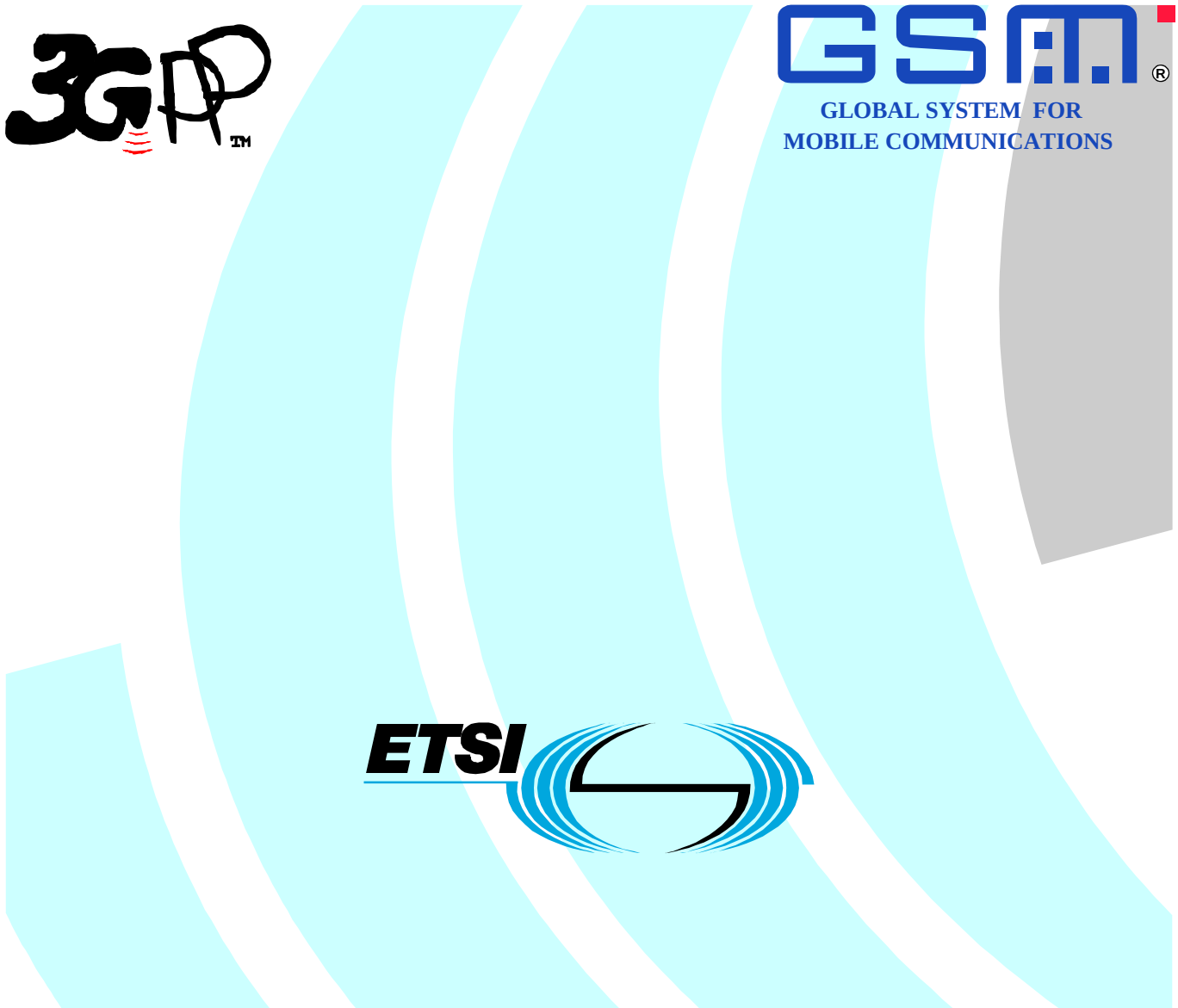
ETSI TS 126 102 V6.0.0 (2004-09)

Technical Specification

Digital cellular telecommunications system (Phase 2+);
Universal Mobile Telecommunications System (UMTS);
Adaptive Multi-Rate (AMR) speech codec;
Interface to Iu and Uu
(3GPP TS 26.102 version 6.0.0 Release 6)



Reference
RTS/TSGS-0426102v600

Keywords
GSM, UMTS

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Foreword

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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:

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1 Scope

The present document specifies the mapping of the AMR generic frame format (3GPP TS 26.101) to the Iu Interface (3GPP TS 25.415 [7]), the Uu Interface and the Nb Interface (3GPP TS 29.415). It further specifies the mapping of Enhanced Full Rate (GSM_EFR) coded speech and of PCM 64 kBit/s (ITU-T G.711 [9]) coded speech to the Nb Interface.

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 26.101: "AMR Speech Codec, Frame structure".

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

[4] 3GPP TS 06.51: " Enhanced Full Rate (EFR) speech processing functions; General Description"

[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".

[7] 3GPP TS 29.415: "Core Network Nb Interface User Plane Protocols".

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

[9] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

3 Definitions and abbreviations

3.1 Definitions

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

AMR Generic Frame Interface: this interface transports the AMR IF1 generic frame as defined in 3GPP TS 26.101

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

CDMA	Code Division Multiple Access
CMI	Codec Mode Indication
CMR/CMC	Codec Mode Request or Codec Mode Command
CN	Core Network
DRC	Downlink Rate Command
FDD	Frequency Duplex Division
FQC	Frame Quality Classification (Iu Interface)
FQI	Frame Quality Indication (AMR IF1)
GSM	Global System for Mobile communications
ITU-T	International Telecommunication Union – Telecommunication standardisation sector (former CCITT)
MGW	Media GateWay
PCM	Pulse Code Modulation, synonym for 64 kBit/s coded speech (see ITU-T G.711 [9])
PDC	Personal Digital Communication
PLMN	Public Land Mobile Network
QoS	Quality of Service
RAB	Radio Access Bearer
RAN	Radio Access Network
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 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. 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.

The mapping of GSM_EFR Speech Codec parameters is defined on the Nb Interface, but not on the Iu Interface.

5 RAB aspects

During the RAB Assignment procedure initiated by the CN to establish the RAB for AMR, the RAB parameters are defined. The AMR RAB is established with one or more RAB co-ordinated sub-flows with predefined sizes and QoS

parameters. In this way, each RAB sub-flow Combination corresponds to one AMR frame type. On the Iu interface, these RAB parameters define the corresponding parameters regarding the transport of AMR 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

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	12.2 / 10.2 / 7.95 / 7.4 / 6.7 / 5.9 / 5.15 / 4.75 kbit/s			This value depends on the highest mode rate in the RFCS
Guaranteed bit rate	12.2 / 10.2 / 7.95 / 7.4 / 6.7 / 5.9 / 5.15 / 4.75 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	244 / 204 / 159 / 148 / 134 / 118 / 103 / 95 bits			Maximum size of payload field in Iu UP, according to the highest mode rate in the RFCS
Traffic Handling Priority	Not applicable			Parameter not applicable for the conversational traffic class. (note 1)
Source statistics descriptor	Speech			(note 1)
SDU Parameters	RAB sub-flow 1 (Class A bits)	RAB sub-flow 2 (Class B bits)	RAB sub-flow 3 (Class C bits)	The number of SDU, their number of RAB sub-flow and their relative sub-flow size is subject to operator tuning (note 3)
SDU error ratio	$7 * 10^{-3}$	-	-	(note 3)
Residual bit error ratio	10^{-6}	10^{-3}	$5 * 10^{-3}$	(note 3 – applicable for every sub-flow)
Delivery of erroneous SDUs	yes	-	-	Class A bits are delivered with error indication; Class B and C bits are delivered without any error indication.
SDU format information 1-9				(note 4)
Sub-flow SDU size 1-9	(note 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.
NOTE 3: These parameters are subject to operator tuning.
NOTE 4: SDU format information has to be specified for each AMR core frame type (i.e. with speech bits and comfort noise bits) included in the RFCS as defined in [2].
NOTE 5: The sub-flow SDU size corresponding to an AMR core frame type indicates the number of bits in the class A, class B and class C fields. The assigned SDU sizes shall be set so that the SCR operation is always possible.

The RAB parameters shall be set so that the SCR operation is always possible.
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 structure 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.

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 [1].

- RFCS:

  In the case of AMR, the RFCS corresponds to the Active Codec Set (ACS) plus potentially SCR authorised in the communication. Annex A of [1] gives an illustration of the usage of RFCI for AMR 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. Therefore, according to [1], PDU type 0 (containing a payload CRC) shall be used for transport of AMR 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 frames 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 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 frames at the TC interface and the PDU exchanged with the Iu transport layer.

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

PDU field	Corresponding field within the generic AMR 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 Class C	
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 26.101, generic AMR frame, format IF1, for the corresponding Codec Mode, respectively Frame Type.

Guidance for setting the number of bits in each RAB sub-flow according to their relative subjective importance is given in 3GPP TS 26.101.

The following two tables are examples of mapping of RAB sub-flows.

Table 6-2 gives three examples of sub-flow mapping.
The RFCI definition is given in order of increasing SDU sizes.

- Example 1 describes Codec Type UMTS_AMR, with all eight codec modes foreseen in the Active Codec Set (ACS) and provision for Source Controlled Rate operation (SCR). In this example, Blind Transport Format Detection is supported and the sub-flow mapping follows the 26.101 class division guidance.

- Example 2 describes Codec Type GSM_EFR, with one codec mode, including SCR.

- Example 3 describes Codec Type FR_AMR, including AMR SCR

Table 6-2: Example for AMR with SCR and three sub-flows, according to subjective class division indication of 3GPP TS 26.101

UMTS_AMR	GSM_EFR	FR_AMR	RAB sub-flows			Total size of bits/RAB sub-flows combination (Mandatory)	Source rate
RFCI Example 1	RFCI Example 2	RFCI Example 3	RAB sub-flow 1 (Optional)	RAB sub-flow 2 (Optional)	RAB sub-flow 3 (Optional)		
2		**2**	**42**	**53**	**0**	95	AMR 4,75 kbps
3			**49**	**54**	**0**	103	AMR 5,15 kbps
4		**3**	**55**	**63**	**0**	118	AMR 5,9 kbps
5		**4**	**58**	**76**	**0**	134	AMR 6,7 kbps
6			**61**	**87**	**0**	148	AMR 7,4 kbps
7			**75**	**84**	**0**	159	AMR 7,95 kbps
8		**5**	**65**	**99**	**40**	204	AMR 10,2 kbps
9	**2**		**81**	**103**	**60**	244	AMR 12,2 kbps
1		**1**	**39**	**0**	**0**	39	AMR SID
	1		**43**	**0**	**0**	43	GSM-EFR SID

Table 6-3 gives one example of sub-flow mapping that supports Equal Error Protection.
The RFCI definition is given in order of increasing SDU sizes.

- Example 4 describes Codec Type PDC_EFR and the corresponding Source Controlled Rate operation (SCR).

Table 6-3: Example of SDU sizes for PDC_EFR with SCR and Equal Error Protection

PDC_EFR	RAB sub-flow	Total size of bits/RAB sub-flows combination (Mandatory)	Source rate
RFCI Example 4	RAB sub-Flow 1 (Mandatory)		
	95	95	AMR 4,75kbps
	103	103	AMR 5,15kbps
	118	118	AMR 5,9kbps
2	**134**	134	AMR 6,7kbps
	148	148	AMR 7,4kbps
	159	159	AMR 7,95kbps
	204	204	AMR 10,2kbps
	244	244	AMR 12,2kbps
	39	39	AMR SID
	43	43	GSM-EFR SID
	38	38	TDMA-EFR SID
1	**37**	37	PDC-EFR SID

6.3 Frame handlers

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

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

The frames from the TC in generic AMR 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 is directly mapped to the Frame Quality Classification (FQC) of the Iu frame according to Table 6-4.

Table 6-4: FQI AMR to 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 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 follows:

$U_i(k)$ 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 l in decreasing subjective importance, as defined in the generic AMR frame format IF1, see TS 26.101 [2].

Then the following mapping in pseudo code applies:

$U_1(k) = d(k-1)$ with k = 1, … M_1

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

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

…

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

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

The uplink Iu frames are mapped onto generic AMR 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 Frame Type and Frame Quality Indicator are determined according to the following table:

Table 6-5: FQC Iu PDU type 0 to AMR FQI and AMR 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 command (DRC) is mapped onto the Codec Mode Request (CMR) towards the AMR Codec. In case a new DRC is received it is mapped into the corresponding CMR of the generic AMR frame format. It is remembered by the TC until the next DRC is received. In each new frame that is sent to the AMR 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 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 frames with the reverse function of clause 6.3.1.6.

7 Uu Interface User Plane (UE)

The interface between the UE AMR speech codec (see 3GPP TS 26.101) 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.

Even though the details of Uu interface are not detailed, there are some functional requirements for the UE that need to be considered, when an AMR codec type (i.e. UMTS AMR2) is being used in a conversational speech call. These requirements are related to the mapping of AMR Generic frame format handling functions. The requirements are

1. The set of available codec modes (bitrates) that the UE may use are configured by UTRAN. The UE shall select, from the configured set of codec modes, a mode that is supported by the current TX power conditions as defined in 3GPP TS25.133. The highest available mode should be used for best speech quality.

2. The lowest configured codec mode is always to be considered supported.

3. When the codec mode is being adapted during a call, the used mode should be changed in a step-by-step fashion within the configured set of codec modes, i.e. by stepping one mode up or down within the configured set. This avoids disruptions on AMR decoding in GSM side, if TFO or TrFO operation is ongoing.

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 and GSM_EFR 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 [7], PDU Type 0 (with payload CRC) shall be used for the transport of AMR and GSM_EFR 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 [7].

8.1.2 Time Alignment Procedure

The handling of Time Alignment on the Nb Interface is described in [7].

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 frames

The mapping of the bits between the generic AMR 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 frames from the Iu Interface unaltered to the Nb Interface and vice versa, as described in [7].

8.2.2 Mapping for PCM Coded Speech

In case of transcoding within the MGW from PCM coded speech to AMR 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 [7]
FQC	set to "good"
RFCI	initialise by MGW, see [7], one value required
Header CRC	as defined in [7]
Payload CRC	as defined in [7]
Payload Field	40 octets of PCM coded speech, in accordance with [8].

8.2.3 Mapping for GSM_EFR frames

The mapping of the bits between the generic GSM_EFR frames and the PDUs for the Nb Interface follows the same principles as the mapping of AMR frames. The PDU for the GSM_EFR speech frame is identical to the PDU for AMR Mode 12.2 kbps. The PDU for the GSM_EFR SID frame is similar to the PDU for AMR SID, with 43 instead of 39 bits in the payload field.

8.3 Frame handlers

Nb PDU Frame handling functions are described in [7].

Annex A (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
1999-12	6	SP-99563			Approved at TSG-SA#6 Plenary		3.0.0
2000-03	7	SP-000025	001	3	Introduction of QoS parameters used at RAB assignment	3.0.0	3.1.0
2000-03	7	SP-000025	002		Introduction of different RFCS set on Iu User Plane	3.0.0	3.1.0
2000-03	7	SP-000025	003	2	Introduction of Time Alignment	3.0.0	3.1.0
2000-12	10	SP-000575	005	1	AMR interface to Iu	3.1.0	3.2.0
2001-03	11	SP-010103	006	2	Removal of TFO and TrFO from Release 99, and removal of Initial Time Alignment	3.2.0	3.3.0
2001-03	11	SP-010103	008	1	Introduction of TFO and TrFO	3.3.0	4.0.0
2002-06	16				Version for Release 5	4.0.0	5.0.0
2002-12	18	SP-020689	012	2	Correction of RAB parameter assignment for AMR	5.0.0	5.1.0
2003-03	19	SP-030087	015	2	AMR Rate Adaptation of Rel-5	5.1.0	5.2.0
2004-04	25	SP-040645	016	1	Mapping of GSM_EFR SID on Nb Interface	5.2.0	6.0.0

History

Document history		
V6.0.0	September 2004	Publication