ETSI TS 146 006 V16.0.0 (2020-09)

**Digital cellular telecommunications system (Phase 2+) (GSM);
Half rate speech;
ANSI-C code for the GSM half rate speech codec
(3GPP TS 46.006 version 16.0.0 Release 16)**

Reference
RTS/TSGS-0446006vg00

Keywords
GSM

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

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

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.

The present document specifies the half rate speech traffic channels for the digital cellular telecommunications system. The present document is part of a series covering the half rate speech traffic channels as described below:

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

GSM 06.06 "Digital cellular telecommunications system (Phase 2+); Half rate speech; ANSI-C code for the GSM half rate speech codec".

GSM 06.07 "Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".

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

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

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

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

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

1 Scope

The present document contains an electronic copy of the ANSI-C code for the GSM half rate codec. The ANSI-C code is necessary for a bit exact implementation of the half rate speech transcoder (GSM 06.20 [2]), Voice Activity Detector (GSM 06.42 [6]), comfort noise (GSM 06.22 [4]), Discontinuous Transmission (GSM 06.41 [5]) and example solutions for substituting and muting of lost frames (GSM 06.21 [3]).

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

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

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

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

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

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

[7] GSM 06.07: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".

[8] American National Standards Institute ANSI 9899 (1990): "Programming Language - C (ISO)".

3 Definitions and abbreviations

3.1 Definitions

Definition of terms used in the present document can be found in GSM 06.20 [2], GSM 06.21 [3], GSM 06.22 [4], GSM 06.41 [5] and GSM 06.42 [6].

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ANSI	American National Standards Institute
DS-HD	Double Sided High Density
ETS	European Telecommunication Standard
GSM	Global System for Mobile communications
I/O	Input/Output
ROM	Read Only Memory

For abbreviations not given in this clause, see GSM 01.04 [1].

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 electronic attachment accompanying the present document.

The C code has been verified on the following systems:

- Sun Microsystem's [1)] workstations and Sun Microsystems acc;
- IBM [2)] PC/AT compatible computers and Borlands Turbo-C [3)] compiler;
- VAX [4)] and Digital Equipment Corporations CC.

ANSI-C 9899 [8] was selected as the programming language because portability was desirable.

The code representation is contained in a MS-DOS [5)] file (called Disk and contained in archive en_300967v080001p0.ZIP which accompanies the present document.

4.1 Directory structure

A listing of the directories is given in table 1.

Table 1: Directory structure listing

Directory name	Contents	Size (bytes)
\c	C files and headers	1 215 563
\d	example binary data input and output files	72 400
\exec	executables and makefiles	5 509
\utils	utility programs and the "reid" program	49 531
readme.txt	usage description of files	9 116

The C code file (called Disk and contained in archive en_300967v080001p0.ZIP) which accompanies the present document has one main directory and four subdirectories. The top directory has in it the file readme.txt which explains the installation procedure, along with some miscellaneous descriptive information regarding the code.

1) Registered trade mark of Sun Microsystems

2) Registered trade mark of International Business Machines

3) Registered trade mark of Borland

4) Registered trade mark of Digital Equipment Corporation

5) Registered trade mark of Microsoft

Below this directory, are the four subdirectories. The "c" subdirectory contains all the source code and header files. This directory alone is essential, the others aid in the building, or testing of the code. All ROM data is in this source directory. After installation, this directory can be made read only.

The "d" subdirectory contains all the speech coder installation verification data files. All of the data files are written/read as 16 bit words, so these may require byte swapping on the target platform. All data and text files are formatted such that they are correct for an IBM PC/AT compatible.

Final verification is to be performed using the GSM half rate test sequences described in GSM 06.07 [7].

The "utils" subdirectory contains miscellaneous utilities which may be useful in the installation of the software. Two programs are provided to transform text files: topcwild and tosnwild. The program topcwild takes UNIX text files and converts them to pc text files. tosnwild does the opposite. The program swapbin is also in this directory. This performs byte swapping on a binary data file. A fourth program, reid, is also contained in this sub directory. This is the residual error insertion program which also provides the format conversion between the encoder output file format and the decoder input file format.

The "exec" subdirectory contains the makefiles for the various platforms. Once the software is installed, this directory will have a compiled version of gsm_hr (the bit-exact C executable), programs from the "utils" directory, and all the object files.

The program gsm_hr is the name of the GSM half rate codec executable file.

4.2 Program execution

The GSM half rate speech codec is implemented as two separate programs:

- (gsm_hr) speech codec;
- (reid) encoder/decoder interface.

The gsm_hr program operates in one of two modes:

- (0) encoding only;
- (1) decoding only.

For encoding, the input is a binary speech file (*.inp) and the output is a binary encoded parameter file (*.cod). For decoding, the input is a binary parameter files (*.dec) and the output is a binary synthesized speech file (*.out). Note that the format for the parameter input file required for decoding (*.dec) is not the same as the format of the parameter output file generated by encoding (*.cod). The reid program will translate an *.cod file into an *.dec file (select error-free mode, EP0).

See the file readme.txt for more information on how to run the gsm_hr and reid programs.

4.3 Code hierarchy

Figures 1 to 7 are call graphs that show the functions used in the speech codec.

The encode call graph is broken down into six separate call graphs. Those clauses, which are large, are separated from the primary encode call tree and given their own call tree. Each vertical column represents a call level. For example, main() is at level 0, encode() at level 1, speechEncoder() at level 2, openLoopLagSearch() at level 3, getCCThreshold() at level 4, etc. The basic operations are not counted as extending the depth, therefore the deepest level is this software is level 6.

Some items have been omitted from this call graph. All standard C functions: printf(), fwrite(), etc. have been omitted. Also, no basic operations (add(), L_add(), mac(), etc.) or double precision extended operations (e.g. L_mpy_ls()) appear in the graphs.

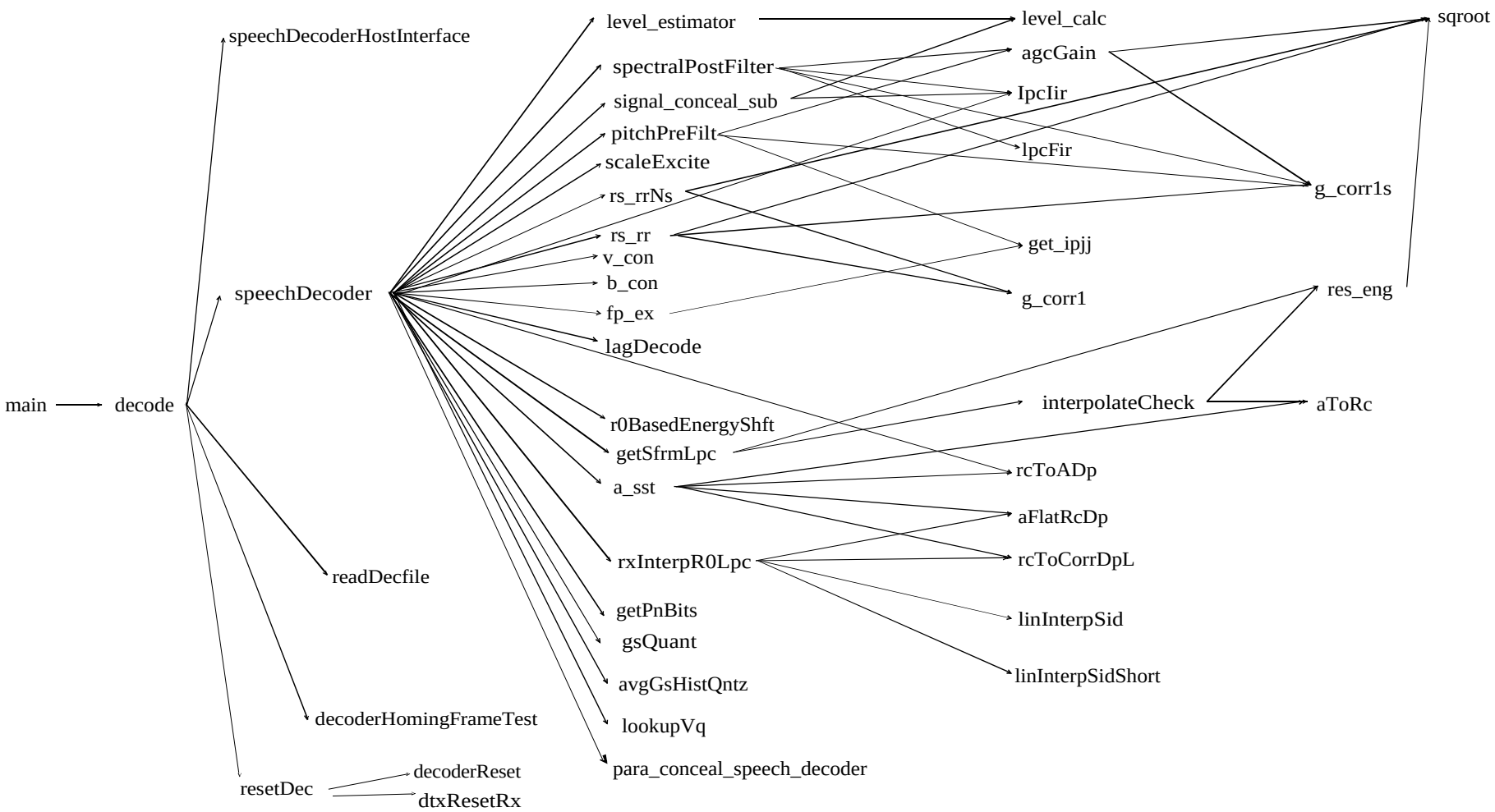

Figure 1: Speech decoder call graph

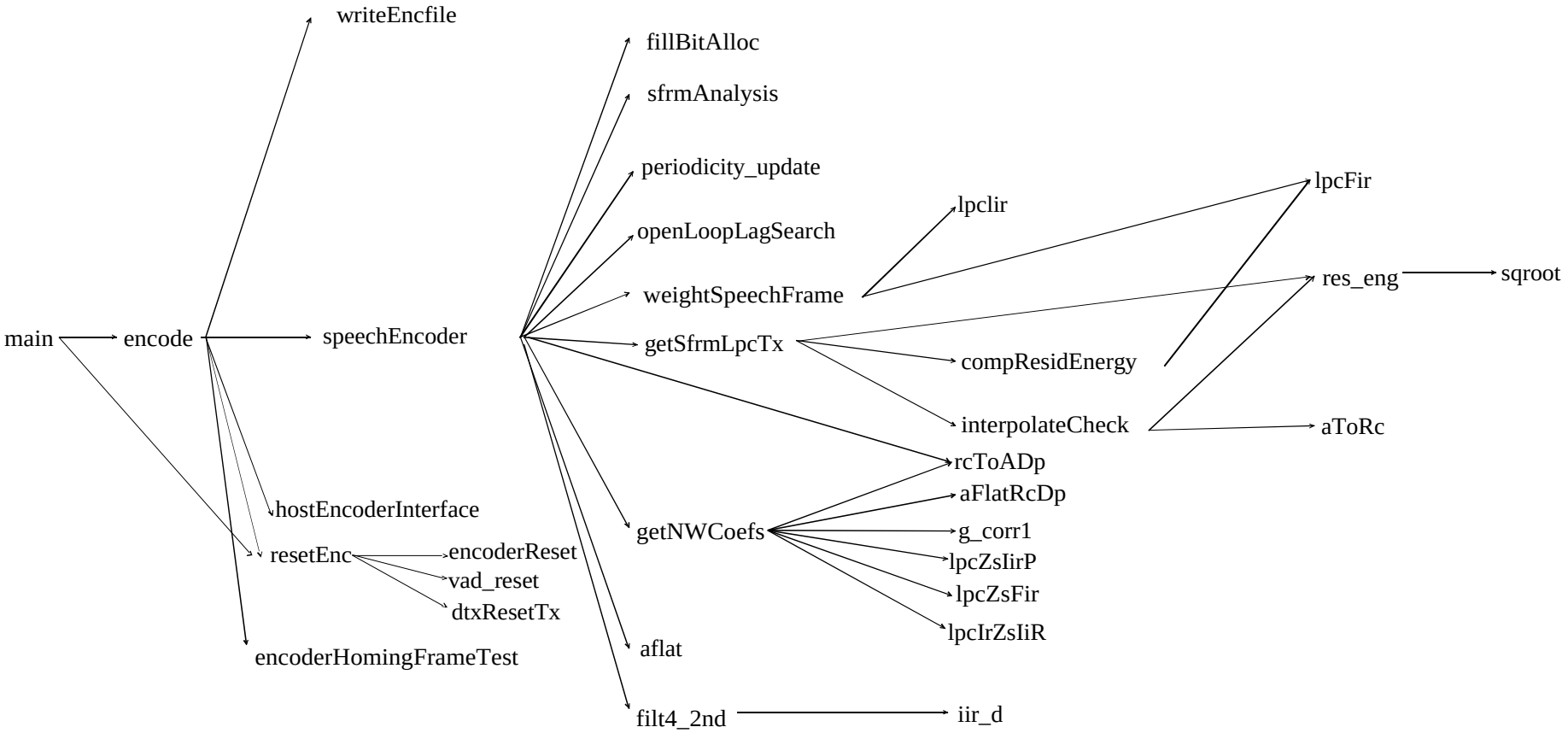

Figure 2: Speech encoder call graph

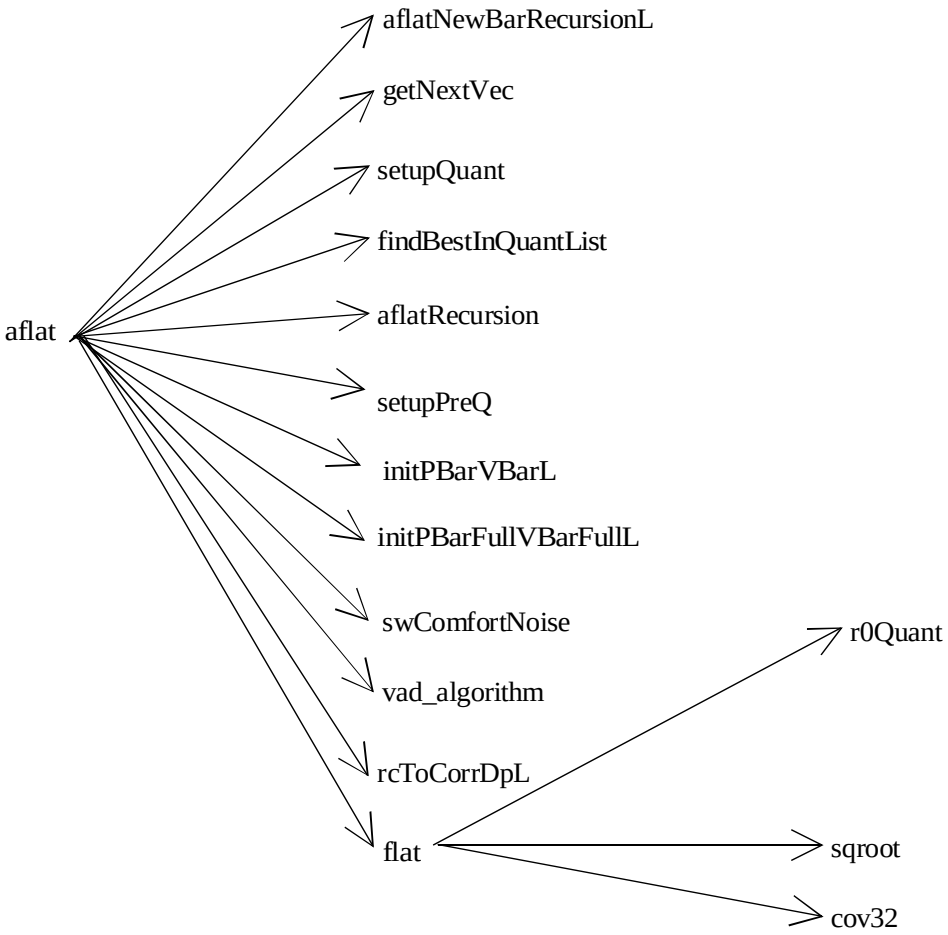

Figure 3: Speech encoder LPC quantization call graph

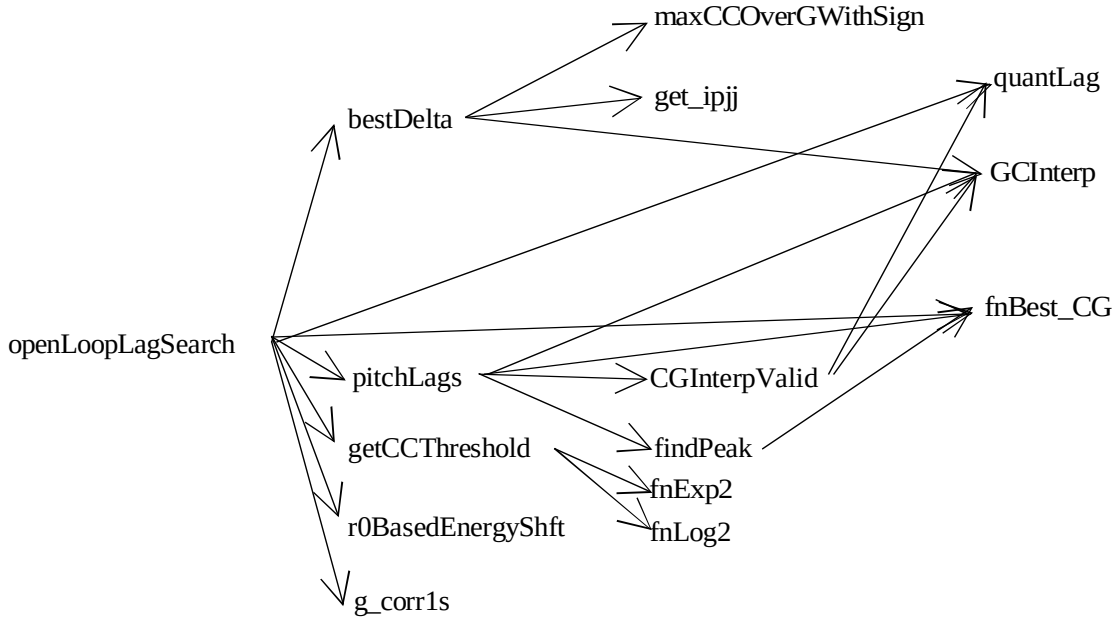

Figure 4: Speech encoder open-loop lag search call graph

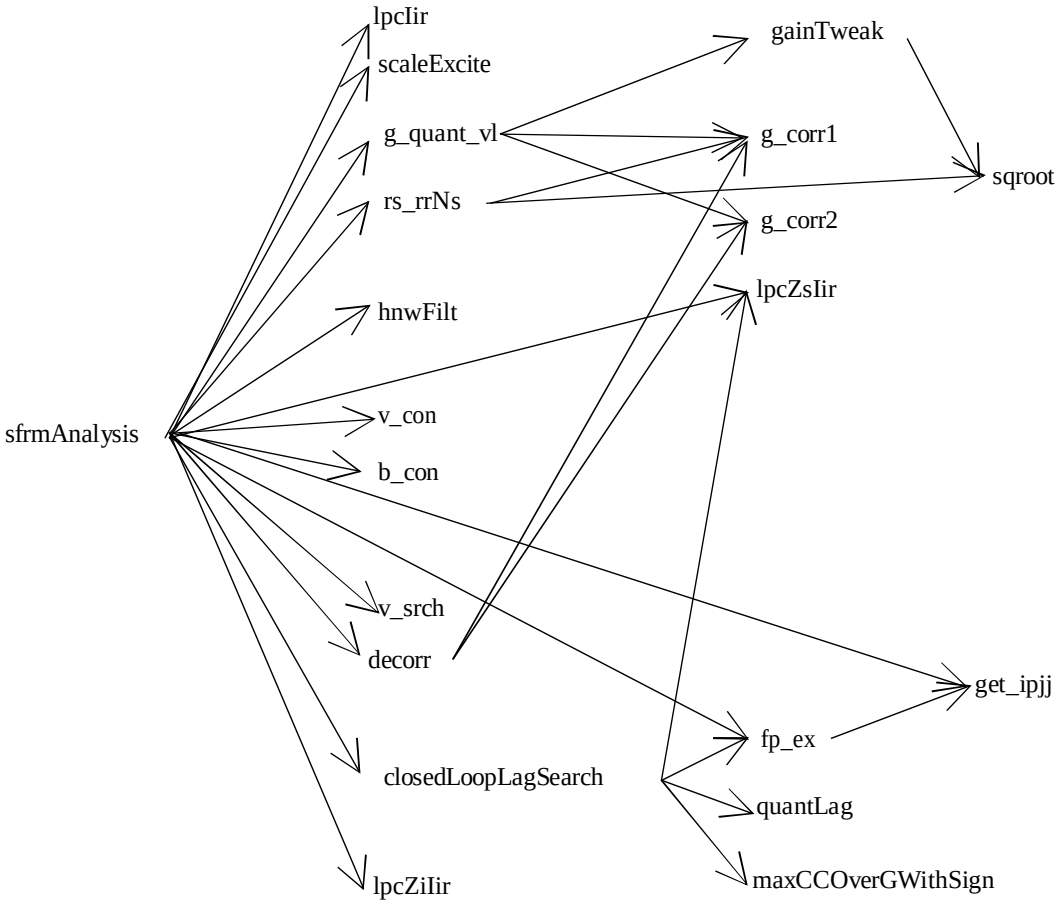

Figure 5: Speech encoder subframe processing call graph

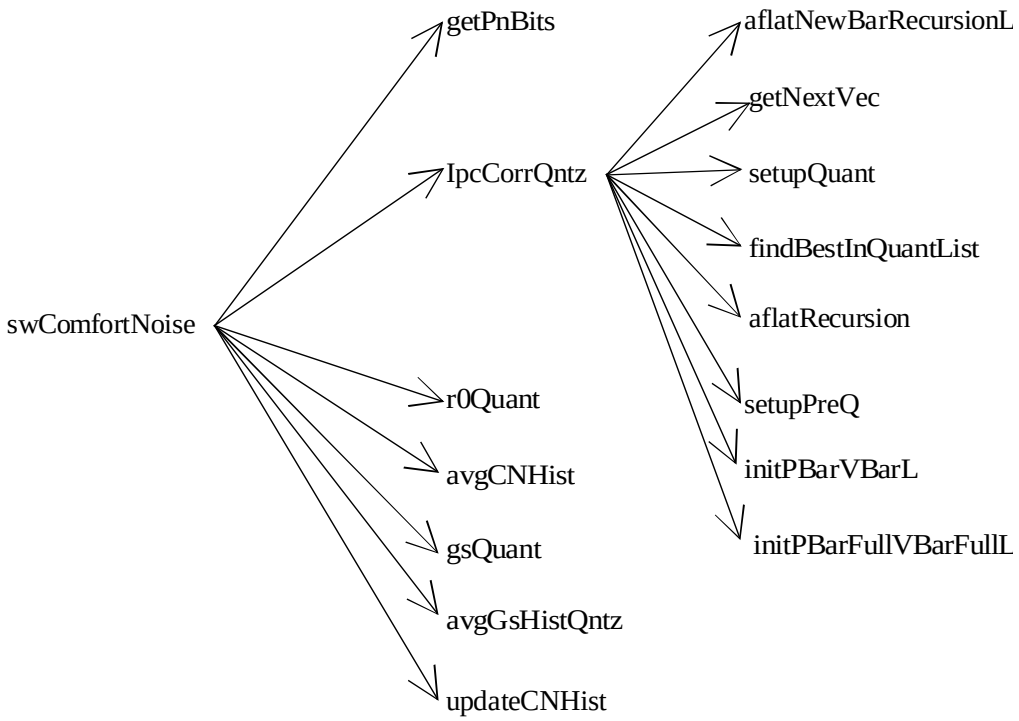

Figure 6: Comfort noise call graph

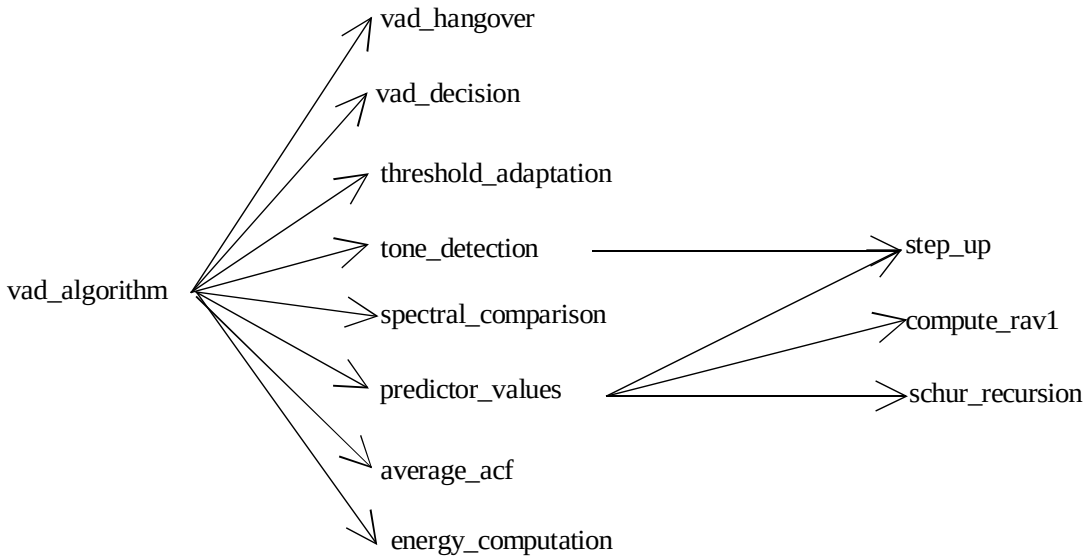

Figure 7: Voice Activity Detector (VAD) call graph

5 ANSI-C code for the GSM half rate speech codec

NOTE: This clause is contained in archive en_300967v080001p0.ZIP which accompanies the present document.

Annex A (informative): Change History

Change history					
SMG No.	**TDoc. No.**	**CR. No.**	**Section affected**	**New version**	**Subject/Comments**
SMG#16				4.0.3	ETSI Publication
SMG#17	332/95 119/96	A001 A002		4.1.0	HR C-code GSM half rate Codec Homing Procedure
SMG#23	97-737	A002		4.1.1	UAP60 and Supplementary notes on 06.06 Call Graph Changes
SMG#20				5.0.0	Release 1996 version
SMG#20				5.0.1	ETSI version change
SMG#22	430/97	A002		5.1.0	UAP 60
SMG#23	97-737	A003		5.1.1	UAP60 and Supplementary notes on 06.06 Call Graph Changes
SMG#27				6.0.0	Release 1997 version
SMG#28				6.0.1	ETSI Publication
SMG#29				7.0.0	Release 1998 version
				7.0.1	Version update to 7.0.1 for Publication
SMG#31				8.0.0	Release 1999 version
				8.0.1	Update to Version 8.0.1 for Publication

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
03-2001	11				Version for Release 4		4.0.0
06-2002	16				Version for Release 5	4.0.0	5.0.0
12-2004	26				Version for Release 6	5.0.0	6.0.0
06-2007	36				Version for Release 7	6.0.0	7.0.0
12-2008	42				Version for Release 8	7.0.0	8.0.0
12-2009	46				Version for Release 9	8.0.0	9.0.0
03-2011	51				Version for Release 10	9.0.0	10.0.0
09-2012	57				Version for Release 11	10.0.0	11.0.0
09-2014	65				Version for Release 12	11.0.0	12.0.0
12-2015	70				Version for Release 13	12.0.0	13.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
03-2017	SA#75					Version for Release 14	14.0.0
06-2018	SA#80					Version for Release 15	15.0.0
2020-07	-	-	-	-	-	Update to Rel-16 version (MCC)	**16.0.0**

History

Document history		
V16.0.0	September 2020	Publication