

ETSI TS 126 442 V16.0.0 (2020-08)



**Universal Mobile Telecommunications System (UMTS);
LTE;
5G;
Codec for Enhanced Voice Services (EVS);
ANSI C code (fixed-point)
(3GPP TS 26.442 version 16.0.0 Release 16)**



Reference

RTS/TSGS-0426442vg00

Keywords

5G,LTE,UMTS

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2020.

All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

3GPP™ and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

oneM2M™ logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners.

GSM® and the GSM logo are trademarks registered and owned by the GSM Association.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under <http://webapp.etsi.org/key/queryform.asp>.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

| | |
|---|-----------|
| Intellectual Property Rights | 2 |
| Legal Notice | 2 |
| Modal verbs terminology..... | 2 |
| Foreword..... | 4 |
| 1 Scope | 5 |
| 2 References | 5 |
| 3 Definitions and abbreviations..... | 6 |
| 3.1 Definitions | 6 |
| 3.2 Abbreviations | 6 |
| 4 C code structure..... | 6 |
| 4.1 Contents of the C source code..... | 6 |
| 4.2 Program execution..... | 7 |
| 5 File formats | 7 |
| 5.1 Speech file (encoder input / decoder output)..... | 7 |
| 5.2 Rate switching profile (encoder input) | 8 |
| 5.3 Parameter bitstream file (encoder output / decoder input) | 8 |
| 5.3.1 ITU-T G.192 compliant format..... | 8 |
| 5.3.2 Compact storage format file..... | 8 |
| 5.4 VoIP parameter bitstream file (decoder input) | 8 |
| 5.5 Bandwidth switching profile (encoder input)..... | 8 |
| 5.6 Channel-aware configuration file (encoder input and decoder output) | 9 |
| 5.7 JBM trace file (decoder output)..... | 9 |
| Annex A (informative): Change history | 10 |
| History | 11 |

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document contains an electronic copy of the ANSI-C code for the Enhanced Voice Services (EVS) Codec. The ANSI-C code is necessary for a bit exact implementation of the EVS Codec (3GPP TS 26.445), Voice Activity Detection (VAD) (3GPP TS 26.451), Comfort Noise Generation (CNG) (3GPP TS 26.449), Discontinuous Transmission (DTX) (3GPP TS 26.450), Packet Loss Concealment (PLC) of Lost Packets (3GPP TS 26.447), Jitter Buffer Management (JBM) (3GPP TS 26.448), and AMR-WB Interoperable Function (3GPP TS 26.446). Requirements for any implementation of the EVS codec to be standard compliant are specified in 3GPP TS 26.444 (Test sequences).

2 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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 26.445: "Codec for Enhanced Voice Services (EVS); Detailed Algorithmic Description".
- [3] 3GPP TS 26.451: "Codec for Enhanced Voice Services (EVS); Voice Activity Detection (VAD)".
- [4] 3GPP TS 26.449: "Codec for Enhanced Voice Services (EVS); Comfort Noise Generation (CNG) Aspects".
- [5] 3GPP TS 26.450: "Codec for Enhanced Voice Services (EVS); Discontinuous Transmission (DTX)".
- [6] 3GPP TS 26.447: "Codec for Enhanced Voice Services (EVS); Error Concealment of Lost Packets".
- [7] 3GPP TS 26.448: "Codec for Enhanced Voice Services (EVS); Jitter Buffer Management".
- [8] 3GPP TS 26.446: "Codec for Enhanced Voice Services (EVS); AMR-WB Backward Compatible Functions".
- [9] 3GPP TS 26.444: "Codec for Enhanced Voice Services (EVS); Test Sequences".
- [10] IETF RFC 3550: "RTP: A Transport Protocol for Real-Time Applications".
- [11] Recommendation ITU-T G.191 (03/10): "Software tools for speech and audio coding standardization".
- [12] Recommendation ITU-T G.192: "A common digital parallel interface for speech standardization activities".

3 Definitions and abbreviations

3.1 Definitions

Definition of terms used in the present document, can be found in 3GPP TS 26.445 [2], 3GPP TS 26.451 [3], 3GPP TS 26.449 [4], 3GPP TS 26.450 [5], 3GPP TS 26.447 [6], 3GPP TS 26.448 [7] and 3GPP TS 26.446 [8].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

| | |
|--------|--|
| ACELP | Algebraic Code-Excited Linear Prediction |
| AMR-WB | Adaptive Multi Rate Wideband (codec) |
| CNG | Comfort Noise Generator |
| DTX | Discontinuous Transmission |
| EVS | Enhanced Voice Services |
| FB | Fullband |
| FEC | Frame Erasure Concealment |
| IP | Internet Protocol |
| JBM | Jitter Buffer Management |
| MSB | Most Significant Bit |
| MTSI | Multimedia Telephony Service for IMS |
| NB | Narrowband |
| PS | Packet Switched |
| PSTN | Public Switched Telephone Network |
| SAD | Sound Activity Detection |
| SC-VBR | Source Controlled - Variable Bit Rate |
| SID | Silence Insertion Descriptor |
| SWB | Super Wideband |
| VAD | Voice Activity Detection |
| WB | Wideband |
| WMOPS | Weighted Millions of Operations Per Second |

4 C code structure

This clause gives an overview of the structure of the bit-exact C code and provides an overview of the contents and organization of the C code attached to the present document.

The C code has been verified on the following systems:

- IBM PC compatible computers with Windows 7 or 8 operating system and Microsoft Visual C++ 2010 compiler, 32 bit builds.
- IBM PC compatible computers with Linux operating system and GNU gcc compiler version 4.3.x, 32 bit builds.

ANSI-C was selected as the programming language because portability was desirable.

4.1 Contents of the C source code

The C code distribution is organized as follows:

Table 1: Source code directory structure

| Directory | Description |
|-----------------|---|
| README.txt | information on how to compile |
| Makefile | UNIX style encoder Makefile |
| Workspace_msvc/ | Directory for the MSVC 2010 project files |
| basic_op/ | Source code files containing all ITU-T fixed-point basic operators. |
| basic_math/ | Source code files contains mathematical fixed-point functions |
| lib_com/ | Source code files used in encoder and decoder |
| lib_dec/ | Source code files used solely in the decoder |
| lib_enc/ | Source code files used solely in the encoder |

The distributed files with suffix "c" contain the source code and the files with suffix "h" are the header files. The ROM data is contained in files named "rom_XXX" with suffix "c".

Makefiles are provided for the platforms in which the C code has been verified (listed above). Once the software is installed, this directory will have a compiled version of the encoder (named EVS_cod) and the decoder (named EVS_dec).

4.2 Program execution

The codec for Enhanced Voice Services is implemented in two programs:

- EVS_cod: speech/audio encoder;
- EVS_dec: speech/audio decoder.

The programs should be called like:

- EVS_cod [encoder options] <speech/audio input file> <parameter file>;
- EVS_dec [decoder options]<parameter file> <speech/audio output file>.

The speech/audio files contain 16-bit linear encoded PCM speech/audio samples and the parameter files contain encoded speech/audio data.

The encoder and decoder options will be explained by running the applications without input arguments. See the file readme.txt for more information on how to run the *encoder* and *decoder* programs.

5 File formats

This clause describes the file formats used by the encoder and decoder programs. The test sequences defined in [1] also use the file formats described here.

5.1 Speech file (encoder input / decoder output)

Speech files read by the encoder and written by the decoder consist of 16-bit words speech/audio sample. The byte order depends on the host architecture (e.g. LSByte first on PCs, etc.). Both the encoder and the decoder program process complete frames (corresponding to 20 ms, for example, 640 samples at 32 kHz sampling frequency) only.

The encoder will pad the last frame to integer multiples of 20ms frames, i.e. n speech frames will be produced from an input file with a length between $[(n-1)*20\text{ms}+1 \text{ sample}; n*20\text{ms}]$. The files produced by the decoder will always have a length of $n*20\text{ms}$.

5.2 Rate switching profile (encoder input)

The encoder program can optionally read in a rate switching profile which specifies the encoding bitrate for each frame of speech processed. The file is a binary file, generated by 'gen-rate-profile', which is part of STL 2009, as contained in ITU-T G.191 [11]. The rate switching profile can contain EVS primary mode bitrates and AMR-WB IO mode bitrates arbitrarily. I.e. switching between the two modes can be specified by the rate switching profile.

5.3 Parameter bitstream file (encoder output / decoder input)

The files produced by the speech/audio encoder/expected by the speech decoder contain an arbitrary number of frames in the following available formats.

5.3.1 ITU-T G.192 compliant format

| | | | | | |
|-----------|-------------|----|----|-----|-----|
| SYNC_WORD | DATA_LENGTH | B1 | B2 | ... | Bnn |
|-----------|-------------|----|----|-----|-----|

Each box corresponds to one `Word16` value in the bitstream file, for a total of $2+nn$ words or $4+2nn$ bytes per frame, where nn is the number of encoded bits in the frame. Each encoded bit is represented as follows: Bit 0 = 0x007f, Bit 1 = 0x0081. The fields have the following meaning:

- `SYNC_WORD`: Word to ensure correct frame synchronization between the encoder and the decoder. It is also used to indicate the occurrences of bad frames.

In the encoder output: (0x6b21)

In the decoder input: Good frames (0x6b21)

Bad frames (0x6b20)

- `DATA_LENGTH`: Length of the speech data. Codec mode and frame type is extracted in the decoder using this parameter

5.3.2 Compact storage format file

The encoder and decoder programs can optionally write and read a file in the octet-based compact storage format. The compact storage format is specified in Annex A.2.6 of [2].

5.4 VoIP parameter bitstream file (decoder input)

| | | | |
|-------------|--------------|------------|--------------------------|
| Packet size | Arrival time | RTP header | G.192 format (see 5.3.1) |
|-------------|--------------|------------|--------------------------|

The fields have the following size and meaning:

- Packet size: 32 bit unsigned integer. (= 12 + 2 + `DATA_LENGTH`)
- Arrival time: 32 bit unsigned integer. in ms.
- RTP header: 96 bits (see RFC 3550 [10]), including RTP timestamp and SSRC.

5.5 Bandwidth switching profile (encoder input)

The encoder program can optionally read in a bandwidth switching profile, which specifies the encoding bandwidth for each frame of speech processed. The file is a text file where each line contains "nb_frames B". B specifies the signal

bandwidth that is one of the supported four bandwidths, i.e. NB, WB, SWB or FB. And "nb_frames" is an integer number of frames and specifies the duration of activation of the accompanied signal bandwidth B.

5.6 Channel-aware configuration file (encoder input and decoder output)

The encoder program can optionally read in a configuration file which specifies the values of FEC indicator *p* and FEC offset *o*, where FEC indicator, *p*: LO or HI, and FEC offset, *o*: 2, 3, 5, or 7 in number of frames. Each line of the configuration file contains the values of *p* and *o* separated by a space.

The channel-aware configuration file is meant to simulate channel feedback from a receiver to a sender, i.e. the decoder would generate FEC indication and FEC offset values for receiver feedback that correspond to the current transmission channel characteristics, thereby allowing optimization of the transmission by the encoder which applies the FEC offset and FEC indication when in the channel-aware mode.

5.7 JBM trace file (decoder output)

The decoder can generate a JBM trace file with the `-Tracefile` switch as a by-product of the decoder operation in case of JBM operation (which is triggered with the `-VOIP` switch on the decoder side).

The trace file is a CSV file with semi-colon as separator. The trace file starts with one header line that contains the column names in the following order:

```
rtpSeqNo;rtpTs;rcvTime;playtime;active
```

For each played out speech frame one entry is written to the trace file. The interval of the playtime values is usually 20ms, but may differ, depending on the JBM operation. Each entry is a line in the trace file that contains values as specified in Table 1.

Table 1: JBM trace file entry format

| Name | Unit | Description |
|----------|--------|--|
| rtpSeqNo | 1 | RTP sequence number of played out speech frame. -1 if no corresponding RTP packet for the speech frame exists. |
| rtpTs | ms | RTP time stamp of played out speech frame. -1 if no corresponding RTP packet for the speech frame exists |
| rcvTime | ms | Absolute reception time of the RTP packet that corresponds to the speech frame. -1 if no corresponding RTP packet for the speech frame exists. |
| playtime | ms | Absolute play time (i.e. the time at which the PCM data is made available by the decoder). Can be floating-point value. |
| active | 0 or 1 | Binary entry, which is set to 1 for active speech frames (i.e. frames that are neither SID nor NO_DATA) |

Annex A (informative): Change history

| Change history | | | | | | | |
|----------------|---------|-----------|----------|-----|-----|---|-------------|
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2014-09 | SA#65 | SP-140458 | | | | Presented at TSG SA#65 foir approval | 1.0.0 |
| 2014-09 | SA#65 | | | | | Approved at TSG SA#65 | 12.0.0 |
| 2014-12 | SA#66 | SP-140724 | 000 1 | - | | Cleanup of EVS Fixed Point Source Code | 12.1.0 |
| 2014-12 | SA#66 | SP-140724 | 000 2 | - | | Bugfixes to EVS Fixed Point Source Code | 12.1.0 |
| 2014-12 | SA#66 | SP-140724 | 000 3 | 1 | | Update of Scope | 12.1.0 |
| 2015-03 | SA#67 | SP-150083 | 000 4 | 1 | | Corrections to the text of the specification | 12.2.0 |
| 2015-03 | SA#67 | SP-150083 | 000 5 | - | | Removal of Floating Point remants in the EVS Fixed Point Source Code | 12.2.0 |
| 2015-03 | SA#67 | SP-150083 | 000 6 | 2 | | Bugfixes to EVS Fixed Point Source Code | 12.2.0 |
| 2015-03 | SA#67 | SP-150083 | 000 7 | 3 | | Implementation of the compact storage format in the EVS Fixed Point Source Code | 12.2.0 |
| 2015-06 | SA#68 | SP-150200 | 000 9 | - | | Bugfixes to EVS Fixed-Point Source Code | 12.3.0 |
| 2015-09 | SA#69 | SP-150434 | 001 0 | 1 | | Corrections to EVS Fixed-Point Source Code | 12.4.0 |
| 2015-12 | SA#70 | SP-150639 | 001 1 | - | | Corrections to EVS Fixed-Point Source Code | 12.5.0 |
| 2015-12 | SA#70 | | | | | Version for Release 13 | 13.0.0 |
| 2016-03 | SA#71 | SP-160064 | 001 3 | - | | Corrections to EVS Fixed-Point Source Code | 13.1.0 |
| 2016-06 | SA#72 | SP-160257 | 001 5 | - | A | Corrections to EVS Fixed-Point Source Code | 13.2.0 |
| 2016-09 | SA#73 | SP-160589 | 001 7 | - | A | Corrections to EVS Fixed-Point Source Code | 13.3.0 |
| 2016-09 | SA#73 | SP-160589 | 001 9 | - | A | Corrections to EVS Fixed-Point Source Code | 13.3.0 |
| 2017-03 | SA#75 | SP-170019 | 002 1 | - | A | Corrections to EVS Fixed-Point Source Code | 13.4.0 |

| Change history | | | | | | | |
|----------------|---------|-----------|----------|-----|-----|--|---------------|
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2017-03 | 75 | | | | | Version for Release 14 | 14.0.0 |
| 2017-12 | 78 | SP-170820 | 002 4 | 1 | A | Corrections to EVS Fixed-Point Source Code | 14.1.0 |
| 2018-06 | 80 | C261 | 002 8 | - | A | Corrections to EVS Fixed-Point Source Code | 14.2.0 |
| 2018-06 | 80 | | | - | | Version for Release 15 | 15.0.0 |
| 2018-12 | 82 | SP-180965 | 003 2 | - | A | Corrections to EVS Fixed-Point Source Code | 15.1.0 |
| 2020-07 | - | - | - | - | - | Update to Rel-16 version (MCC) | 16.0.0 |

History

| Document history | | |
|-------------------------|-------------|-------------|
| V16.0.0 | August 2020 | Publication |
| | | |
| | | |
| | | |
| | | |