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TECHNICAL SPECIFICATION

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Contents

Foreword

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

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

Version x.y.z

where:

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

1 Scope

The present document specifies the mapping of the AMR wideband generic frame format (3GPP TS 26.201) to the Iu Interface (3GPP TS 25.415), the Uu Interface and the Nb Interface (3GPP TS 29.415) of a BICC-based circuit switched core network. It further specifies the mapping of PCM 64 kBit/s (ITU-T G.711) coded speech to the Nb Interface of a BICC-based circuit switched core network.

The mapping of the AMR wideband generic frame format to RTP for the A-Interface and the Nb Interface for a SIP-I - based circuit switched core network is described in TS 26.102.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 25.415: "Iu Interface CN-UTRAN User plane Protocols".

[2] 3GPP TS 26.201: "AMR Wideband Speech Codec, Frame structure".

[3] 3GPP TS 23.107: "QoS Concept and Architecture".

[5] 3GPP TS 28.062: " In-band Tandem Free Operation (TFO) of Speech Codecs, Stage 3".

[6] 3GPP TS 23.153: "Out of band transcoder control, Stage 2".

[6] 3GPP TS 29.415: "Core Network Nb Interface User Plane Protocols".

[7] ITU-T I.366.2: "AAL type 2 service specific convergence sublayer for trunking".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definitions apply:

AMR Wideband Generic Frame Interface: this interface transports the AMR-WB IF1 generic frame as defined in 3GPP TS 26.201.

3.2 Abbreviations

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

AAL2	ATM Adaptation Layer 2
ACS	Active Codec Set
AMR	Adaptive Multi-Rate
AS	Access Stratum
ATM	Asynchronous Transfer Mode

BFH	Bad Frame Handling
CMR/CMC	Codec Mode Request or Codec Mode Command
CMI	Codec Mode Indication
CN	Core Network
CDMA	Code Division Multiple Access
DRC	Downlink Rate Command
FDD	Frequency Duplex Division
FQC	Frame Quality Classification (Iu Interface)
FQI	Frame Quality Indication (AMR-WBIF1)
GSM	Global System for Mobile communications
ITU-T	International Telecommunication Union – Telecommunication standardisation sector (former CCITT)
MAC	Media Access Control
MGW	Media GateWay
PCM	Pulse Code Modulation, synonym for 64 kBit/s coded speech (see ITU-T G.711)
PLMN	Public Land Mobile Network
QoS	Quality of Service
RAN	Radio Access Network
RAB	Radio Access Bearer
RF	Radio Frequency
RFC	RAB sub-flow Combination
RFCI	RFC Indicator
RFCS	RFC Set
RX	Receive
SCR	Source Controlled Rate
SDU	Source Data Unit
SID	Silence Insertion Descriptor
SMpSDU	Support Mode for Predefined SDU sizes
SPD	SPeech Decoder
SPE	SPeech Encoder
TC	Transcoder
TDD	Time Duplex Division
TDMA	Time Division Multiple Access
TFO	Tandem Free Operation
TrFO	Transcoder Free Operation
TX	Transmit
UE	User Equipment (terminal)
URC	Uplink Rate Command

4 General

The mapping of the AMR-WB Speech Codec parameters to the Iu interface specifies the frame structure of the speech data exchanged between the RNC and the TC in case of normal operation and Tandem Free Operation, respectively between RNC 1 and RNC 2 in case of Transcoder Free Operation. This mapping is independent from the radio interface in the sense that it has the same structure for both FDD and TDD modes of the UTRAN.

The mapping between the Speech Codec and the Radio Access Network within the UE is not an open interface and need not to be detailed.

The mapping on the Nb Interface is identical to the one on the Iu Interface in case of Transcoder Free Operation, with the MGW relaying the SDUs unaltered between Iu and Nb Interfaces.
In case of transcoding within the MGW the PCM coded speech is mapped onto the Nb Interface in packets of 40 octets.

5 RAB aspects

During the RAB Assignment procedure initiated by the CN to establish the RAB for UMTS_AMR-WB, the RAB parameters are defined. The UMTS_AMR-WB RAB is established with one or more RAB co-ordinated sub-flows with predefined sizes and QoS parameters. In this way, each Transport Format Combination between sub-flows corresponds

to one UMTS_AMR-WB frame type. On the Iu interface, these RAB parameters define the corresponding parameters regarding the transport of UMTS_AMR-WB frames.

Some of the QoS parameters in the RAB assignment procedure are determined from the Bearer Capability Information Element used at call set up. These QoS parameters as defined in [3], can be set as follows:

Table 5-1: Example of mapping of BC IE into QoS parameters for UMTS_AMR-WB

RAB service attribute	RAB service attribute value		Comments
Traffic Class	Conversational		
RAB Asymmetry Indicator	Symmetric, bidirectional		Symmetric RABs are used for uplink and downlink
Maximum bit rate	12,65 kbit/s in configurations 0 and 1 15,85 kbit/s in configurations 2 and 3 23,85 kbit/s in configurations 4 and 5		This value depends on the highest mode rate in the RFCS (note 2)
Guaranteed bit rate	6,60 kbit/s		One of the values is chosen, depending on the lowest rate controllable SDU format (note 2)
Delivery Order	Yes		(note 1)
Maximum SDU size	253 in configurations 0 and 1 317 in configurations 2 and 3 477 in configurations 4 and 5		Maximum size of payload field in Iu UP, according to the highest mode rate in the RFCS (note 2)
Traffic Handling Priority	Not applicable		Parameter not applicable for the conversational traffic class. (note 1)
Source statistics descriptor	Speech		(note 1)
SDU Parameters	RAB subflow 1 (Class A bits)	RAB subflow 2 (Class B bits)	The number of SDU, their number of RAB subflow is subject to operator tuning (note 3)
SDU error ratio	$7 * 10^{-3}$	-	(note 3)
Residual bit error ratio	10^{-6}	10^{-3}	(note 3 – applicable for every subflow)
Delivery of erroneous SDUs	yes	-	Class A bits are delivered with error indication; Class B bits are delivered without any error indication.
SDU format information 1-5			(note 4)
sub-flow SDU size 1-5	(note 5)	(note 5)	

NOTE 1: These parameters apply to all UMTS speech codec types.
NOTE 2: The guaranteed bit rate depends on the periodicity and the lowest rate controllable SDU size. All UMTS_AMR-WB configurations as defined in TS 26.103 contain the 6,60 kbps codec mode as lowest and therefore "guaranteed bit rate". The "maximum bit rate" and the "maximum SDU size" depend on the selected UMTS_AMR-WB configuration.
NOTE 3: These parameters are subject to operator tuning.
NOTE 4: SDU format information has to be specified for each AMR-WBcore frame type (i.e. with speech bits and comfort noise bits) included in the RFCS as defined in [2].
NOTE 5: The subflow SDU size corresponding to an AMR-WBcore frame type indicates the number of bits in the class A, class B fields.

The conversational traffic class shall be used for the speech service, which is identified by the ITC parameter of the bearer capability information element in the SETUP message. This shall apply for all UMTS speech codec types.
The parameters traffic class, transfer delay, traffic handling priority and source statistics descriptor shall be the same for all speech codec types applicable for UMTS.

6 Iu Interface User Plane (RAN)

The data structures exchanged on the Iu interface are symmetrical, i.e. the structure of the uplink data frames is identical to that of the downlink data frames. This facilitates Tandem Free Operation and Transcoder Free Operation.

6.1 Frame structure on the Iu UP transport protocol

6.1.1 Initialisation

At the initialisation of the SMpSDU mode of operation, several parameters are set by the CN. The initialisation procedure is described in 3GPP TS 25.415 [1].

- RFCS:

  In the case of UMTS_AMR-WB, the RFCS corresponds to the Active Codec Set (ACS) plus SCR authorised in the communication. *Annex A of [1] gives an illustration of the usage of RFCI for UMTS_AMR-WB speech RAB. RFCS used in downlink may differ from that in uplink.*

- Delivery of erroneous SDUs:

  This parameter shall be set to YES. Erroneous speech frames may be used to assist the error concealment procedures.

The PDU type 0 shall be used for the transport of AMR-WB data.

6.1.2 Time Alignment Procedure

The TC should adjust the timing of the speech data transmission in downlink direction according to the time alignment frame sent by the RNC.

Time alignment procedure shall be dismissed in case of TFO and TrFO.

6.2 Mapping of the bits

The mapping of the bits between the generic AMR-WB frames and the PDU is the same for both uplink and downlink frames.

The following table gives the correspondence of the bit fields between the generic AMR-WB frames at the TC interface and the PDU exchanged with the Iu transport layer.

Table 6-1: Mapping of generic AMR-WB frames onto Iu PDUs

PDU field	**Corresponding field within the generic AMR-WB frame**	**Comment**
PDU Type	N/A	Type 0
Frame Number	N/A	
FQC	Frame Quality Indicator	
RFCI	Frame Type	
Payload CRC	N/A	
Header CRC	N/A	
Payload Fields (N sub-flows)	Class A or SID payload Class B	
SDU #1	Most important speech bits come first	Mandatory
SDU #2	Next bits follow	Optional
…	…	Optional
SDU #N	Least important speech bits	Optional

The number of RAB sub-flows, their corresponding sizes, and their attributes such as "Delivery of erroneous SDUs" shall be defined at the RAB establishment and signalled in the RANAP RAB establishment request, as proposed in clause 5. The number of RAB sub-flows are corresponding to the desired bit protection classes. The total number of bits in all sub-flows for one RFC shall correspond to the total number given in 3GPP TS 26.201, generic AMR-WB frame, format IF1, for the corresponding Codec Mode respectively Frame Type.

Table 6-2 gives three examples of sub-flow mapping, one for each allowed configuration.
The RFCI definition is given in order of increasing SDU sizes.

In all examples, the sub-flow mapping follows the class division of TS 26.201, with some slight modification: in order to support Blind Transport Format Detection the number of bits in RAB sub-flow 1 is sometimes increased slightly to include not only the Class A bits, but also one or two bits from Class B (the next bits in order of subjective importance according to TS 26.201) . Blind Transport Format Detection requires that RAB sub-flow1 has a different number of bits for each mode. As the 12.65, 15.85, and 23.85 modes all have 72 Class A bits, they would be not be distinguishable if only Class A bits were included in RAB sub-flow1.

- Example 1 describes Codec Type UMTS_AMR-WB, with the three lowest codec modes foreseen in the Active Codec Set (ACS) and provision for Source Controlled Rate operation (SCR).

- Example 2 describes Codec Type UMTS_AMR-WB as in example 1, with codec mode 15.85 in addition. The number of bits allocated to RAB sub-flow 1 in codec mode 15.85 is 73 in order to support Blind Transport Format Detection.

- Example 3 describes Codec Type UMTS_AMR-WB as in example 1, with codec mode 23.85 in addition. The number of bits allocated to RAB sub-flow 1 in codec mode 23.85 is 74 in order to support Blind Transport Format Detection.

Table 6-2: Examples for UMTS_AMR-WB with SCR and two sub-flows, according to subjective class division indication of 3GPP TS 26.201

UMTS_AMR-WB	RAB sub-flows		Total number of bits per RAB sub-flow combination (Mandatory)	Source rate
RFCI	RAB sub-flow 1 (Optional)	RAB sub-flow 2 (Optional)		
Example 1				
1	40	0	40	AMR-WB SID
2	54	78	132	AMR-WB 6.6 kbps
3	64	113	177	AMR-WB 8.85 kbps
4	72	181	253	AMR-WB 12.65 kbps
Example 2				
1	40	0	40	AMR-WB SID
2	54	78	132	AMR-WB 6.6 kbps
3	64	113	177	AMR-WB 8.85 kbps
4	72	181	253	AMR-WB 12.65 kbps
5	73	244	317	AMR-WB 15.85 kbps
Example 3				
1	40	0	40	AMR-WB SID
2	54	78	132	AMR-WB 6.6 kbps
3	64	113	177	AMR-WB 8.85 kbps
4	72	181	253	AMR-WB 12.65 kbps
5	74	403	477	AMR-WB 23.85 kbps

6.3 Frame handlers

Iu PDU Frame handling functions are described in 3GPP TS 25.415. This sections describes the mandatory frame handling functions at the AMR-WB Generic frame interface.

6.3.1 Handling of frames from TC to Iu interface (downlink)

The frames from the TC in generic AMR-WB frame format IF1 are mapped onto the Iu PDU as follows.

6.3.1.1 Frame Quality Indicator

The Frame Quality Indicator (FQI) from the TC, respectively from the distant TFO partner, is directly mapped to the Frame Quality Classification (FQC) of the Iu frame according to Table 6-3.

Table 6-3: FQI AMR-WBto FQC Iu PDU mapping

FQI AMR	FQI value (1 bit)	FQC PDU	FQC value (2 bit)
GOOD	1	GOOD	00
BAD	0	BAD	01

6.3.1.2 Frame Type

The received Frame Type Index l is mapped onto the RFCI j thanks to the assigned RFCS table: the correspondence between Codec Mode, Frame Type Index l and RFCI j is defined at RAB assignment.

6.3.1.3 Codec Mode Indication

The Codec Mode Indication is not used.

6.3.1.4 Codec Mode Request

Codec Mode Request (CMR) in downlink direction is forwarded to the rate control procedure when it changes, or when it is commanded so by the TC in case of TFO, see 3G TS 28.062.

6.3.1.5 Optional internal 8 bits CRC

The internal AMR-WB codec CRC is not used on the Iu interface.

6.3.1.6 Mapping of Speech or Comfort Noise parameter bits

Let us define the N payload fields of the N sub-flows for RFCI j as follow :

$U_i(k)$ shall be the bits in sub-flow i, for k =1 to Mi

M_i shall be the size of sub-flow i, for i = 1 to N

d(k) shall be the bits of the speech or comfort noise parameters of the corresponding Frame Type 1 in decreasing subjective importance, as defined in the generic AMR-WB frame format IF1, see TS 26.201.

Then the following mapping in pseudo code applies:

$U_1(k) = d(k-1)$ with $k = 1, \ldots M_1$

$U_2(k) = d(k-1 + M_1)$ with $k = 1, \ldots M_2$

$U_3(k) = d(k-1 + M_2)$ with $k = 1, \ldots M_3$

…

$U_N(k) = d(k-1 + M_{N-1})$ with $k = 1 \ldots M_N$

6.3.2 Handling of frames from Iu interface to TC (uplink)

The uplink Iu frames are mapped onto generic AMR-WB frames, format IF1, as follows.

6.3.2.1 Frame Quality Indicator

At reception of Iu PDU the Iu frame handler function set the Frame Quality Classification according to the received FQC, Header-CRC check, and Payload-CRC check (see 25.415). AMR-WB Frame Type and Frame Quality Indicator are determined according to the following table:

Table 6-4: FQC Iu PDU type 0 to AMR-WB FQI and AMR-WB Frame Type mapping

FQC	FQC value **(2 bits)**	Resulting FQI	FQI value **(1 bit)**	**Resulting Frame Type**
GOOD	00	GOOD	1	from RFCI
BAD	01	BAD	0	NO_DATA
BAD Radio	10	BAD	0	from RFCI
Reserved	11	BAD	0	Reserved

6.3.2.2 Frame Type

The received RFCI j is mapped onto the Frame Type Index l thanks to the RFCS table.

6.3.2.3 Codec Mode Indication

The Codec Mode Indication is not used.

6.3.2.4 Codec Mode Request

The received Downlink Rate Control (DRC) command is mapped onto the Codec Mode Request (CMR) towards the AMR-WB Codec. In case a new DRC is received it is mapped into the corresponding CMR of the generic AMR-WB frame format. It is remembered by the TC until the next DRC is received. In each new frame that is sent to the AMR-WB Codec, the stored CMR is resent, in order to control the Codec Mode for the downlink direction.

6.3.2.5 Optional internal 8 bits CRC

The internal AMR-WB Codec CRC is not used on the Iu interface.

6.3.2.6 Speech and Comfort noise parameter bits

The speech and Comfort noise parameter bits are mapped from the sub-flows to the payload of the generic AMR-WB frames with the reverse function of subclause 6.3.1.6.

7 Uu Interface User Plane (UE)

The interface between the UE AMR-WB speech codec (see 3GPP TS 26.201) and the Radio Access Network is an internal UE interface and is not detailed. The mapping is corresponding to the mapping described in clause 6 for the Iu interface.

NOTE: In case of modification of the maximum rate (e.g. by the RNC), it takes a short time period until the speech frames sent by the UE to the Radio Access Network comply with the modified maximum rate. To facilitate optimization of performance (for instance avoiding problems like audio gaps due to discarded packets) in sending direction from the UE to the network when changing mode as requested, it is a good implementation practice to allow adaptation of the UE Encoder to take effect, and to maintain currently used rate for the next few frames after the information about the rate adaptation has been sent to the UE Encoder.

8 Nb Interface User Plane (CN)

The data structures exchanged on the Nb interface are symmetrical, i.e. the structures of the sent and received data frames are identical.

8.1 Frame structure on the Nb UP transport protocol

Delivery of erroneous SDUs for AMR-WB data and PCM coded speech on the Nb interface shall be set to: "YES".

Erroneous speech frames may be used to assist the error concealment procedures. Therefore, according to [1] and [6], PDU Type 0 (with payload CRC) shall be used for the transport of AMR-WB coded speech on the Nb interface. PDU Type 0 (with payload CRC) shall be used for the transport of PCM coded speech on the Nb interface, too.

8.1.1 Initialisation

The initialisation procedure is used for support mode. At the initialisation several parameters are set by the CN. The initialisation procedure for the Nb Interface is described in [6].

8.1.2 Time Alignment Procedure

The handling of Time Alignment on the Nb Interface is described in [6].

The Time alignment procedure shall be dismissed in case of TFO and TrFO.

8.2 Mapping of the bits

8.2.1 Mapping for AMR-WB frames

The mapping of the bits between the generic AMR-WB frames and the PDU for the Nb Interface is identical to the mapping on the Iu Interface. In case of TrFO the MGW relays the AMR-WB frames from the Iu Interface unaltered to the Nb Interface and vice versa, as described in [6].

8.2.2 Mapping for PCM Coded Speech

In case of transcoding within the MGW from PCM coded speech to AMR-WB frames and vice versa the mapping for the PCM coded speech on the Nb Interface shall be as defined in Table 8-1.

Table 8-1: Mapping of PCM Coded Speech onto Nb PDU, Type 0

PDU field	Comment
PDU Type	Type 0 (with Payload CRC)
Frame Number	as defined in [6]
FQC	set to "good"
RFCI	initialise by MGW, see [6], one value required
Header CRC	as defined in [6]
Payload CRC	as defined in [6]
Payload Field	40 octets of PCM coded speech, in accordance with [7].

8.3 Frame handlers

Nb PDU Frame handling functions are described in [6].

Annex A (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
03-2001	11	SP-010091			Presented as version 2.0.0 for approval		5.0.0
09-2002		SP-020437	001	2	Consideration of allowed Configurations for AMR-WB	5.0.0	5.1.0
12-2004	26				Version for Release 6	5.1.0	6.0.0
06-2007	36				Version for Release 7	6.0.0	7.0.0
09-2008	41	SP-080475	003	2	Addition of CS over IP User Plane	7.0.0	8.0.0
12-2008	42				Update of LTE logo and Copyright statement	8.0.0	8.0.1
12-2009	46				Version for Release 9	8.0.1	9.0.0
03-2011	51				Version for Release 10	9.0.0	10.0.0
06-2012	56	SP-120223	0005		Correction of Example Text Regarding Number of Class A and B bits and RAB sub flows	10.0.0	10.1.0
09-2012	57				Version for Release 11	10.1.0	11.0.0
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12-2015	70				Version for Release 13	12.0.0	13.0.0

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2016-09	73	SP-160601	0006	1	F	Clarification to avoid rate adaptation quality issues in uplink for UTRAN	14.0.0
2018-06	80					Version for Release 15	15.0.0
2020-07	-	-	-	-	-	Update to Rel-16 version (MCC)	16.0.0
2022-04	-	-	-	-	-	Update to Rel-17 version (MCC)	17.0.0
2024-03	-	-	-	-	-	Update to Rel-18 version (MCC)	18.0.0
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