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pr **ETS 300 395-1**

March 1996

EUROPEAN TELECOMMUNICATION STANDARD

Source:ETSI TC-RES

Reference: DE/RES-06002-1

ICS: 33.020, 33.060.50

Key words: TETRA, CODEC

Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA); Speech codec for full-rate traffic channel; Part 1: General description of speech functions

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Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Radio Equipment Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Public Enquiry phase of the ETSI standards approval procedure.

This ETS consists of four parts as follows:

Part 1: "General description of speech functions";

Part 2: "TETRA codec";

Part 3: "Specific operating features";

Part 4: "Codec conformance testing".

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

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1 Scope

This ETS is an introduction to the other parts of this ETS dealing with the speech processing functions in the TETRA system. In addition to this introduction, this ETS contains the full specification of the speech codec including provisions for specific cases of operation and optional functionalities plus codec conformance testing. In this part, a general overview of the speech processing parts is given with reference to the ETSs where each part is specified in detail.

2 Normative references

This ETS incorporates, by dated or 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] ETS 300 395-2 (1995): "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA) system; Speech codec for full-rate traffic channel; Part 2: TETRA codec".

[2] ETS 300 395-3 (1995): "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA) system; Speech codec for full-rate traffic channel; Part 3: Specific operating features".

[3] ETS 300 395-4 (1995): "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA) system; Speech codec for full-rate traffic channel; Part 4: Codec conformance testing".

[4] ETS 300 392-2 (1995): "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA) system; Voice plus Data; Part 2: Air Interface".

[5] ETS 300 392-7 (1995): "Radio Equipment and Systems (RES); Trans-European Trunked Radio (TETRA) system; Voice plus Data; Part 7: Security".

3 Definitions, and abbreviations

3.1 Definitions

Refer to ETS 300 392 part 2 [4], clause 3 for common TETRA definitions.

3.2 Abbreviations

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

ACELP	Algebraic CELP
BS	Base Station
CELP	Code-Excited Linear Predictive
MFG	Missing Frame Generation
MFS	Missing Frame Substitution
MS	Mobile Station
PCM	Pulse Code Modulated

Refer to ETS 300 392 part 2 [4], clause 3 for common TETRA abbreviations.

4 General

Figure 1 illustrates a reference configuration with the various speech processing functions shown as building blocks. When appropriate, the relevant clauses of this ETS are mentioned in the corresponding building block. The data exchanged between the various functions are also indicated on figure 1.

NOTE 1: The standardised interface points are specifically identified by circled numbers. The unnumbered interfaces are unspecified and may consist of any information required by the implementation.

On figure 1, audio parts are included to exhibit the entire speech path between the audio input/output in the Mobile Station (MS) and the digital interface to any network in the Base Station (BS). However, it must be understood that such audio parts are provided only for the convenience of the reader, but are not further defined in the TETRA standard. Therefore, the audio input and output to and from the TETRA speech codec is specified as 16 bit linear Pulse Code Modulated (PCM).

In most of the operational configurations, the speech codec will be associated to an encryption unit. This unit appears also on figure 1 in both the transmit and the receive sides.

NOTE 2: The definition of the messages at standardised interface points 3, 4 and 8 are given in ETS 300 392-7 [5].

5 Full rate speech codec

As shown on figure 1, the speech encoder input consists of a 16 bit uniform PCM signal coming either from the audio parts of the MS or from the interface with the network at the BS. At the output of the speech encoder, the processed speech is delivered to the channel coding function in order to produce in normal operative conditions an encoded block of 432 bits for 60 ms of speech data, which corresponds to a gross bit rate of 7,2 kbit/s. However, when capacity of the speech traffic channel is partly stolen for signalling purposes, the channel coding function shall produce only an encoded block of 216 bits for 30 ms of speech data.

At the receiver side, the inverse operations shall take place. In addition to the previously defined signals, the speech decoder shall receive from the speech decoder control a bad frame indication flag allowing error concealment and therefore generation of modified speech parameters.

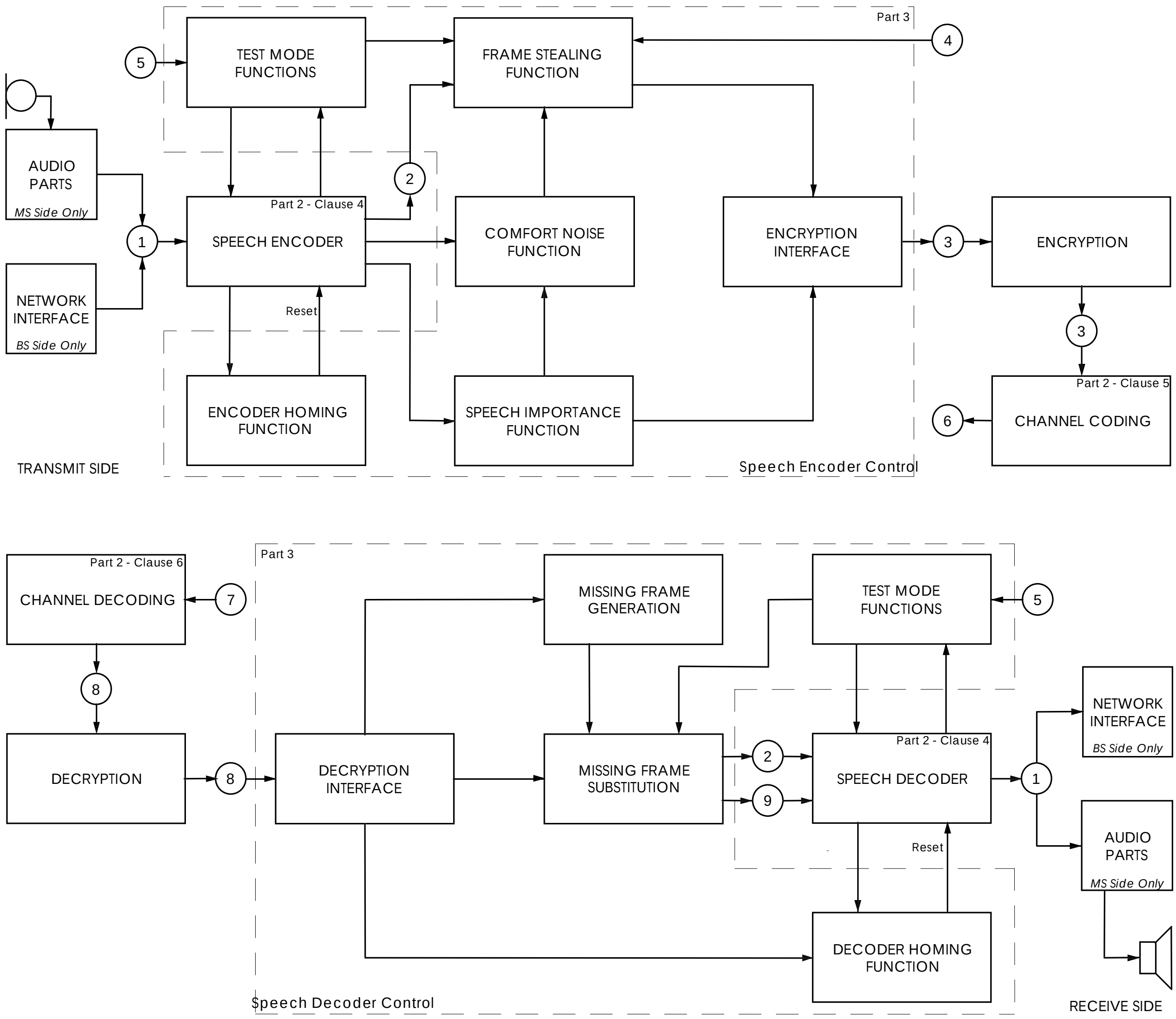
The full rate speech source encoder and decoder is entirely defined in ETS 300 395 part 2 [1], clause 4. This clause describes the detailed mapping between input blocks of 240 speech samples in 16-bit uniform PCM format to encoded blocks of 137 bits and from encoded blocks of 137 bits to output blocks of 240 reconstructed speech samples. The sampling rate shall be 8 000 sample/s leading to an average bit rate for the encoded speech parameters of 4 567 bit/s.

The speech coding/decoding algorithm is based on the Code-Excited Linear Predictive (CELP) coding model. The TETRA codec implements an Algebraic CELP (ACELP) technique in which special innovation codebooks having an algebraic structure are used.

Clause 4 of ETS 330 395-2 [1] provides a complete description of the codec, including detailed block diagrams, while ETS 300 395-2 [1], clause 8 introduces the bit exact description of the codec. This description is given as C code, fixed point, bit exact, written according to the ANSI C language standards.

ETS 330 395-2 [1], clause 5 describes in the same manner the speech channel encoder, ETS 330 395-2 [1], clause 6 the speech channel decoder, and ETS 330 395-2 [1], clause 7 the codec performance, including the minimum required speech channel decoder performance.

Such a description enables the verification of compliance to ETS 300 395-2 [1] to a high degree of confidence by use of a set of digital test sequences. These test sequences, as well as their practical use, are described in ETS 300 395-4 [3].



1) 16 bit uniform PCM, 8 000 samples/s
2) Encoded speech frame 30 ms, 137 bits/frame
3) Encoded speech frame in "TMD_UNITDATA_request" message
4) Stolen indication in "TMD_REPORT_indication" message
5) Test mode control
6) Encoded block delivered by the channel coding function
7) Encoded block received by the channel decoding function
8) Encoded speech frame in "TMD_UNITDATA_indication" message
9) Bad frame indicator

Figure 1: Overview of audio processing functions

6 Speech control unit

All the other functions associated with the speech codec as illustrated in figure 1 are described in ETS 300 395-3 [2].

6.1 Lost frame aspects

At the receiver side, speech frames may be lost due to either transmission errors or frame stealing. In the TETRA system, frame stealing may be needed for system control purposes or for ciphering synchronisation. In any case, specific actions have to be taken in order to provide the speech decoder with an adequate set of parameters allowing a smooth restitution of the speech waveform. The two functions Missing Frame Generation (MFG) and Missing Frame Substitution (MFS) may be used for that purpose.

At the encoder, the frame stealing function can, on request, replace by other information the contents of the encoded speech frame delivered by the speech encoder. As frame stealing is the result of a decision taken by the system, the speech encoder may take advantage of this information.

6.2 Comfort noise aspects

In case of important flat fading, i.e. corresponding to a significant number of lost frames, it is no longer possible to generate an acceptable synthetic signal from previously received speech parameters. In order to avoid annoying discontinuities due to the possibility of no sound perceived at the receiver, and therefore to provide a better listening comfort to the user, some additional process may be useful.

At the encoder, the comfort noise function may compute specific parameters which can be used for comfort noise generation at the receiver.

6.3 Importance parameter

In the framework of the TETRA system, a number of arising issues can be efficiently solved if it is possible to detect with enough reliability an importance parameter for each speech frame. Examples of applications involving such an importance parameter include initiation or termination of transmission, control of discontinuous transmission, control of communication direction in half-duplex mode, control of comfort noise generation at the receiver, or still indication of a frame stealing possibility with minimal impact on speech.

The speech importance function shall compute this importance parameter.

6.4 Homing function

The TETRA speech codec is defined in bit exact arithmetic. Consequently, a given input sequence shall always produce the corresponding bit exact output sequence, provided that the internal state variables are also always reset to a known state at the beginning of the experiment.

The input test sequences provided in ETS 300 395-4 [3] shall result in corresponding output test sequences, provided that the tested modules are in their home-state when starting.

Special inband signalling frames described in ETS 300 395-3 [2] have been defined to provoke reset of the speech coder and decoder to a known state.

7 Conformance testing

TETRA codec conformance testing is entirely described in ETS 300 395-4 [3]. This ETS focuses on the core of the TETRA codec, as described in ETS 300 395-2 [1], while the specific operating features as described in ETS 300 395-3 [2] should be disabled for conformance testing purposes.

History

Document history		
March 1996	Public Enquiry	PE 103: 1996-03-04 to 1996-06-28