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GSM

**GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS**

Digital cellular telecommunications system;
Discontinuous Transmission (DTX) for Enhanced
Full Rate (EFR) speech traffic channels
(GSM 06.81)

ETSI

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Foreword

This final draft European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Vote phase of the ETSI standards approval procedure.

This final draft ETS describes the general baseband operation of Enhanced Full Rate speech traffic channels in the transmitter and in the receiver of GSM Mobile Stations and Base Station Systems during Discontinuous Transmission (DTX) within the digital cellular telecommunications system.

This final draft ETS corresponds to GSM technical specification, GSM 06.81, version 5.1.1

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
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Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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1   Scope

This European Telecommunication Standard (ETS) gives a description of the general baseband operation of Enhanced Full Rate speech traffic channels in the transmitter and in the receiver of GSM Mobile Stations (MS)s and Base Station Systems (BSS)s during Discontinuous Transmission (DTX).

For clarity, the description is structured according to the block diagrams in figures 1 and 4. Except in the case described next, this structure of distributing the various functions between system entities is not mandatory for implementation, as long as the operation on the air interface and on the speech decoder output remains the same.

In the case of BSSs where the speech transcoder is located remotely in the Base Station Controller (BSC), the implementation of the interfaces between the DTX handlers and the Radio Sub System (RSS) as described in this ETS together with all their flags is mandatory, being part of the A-bis interface as described in GSM 08.60 (ETS 300 737) [13].

The DTX functions described in this technical specification are mandatory for implementation in the 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 100): "Digital cellular telecommunication system (Phase 2); Abbreviations and acronyms".

[2]   GSM 04.08 (ETS 300 557): "Digital cellular telecommunication system (Phase 2); Mobile radio interface layer 3 specification".

[3]   GSM 05.03 (ETS 300 575): "Digital cellular telecommunication system (Phase 2); Channel coding".

[4]   GSM 05.05 (ETS 300 577): "Digital cellular telecommunication system (Phase 2); Radio transmission and reception".

[5]   GSM 05.08 (ETS 300 578): "Digital cellular telecommunication system (Phase 2); Radio subsystem link control".

[6]   GSM 06.51 (ETS 300 723): "Digital cellular telecommunications system; Enhanced Full Rate (EFR) speech processing functions; General description".

[7]   GSM 06.53 (ETS 300 724): "Digital cellular telecommunications system; ANSI-C code for the GSM Enhanced Full Rate (EFR) speech codec".

[8]   GSM 06.54 (ETS 300 725): "Digital cellular telecommunications system (Phase 2); Test vectors for the GSM Enhanced Full Rate (EFR) speech codec".

[9]   GSM 06.60 (ETS 300 726): "Digital cellular telecommunications system; Enhanced Full Rate (EFR) speech transcoding".

[10]   GSM 06.61 (ETS 300 727): "Digital cellular telecommunications system; Substitution and muting of lost frame for Enhanced Full Rate (EFR) speech traffic channels".

[11]   GSM 06.62 (ETS 300 728): "Digital cellular telecommunications system; Comfort noise aspects for Enhanced Full Rate (EFR) speech traffic channels".

[12]   GSM 06.82 (ETS 300 730): "Digital cellular telecommunications system; Voice Activity Detector (VAD) for Enhanced Full Rate (EFR) speech traffic channels".

[13]   GSM 08.60 (ETS 300 737): "Digital cellular telecommunication system (Phase 2+); Inband control of remote transcoders and rate adaptors for Enhanced Full Rate (EFR) and full rate traffic channels".

3   Definitions, symbols and abbreviations

3.1   Definitions

For the purpose of this ETS, the following definitions apply.

frame: Time interval of 20 msec. corresponding to the time segmentation of the Enhanced Full Rate speech transcoder (GSM 06.60 (ETS 300 726) [9]), also used as a short term for a traffic frame.

traffic frame: Block of 244 information bits transmitted on the Enhanced Full Rate speech traffic channel.

SID frame: Frame characterized by the SID (SIlence Descriptor) code word. It conveys information on the acoustic background noise.

SID code word: Fixed bit pattern defined in GSM 06.62 (ETS 300 728) [11], for labelling a traffic frame as a SID frame.

SID field: The bit positions defined in GSM 06.62 (ETS 300 728) [11], of the SID codeword within a SID frame.

speech frame: Traffic frame that cannot be classified as a SID frame.

bad traffic frame: A traffic frame flagged BFI flag ="1" (Bad Frame Indication) by the Radio Subsystem.

good traffic frame: A traffic frame flagged BFI flag ="0" by the Radio Subsystem.

good speech frame: A good traffic frame which is not an accepted SID frame.

accepted SID frame: A traffic frame which is flagged with SID="1" or SID="2" by the Radio Subsystem.

valid SID frame: A good traffic frame flagged with SID="2" by the Radio Subsystem. This frame is valid for updating of comfort noise parameters at any time.

invalid SID frame: An accepted SID frame which was not classified as valid SID frame. This frame is not valid for updating comfort noise parameters, but the frame conveys information that comfort noise generations should be started or continued.

unusable frame: A bad traffic frame that is not an accepted SID frame.

lost SID frame: An unusable frame received when the RX DTX handler is generating comfort noise and a SID frame is expected (Time Alignment Flag, TAF="1").

lost speech frame: An unusable frame received when the RX DTX handler is passing on traffic frames directly to the speech decoder.

VAD flag: Boolean flag, generated by the VAD algorithm defined in GSM 06.82 (ETS 300 729) [12] indicating the presence ("1") or the absence ("0") of a speech frame.

SP flag: Boolean flag, generated by the TX DTX handler, indicating the presence of a speech frame ("1") or the presence of a SID frame ("0").

TAF flag: Time Alignment Flag. Boolean flag, marks with TAF=1 those traffic frames that are aligned with the SACCH multiframe structure (see GSM 05.08 (ETS 300 578) [5]). The next SID frame is expected at the decoder when TAF=1.

hangover period: A period of 7 frames added at the end of a speech burst in which VAD flag ="0" and SP flag ="1".

3.2   Symbols

For the purpose of this ETS, the following symbols apply.

$N_{elapsed}$ Number of elapsed frames since the last updated SID frame.

3.3   Abbreviations

For the purpose of this ETS, the following abbreviations apply.

BFI   Bad Frame Indicator
BSC   Base Station Controller
BSS   Base Station System
DTX   Discontinuous Transmission
ETS   European Telecommunication Standard
FACCH   Fast Associated Control CHannel
GSM   Global System for Mobile Telecommunications
MS   Mobile Station
RSS   Radio Sub System
RX   Receive
SACCH   Slow Associated Control CHannel
SID   SIlence Descriptor
TX   Transmit
VAD   Voice Activity Detector

For abbreviations not given in this subclause, see GSM 01.04 (ETR 100) [1].

4   General

Discontinuous Transmission (DTX) is a mechanism which allows the radio transmitter to be switched off most of the time during speech pauses for the following two purposes:

-       to save power in the Mobile Station (MS);

-       to reduce the overall interference level over the air interface.

DTX shall be in operation in GSM MS if commanded so by the network, see GSM 04.08 (ETS 300 557) [2].

4.1   General organization

The overall DTX mechanism described in this draft ETS requires the following functions:

-       a Voice Activity Detector (VAD) on the transmit (TX) side;

-       evaluation of the background acoustic noise on the transmit (TX) side, in order to transmit characteristic parameters to the receive (RX) side;

-       generation on the receive (RX) side of a similar noise, called comfort noise, during periods where the radio transmission is switched off.

The Voice Activity Detector (VAD) is defined in GSM 06.82 (ETS 300 729) [12] and the comfort noise functions in GSM 06.62 (ETS 300 728) [11]. Both are based partly on the speech transcoder and its internal variables, defined in GSM 06.60 (ETS 300 726) [9].

In addition to these functions, if the parameters arriving at the RX side are detected to be seriously corrupted by errors, the speech or comfort noise must be generated from substituted data in order to avoid seriously annoying effects for the listener. This function is defined in GSM 06.61 (ETS 300 727) [10].

An overall description of the speech processing parts can be found in GSM 06.51 (ETS 300 723) [6].

5 Transmit (TX) side

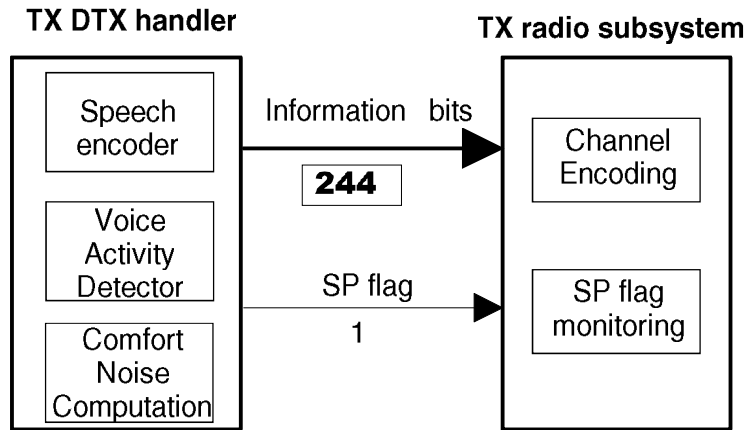A block diagram of the transmit side DTX functions is shown in figure 1.

Figure 1: Block diagram of the transmit side DTX functions

5.1 General operation

The TX DTX handler continuously passes traffic frames, individually marked by a flag SP, to the Radio Subsystem (RSS). This binary flag is redundant to the SID code word labelling. SP flag ="1" indicates a speech frame, SP flag ="0" a SID frame.

The scheduling of the frames for transmission on the air interface is controlled by the radio subsystem (RSS) alone, on the basis of the SP flag as described in subclause 5.1.1.

5.1.1 Functions of the TX DTX handler

To allow an exact verification of the TX DTX handler functions, all frames before the reset of the system are treated as if there were speech frames of an infinitely long time. Therefore, the first 7 frames after the reset are always marked with SP flag ="1", even if VAD flag ="0" (hangover period, see figure 2).

The Voice Activity Detector (VAD) shall operate all the time in order to assess whether the input signal contains speech or not. The output is a binary flag (VAD flag ="1" or VAD flag ="0", respectively) on a frame by frame basis (see GSM 06.82 (ETS 300 729) [12]).

The VAD flag controls indirectly, via the TX DTX handler operations described below, the overall DTX operation on the transmit side.

Whenever VAD flag ="1", the speech encoder output frame shall be passed directly to the radio subsystem (RSS), marked with SP flag ="1".

At the end of a speech burst (transition VAD flag ="1" to VAD flag ="0"), it takes 8 consecutive frames to make a new updated SID frame available (see GSM 06.62 (ETS 300 728) [11]). Normally, the first 7 speech encoder output frames after the end of the speech burst shall therefore be passed directly to the radio subsystem, marked with SP flag ="1" ("hangover period"). The first new SID frame is then passed to the RSS as frame 8 after the end of the speech burst, marked with SP flag ="0" (see figure 2).
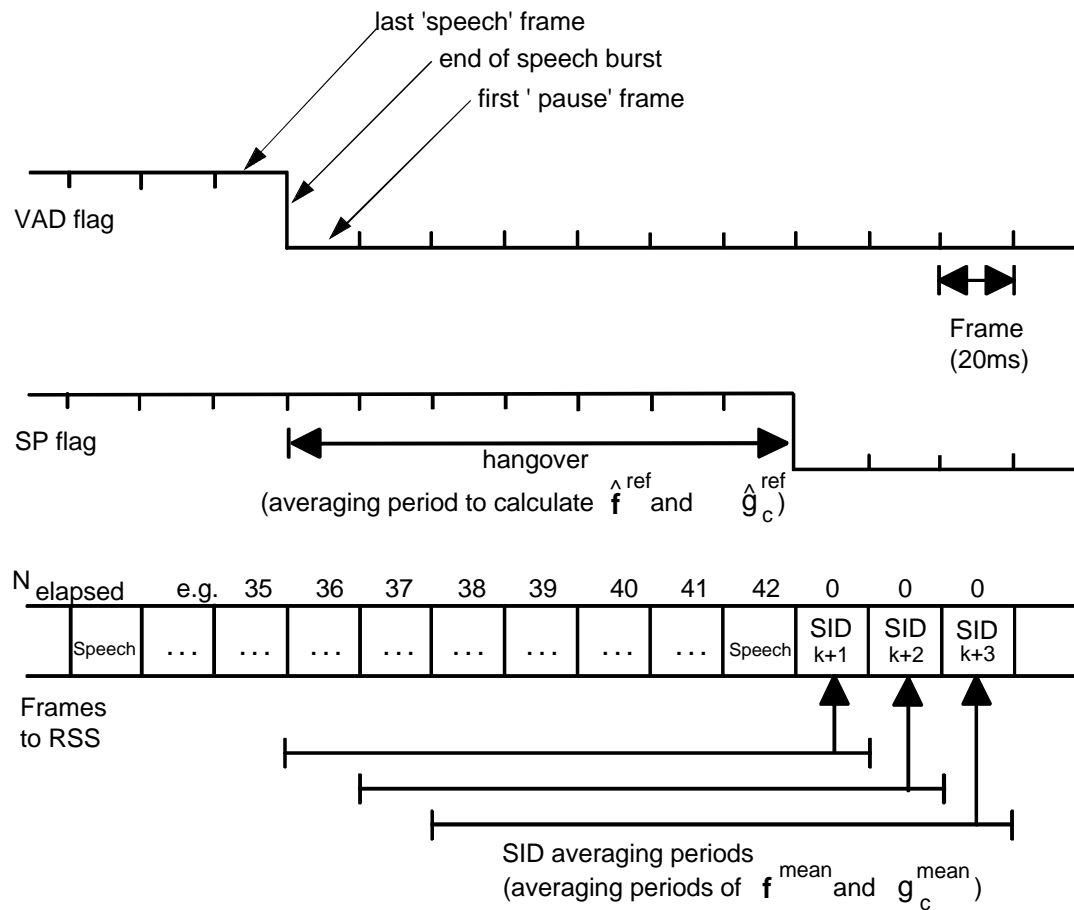
Figure 2: Normal hangover procedure (N$_{elapsed}$ > 23)

If, however, at the end of the speech burst, less than 24 frames have elapsed since the last SID frame was computed and passed to the RSS, then this last SID frame shall repeatedly be passed to the RSS, until a new updated SID frame is available (8 consecutive frames marked with VAD flag ="0").This reduces the activity on the air in cases where short background noise spikes are taken for speech, by avoiding the "hangover" waiting for the SID frame computation (see figure 3).

NOTE: Figure 3 shows as example the longest possible speech burst without hangover.
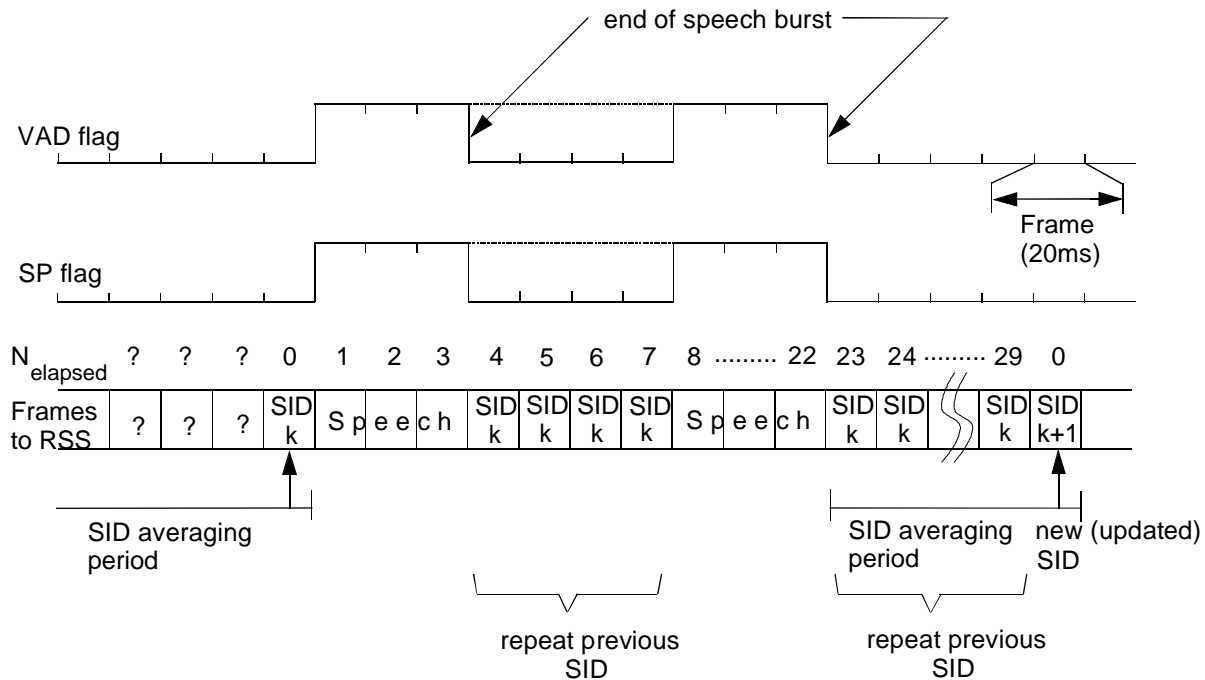
Figure 3: Handling of short speech bursts ($N_{elapsed} < 24$) (Example)

Once the first SID frame after the end of a speech burst has been computed and passed to the Radio Subsystem, the TX DTX handler shall continuously compute and pass updated SID frames to the Radio Subsystem (RSS), marked with SP flag ="0" as long as VAD flag ="0".

The speech encoder is operated in full speech modality if SP flag ="1" and in a simplified mode if SP flag ="0", because not all encoder functions are required for the evaluation of comfort noise parameters.

5.1.2 Functions of the TX Radio Subsystem

The following traffic frames shall be scheduled for transmission:

- all frames marked with SP flag ="1";

- the first one with SP flag ="0" after one or more frames with SP flag ="1";

- those marked with SP=0 and aligned with the SACCH multiframe structure as described in GSM 05.08 (ETS 300 578) [5].

This has the overall function, that the radio transmission is cut after the transmission of a SID frame when the speaker stops talking. During speech pauses the transmission is resumed at regular intervals for transmission of one SID frame, in order to update the generated comfort noise on the RX side (and to improve the measurement of the link quality by the RSS).

If a SID frame (SP flag ="0"), scheduled for transmission is stolen for Fast Associated Control Channel (FACCH) signalling purposes, then the subsequent frame shall be scheduled for transmission instead.

6   Receive (RX) side

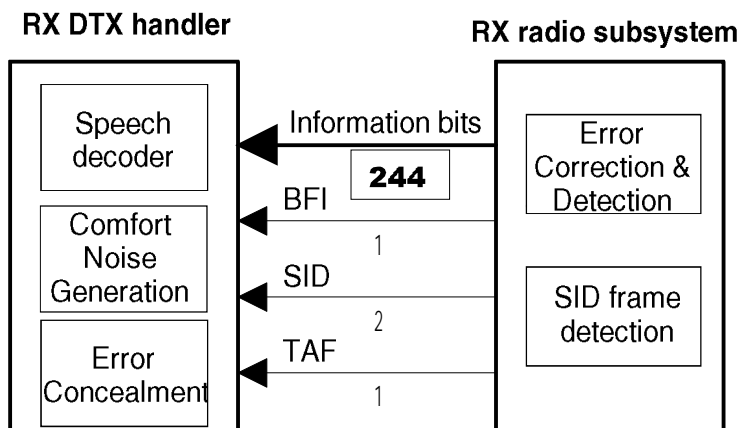A block diagram of the receive side DTX functions is shown in figure 4 below.

Figure 4: Block diagram of the receive side DTX functions

6.1   General operation

Whatever their context (speech, SID, FACCH or none), the RSS continuously passes the received traffic frames to the RX DTX handler, individually marked by various pre-processing functions with 3 flags. These are the Bad Frame Indicator (BFI) flag, the Silence Descriptor (SID) flag and the Time Alignment Flag (TAF) described in subclause 6.1.1 and table 1, which serve to classify the traffic frame according to the list of terms defined in subclause 3.1. This classification, summarized in table 1, allows the RX DTX handler to determine in a simple way how the received frame is to be handled.

Table 1: Classification of traffic frames

BFI	SID		
	2	1	0
0	Valid SID frame		Good speech frame
1	Invalid SID frame		Unusable frame

6.1.1   Functions of the RX radio subsystem

The binary BFI flag (see GSM 05.05 (ETS 300 577) [4]) indicates whether the traffic frame is considered to contain meaningful information bits (BFI flag ="0") or not (BFI flag ="1"). In the context of this draft ETS, a FACCH frame is considered not to contain meaningful bits and shall be marked with BFI flag ="1". The BFI flag must fulfil the performance requirements of GSM 05.05 (ETS 300 577) [4].

The SID frame detector compares bit by bit the relevant bits of the received traffic frame (the SID field) with the SID code word defined in GSM 06.62 (ETS 300 728) [11] and gives back the ternary SID flag. The SID flag is coded as follows, where n designates the number of bit deviations:

$SID = 2$ when $n < 2$

$SID = 1$ when $2 <= n < 16$

$SID = 0$ when $n >= 16$

The binary TAF flag marks with TAF="1" those traffic frames that are aligned with the SACCH multiframe structure as described in GSM 05.08 (ETS 300 578) [5].

6.1.2 Functions of the RX DTX handler

The RX DTX handler is responsible for the overall DTX operation on the RX side.

The DTX operation on the RX side shall be as follows:

- whenever a good speech frame is detected, the DTX handler shall pass it directly on to the speech decoder;

- when lost speech or lost SID frames are detected, the substitution and muting procedure defined in GSM 06.61 (ETS 300 727) [10] shall be applied;

- valid SID frames shall result in comfort noise generation, as defined in GSM 06.62 (ETS 300 728) [11], until the next SID frame is expected (TAF ="1") or good speech frames are detected. During this period, the RX DTX handler shall ignore any unusable frames delivered by the RSS;

- an invalid SID frame shall be substituted by the last valid SID frame and the procedure for valid SID frames be applied.

History

Document history			
March 1996	Public Enquiry	PE 103:	1996-03-04 to 1996-06-28
November 1996	Vote	V 115:	1996-11-25 to 1997-01-17