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Technical Specification

Universal Mobile Telecommunications System (UMTS); Speech Codec List for GSM and UMTS (3GPP TS 26.103 version 3.1.0 Release 1999)



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Foreword

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1 Scope

The present Technical Specification outlines the Codec List in 3GPP including both systems, GSM and UMTS, to be used by the Bearer Independent Call Control (BICC) protocol to set up a call or modify a call in **Transcoder Free Operation (TrFO)**.

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] TS 26.090 : "AMR Speech Codec; Speech Transcoding Functions".
- [2] TS 26.093 : "AMR Speech Codec; Source Controlled Rate Operation".
- [3] TS 26.101 : "Mandatory Speech Codec Speech Processing Functions; AMR Speech Codec Frame Structure".
- [4] GSM 06.xx : "Enhanced Full Rate Codec Recommendations".
- [5] GSM 26.xx : "Adaptive Multi-Rate Codec Recommendations".
- [6] "ITU Q.765.5: "Use of Application Transport Mechanism for Bearer Independent Call Control"

3 Definitions and Abbreviations

3.1 Definitions

Codec Type: defines a specific type of speech Coding algorithms (e.g. GSM FR, GSM FR AMR).

Codec Mode: defines a specific mode of a Codec Type (e.g. 12,2 kBit/s Mode of the GSM FR AMR).

Organisation Identifier (OID): Identifies the standard organisation (e.g. 3GPP) producing a specification for a Codec List. ITU-T is responsible for maintaining the list of Organisation Identifiers.

3.2 Abbreviations

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

SCR	Source Controlled Rate operation (synonym to DTX)
DTX	Discontinuous Transmission
SID	Silence Descriptor
RX	Receive

TX	Transmit
OID	Organisation IDentifier (e.g. ITU-T, 3GPP)
CoID	Codec IDentifier
BICC	Bearer Independent Call Control
TFO	Tandem Free Operation (also sometimes called "Transcoder-Through" or "Codec-Bypass")
TrFO	Transcoder Free Operation
GSM	Global System for Mobile communication
UMTS	Universal Mobile Telecommunications System

4 General

The present Technical Specification outlines the 3GPP internal Codec List for both, GSM and UMTS, to be used by the Bearer Independent Call Control (BICC) protocol to set up a call or modify a call in Transcoder Free Operation (TrFO).

Transcoder Free Operation allows the transport of speech signals in the coded domain from one user equipment (UE) to the other user equipment through the radio access network (RAN) and core network (CN), possibly through a transit network (TN). This enables high speech quality, low transmission costs and high flexibility.

The necessary Codec Type selection and resource allocation are negotiated out of band before and after call setup. Possible Codec (re-)configuration, Rate Control and DTX signalling may be performed after call setup by additional inband signalling or a combination of inband and out-of-band signalling.

Up to release '99 GSM does not support Transcoder Free Operation, but specifies the Tandem Free Operation (TFO). Tandem Free Operation enables similar advantages, but is based on pure inband signalling after call setup. The parameters defined in this Technical Specification allow interaction between TrFO and TFO. They further provide an evolutionary path for GSM towards Transcoder Free Operation.

5 Definition of the 3GPP Codec List

The GSM and UMTS standards define currently six different Codec Types: GSM Full Rate, GSM Half Rate, GSM Enhanced Full Rate, GSM Full Rate Adaptive Multi-Rate, GSM Half Rate Adaptive Multi-Rate, UMTS Adaptive Multi-Rate and UMTS Adaptive Multi-Rate 2.

The definition of the common Codec List in 3GPP for GSM and UMTS follows the specifications given in ITU Q.765.5: The most preferred Codec Type is listed first, followed by the second preferred one, and so on. An informative example for a codec list for UMTS can be found in Annex A.

5.1 GSM Full Rate Codec Type

The Codec IDentification (CoID) code is defined to be: FR_CoID := 0x0000.0000.

The GSM Full Rate Codec Type has no additional parameters.

For information (for exact details see GSM Recommendations):

The GSM Full Rate Codec Type supports one fixed Codec Mode with 13.0 kBit/s.

DTX may be enabled in uplink and in downlink independently of each other. DTX on or off is defined by the network on a cell basis and can not be negotiated at call setup or during the call. The DTX scheme uses one SID frame to mark the end of a speech burst and to start Comfort Noise Generation. Identical SID frames for comfort noise updates are sent in speech pauses about every 480 ms, aligned with the cell's TDMA frame structure. The defined Tandem Free

Operation allows the reception of GSM FR DTX information for the downlink direction in all cases. The TFO respectively TrFO partner is prepared to receive DTX information as well.

5.2 GSM Half Rate Codec Type

The Codec IDentification (CoID) code is defined to be: HR_CoID := 0x0000.0001.

The GSM Half Rate Codec Type has no additional parameters.

For information (for exact details see GSM Recommendations):

The GSM Half Rate Codec Type supports one fixed Codec Mode with 5.60 kBit/s.

DTX may be enabled in uplink and in downlink independently of each other. DTX on or off is defined by the network on a cell basis and can not be negotiated at call setup or during the call. The DTX scheme uses one SID frame to mark the end of a speech burst and to start Comfort Noise Generation. Identical SID frames for comfort noise updates are sent in speech pauses about every 480 ms, aligned with the cell's TDMA frame structure. The defined Tandem Free Operation allows the reception of GSM HR DTX information for the downlink direction in all cases. The TFO respectively TrFO partner shall be prepared to receive DTX information as well.

5.3 GSM Enhanced Full Rate Codec Type

The Codec IDentification (CoID) code is defined to be: EFR_CoID := 0x0000.0010.

The GSM Enhanced Full Rate Codec Type has no additional parameters.

For information (for exact details see GSM Recommendations):

The GSM Enhanced Full Rate Codec Type supports one fixed Codec Mode with 12.2 kBit/s.

DTX may be enabled in uplink and in downlink independently of each other. DTX on or off is defined by the network on a cell basis and can not be negotiated at call setup or during the call. The DTX scheme uses one SID frame to mark the end of a speech burst and to start Comfort Noise Generation. It is important to note that the Comfort Noise parameters for this start of the comfort noise generation are calculated at transmitter side from the previous eight speech frames. A DTX hangover period needs to be applied therefore at transmitter side before sending the first SID frame. SID frames with incremental information for comfort noise updates are sent in speech pauses about every 480 ms, aligned with the cell's TDMA frame structure. The defined Tandem Free Operation allows the reception of GSM EFR DTX information for the downlink direction in all cases. The TFO respectively TrFO partner shall be prepared to receive DTX information as well.

5.4 Adaptive Multi-Rate Codec Types

The Adaptive Multi-Rate Codec algorithm is applied in GSM and UMTS in four different Codec Types.

The Codec IDentification (CoID) codes are defined to be:

FR_AMR_CoID := 0x0000.0011.
 HR_AMR_CoID := 0x0000.0100.
 UMTS_AMR_CoID := 0x0000.0101.
 UMTS_AMR_2_CoID := 0x0000.0110.

The AMR may have several additional parameters. These parameters are optional at originating side, but mandatory for the terminating side:

Active Codec Set, ACS: eight bits.

In FR AMR and HR AMR up to four modes may be selected by setting the corresponding bits to "1";

In HR AMR only four out of the lower six modes can be selected;

In UMTS AMR and UMTS AMR2 up to all eight modes may be selected.

If the ACS is not specified at originating side, then all modes are supported there.

The terminating side may then select freely.

If ACS is not provided, then SCS and MACS can not be provided as well.

Supported Codec Set, SCS: eight bits.

In FR AMR, UMTS AMR and UMTS AMR2 up to eight modes may be selected by setting the corresponding bits to "1".

In HR AMR only the lower six modes may be selected.
 If the SCS is not specified at originating side, then all modes are supported there.
 The terminating side may then select freely.
 If SCS is not provided, then MACS can not be provided as well.

Maximal number of Codec Modes, MACS: three bits.

In FR AMR and HR AMR one to four Codec Modes are allowed within the ACS.
 Coding: “001”: one, “010”: two, “011”: three, “100”: four Codec modes allowed.
 In UMTS AMR and UMTS AMR2 up to eight Codec Modes are allowed within the ACS.
 Coding: “001”: one, “010”: two, ... “111”: seven, “000” eight Codec modes allowed.
 If MACS is not specified at originating side, then the maximum of modes is supported there.
 The terminating side may then select freely.

Initial Codec Mode: three bits; one of the Codec Modes within the ACS is indicated as starting mode.

Coding: “000”: 4,75 kBit/s Codec Mode; ... “111”: 12,2 kBit/s Codec Modes is Initial Codec Mode.
 If the ICM is not specified at originating side, then the terminating side may select freely.

The Length Indicator field (LI) is set to 3, 4, 5 or 6 at originating side, depending on how many parameters are specified. The terminating side shall return the selected Codec with a full set of parameters. Hence LI shall be set to 6 always by the terminating side. If any node in the path from originating side to terminating side does not support the parameter set offered by the originating side, it may restrict it. If necessary the missing, optional parameter octets may have to be inserted then.

The “Single Codec” information element consists of 5 to 8 octets in case of the AMR Codec Types (table 5.4):

Table 5.4: Coding of “Single Codec” for the Adaptive Multi-Rate Codec Types

Octet	Parameter	MSB 8	7	6	5	4	3	2	1 LSB
1 m	Single Codec	Single Codec (see ITU-T Q.765.5)							
2 m	Length Indication	6							
3 m	Compat. Info	Compatibility Information							
4 m	OID	3GPP (“non-ITU-T organisation according to reference [5]”, See ITU-T Q.765.5)							
5 m	CoID	FR_AMR_CoID, HR_AMR_CoID, UMTS_AMR_CoID or UMTS_AMR_2_CoID							
6 o	ACS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
7 o	SCS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
8 o	ICM, MACS	(spare)	(spare)	ICM			MACS		

with “m” = mandatory and “o” = optional

For information on GSM procedures (for exact details see GSM Recommendations):

The GSM AMR Codec Types comprise eight (Full Rate), respectively six (Half Rate) different Codec Modes: 12,2 ... 4,75 kBit/s.

The active Codec Mode is selected from the Active Codec Set (ACS) by the network (Codec Mode Command) with assistance by the mobile station (Codec Mode Request). This Codec Mode Adaptation, also termed Rate Control, can be performed every 40 ms by going one Codec Mode up or down within the ACS. The Codec Modes in uplink and downlink at one radio leg may be different. In Tandem Free Operation both radio legs (A and B) are considered for the optimal selection of the active Codec Mode in each direction (uplink A and then downlink B, respectively vice versa) by the “Distributed Rate Control” algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate. Besides this “Maximum Rate Control” the active Codec Mode may sometimes be frozen to a fixed mode by any of the two radio legs to allow a smooth handover procedure (“Exact Rate Control”). All rate control commands are transmitted inband: on the radio interface, the BTS-TRAU interface and the TRAU-TRAU interface.

The Active Codec Set is configured at call setup or reconfigured during the call. It consists of one up to maximally four Codec Modes (MACS) at a given time, selected from the Supported Codec Set. The maximal number of Codec Modes and the Supported Codec Set may be constrained by the network to consider resources and radio conditions. The Active Codec Sets in uplink and downlink are identical, but may be different as well (ffs). First, at start up of Tandem Free Operation, both Active Codec Sets are taken into account to determine the common Active Codec Set. In a later phase the Supported Codec Sets and MACSs of both radio legs may be taken into account to find the optimum Common Active Codec Set. All configuration data and update protocols are transmitted inband.

The DTX scheme of the Adaptive Multi-Rate Codec Type marks with a specific SID_FIRST frame the end of a speech burst. SID_FIRST does not contain Comfort Noise parameters. This SID_FIRST starts the comfort noise generation with parameters that are calculated at receiver side from the latest received seven speech frames. A DTX hangover period needs to be applied therefore at transmitter side before sending of this SID_FIRST.

Absolutely coded SID_UPDATE frames follow about every eighth frame (160 ms) in speech pauses. SID_UPDATE frames are sent independently of the cell's TDMA frame structure and are related only to the source signal.

An ONSET frame (typically) precedes in uplink direction the beginning of a new speech burst. DTX on or off is defined by the network on a cell basis. The defined Tandem Free Operation allows the reception of GSM-AMR DTX information for the downlink direction in all cases.

Note: The DTX scheme of the Enhanced Full Rate Codec Type is not compatible with the DTX scheme of the Adaptive Multi-Rate Codec Type in Codec Mode 12.2 kBit/s, although the speech modes of these two Codec Types are bit exact identical.

For information on UMTS procedures (for exact details see Release 4 specifications TS 28.062 (TFO) and TS 23.153 (TrFO)).

The UMTS AMR Codec Type comprises eight different Codec Modes: 12,2 ... 4,75 kBit/s.

The active Codec Mode is selected from the Active Codec Set (ACS) by the network. This Codec Mode Adaptation, also termed Rate Control, can be performed every 20 ms by going to any arbitrary Codec Mode within the ACS. The Codec Modes in uplink and downlink at one radio leg may be different. In Tandem Free Operation or Transcoder Free Operation both radio legs (A and B) are considered for the optimal selection of the active Codec Mode in each direction (uplink A and then downlink B, respectively vice versa) by a "Distributed Rate Control" algorithm. The worst of both radio legs determine the highest allowed Codec Mode, respectively the maximally allowed rate. Besides this "Maximum Rate Control" the active Codec Mode may sometimes be frozen to a fixed mode by any of the two radio legs to allow a smooth handover procedure ("Exact Rate Control"). All rate control commands are transmitted inband on the IU and A interface and out of band on the radio interface.

The Active Codec Set is configured at call setup or reconfigured during the call. It consists of one up to maximally eight Codec Modes (MACS) at a given time, selected from the Supported Codec Set. The maximal number of Codec Modes and the Supported Codec Set may be constrained by the network to consider resources and radio conditions.

The Active Codec Sets in uplink and downlink are identical.

At call setup the Originating Side sends the AMR parameter set (included in the Codec List). The Terminating side then selects a suitable ACS from the given information and sends it back. In case the terminating side does not support TrFO a transcoder is allocated in the path at a suitable position, preferably as close as possible to the terminating side. This transcoder may by inband signalling install a Tandem Free Operation after call setup. Then, at start up of Tandem Free Operation, both Active Codec Sets are taken into account to determine the common Active Codec Set. In a later phase the Supported Codec Sets and MACSs of both radio legs may be taken into account to find the optimum Common Active Codec Set. All configuration data and update protocols are transmitted inband on the TFO interface, but (possibly) out of band within the UMTS network. For information on Tandem Free Operation see GSM 08.62 respectively TS 28.062.

The SCR scheme of the default Adaptive Multi-Rate Codec Type marks with a specific SID_FIRST frame the end of a speech burst. SID_FIRST does not contain Comfort Noise parameters. This SID_FIRST starts the comfort noise generation with parameters that are calculated at receiver side (!) from the latest received seven speech frames. A DTX hangover period needs to be applied therefore at transmitter side before sending of this SID_FIRST.

Absolutely coded SID_UPDATE frames follow about every eighth frame (160 ms) in speech pauses. SID_UPDATE frames are sent independently of the cell's timing structure and are related only to the source signal.

An ONSET frame does (typically) not exist in UMTS networks, but may be received in TFO from the distant partner. It marks the beginning of a speech burst. SCR on or off is defined by the network on a cell or call (ffs) basis. The defined Tandem Free Operation and Transcoder Free Operation allows the reception of AMR SCR information for the downlink direction in all cases.

The SCR scheme of UMTS AMR Codec Type is fully compatible to the DTX scheme of FR AMR and HR AMR of GSM.

UMTS AMR2 Codec Type is similar to UMTS AMR, except for rate control. An UMTS AMR2 encoder is allowed to perform codec mode change only every 2nd frame similar to GSM AMR Codec Types. On the decoder direction, an UMTS AMR2 codec can accept mode changes in every frame. Therefore this codec type is compatible (in TFO and TrFO sense) with both UMTS AMR, FR AMR and HR AMR Codec Types.

For compatibility with other systems the UMTS AMR Codec applications may optionally support various other DTX and Rate Control schemes: GSM EFR, TDMA EFR, PDC EFR.

The exact details of these Codec Types and their related procedures (DTX, Rate Control, etc) are described in the respective standard documentation.

Up to release '99 it is not possible to establish a Transcoder Free Operation between UMTS and these other systems, but it may soon be possible to establish Tandem Free Operation between UMTS and all these other systems.

Annex A (informative) : Example Codec List for UMTS

This Annex gives some informative examples how the Codec List for UMTS may look like for the BICC protocol. UMTS does support: UMTS AMR, UMTS AMR2, FR AMR and HR AMR. It may support also GSM EFR, TDMA EFR and PDC EFR.

One list (with arbitrarily selected Codec Type preference) could look at Originating side like:

Octet	Parameter	MSB 8	7	6	5	4	3	2	1 LSB
1	Codec List	Codec List (see ITU-T Q.765.5)							
2	Length Indication (LI)	30							
3	Compat. Info	Compatibility Information							
4	Single Codec LI	Single Codec (see ITU-T Q.765.5)							
5	LI	6							
6	Compat. Info	Compatibility Information							
7	OID	3GPP ("non-ITU-T organisation according to reference [5]", See ITU-T Q.765.5)							
8	CoID	UMTS_AMR_CoID							
9 o	ACS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
10 o	SCS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
11 o	MACS	(spare)	(spare)	ICM				MACS	
12	Single Codec LI	Single Codec (see ITU-T Q.765.5)							
13	LI	6							
14	Compat. Info	Compatibility Information							
15	OID	3GPP ("non-ITU-T organisation according to reference [5]", See ITU-T Q.765.5)							
16	CoID	FR_AMR_CoID							
17 o	ACS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
18 o	SCS	12.2	10.2	7.95	7.40	6.70	5.90	5.15	4.75
19 o	MACS	(spare)	(spare)	ICM				MACS	
20	Single Codec LI	Single Codec (see ITU-T Q.765.5)							
21	LI	6							
22	Compat. Info	Compatibility Information							
23	OID	3GPP ("non-ITU-T organisation according to reference [5]", See ITU-T Q.765.5)							
24	CoID	HR_AMR_CoID							
25 o	ACS	(spare)	(spare)	7.95	7.40	6.70	5.90	5.15	4.75
26 o	SCS	(spare)	(spare)	7.95	7.40	6.70	5.90	5.15	4.75
27 o	MACS	(spare)	(spare)	ICM				MACS	
28	Single Codec LI	Single Codec (see ITU-T Q.765.5)							
29	LI	3							
30	Compat. Info	Compatibility Information							
31	OID	3GPP ("non-ITU-T organisation according to reference [5]", See ITU-T Q.765.5)							
32	CoID	EFR_CoID							

with "o" = optional octet

The Terminating Side selects one of the Codec Types and returns it, together with the selected codec attributes.

The AMR Codec Types may have very similar, if not identical codec attributes at Originating side. The UMTS as Originating side can, however, already decide, which configuration would be preferred in case the Terminating side is UMTS, or GSM FR or GSM HR. A GSM as Originating side can not offer UMTS AMR or UMTS AMR2 and the Codec attributes for FR AMR and HR AMR may be quite different.

Annex B (informative): Change history

Change history							
Date	TSG SA#	TSG Doc.	CR	Rev	Subject/Comment	Old	New
1999-12	06				Approved		3.0.0
2001-12	14	SP-010698	011		Inclusion of codec type UMTS AMR2 in R99 codec list	3.0.0	3.1.0

History

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