehicle, whilst this gives some confidence that the system can work in a typical environment, the testing is by no means complete. It is assumed that the manufacturer submits the handsfree system with the transducers fitted in reasonable locations within the vehicle (the transducers should not impede the normal operation of the vehicle or its fittings). Unusual installations should be agreed for suitability with the relevant Type Approval Authority before testing.

In a real vehicle installation, care should be taken to allow for the acoustic properties of that vehicle and the likely acoustic environment. It is important that the best possible coupling between the microphone and the MS user is achieved. Hence the microphone should be directional and mounted as close to the user's mouth as practical. The loudspeakers should be mounted in such a way that the maximum receive signal is directed at the user, rather than dissipated by the various obstacles in that vehicle, such as the seats.

Proper consideration for the noise environment and the direct coupling between the microphone and loudspeakers is necessary. Excessive noise coupled into the microphone can mask the MS user's send speech and potentially affect the operation of DTX. The vehicle noise environment can potentially mask the received speech, unless sufficient volume is provided. However, direct coupling between the transducers can cause annoying echo to be heard by the far end user.

Primary factors affecting the coupling between the loudspeaker(s) and microphone(s) include:

1) directionality of the microphone(s);

2) directionality of the loudspeaker(s);

3) location of the transducers in relation to each other and reflecting surfaces such as the windows and windscreen.

3.1 Overall Loss/Loudness ratings

The overall international connection involving PLMNs and the PSTN should meet the overall loudness rating (OLR) limits in ITU-T Recommendation G.111. The national parts of the connection should therefore meet the send and receive loudness rating (SLR, RLR) limits in ITU-T Recommendation G.121.