Source: **Ericsson & Nokia**

Title: **CRs to TS 26.103 on UMTS_AMR_2 and AMR Wideband (Release 4 and Release 5)**

Document for: **Approval**

Agenda Item: **7.4.3 / 11**

The following CRs,produced by correspondence in replacement of CR 26.103 008 rev 2 in SP-010104, are presented to TSG SA #11 for approval.

Spec	CR	Rev	Phase	Subject	Cat	Ver	WG	Meeting	S4 doc
26.103	008	3	Rel-4	Introduction of UMTS_AMR_2	B	4.0.0	S4	TSG-SA#11	S4-010248rev
26.103	009		Rel-5	Introduction of AMR Wideband	B	4.0.0	S4	TSG-SA#11	S4-010248rev

3GPP TSG-S4#16 meeting
February 26 - March 2, 2001, Sophia Antipolis, France

Tdoc S4 (01)0248rev

CR-Form-v3

CHANGE REQUEST

⌘ **26.103** CR **008** ⌘ rev **3** ⌘ Current version: **4.00** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘   (U)SIM ☐   ME/UE **X**   Radio Access Network **X**   Core Network **X**

Title: ⌘	**Introduction of UMTS AMR 2**	
Source: ⌘	Ericsson	
Work item code: ⌘	AMR	***Date:*** ⌘ 21.3.2001
Category: ⌘	**B**	***Release:*** ⌘ REL-4

Use <u>one</u> of the following categories:
  F *(essential correction)*
  A *(corresponds to a correction in an earlier release)*
  B *(Addition of feature),*
  C *(Functional modification of feature)*
  D *(Editorial modification)*
Detailed explanations of the above categories can
be found in 3GPP TR 21.900.

Use <u>one</u> of the following releases:
  2   *(GSM Phase 2)*
  R96   *(Release 1996)*
  R97   *(Release 1997)*
  R98   *(Release 1998)*
  R99   *(Release 1999)*
  REL-4 *(Release 4)*
  REL-5 *(Release 5)*

Reason for change: ⌘	Addition of UMTS_AMR_2 codec type for TFO and TrFO compatibility
Summary of change: ⌘	Add UMTS_AMR_2 in the Codec Lists
Consequences if not approved: ⌘	GSM and UMTS can not directly go into TFO/TrFO

Clauses affected: ⌘	4, 5
Other specs Affected: ⌘	☐ Other core specifications ⌘ ☐ Test specifications ☐ O&M Specifications
Other comments: ⌘	UMTS_AMR_2 is working assumption for GSM-UMTS dual_system terminals

1 Scope

The present Technical Specification outlines the Codec Lists in 3GPP including both systems, GSM and UMTS, to be used by the Out of Band Transcoder Control (OoBTC) protocol to set up a call or modify a call in **Tr**anscoder **F**ree **O**peration (TrFO) and in "transcoder at the edge" scenarios.

The TS further specifies the coding of the Supported Codec List Information Elements for the UMTS radio access technology.

The Supported Codec List IE includes Codec_Types from the TDMA and PDC systems, to support TFO or TrFO between UMTS and TDMA, or UMTS and PDC.

2 Normative references

The present Technical Specification 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 TS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1]   3GPP TS 26.090 : "AMR Speech Codec; Speech Transcoding Functions".

[2]   3GPP TS 26.093 : "AMR Speech Codec; Source Controlled Rate Operation".

[3]   3GPP 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 06.xx : "Adaptive Multi-Rate Codec Recommendations".

[6]   "ITU Q.765.5: "Use of Application Transport Mechanism for Bearer Independent Call Control"

[7]   3GPP TS 28.062 : "In-band Tandem Free Operation (TFO) of Speech Codecs, Stage 3 - Service Description".

[8]   3GPP TS 23.153 : "Out of Band Transcoder Control - Stage 2".

[9]   3GPP TS 24.008: "Mobile radio interface layer 3 specifications, Core Network Protocols"

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.

System Identifier (SysID): Identifies the radio access technology (e.g. GSM or UMTS) for which the supported Codec List is defined.

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

TFO   **T**andem **F**ree **O**peration
(also sometimes called "Transcoder-Through" or "Codec-Bypass")

TrFO   **Tr**anscoder **F**ree **O**peration

GSM   Global System for Mobile communication

UMTS   Universal Mobile Telecommunications System

SysID   System Identifier

TDMA   Time Division Multiple Access (synonym for ...)

PDC   Personal Digital Communication (synonym for ...)

OoBTC   Out of Band Transcoder Control

4 General

The present Technical Specification outlines the 3GPP internal Codec Lists for both, GSM and UMTS, to be used by the Out of Band Transcoder Control (OoBTC) protocol to set up a call or modify a call in Transcoder Free Operation (TrFO).

It further specifies the coding of the Supported Codec List Information Elements as defined in 3GPP TS 24.008 for the UMTS radio access technology.

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 <u>before</u> 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 <u>after</u> 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.

The GSM and UMTS standards define currently <u>nine</u> ~~eight~~ different Codec Types: GSM Full Rate, GSM Half Rate, GSM Enhanced Full Rate, Full Rate Adaptive Multi-Rate, Half Rate Adaptive Multi-Rate, UMTS Adaptive Multi-Rate, <u>UMTS Adaptive Multi-Rate 2,</u> TDMA EFR and PDC EFR.
Within each radio access technology the following Codec Types may be used, see table 4.1.

Table 4.1: Support of Codec Types in Radio Access Technologies

	PDC EFR	TDMA EFR	UMTS AMR2	UMTS AMR	FR AMR	HR AMR	GSM EFR	GSM HR	GSM FR
GSM	~~not defined~~	not defined	~~not possible~~	Not possible	yes (4 modes)	yes (4 modes)	Yes	Yes	yes
UMTS	~~yes~~	yes	yes (8 modes)	Yes (8 modes)	yes (8 modes)	yes, but use FR AMR	Yes	Not defined	not defined

									PDC EFR
GSM									not defined
UMTS									yes

5 3GPP Codec List for OoBTC

The definition of the common Codec List for Out of Band Transcoder Control (3GPP TS 23.153, [8]) 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 (GSM FR)

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 (GSM HR)

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 (GSM EFR)

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 Four~~Three~~ Adaptive Multi-Rate Codec Types (FR AMR, HR AMR, UMTS AMR, UMTS AMR 2)

The Adaptive Multi-Rate Codec algorithm is applied in GSM and UMTS in four~~three~~ 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.
   When applied in GSM then for the FR AMR and the 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;
   When applied in UMTS then for the FR AMR, UMTS AMR and UMTS AMR 2 up to all eight modes may be selected.
   If the ACS is not specified at originating side, then all modes are supported there.
   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 AMR 2 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.
   If SCS is not provided, then MACS can not be provided as well.

Maximal number of Codec Modes, MACS: three bits.
   When applied in GSM then for the FR AMR and the HR AMR one to four Codec Modes are allowed within the ACS.
   Coding: "001: one, "010": two, "011": three, "100": four Codec modes allowed.
   When applied in UMTS then for the FR AMR, the UMTS AMR and the UMTS AMR 2 one 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.

Optimisation Mode for ACS , OM: two bits.
   Coding: "0": Optimisation of the ACS not supported, "1": Optimisation supported by out-of-band signalling,
   "2": Optimisation supported by fast inband signalling, "3": reserved.
   Codes "0", "1" and "2" are defined in GSM for AMR TFO (see 3GPP TS 28.062, [7])

Codes "0" and "1" are defined in UMTS for AMR TFO, "2"and "3" are reserved in UMTS for AMR TFO.

The Optimisation Mode indicates in TFO, whether the sending side supports the modification (optimisation) of its ACS for the needs of the distant side. This parameter is necessary in UMTS OoBTCC to support TFO in "transcoders at the edge" scenarios. In case the OM is set to "not supported" the offered ACS can not be altered. Only Rate Control can then be used to restrict the modes within the ACS.
The use of the Optimisation Mode parameter for TrFO is defined in 3GPP TS 23.153 [9].

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	ETSI OID (See ITU-T Q.765.5 [6])							
5 m	CoID	FR_AMR_CoID, or HR_AMR_CoID, or 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	OM, MACS	(spare)	(spare)	(spare)	OM		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 Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate ("Maximum 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 typically identical.
First, at start up of Tandem Free Operation, both Active Codec Sets, the Supported Codec Sets, the MACSs and the OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both radio legs may be taken into account to find the optimum configuration. For exact details see 3GPP TS 28.062. 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 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO):

Normative for UMTS: The FR AMR, the UMTS AMR and the UMTS AMR 2 Codec Types comprises eight different Codec Modes: 12,2 … 4,75 kBit/s. If the UMTS AMR 2 is available then only the UMTS AMR 2 shall be indicated in the Codec List, because it is compatible to all AMR Codec Types. If the UMTS_AMR 2 is not available, then UMTS AMR shall be indicated, together with FR AMR, if FR AMR is available.
Only one of these two Codec Types shall be indicated in the Codec List, with preference to the UMTS AMR 2.

For information on UMTS procedures (for exact details see 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO):

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 for the UMTS AMR every 20 ms by going to any arbitraryanother Codec Mode within the ACS. For the UMTS AMR 2 this Rate ControlCodec Mode Adaptation can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. The UE selects at call setup one of the two possible phases for Rate ControlCodec Mode Adaptation (odd or even frames). During the call changes of the Codec Mode in uplink direction are only allowed in this selected phase. Rate Control commands received in downlink direction are considered at the next possible phase. By this definition the UMTS AMR 2 Codec Type is TFO and TrFO compatible to the FR –AMR, HR –AMR, UMTS –AMR and UMTS –AMR –2 Codec Types.

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 Decision" 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 IuU and NbA interfaces 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 typically 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, the Supported Codec Sets, the MACSs and the OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both radio legs may be taken into account to find the optimum configuration. All configuration data and update protocols are transmitted inband on the TFO interface, but out of band within the UMTS network. For information on Tandem Free Operation see 3GPP TS 08.62, respectively 3GPP TS 28.062 and on Transcoder Free Operation see 3GPP TS 23.153 for OoBTC.

The SCR scheme of the default Adaptive Multi-Rate Codec Types 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" is always defined by the network. 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 schemes of the UMTS AMR, the UMTS AMR 2 and the FR –AMR Codec Types in UMTS are fully compatible to the DTX schemes of FR AMR and HR AMR in GSM.

For compatibility with other systems the UMTS AMR Codec application 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.~~

5.5   TDMA Enhanced Full Rate Codec Type (TDMA EFR)

The Codec IDentification (CoID) code is defined to be: TDMA_EFR_CoID := 0x0000.0111~~0~~.

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

<u>For information</u> (for exact details see TDMA Recommendations):

The TDMA Enhanced Full Rate Codec Type supports one fixed Codec Mode with 7.4 kBit/s. This codec mode is bit exact identical with AMR codec mode at 7.4 kBit/s.

In a TDMA system DTX may be enabled in uplink, but not in downlink. The DTX scheme uses one SID frame to mark the end of a speech burst and to start or continue Comfort Noise Generation.

The defined Tandem Free Operation allows the reception of TDMA EFR DTX information for the downlink direction in all cases. In TDMA systems the transcoder has to generate comfort noise in speech like frames to be sent downlink. In UMTS the downlink DTX shall always be supported and the transcoder can therefore stay transparently in TFO.

5.6   PDC Enhanced Full Rate Codec Type (PDC_EFR)

The Codec IDentification (CoID) code is defined to be: TDMA_EFR_CoID := 0x0000.<u>1000</u>~~0111~~.

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

<u>For information</u> (for exact details see PDC Recommendations):

The PDC Enhanced Full Rate Codec Type supports one fixed Codec Mode with 6.7 kBit/s. This codec mode is bit exact identical with AMR codec mode at 6.7 kBit/s.

In a PDC system DTX may be enabled in uplink, but not in downlink. The DTX scheme uses one SID frame to mark the end of a speech burst and to start or continue Comfort Noise Generation.

The Tandem Free Operation allows the reception of PDC EFR DTX information for the downlink direction in all cases. In PDC systems the transcoder has to generate comfort noise in speech like frames to be sent downlink. In UMTS the downlink DTX shall always be supported and the transcoder can therefore stay transparently in TFO.

6   Codec List for the Call Control Protocol

For call control on the air interface the Codec Lists need to be specified for each radio access technology separately, because it can not be expected that an UE supports the same Codec Types in different radio access technologies.

3GPP TS 24.008 [9] *defines the call control signalling and how to use the "Supported Codec List Information Element"* (IE). It contains Codec Lists (~~-~~in form of Codec Bitmaps) for each supported radio access technology (identified by a SysID).

The coding of this is IE is given here. It is ~~designed in a similar way as~~<u>also used</u> for TFO in 3GPP TS 28.062 [7].

6.1   System Identifiers for GSM and UMTS

The system identifiers for the radio access technologies supported by this specification are:

SysID for GSM: 0x0000.0000 (bit 8 .. bit 1)

SysID for UMTS: 0x0000.0100 (bit 8 .. bit 1)

These values are selected in accordance with [7] (3GPP TS 28.062).

6.2 Codec Bitmap

The Codec Types are coded in the first and second octet of the Codec List Bitmap as follows:

bit 8	87	7	6	5	4	3	2	bit 1	
PDC EFR	TDMA EFR	UMTS AMR 2	UMTS AMR	HR AMR	FR AMR	GSM EFR	GSM HR	GSM FR	Octet 1

bit 16	15	14	13	12	11	10	bit 9	
(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	(reserved)	PDC EFR	Octet 2

A Codec Type is supported, if the corresponding bit is set to "1". All reserved bits shall be set to "0".

6.3 Selected Codec Type

The Selected Codec Type is coded as shown in Table 6.3-1. The same coding is used also in 3GPP TS 28.062 [7]. in accordance with [7] (*3GPP TS* 28.062) (long form).

Table 6.3-1: Coding of the selected Codec_Type (long form)

Bit 8…Bit 1 CoID	Codec_Type	Name
0000.0000	GSM Full Rate (13.0 kBit/s)	GSM FR
0000.0001	GSM Half Rate (5.6 kBit/s)	GSM HR
0000.0010	GSM Enhanced Full Rate (12.2 kBit/s)	GSM EFR
0000.0011	Full Rate Adaptive Multi-Rate (FR AMR)	FR AMR
0000.0100	Half Rate Adaptive Multi-Rate HR (AMR_HR)	HR AMR
0000.0101	UMTS Adaptive Multi-Rate UMTS (AMR_UMTS)	UMTS AMR
0000.0110	UMTS Adaptive Multi-Rate 2	UMTS AMR 2
0000.0111 0	TDMA Enhanced Full Rate (7.4 kBit/s)	TDMA EFR
0000.1000 0111	PDC Enhanced Full Rate (6.7 kBit/s)	PDC EFR
other codes	reserved for future use.	

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 OoBTC protocol. UMTS does support: UMTS AMR, 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	Single Codec (see ITU-T Q.765.5)							
5	LI	6							
6	Compat. Info	Compatibility Information							
7	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
12	Single Codec	Single Codec (see ITU-T Q.765.5)							
13	LI	6							
14	Compat. Info	Compatibility Information							
15	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
20	Single Codec	Single Codec (see ITU-T Q.765.5)							
21	LI	6							
22	Compat. Info	Compatibility Information							
23	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
28	Single Codec	Single Codec (see ITU-T Q.765.5)							
29	LI	3							
30	Compat. Info	Compatibility Information							
31	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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 three 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 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
12-2000	10	SP-000576	004		Introduction of Codec Type Bit-Map for Codec Negotiation	3.0.0	4.0.0
12-2000	10	SP-000576	005		Introduction of Selected Codec Type for Codec Negotiation	3.0.0	4.0.0
12-2000	10	SP-000576	006		Clarification for the use of the Codec List Information Element	3.0.0	4.0.0

3GPP TSG-S4#16 meeting   *Tdoc S4 (01)0248rev2*
February 26 - March 2, 2001, Sophia Antipolis, France

CHANGE REQUEST

⌘	**26.103 CR 009**	⌘	rev		⌘	Current version:	**4.00**	⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘   (U)SIM [ ]   ME/UE [**X**]   Radio Access Network [**X**]   Core Network [**X**]

Title: ⌘	Introduction of AMR Wideband	
Source: ⌘	NOKIA	
Work item code: ⌘	AMR-WB	***Date:*** ⌘ 22.3.2001
Category: ⌘ **B**		***Release:*** ⌘ REL-5

Use <u>one</u> of the following categories:
F *(essential correction)*
A *(corresponds to a correction in an earlier release)*
B *(Addition of feature),*
C *(Functional modification of feature)*
D *(Editorial modification)*
Detailed explanations of the above categories can
be found in 3GPP TR 21.900.

Use <u>one</u> of the following releases:
2   *(GSM Phase 2)*
R96   *(Release 1996)*
R97   *(Release 1997)*
R98   *(Release 1998)*
R99   *(Release 1999)*
REL-4 *(Release 4)*
REL-5 *(Release 5)*

Reason for change: ⌘	Additions for AMR wideband codec type
Summary of change: ⌘	Changes needed to add AMR-WB codec into the speech codec list
Consequences if not approved: ⌘	

Clauses affected: ⌘	2, 4, 5.7, 6.2 and 6.3

Other specs Affected: ⌘	[ ] Other core specifications ⌘	
	[ ] Test specifications	
	[ ] O&M Specifications	

Other comments: ⌘	

1 Scope

The present Technical Specification outlines the Codec Lists in 3GPP including both systems, GSM and UMTS, to be used by the Out of Band Transcoder Control (OoBTC) protocol to set up a call or modify a call in **Tr**anscoder **F**ree **O**peration (TrFO) and in "transcoder at the edge" scenarios.

The TS further specifies the coding of the Supported Codec List Information Elements for the UMTS radio access technology.

The Supported Codec List IE includes Codec_Types from the TDMA and PDC systems, to support TFO or TrFO between UMTS and TDMA, or UMTS and PDC.

2 Normative references

The present Technical Specification 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 TS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1]   3GPP TS 26.090 : "AMR Speech Codec; Speech Transcoding Functions".

[2]   3GPP TS 26.093 : "AMR Speech Codec; Source Controlled Rate Operation".

[3]   3GPP 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 06.xx : "Adaptive Multi-Rate Codec Recommendations".

[6]   "ITU Q.765.5: "Use of Application Transport Mechanism for Bearer Independent Call Control"

[7]   3GPP TS 28.062 : "In-band Tandem Free Operation (TFO) of Speech Codecs, Stage 3 - Service Description".

[8]   3GPP TS 23.153 : "Out of Band Transcoder Control - Stage 2".

[9]   3GPP TS 24.008: "Mobile radio interface layer 3 specifications, Core Network Protocols"

[10]   3GPP TS 26.190 : "AMR Wideband Speech Codec; Speech Transcoding Functions".

[11]   3GPP TS 26.193 : "AMR Wideband Speech Codec; Source Controlled Rate Operation".

[12]   3GPP TS 26.201 : "Mandatory Speech Codec Speech Processing Functions; AMR Wideband Speech Codec Frame Structure".

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.

System Identifier (SysID): Identifies the radio access technology (e.g. GSM or UMTS) for which the supported Codec List is defined.

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

TFO   **T**andem **F**ree **O**peration
      (also sometimes called "Transcoder-Through" or "Codec-Bypass")

TrFO   **Tr**anscoder **F**ree **O**peration

GSM   Global System for Mobile communication

UMTS   Universal Mobile Telecommunications System

SysID   System Identifier

TDMA   Time Division Multiple Access (synonym for ...)

PDC   Personal Digital Communication (synonym for ...)

OoBTC   Out of Band Transcoder Control

4   General

The present Technical Specification outlines the 3GPP internal Codec Lists for both, GSM and UMTS, to be used by the Out of Band Transcoder Control (OoBTC) protocol to set up a call or modify a call in Transcoder Free Operation (TrFO).

It further specifies the coding of the Supported Codec List Information Elements as defined in 3GPP TS 24.008 for the UMTS radio access technology.

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.

The GSM and UMTS standards define currently teneight different Codec Types: GSM Full Rate, GSM Half Rate, GSM Enhanced Full Rate, Full Rate Adaptive Multi-Rate, Half Rate Adaptive Multi-Rate, UMTS Adaptive Multi-Rate, TDMA EFR, and PDC EFR, Full Rate Adaptive Multi-Rate WideBand and UMTS Adaptive Multi-Rate WideBand.

Within each radio access technology the following Codec Types may be used, see table 4.1.

Table 4.1: Support of Codec Types in Radio Access Technologies

	PDC EFR	TDMA EFR	UMTS AMR	FR AMR	HR AMR	GSM EFR	GSM HR	GSM FR
GSM	~~not defined~~	not defined	Not possible	yes (4 modes)	yes (4 modes)	Yes	Yes	yes
UMTS	~~yes~~	yes	Yes (8 modes)	yes (8 modes)	yes, but use FR AMR	Yes	Not defined	not defined

					UMTS AMR-WB	FR AMR-WB	PDC EFR
GSM					Not possible	yes (4 modes)	not defined
UMTS					yes (9 modes)	yes (7 modes)	yes

5 3GPP Codec List for OoBTC

The definition of the common Codec List for Out of Band Transcoder Control (3GPP TS 23.153, [8]) 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 (GSM FR)

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 (GSM HR)

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 (GSM EFR)

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 Three Adaptive Multi-Rate Codec Types (FR AMR, HR AMR, UMTS AMR)

The Adaptive Multi-Rate Codec algorithm is applied in GSM and UMTS in fourthree 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.

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.
   When applied in GSM then for the FR AMR and the 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;
   When applied in UMTS then for the FR AMR and UMTS AMR up to all eight modes may be selected.
   If the ACS is not specified at originating side, then all modes are supported there.
   If ACS is not provided, then SCS and MACS can not be provided as well.
Supported Codec Set, SCS: eight bits.
   In FR AMR, and UMTS AMR 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.
   If SCS is not provided, then MACS can not be provided as well.

Maximal number of Codec Modes, MACS: three bits.
   When applied in GSM then for the FR AMR and the HR AMR one to four Codec Modes are allowed within the ACS.
   Coding: "001: one, "010": two, "011": three, "100": four Codec modes allowed.
   When applied in UMTS then for the FR AMR and the UMTS AMR one 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.

Optimisation Mode for ACS , OM: two bits.

    Coding: "0": Optimisation of the ACS not supported, "1": Optimisation supported by out-of-band signalling,

    "2": Optimisation supported by fast inband signalling, "3": reserved.

    Codes "0", "1" and "2" are defined in GSM for AMR TFO (see 3GPP TS 28.062, [7])

    Codes "0" and "1" are defined in UMTS for AMR TFO, "2"and "3" are reserved in UMTS for AMR TFO.

    The Optimisation Mode indicates in TFO, whether the sending side supports the modification (optimisation) of its
ACS for the needs of the distant side. This parameter is necessary in UMTS OoBTCC to support TFO in
"transcoders

    at the edge" scenarios. In case the OM is set to "not supported" the offered ACS can not be altered.

    Only Rate Control can then be used to restrict the modes within the ACS.

    The use of the Optimisation Mode parameter for TrFO is defined in 3GPP TS 23.153 [9].

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	ETSI OID (See ITU-T Q.765.5 [6])							
5 m	CoID	FR_AMR_CoID, or HR_AMR_CoID, or UMTS_AMR_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	OM, MACS	(spare)	(spare)	(spare)	OM		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 Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode,
respectively the maximally allowed rate ("Maximum 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 typically identical.
First, at start up of Tandem Free Operation, both Active Codec Sets, the Supported Codec Sets, the MACSs and the
OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both
radio legs may be taken into account to find the optimum configuration. For exact details see 3GPP TS 28.062. 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 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO):

Normative: The FR AMR and the UMTS AMR Codec Types 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 for the UMTS AMR every 20 ms by going to any arbitraryanother 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 Decision" 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 IuU and NbA interfaces and out of band on the radio interface (fss).

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 typically 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, the Supported Codec Sets, the MACSs and the OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both radio legs may be taken into account to find the optimum configuration. All configuration data and update protocols are transmitted inband on the TFO interface, but out of band within the UMTS network. For information on Tandem Free Operation see 3GPP TS 08.62, respectively 3GPP TS 28.062 and on Transcoder Free Operation see 3GPP TS 23.153 for OoBTC.

The SCR scheme of the default Adaptive Multi-Rate Codec Types 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" is always defined by the network. 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 schemes of the UMTS AMR and the FR AMR Codec Types in UMTS are fully compatible to the DTX schemes of FR AMR and HR AMR in GSM.

For compatibility with other systems the UMTS AMR Codec application 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.

5.5 TDMA Enhanced Full Rate Codec Type (TDMA EFR)

The Codec IDentification (CoID) code is defined to be: TDMA_EFR_CoID := 0x0000.0111~~0~~.

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

For information (for exact details see TDMA Recommendations):

The TDMA Enhanced Full Rate Codec Type supports one fixed Codec Mode with 7.4 kBit/s. This codec mode is bit exact identical with AMR codec mode at 7.4 kBit/s.

In a TDMA system DTX may be enabled in uplink, but not in downlink. The DTX scheme uses one SID frame to mark the end of a speech burst and to start or continue Comfort Noise Generation.

The defined Tandem Free Operation allows the reception of TDMA EFR DTX information for the downlink direction in all cases. In TDMA systems the transcoder has to generate comfort noise in speech like frames to be sent downlink. In UMTS the downlink DTX shall always be supported and the transcoder can therefore stay transparently in TFO.

5.6 PDC Enhanced Full Rate Codec Type (PDC_EFR)

The Codec IDentification (CoID) code is defined to be: TDMA_EFR_CoID := 0x0000.1000~~0111~~.

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

For information (for exact details see PDC Recommendations):

The PDC Enhanced Full Rate Codec Type supports one fixed Codec Mode with 6.7 kBit/s. This codec mode is bit exact identical with AMR codec mode at 6.7 kBit/s.

In a PDC system DTX may be enabled in uplink, but not in downlink. The DTX scheme uses one SID frame to mark the end of a speech burst and to start or continue Comfort Noise Generation.

The Tandem Free Operation allows the reception of PDC EFR DTX information for the downlink direction in all cases. In PDC systems the transcoder has to generate comfort noise in speech like frames to be sent downlink. In UMTS the downlink DTX shall always be supported and the transcoder can therefore stay transparently in TFO.

5.7 Two Adaptive Multi-Rate Wideband Codec Types (FR AMR-WB, UMTS AMR-WB, ~~UMTS_AMR-WB_2~~)

The Adaptive Multi-Rate - WideBand Codec algorithm is applied in GSM and UMTS in two different Codec Types. The Codec IDentification (CoID) codes are defined to be:
FR_AMR-WB_CoID := 0x0000.1001~~0~~.
UMTS_AMR-WB_CoID := 0x0000.10~~0~~10.
~~UMTS_AMR-WB_2_CoID:=0x0000.1011.~~

The AMR-WB may have several additional parameters. These parameters are optional at originating side, but mandatory for the terminating side:
Active Codec Set, ACS0 & ACS1: nine bits.
    When applied in GSM then for the FR AMR-WB up to four modes from the seven lowest modes may be selected by setting the corresponding bits to "1";
    When applied in UMTS then for the FR AMR-WB up to seven lowest modes may be selected.
    When applied in UMTS then for the UMTS AMR-WB ~~and UMTS AMR-WB 2~~ up to all nine modes may be selected.
    If the ACS is not specified at originating side, then all modes are supported there.
    If ACS is not provided, then SCS and MACS can not be provided as well.
Supported Codec Set, SCS0 & SCS1: nine bits.
    In FR AMR-WB up to seven lowest modes may be selected by setting the corresponding bits to "1".
    In UMTS AMR-WB ~~and UMTS AMR-WB 2~~ up to nine modes may be selected by setting the corresponding bits to "1".
    If the SCS is not specified at originating side, then all modes are supported there.

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

Maximal number of Codec Modes, MACS: four bits.
When applied in GSM then for the FR –AMR-WB one to four Codec Modes are allowed within the ACS.
Coding: "001: one, "010": two, "011": three, "100": four Codec modes allowed.
When applied in UMTS then for the FR –AMR-WB one up to seven Codec Modes are allowed within the ACS.
When applied in UMTS then for the UMTS AMR-WB ~~and UMTS AMR WB 2~~ one up to nine Codec Modes are allowed within the ACS.
Coding: "0001: one, "0010": two, … "0111": seven, "1000" eight, "1001" nine Codec modes allowed.
If MACS is not specified at originating side, then the maximum of modes is supported there.

Optimisation Mode for ACS , OM: one~~two~~ bit~~s~~.
Coding: "0": Optimisation of the ACS not supported, "1": Optimisation of the ACS supported
(see 3GPP TS 28.062, [7]).
~~by out of band signalling,~~
~~"2": Optimisation supported by fast inband signalling, "3": reserved.~~
~~Codes "0", "1" and "2" are defined in GSM for AMR-WB TFO (see 3GPP TS 28.062, {7})~~
~~Codes "0" and "1" are defined in UMTS for AMR-WB TFO, "2"and "3" are reserved in UMTS for AMR-WB TFO.~~

The Optimisation Mode indicates in TFO, whether the sending side supports the modification (optimisation) of its ACS for the needs of the distant side. This parameter is necessary in UMTS OoBTCC to support TFO in "transcoders at the edge" scenarios. In case the OM is set to "not supported" the offered ACS can not be altered. Only Rate Control can then be used to restrict the modes within the ACS.
The use of the Optimisation Mode parameter for TrFO is defined in 3GPP TS 23.153 [9].

The Length Indicator field (LI) is set to 3, 5, 7 or 8 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 8~~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 10 octets in case of the AMR-WB Codec Types (table 5.7~~4~~):

Table 5.7: Coding of "Single Codec" for the Adaptive Multi-Rate - WideBand 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	8							
3 m	Compat. Info	Compatibility Information							
4 m	OID	ETSI OID (See ITU-T Q.765.5 [6])							
5 m	CoID	FR_AMR-WB_CoID or UMTS_AMR-WB_CoID							
6 o	ACS0	23.05	19.85	18.25	15.85	14.25	12.65	8.85	6.60
7 o	ACS1	(spare)	(spare)	(spare)	(spare)	(spare)	(spare)	(spare)	23.85
8 o	SCS0	23.05	19.85	18.25	15.85	14.25	12.65	8.85	6.60
9 o	SCS1	(spare)	(spare)	(spare)	(spare)	(spare)	(spare)	(spare)	23.85
10 o	OM, MACS	(spare)	(spare)	(spare)	OM	MACS			

with "m" = mandatory and "o" = optional

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

The FR –AMR-WB Codec Type comprises seven different Codec Modes: 19,85 … 6,60 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 Decision" algorithm. The worst of both radio legs determines the highest allowed Codec Mode, respectively the maximally allowed rate ("Maximum 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 typically identical.
First, at start up of Tandem Free Operation both Active Codec Sets, the Supported Codec Sets, the MACSs and the OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both radio legs may be taken into account to find the optimum configuration. For exact details see 3GPP TS 28.062. All configuration data and update protocols are transmitted inband.

The DTX scheme of the Adaptive Multi-Rate Wideband 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 FR –AMR-WB DTX information for the downlink direction in all cases.

For information on UMTS procedures (for exact details see 3GPP TS 28.062 (TFO) and 3GPP TS 23.153 (TrFO):

The UMTS AMR-WB Codec Type comprises nine different Codec Modes: 23.85 … 6.60 kbit/s.
If an UE supports AMR-WB it shall supported the UMTS AMR-WB Codec Type. There is no need to support the FR AMR-WB Codec Type.

The UMTS_AMR_WB and the UMTS_AMR_WB_2 Codec Types comprises nine different Codec Modes: 23.85 … 6.60 kbit/s. Only one of these two Codec Types shall be indicated in the Codec List, with preference to the UMTS_AMR_WB_2.

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 for the UMTS AMR-WB every 20 ms for the downlink traffic channel, but only every 40ms for the uplink traffic channel by going to any arbitraryanother Codec Mode within the ACS. For the UMTS AMR-WB 2 this Rate Control can be performed every 20ms for the downlink traffic channel, but only every 40ms for the uplink radio channel. The UE selects at call setup one of the two possible phases for Rate ControlCodec Mode Adaptation (odd or even frames). During the call changes of the Codec Mode in uplink direction are only allowed in this selected phase. Rate Control commands received in downlink direction are considered at the next possible phase. By this definition the UMTS AMR-WB 2 Codec Type is TFO and TrFO compatible to the FR AMR-WB and the, UMTS AMR-WB Codec Types and UMTS AMR WB 2.

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 Decision" 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 IuU and NbA interfaces 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 nine 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 typically identical.
At call setup the Originating Side sends the AMR-WB 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, the Supported Codec Sets, the MACSs and the OMs are taken into account to determine the optimal common Active Codec Set. In a later phase the Codec Lists of both radio legs may be taken into account to find the optimum configuration. All configuration data and update protocols are transmitted inband on the TFO interface, but out of band within the UMTS network. For information on Tandem Free Operation see 3GPP TS 208.062, respectively 3GPP TS 28.062 and on Transcoder Free Operation see 3GPP TS 23.153 for OoBTC.

The SCR scheme of the default Adaptive Multi-Rate WideBand Codec Types 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" is always defined by the network. The defined Tandem Free Operation and Transcoder Free Operation allows the reception of AMR-WB SCR information for the downlink direction in all cases.

The SCR schemes of the UMTS AMR-WB, UMTS AMR-WB 2 and FR –AMR-WB Codec Types in UMTS are fully compatible to the DTX scheme of FR –AMR-WB in GSM.

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.

6 Codec List for the Call Control Protocol

For call control on the air interface the Codec Lists need to be specified for each radio access technology separately, because it can not be expected that an UE supports the same Codec Types in different radio access technologies.

3GPP TS 24.008 [9] *defines the call control signalling and how to use the "Supported Codec List* Information Element" (IE). It contains Codec Lists (-in form of Codec Bitmaps) for each supported radio access technology (identified by a SysID).

The coding of this is IE is given here. It is designed in a similar way asalso used for TFO in 3GPP TS 28.062 [7].

6.1 System Identifiers for GSM and UMTS

The system identifiers for the radio access technologies supported by this specification are:

SysID for GSM: 0x0000.0000 (bit 8 .. bit 1)

SysID for UMTS: 0x0000.0100 (bit 8 .. bit 1)

These values are selected in accordance with [7] (3GPP TS 28.062).

6.2 Codec Bitmap

The Codec Types are coded in the first and second octet of the Codec List Bitmap as follows:

bit 8	7	6	5	4	3	2	bit 1	
PDC EFR	TDMA EFR	UMTS AMR	HR AMR	FR AMR	GSM EFR	GSM HR	GSM FR	Octet 1

bit 16	15	14	13	1212	11	10	bit 9	
(reserved)	(reserved)	(reserved)	(reserved)	(reserved) UMTS AMR-WB 2	UMTS AMR-WB	FR AMR-WB	PDC EFR	Octet 2

A Codec Type is supported, if the corresponding bit is set to "1". All reserved bits shall be set to "0".

6.3 Selected Codec Type

The Selected Codec Type is coded as shown in Table 6.3-1. The same coding is used also in 3GPP TS 28.062 [7]. ~~in accordance with [7] (*3GPP TS* 28.062) (long form).~~

Table 6.3-1: Coding of the selected Codec_Type (long form)

Bit 8…Bit 1 CoID	Codec_Type	Name
0000.0000	GSM Full Rate (13.0 kBit/s)	GSM FR
0000.0001	GSM Half Rate (5.6 kBit/s)	GSM HR
0000.0010	GSM Enhanced Full Rate (12.2 kBit/s)	GSM EFR
0000.0011	Full Rate Adaptive Multi-Rate ~~(FR_AMR)~~	FR AMR
0000.0100	Half Rate Adaptive Multi-Rate ~~HR (AMR_HR)~~	HR AMR
0000.0101	UMTS Adaptive Multi-Rate ~~UMTS (AMR_UMTS)~~	UMTS AMR
0000.0111~~0~~	TDMA Enhanced Full Rate (7.4 kBit/s)	TDMA EFR
0000.1000 ~~0111~~	PDC Enhanced Full Rate (6.7 kBit/s)	PDC EFR
0000.1001~~0~~	Full Rate Adaptive Multi-Rate WideBand ~~(FR_AMR_WB)~~	FR _AMR-WB
0000.100~~0~~10	UMTS Adaptive Multi-Rate WideBand ~~UMTS (AMR-WB_UMTS)~~	UMTS AMR-WB
0000.1011	~~UMTS Adaptive Multi-Rate WideBand 2~~reserved	~~UMTS AMR-WB 2~~
other codes	reserved for future use.	

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 OoBTC protocol. UMTS does support: UMTS AMR, 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	Single Codec (see ITU-T Q.765.5)							
5	LI	6							
6	Compat. Info	Compatibility Information							
7	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
12	Single Codec	Single Codec (see ITU-T Q.765.5)							
13	LI	6							
14	Compat. Info	Compatibility Information							
15	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
20	Single Codec	Single Codec (see ITU-T Q.765.5)							
21	LI	6							
22	Compat. Info	Compatibility Information							
23	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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)	(spare)	OM		MACS		
28	Single Codec	Single Codec (see ITU-T Q.765.5)							
29	LI	3							
30	Compat. Info	Compatibility Information							
31	OID	ETSI OID (See ITU-T Q.765.5 [6])							
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 three 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 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
12-2000	10	SP-000576	004		Introduction of Codec Type Bit-Map for Codec Negotiation	3.0.0	4.0.0
12-2000	10	SP-000576	005		Introduction of Selected Codec Type for Codec Negotiation	3.0.0	4.0.0
12-2000	10	SP-000576	006		Clarification for the use of the Codec List Information Element	3.0.0	4.0.0