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Foreword

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

This ETS specifies the comfort noise aspect for full rate speech traffic channels for the digital cellular telecommunications system.

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Date of adoption:	18 April 1997
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1 Scope

This European Telecommunication Standard (ETS) gives the detailed requirements for the correct operation of the background acoustic noise evaluation, noise parameter encoding/decoding and comfort noise generation in GSM Mobile Stations (MS)s and Base Station Systems (BSS)s during Discontinuous Transmission (DTX) on full rate speech traffic channels.

The requirements described in this ETS are mandatory for implementation in all GSM MSs. The receiver requirements are mandatory for implementation in all GSM BSSs, the transmitter requirements only for those where downlink DTX will be used.

2 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.

- [1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".
- [2] GSM 05.03 (ETS 300 909): "Digital cellular telecommunications system (Phase 2+); Channel coding".
- [3] GSM 06.10 (ETS 300 961): "Digital cellular telecommunications system; Full rate speech; Transcoding".
- [4] GSM 06.31 (ETS 300 964): "Digital cellular telecommunications system; Full rate speech; Discontinuous Transmission (DTX) for full rate speech traffic channels".

3 Definitions and abbreviations

The definitions of terms used in this ETS can be found in GSM 01.04 [1] and GSM 06.31 [4].

Abbreviations used in this ETS are listed in GSM 01.04 [1].

4 General

The overall operation of Discontinuous Transmission is described in GSM 06.31 [4].

A basic problem when using DTX is that the background acoustic noise, which is transmitted together with the speech, would disappear when the radio transmission is cut, resulting in a modulation of the background noise. Since the DTX switching can take place rapidly, it has been found that this effect can be very annoying for the listener - especially in a car environment with high background noise levels. In bad cases the speech may be hardly intelligible.

This ETS specifies the way to overcome this problem by generating on the receive side synthetic noise similar to the transmit side background noise. The parameters of this so called comfort noise are estimated on the transmit side and transmitted to the receive side before the radio transmission is cut and at a regular low rate afterwards. This allows the comfort noise to adapt to the changes of the noise on the transmit side.

5 Functions on the transmit side

The comfort noise evaluation algorithm uses the unquantized block amplitude and Log Area Ratio (LAR) parameters of the full rate speech encoder, defined in subclauses 4.2.15 and 4.2.6 of GSM 06.10 [3]. These parameters give information on the level and the spectrum of the background noise, respectively.

The evaluated comfort noise parameters are encoded into a special frame, called a SID (Silence Descriptor) frame, for transmission to the receive side.

The SID frame also serves to initiate the comfort noise generation on the receive side, as a SID frame is always sent at the end of a speech burst, i.e. before the radio transmission is cut.

The scheduling of SID or speech frames on the radio path is described in GSM 06.31 [4].

5.1 Background acoustic noise evaluation

The comfort noise parameters to be encoded into a SID frame are calculated over $N=4$ consecutive frames marked with $VAD=0$, as follows:

The Log Area Ratio parameters shall be averaged according to the equation:

$$\text{mean}(LAR(i)) = \frac{1}{N} \sum_{n=1}^N LAR[j-n](i) \quad i = 1, 2, \dots, 8$$

where $LAR[j](i)$ is the i 'th Log Area Ratio coefficient of the current frame j and $j-n$ indicates the previous frames.

The block amplitude parameter shall be averaged according to the equation:

$$\text{mean}(x_{\max}) = \frac{1}{(4N)} \sum_{n=1}^N \sum_{i=1}^4 x_{\max}[j-n](i) \quad i = 1, 2, \dots, 8$$

where $x_{\max}[j](i)$ is the block amplitude in sub-segment i of the current frame. The SID frame containing these averaged parameters is passed to the Radio Subsystem instead of frame number j .

5.2 SID-frame encoding

The SID-frame encoding algorithm exploits the fact that only some of the 260 bits in a frame are needed to code the comfort noise parameters. The other bits can then be used to mark the SID-frame by means of a fixed bit pattern, called the SID code word.

The log area ratio coefficients are replaced by the mean ($LAR(i)$) values defined above and encoded as described in GSM 06.10 [3].

The block amplitude values are replaced by the mean (x_{\max}) value defined above, repeated four times inside the frame and encoded as described in GSM 06.10 [3].

The SID code word consists of 95 bits which are all zero. The bits of the SID code word are inserted in the SID field defined as the positions of those 95 bits of the encoded RPE-pulses X_{mc} , which are in the error protection class I (see GSM 05.03 [2], table 2).

The remaining bits in the SID frame are set to zero. The use of these bits is for further study.

6 Functions on the receive side

The situations in which comfort noise shall be generated on the receive side are defined in GSM 06.31 [4]. Generally speaking, the comfort noise generation is started or updated whenever a valid SID frame is received.

6.1 Comfort noise generation and updating

The comfort noise generation procedure uses the RPE-LTP speech decoder algorithm defined in GSM 06.10 [3].

When comfort noise is to be generated, then the various encoded parameters are set as follows:

The RPE pulses (X_{mcr}) are replaced by a locally generated random integer sequence, uniformly distributed between 1 and 6.

Also the grid position parameters (M_{cr}) are set to random integer values, uniformly distributed between 0 and 3.

The LTP gain values (b_{cr}) are set to 0.

The LTP lag values (N_{cr}) of the 4 sub-segments are set to 40, 120, 40 and 120 respectively.

The 4 block amplitude values (X_{maxcr}) used are those received in the SID frame.

The log area ratio parameters (LAR_{cr}) used are those received in the SID frame.

With these parameters, the speech decoder now performs the standard operations described in GSM 06.10 [3] and synthesizes comfort noise.

Updating of the comfort noise parameters occurs each time a valid SID frame is received, as described in GSM 06.31 [4].

When updating the comfort noise, the parameters above should preferably be interpolated over a few frames to obtain smooth transitions.

History

Document history	
December 1996	Unified Approval Procedure UAP 61: 1996-12-16 to 1997-04-11
May 1997	First Edition