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Technical Specification

**Digital cellular telecommunications system (Phase 2+);
Rate adaption on the Base Station System -
Mobile-services Switching Centre (BSS - MSC) interface
(3GPP TS 08.20 version 8.2.0 Release 1999)**

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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Contents

Foreword

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

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1 Scope

The present document defines rate adaptation functions to be used in GSM PLMN Base Station Systems (BSS) transcoders and IWF for adapting radio interface data rates to the 64 kbit/s used at the A-interface in accordance with 3GPP TS 03.10.

The number of Base Station System - Mobile-services Switching Centre (BSS - MSC) traffic channels supporting data rate adaptation may be limited. In this case some channels may not support data rate adaptation. Those that do, must conform to this specification.

NOTE: This specification should be considered together with 3GPP TS 04.21 to give a complete description of PLMN rate adaptation.

2 References, Abbreviations and Definitions

2.1 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.

[1] 3GPP TS 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] 3GPP TS 02.34: “Digital cellular telecommunications system (Phase2+): High Speed Circuit Switched Data (HSCSD) - Stage1"

[3] 3GPP TS 03.10: "Digital cellular telecommunications system (Phase 2+); GSM Public Land Mobile Network (PLMN) connection types".

[4] 3GPP TS 03.34: “Digital cellular telecommunications system (Phase 2+): High Speed Circuit Switched Data (HSCSD) - Stage2".

[5] 3GPP TS 04.21: "Digital cellular telecommunications system (Phase 2+); Rate adaption on the Mobile Station - Base Station System (MS - BSS) interface".

[6] 3GPP TS 04.22: "Digital cellular telecommunications system (Phase 2+); Radio Link Protocol (RLP) for data and telematic services on the Mobile Station - Base Station System (MS - BSS) interface and the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".

[7] 3GPP TS 05.03: "Digital cellular telecommunications system (Phase 2+); Channel coding".

[8] 3GPP TS 07.01: "Digital cellular telecommunications system (Phase 2+); General on Terminal Adaptation Functions (TAF) for Mobile Stations (MS)".

[9] 3GPP TS 08.08: "Digital cellular telecommunications system (Phase 2+); Mobile Switching Centre - Base Station System (MSC - BSS) interface; Layer 3 specification".

[10] 3GPP TS 09.07: "Digital cellular telecommunications system (Phase 2+); General requirements on interworking between the Public Land Mobile Network (PLMN) and the Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN)".

[11] CCITT Recommendation V.110: "Support of data terminal equipment’s (DTEs) with V-Series interfaces by an integrated services digital network".

[12] CCITT Recommendation I.460:-Multiplexing, rate adaption and support of existing interfaces.

2.2 Abbreviations

In addition to those below, abbreviations used in this specification are listed in 3GPP TS 01.04.

FPS Frame Pattern Substitution
FSI Frame Start Identifier
ZSP Zero Sequence Position

2.3 Definitions

For the purposes of the present document, the following terms and definitions apply.

Substream: Stream of data with explicit or implicit numbering between splitter and combine functions.

Channel: A physical full rate channel on the radio interface (TCH/F) independent of the contents.

A interface circuit: The 8 bits that constitute one 64 kbps circuit on the A interface.

A interface subcircuit: One specific bit position or one specific pair of bit positions within the A interface circuit.

EDGE channel: A general term referring to channels based on 8PSK modulation; i.e. TCH/F28.8, TCH/F32.0, and TCH/F43.2.

3 General approach

3GPP TS 03.10 (clause 6) defines the PLMN connection types necessary to support the GSM PLMN data and telematic services.

Within the BSS , transcoder and IWF, there are several data rate adaptation functions which are combined as shown in 3GPP TS 03.10 as part of a connection type.

These functions are RA0, RA1, RA1/RA1' , RA1'' , RAA", RA1'/RAA', RAA' and RA2. The RA2 function is equivalent to that described in CCITT Recommendation V.110. In addition, splitting/combining, padding and inband numbering functions as defined in 3GPP TS 04.21 and multiplexing as defined herein are used in cases where more than one channel is allowed.

The RA1/RA1' and RA1'/RAA' are relay functions used as indicated in 3GPP TS 03.10.

The BSS uses the information contained in the ASSIGNMENT REQUEST message on the A-interface (see 3GPP TS 08.08) to set the "E bits" and to map the "D bits" as shown below, as well as to choose the correct channel coding.

4 The RA0 Function

The RA0 function is specified in 3GPP TS 04.21

5 The RA1 Function

For connections where only one channel is allowed used on the radio interface, the specification in 3GPP TS 04.21 for adaptation of synchronous data rates up to and including 9,6 kbit/s to intermediate rates 8 or 16 kbit/s applies.

For connection where more than one channel are used on the radio interface, rate adaptation is applied on the corresponding substreams as specified in 3GPP TS 04.21 for AIUR of 4,8 kbit/s or 9,6 kbit/s.

6 The RA1'' Function

The RA1'' function is specified in 3GPP TS 04.21. The RA1'' function is only applicable in BSS for AIUR higher than 38,4 kbit/s.

7 Split/Combine and Padding Functions

The Split/Combine-function in the IWF is used in cases when up to and including 4substreams are used.

The Split/Combine-function in the BSS is used only when more than four substreams are used.

7.1 Data Frame distribution into the channels by the Split/Combine function

Described in 3GPP TS 04.21

7.2 Substream numbering

Described in 3GPP TS 04.21

7.3 Initial Substream Synchronisation for Transparent Services

Described in 3GPP TS 04.21

7.4 Frame Synchronisation and Action on loss of Synchronisation

When in the IWF, the Split/Combine function is responsible for controlling the initial frame synchronisation procedure and re-synchronisation procedure as described in 3GPP TS 09.07.

7.5 Network Independent Clocking

NIC is specified in 3GPP TS 04.21

7.6 Padding

Padding is specified in 3GPP TS 04.21

8 The EDGE Multiplexing Function

In EDGE configurations where the number of radio interface channels and number of channels or substreams used between BTS and MSC do not match, a multiplexing function is required at BTS to perform data multiplexing/demultiplexing between the radio interface and network channel configurations. A similar function is also used at MS as described in 04.21.

The EDGE multiplexing function is located between the radio interface and RA1'/RAA' function.

8.1 Transparent services

TCH/F28.8;

Uplink direction
Refer to the description of corresponding downlink procedures in 3GPP TS 04.21. Two TCH/F14.4 substreams are forwarded towards the MSC as in a 2×TCH/F14.4 multislot connection.

Downlink direction
The multiplexing function combines the data received through the two TCH/F14.4 substreams into the 29.0 kbit/s radio interface channel. Refer to the description of corresponding uplink procedures in 3GPP TS 04.21.

TCH/F32.0

Uplink direction
The multiplexing function maps the data received from the radio interface into one 64 kbit/s channel so that data carried by timeslot a (0≤a≤6) precedes data carried by timeslot a+n (1≤a+n≤7) — the timeslots belonging to one TDMA-frame.

Downlink direction
The multiplexing function distributes the data received from the 64 kbit/s channel into two 32.0 kbit/s radio interface channels so that 640-bit data blocks are allocated to timeslots a (0≤a≤6) and a+n (1≤a+n≤7). In the datastream, data carried by timeslot a precedes data carried by timeslot a+n of the same TDMA-frame.

8.2 Non-Transparent services

TCH/F28.8;

Uplink direction
The multiplexing function demultiplexes the data received through the 29.0 kbit/s radio interface channel into two TCH/F14.4 substreams. Two 290-bit blocks carrying the two halves of one RLP frame belong to the same substream. Refer to the corresponding downlink procedures in 3GPP TS 04.21.

Downlink direction
The multiplexing function multiplexes the 290-bit blocks received through two TCH/F14.4 substreams into the 29.0 kbit/s radio interface channel. Refer to the corresponding uplink procedures in 3GPP TS 04.21.

TCH/F43.2;

Uplink direction
The multiplexing function demultiplexes the data received through the 43.5 kbit/s radio interface channel into three TCH/F14.4 substreams. Two 290-bit blocks carrying the two halves of one RLP frame belong to the same substream. Refer to the corresponding downlink procedures in 3GPP TS 04.21.

Downlink direction
The multiplexing function multiplexes the 290-bit blocks received through three TCH/F14.4 substreams into the 43.5 kbit/s radio interface channel. Refer to the corresponding uplink procedures in 3GPP TS 04.21.

9 The RA1/RA1' Function

For AIURs less or equal to 38,4 kbit/s, the RA1/RA1' function in the BSS is applied on each of the n substreams and there are no significant differences between the single slot case and the multislot case. For AIURs less or equal to 38,4 kbit/s RA1/RA1' is as specified in 3GPP TS 04.21 for the single slot case. The table below gives a relation between the AIUR, channel coding and number of substreams. As an example from table 1: The wanted AIUR is 28,8 kbit/s, the number of substreams needed to support this rate is 3. Each individual substream is rate adapted as in the single slot case.

For AIURs of 48 kbit/s, 56 kbit/s and 64 kbit/s, RA1/RA1'' is as specified in 3GPP TS 04.21 for these rates.

Table 1: Relationship between AIUR, channel coding and number of channels

	Multislot intermediaterate 8 kbps		**Multislot intermediate rate of 16 kbps**	
AIUR	Transparent	Non-transparent	Transparent	Non-transparent
≤2,4 kbit/s	1	N/A	N/A	N/A
4,8 kbit/s	1	1	N/A	N/A
9,6 kbit/s	2	2	1	1
14,4 kbit/s	3	3	2	N/A
19,2 kbit/s	4	4	2	2
28,8 kbit/s	N/A	N/A	3	3
38,4 kbit/s	N/A	N/A	4	4
48 kbit/s	N/A	N/A	5	N/A
56 kbit/s	N/A	N/A	5	N/A
64 kbit/s	N/A	N/A	6	N/A

9.1 Radio Interface rate of 12 kbit/s

Described in 3GPP TS 04.21.

9.2 Radio Interface rate of 6 kbit/s

Described in 3GPP TS 04.21.

9.3 Radio Interface rate of 3.6 kbit/s

Described in 3GPP TS 04.21.

9.4 Synchronisation

Refer to 3GPP TS 04.21.

9.5 Idle frames

Refer to 3GPP TS 04.21

10 THE RA1'/RAA' FUNCTION

The RA1'/RAA' is only applicable when TCH/F14.4, TCH/F28.8, or TCH/F43.2 channel coding is used. The RA1/RAA' converts 290-bit blocks from the channel coder or EDGE multiplexing function into E-TRAU frames and vice versa. The format of E-TRAU frame is specified in 3GPP TS 08.60.

The RA1'/RAA' function in the BSS is applied on each of the n substreams and there are no significant differences between the single slot case and the multislot case. The table below gives a relation between the AIUR, channel coding and number of substreams. As an example from table 2 : The wanted AIUR is 28,8 kbit/s, the number of substreams needed to support this rate is 2. Each individual substream is rate adapted as in the single slot case.

Table 2 Relationship between AIUR, channel coding and number of channels.

AIUR	Transparent	Non-transparent
14,4 kbit/s	1	1
28,8 kbit/s	2	2
38,4 kbit/s	3	N/A
43,2 kbit/s	N/A	3
48 kbit/s	4	N/A
56 kbit/s	4	N/A
57,6 kbit/s	N/A	4
64 kbit/s	5	N/A

10.1 Radio Interface rate of 14,5 kbit/s

See 3GPP TS 08.60.

10.2 Synchronisation

See 3GPP TS 08.60.

10.3 Idle frames

See 3GPP TS 08.60.

11 THE RAA' FUNCTION

The RAA' function is only applicable when TCH/F14.4, TCH/F28.8, or TCH/F43.2 channels are used.

The RAA' converts E-TRAU frame into A-TRAU frame and vice versa.

The format of the E-TRAU frame is specified in 3GPP TS 08.60.

11.1 Coding of A-TRAU frame

The format of the A-TRAU frame is given in Figure 5.

An A-TRAU frame carries eight 36 bit-data frames.

C Bits

Table 3

C1	C2	C3	C4	Date Rate
0	1	1	1	14,4 kbit/s
0	1	1	0	14.4 kbit/s idle (IWF to BSS only)

Table 4

C5	BSS to IWF Frame Type note 1	IWF to BSS UFE (Uplink Frame Error)
1	idle	framing error
0	data	no framing error

NOTE 1: Bit C5 corresponds to bit C6 of the E-TRAU frame as defined in 3GPP TS 08.60.

M Bits

Transparent data

M1 and M2 are as defined in 3GPP TS 04.21.

Non transparent data

See subclause 15.2 of this GSM TS.

Z bits

Bits Zi are used for Framing Pattern Substitution.

See subclause 11.2.

11.2 Framing Pattern Substitution in A-TRAU frame

The Framing Pattern Substitution is used in each of the eight 36 bit data fields of the A-TRAU frame (see Figure 5) to avoid transmitting a sequence of eight zeroes (called Z sequence in the following).

The purposes of FPS is to avoid erroneous synchronisation to the A-TRAU due to sixteen zeroes occurring accidentally in the data bits and to avoid erroneous synchronisation to V.110. The synchronisation pattern of two consecutive V.110 frames cannot be found within a stream of A TRAU frames.

11.2.1 FPS encoding

A Zero Sequence Position (ZSP) field is used to account for the occurrence of eight zeroes in the 36 bit data field.

NOTE: A sequence of eight zeroes is considered as a block (e.g. a stream of eleven consecutive zeroes produces only one ZSP and not four ZSPs).

The ZSP field is defined as follows:

Table 5

1	2	3	4	5	6	7	8
1	C	A0	A1	A2	A3	A4	1

The meaning of the different bits of the ZSP field is :

C : Continuation bit. '0' means that there is another ZSP in the data field. '1' means that there is no other ZSP.

A0-A4 :address of the next Z sequence (eight zeroes) to be inserted. The address ‘00001’ corresponds to the bit D1, the value ‘11101’ to the bit D29, (A0 is the msb, A4 is the lsb).

NOTE: a Z sequence substitution cannot occur at bit D30..D36 (as it is 8 bit long)

1 : locking bit prevent the false occurrence of a Z sequence.

The Framing Pattern Substitution is applied in each of the eight 36 bit data field (see Figure 5).

Bit Zi indicates whether FPS is used in the ith 36 bit data field (i=1 to 8). The coding of the Zi bit is the following:

Table 6

Zi (i=1..8)	meaning
1	no substitution
0	at least one substitution

If Zi bit indicates no substitution, the output data bits of FPS are equal to the input data bits.

If Zi indicates at least one substitution, the bits D1-D8 contain the first ZSP.

The following description indicates the general operating procedures for FPS. It is not meant to indicate a required implementation of the encoding procedure.

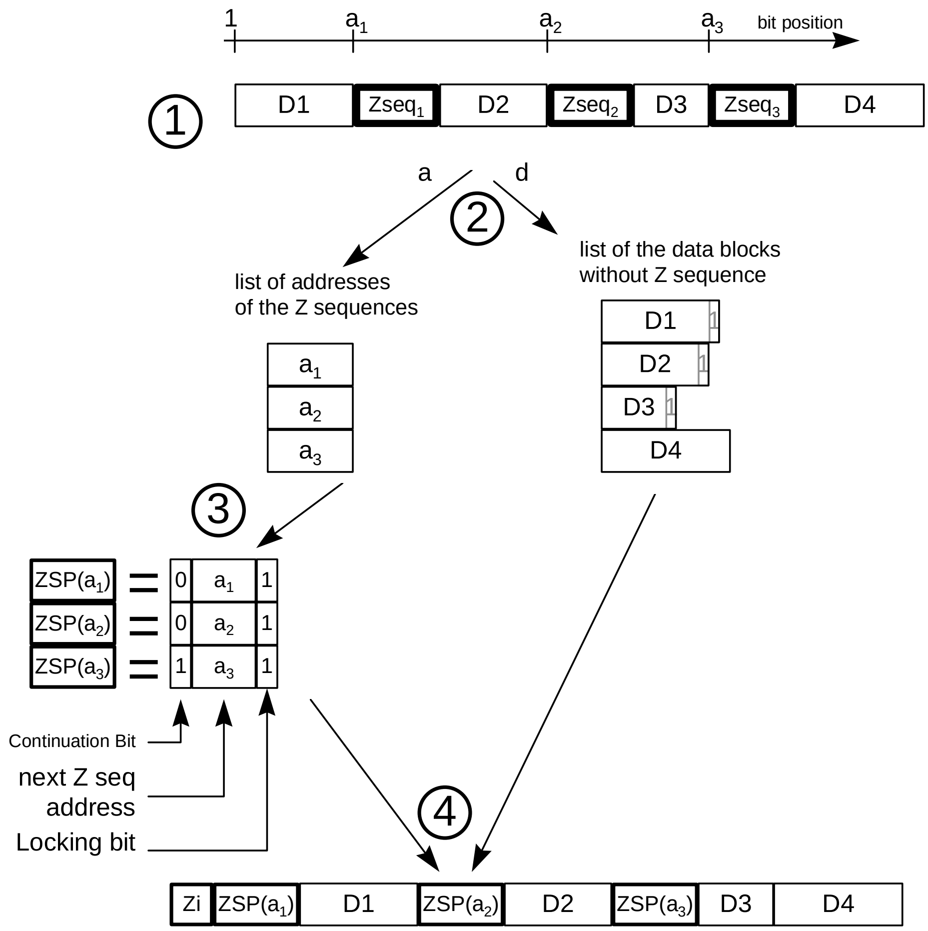

Figure 1

Step 1 :

The input 36 bit sub frame is considered as a bit stream in which the bits are numbered from 1 to 36.

This bit stream contains 0, 1 or several Z sequences, ($Zseq_1$ to $Zseq_3$ on the figure)

The Z sequence is a sequence of 8 consecutive zeroes : '0000 0000'

Step 2 :

Starting from this bit stream, two lists are built up :

2-a : the 'a' list which contains the address of the first bit of each Z sequences.

2-d : the 'd' list which contains all the data blocks which do not have the Z sequence.

Step 3 :

The 'a' list is transformed so as to build the ZSP list. Each ZSP element is used to indicate:

at which address is the next Z sequence of the message

if yet another ZSP element will be found at this address (link element)

Step 4 :

The output 37 bit sub frame is built from:

the Zi field which indicates whether the original message has been transformed or not with this technique. In the example given in Figure 1, Zi should be set to '0' to indicate that at least one FPS has occurred.

the ZSP and D elements interleaved.

As the ZSP elements have exactly the same length as the Z sequence, the sub frame length is only increased by one (the Zi bit), whatever the number of frame pattern substitutions may be.

For special cases, refer to annex A.

11.3 A-TRAU Synchronisation Pattern

The frame synchronisation is obtained by means of the first two octets in each frame, with all bits coded binary "0" and the first bit in octet no 2 coded binary "1". The following 17 bit alignment pattern is used to achieve frame synchronisation :

```
00000000 00000000 1XXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
```

12 THE RAA” FUNCTION

On the IWF side of the A interface, the RAA" function converts between the A-TRAU format and a synchronous stream. FPS is performed by this function as well, see subclause 11.2. In transparent operation, the RAA" function handles the M1 and M2 bits as specified for the RA1' function in 3GPP TS 04.21.

In non-transparent operation, the RAA" function maps between the A-TRAU format and 290 bit blocks consisting of M1, M2 and 288 bits making up half of an RLP frame, see subclause 15.2 of this GSM TS.

13 The RA2 Function

Described in 3GPP TS 04.21. The RA2 function is applicable only for single slot operations.

14 The A-interface Multiplexing Function

The multiplexing function is only applicable for AIUR up to and including 57.6 kbit/s for multislot operations.

The multiplexing function is based on the CCITT I.460. The multiplexing function is used to combine n (n=2 to 4) substreams of multislot intermediate rate of 8 kbit/s or n substreams of multislot intermediate rate of 16 kbit/s on one 64 kbit/s stream by using subcircuits in each octet to each substream such that:

i) An 8 kbit/s substream is allowed to occupy subcircuits with positions 1,3,5 or 7 of each octet of the 64 kbit/s stream; a 16 kbit/s stream occupies bit positions (1,2) or (3,4) or (5,6) or (7,8).

ii) The order of the bits at each substream is identical before and after multiplexing.

iii) All unused bit positions shall be set to binary “1".

iv) For transparent multislot configurations the lowest allowed subcircuits are always used.

v) For non-transparent multislot configurations, the lowest allowed subcircuits shall be used at call set up and after change of channel configuration except at downgrading. At downgrading any of the used subcircuits can be released. At a possible subsequent upgrading, the lowest available bit positions shall be used for the added substreams.

NOTE: The rules given here are almost identical to those of I.460, Section 'Fixed format multiplexing', except for the rule i) is stricter in that 8 kbit/s substreams cannot occupy any positions, iv) and v) are added.

15 Support of non-transparent bearer services

15.1 TCH/F9.6 and TCH/F4.8 kbit/s channel codings

In the case of non-transparent services the RA1/RA1' function performs the same mapping as that described for transparent services, using 12 and 6 kbit/s radio interface data rates, with the following modification.

The E2 and E3 bits in the modified CCITT V.110 80 bit frames shown in Figure 3 (derived from the standard CCITT V.110 frame shown in Figure 2) are used to indicate each consecutive sequence of CCITT V.110 80 bit frames corresponding to the four modified CCITT V.110 60 bit frames (Figure 4) received/transmitted in one radio interface frame. This allows 240 bit Radio Link Protocol frames to/from the MSC to be aligned with the 4x60 bit frames encoded by the radio subsystem channel coder as a single unit (see 3GPP TS 05.03). The 8 bits consisting of the E2 and E3 bits in one of the above sequences is referred to as the Frame Start Identifier. The FSI value is 00 01 10 11. This value is assigned to the E2 and E3 bits as shown in Table7.

Table 7

	E2	E3
First Modified CCITT V.110 80 bit frame	0	0
Second	0	1
Third	1	0
Fourth	1	1

As each RLP frame is transported between the BSS and MSC in four modified CCITT V.110 80 bit frames, it is necessary following a transmission break and at start up, to determine which modified CCITT V.110 80 bit frame of the stream is the first for a particular RLP frame. This is needed so that correct alignment with the radio subsystem can be achieved.

Modified V.110 80 bit frames can slip in time during re-routing, and whilst sync exists within the modified CCITT V.110 80 bit frame to determine the modified CCITT V.110 80 bit frame boundaries, the FSI is required to determine which quarter of an RLP frame each modified CCITT V.110 80 bit frame contains.

Table 8 : Relationship between FNUR, AIUR, substream rate, number of substreams and intermediate rate

FNUR	AIUR	Number of Channels x Substream Rate	Channel Coding	Multislot Intermediate Rate
≤2,4 kbit/s	2,4 kbit/s	2-8 times duplication of each bit to reach 2,4 kbit/s	TCH/F4.8	8 kbit/s
4,8 kbit/s	4,8 kbit/s	4,8 kbit/s	TCH/F4.8	8 kbit/s
4,8 kbit/s	9,6 kbit/s	9,6 kbit/s	TCH/F9.6	16 kbit/s
9,6 kbit/s	9,6 kbit/s	2x4,8 kbit/s	2XTCH/F4.8	8 kbit/s
9,6 kbit/s	9,6 kbit/s	9,6 kbit/s	TCH/F9.6	16 kbit/s
14,4 kbit/s	14,4 kbit/s	3X4,8 kbit/s	3XTCH/F4.8	8 kbit/s
14,4 kbit/s	19,2 kbit/s	2X9,6 kbit/s	2XTCH/F9.6	16 kbit/s
19,2 kbit/s	19,2 kbit/s	4X4,8 kbit/s	4XTCH/F4.8	8 kbit/s
19,2 kbit/s	19,2 kbit/s	2X9,6 kbit/s	2XTCH/F9.6	16 kbit/s
28,8 kbit/s	28,8 kbit/s	3X9,6 kbit/s	3XTCH/F9.6	16 kbit/s
38,4	38,4 kbit/s	4X9,6 kbit/s	4XTCH/F9.6	16 kbit/s
NOTE: The table gives the relation between the FNUR, AIUR, Substream Rate, Channel Coding and Intermediate Rate. As an example: the wanted FNUR is 14,4 kbit/s and the selected channel coding is TCH/F9.6. The data stream is split into two substreams of 9,6 kbit/s yielding an AIUR of 19,2 kbit/s.				

15.1.1 Alignment

An alignment window spanning four modified CCITT V.110 80 bit frames is used to search for the pattern of 8 bits described above in order to identify alignment with an RLP frame.

In the event of failure to detect the 8 bit pattern, the alignment window is shifted one complete modified V.110 80 bit frame, discarding the contents of the most historical frame and then checking the new 8 bit pattern.

15.1.2 Support of Discontinuous Transmission (DTX)

The E1 bit in the modified CCITT V.110 80 bit frame shown in Figure 3 is used in the direction MSC-BSS to indicate that DTX may be invoked (see 3GPP TS 04.22). The E1 bit in all of the four consecutive frames relating to the RLP frame to which DTX may be applied shall be set to 1. If DTX is not to be applied, the E1 bit shall be set to 0.

In the direction BSS-MSC the E1 bit shall always be set to 0.

15.1.3 Order of Transmission

The first bit of each quarter of an RLP frame to be transmitted will correspond to bit D1 of a modified V.110 frame (figures 3 and 4). The remaining 59 bits of each quarter of an RLP frame will correspond to the D and D' bits , D2 - D'12, in order left to right and top to bottom as shown in figures 3 and 4.

The first quarter of an RLP frame to be transmitted will contain the E2 and E3 bit code 00 as shown in Table 1. The second quarter will contain the code 01, etc.

15.2 TCH/F14.4, TCH/F28.8, and TCH/F43.2 channel codings

In case of non-transparent service, a 576 bit RLP frame is mapped over two consecutive A-TRAU frames.

Because of that mapping, it is required, following a transmission break and at start up, to determine which A-TRAU frame of the stream is the first for a particular RLP frame. This is needed so that correct alignment with the radio subsystem can be achieved.

The two consecutive M1 bits are referred to as the Frame Start Identifier. The FSI value is 01. This value is assigned to the M1 bits as shown in Table 9.

Table 9

	M1 bit
First A-TRAU frame	0
Second A-TRAU frame	1

A-TRAU frames can slip in time during re-routing, and whilst A-TRAU frame synchronisation exists, the FSI is required to determine which half of an RLP frame each A-TRAU frame contains.

Table 10 : Relationship between AIUR, substream rate, number of substreams and intermediate rate

	AIUR	Number of substreams x AIUR per substream	Channel Coding	Multislot intermediate Rate
	14,4 kbit/s	14,4 kbit/s	TCH/F14.4	16 kbit/s
	28,8 kbit/s	2X14,4 kbit/s	2XTCH/F14.4 1XTCH/F28,8	16 kbit/s
	43,2 kbit/s	3X14,4 kbit/s	3XTCH/F14.4 1XTCH/F43,2	16 kbit/s
	57,6 kbit/s	4X14,4 kbit/s	4XTCH/F14.4	16 kbit/s
	57,6 kbit/s	4X14,4 kbit/s	4XTCH/F14.4 2XTCH/F28,8	16 kbit/s

NOTE: The table gives the relation between AIUR, Substream Rate, Channel Coding and Intermediate Rate. As an example: the AIUR is 28,8 kbit/s and the selected channel coding is 14,5 kbit/s. The data stream is split into two substreams of 14,5 kbit/s yielding an AIUR of 28,8 kbit/s

The same number of substreams is used in each direction, even if the AIURs in each direction differ. Superfluous substreams are filled with idle frames. These are inserted at the BTS or IWF and are discarded at the IWFor BTS respectively. At the IWF, the down link AIUR is determined by the out of band signalling (Assignment Complete, Handover Performed), whereas the up link AIUR is determined inband by examining the possible substream positions on the A interface.

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15.2.1 Alignment

An alignment window spanning two 290 bit blocks in case of TCH/F14.4 channel is used to search for the pattern of 2 bits '01' described in subclause 15.2, in order to identify alignment with an RLP frame.

In the event of failure to detect the 2 bits pattern the alignment window is shifted one 290 bit block, discarding the contents of the most historical frame and then checking the new 2 bits pattern.

15.2.2 Support of Discontinuous Transmission (DTX)

The M2 bit in the A-TRAU frame shown in Figure 5 is used in the direction MSC to BSS to indicate that DTX may be invoked (see 3GPP TS 04.22). The M2 bit in all of the two consecutive A-TRAU frames relating to the RLP frame to which DTX may be applied shall be set to 1. If DTX is not to be applied, the M2 bit shall be set to 0.

In the direction BSS to MSC the M2 bit shall always be set to 0.

16 Support of transparent bearer services

16.1 TCH/F9.6 and TCH/F4.8 channel codings

16.1.1 User rate adaptation on the A interface, AIUR less or equal to 38,4 kbit/s

The CCITT V.110 80 bit frame is used for transparent data on the A interface. These frames are transmitted on up to four substreams multiplexed into one stream sent over the A interface. The split/combine function is applied on the substreams as specified in clause 5 of this GSM TS. The relation between the AIUR and the number of channels is specified in table11.

The 64 kbit/s consists of octets, bits 1 through 8, with bit 1 transmitted first.

For a 9 600 bit/s radio interface user rate the V.110 frame is carried with a 16 kbits/s stream which occupies bit positions (1,2).

For radio interface user rates of either 4 800 bit/s, 2 400 bit/s, 1 200 bit/s, 300 bit/s or 1 200/75 bit/s the V.110 frame is carried with a 8 kbits/s stream which occupies bit position (1). For user rates < 1 200bit/s asynchronous characters are padded with additional stop elements by the RA0 function (in the MSC/IWF) to fit into 600 bit/s synchronous RA1 rate prior to rate adaptation to 64 kbits/s.

No use of 4 kbit/s stream is foreseen.

In a given V.110 frame on the A interface:

- for 9 600 bit/s there is no repetition of bits D within the 16 kbit/s stream ;
- for 4 800 bit/s there is no repetition of bits D within the 8 kbit/s stream ;
- for 2 400 bit/s each bit D is repeated twice within the 8 kbit/s stream (D1 D1 D2 D2 etc) ;
- for 1 200 bit/s each bit D is repeated four times within the 8 kbit/s stream (D1 D1 D1 D1 D2 D2 D2 D2 etc) ;
- for 600 bit/s each bit D is repeated eight times within the 8kbit/s stream (D1 D1 D1 D1 D1 D1 D1 D1 D2 D2 D2 D2 D2 D2 D2 D2 etc);
- for 1 200/75 bit/s each bit D is repeated four times within the 8 kbit/s stream for 1 200 bit/s. 75 bit/s will be padded by additional stop elements to fit 600 bit/s by the RA0 function. For the resulting 600 bit/s each bit D is repeated eight times within the 8kbit/s stream.

16.1.2 User rate Adaptation on the A-interface, AIUR greater than 38,4 kbit/s

For AIUR of 48 kbit/s, 56 kbit/s and 64 kbit/s one stream consisting of CCITT V.110 32 bit frames or 64 bit frames, as specified in 3GPP TS 04.21 is transmitted over the A-interface. Splitting/Combining which occurs in the BSS, is as specified in 3GPP TS 04.21.

Table 11 gives the relation between the User Rate, Substream Rate Channel Coding and the Intermediate Rate.

16.1.3 Relation between AIUR and the number of channels

Table11: Relationship between the AIUR, substream rate, channel coding, intermediate rate and number of channels

AIUR	Number of channels x Substream Rate	Channel Coding	(Multislot) intermediate Rate (Note1)
≤2,4 kbit/s	2-8 times duplication of each bit to reach 4,8 kbit/s	TCH/F4.8	8 kbit/s
4,8 kbit/s	4,8 kbit/s	TCH/F4.8	8 kbit/s
9,6 kbit/s	2X4,8 kbit/s	2XTCH/F4.8	8 kbit/s
9,6 kbit/s	9,6 kbit/s	TCH/F9.6	16 kbit/s
14,4 kbit/s	3X4,8 kbit/s	3XTCH/F4.8	8 kbit/s
14,4 kbit/s	2X9,6 kbit/s w/ padding	2XTCH/F9.6	16 kbit/s
19,2 kbit/s	4X4,8 kbit/s	4XTCH/F4.8	8 kbit/s
19,2 kbit/s	2X9,6 kbit/s	2XTCH/F9.6	16 kbit/s
28,8 kbit/s	3x9,6 kbit/s	3XTCH/F9.6	16 kbit/s
38,4 kbit/s	4X9,6 kbit/s	4XTCH/F9.6	16 kbit/s
48 kbit/s	5X9,6 kbit/s	5XTCH/F9.6	64 kbit/s
56 kbit/s	5X11,2 kbit/s	5XTCH/F9.6	64 kbit/s
64 kbit/s	66x11,2 kbit/s w/padd.	6XTCH/F9.6	64 kbit/s
NOTE: For AIURs ≤ 38,4 kbit/s this column indicates the multislot intermediate rate: for higher AIURs it indicates the intermediate rate.			

16.1.4 Handling of status bits X, SA, SB

In the single slot case, status bit SA is coded repeatedly as S1, S3, S6, S8, and SB is coded repeatedly as S4 and S9 in Figure 2. In the multislot case, status bit SA is coded repeatedly as S6, S8 and SB is coded as S9 in figures 2, 5 and 6.

The handling of the status bits will comply with the synchronisation procedures for transparent services which are as described in 3GPP TS 09.07 (MSC), 3GPP TS 04.21 (BSS), 3GPP TS 07.01 (MS).

16.1.5 Handling of bits E1 to E7

Bits E1 to E3 are used according to 04.21.

Bits E4 to E7 may be used for network independent clocking as indicated in 3GPP TS 04.21.

16.2 TCH/F14.4, TCH/F28.8, and TCH/F32.0 channel codings

16.2.1 User rate adaptation on the A interface, AIUR less or equal to 56 kbit/s

The A-TRAU frame is used for transparent user data rates other than 32 kbit/s on the A interface. The A-TRAU frames are transmitted on up to four substreams multiplexed into one stream sent over the A interface. The split/combine function is applied on the substreams as specified in clause 7 of this TS. The relation between the AIUR and the number of channels is specified in table 12.

In a given A-TRAU frame on the A interface:

- for 14 400 bit/s there is no repetition of bits D within the 16 kbit/s stream in a given A-TRAU frame on the A interface.

The CCITT I.460 rate adaptation is used for the transparent 32 kbit/s user rate on the A interface, i.e. four bits of each octet in the 64 kbit/s time slot are used for transporting the 32 kbit/s user data.

16.2.2 User Rate Adaptation on the A-interface, AIUR greater than 56 kbit/s

For AIUR of 64 kbit/s one stream consisting of CCITT V.110 32 bit frames or 64 bit frames, as specified in 3GPP TS 04.21 is transmitted over the A-interface. Splitting/Combining which occurs in the BSS, is as specified in 3GPP TS 04.21.

Table 12 gives the relation between the User Rate, Substream Rate Channel Coding and the Intermediate Rate.

16.2.3 Relation between AIUR and the number of channels

Table 12: Relationship between the AIUR, AIUR per substream, channel coding, intermediate rate and number of substreams

AIUR	Number of substreams x AIUR per substream	Channel Coding	Multislot intermediate Rate (note 1)
14,4 kbit/s	14,4 kbit/s	TCH/F14.4	16 kbit/s
28,8 kbit/s	2X14,4 kbit/s	TCH/F14.4 TCH/F28.8	16 kbit/s
32 kbit/s	1x32 kbit/s	TCH/F32.0	32 kbit/s
38,4 kbit/s	3X14,4 kbit/s w/padding	TCH/F14.4	16 kbit/s
48 kbit/s	4X14,4 kbit/s w/padding	TCH/F14.4	16 kbit/s
56 kbit/s	4X14,4 kbit/s w/padding 1x64.0 kbit/s (Note 2)	TCH/F14.4 TCH/F32.0	16 kbit/s 64 kbit/s
64kbit/s	5X14,4 kbit/s w/padding 1x64.0 kbit/s (Note 2)	TCH/F14.4 TCH/F32.0	64 kbit/s
NOTE 1: For AIURs ≤ 56 kbit/s this column indicates the multislot intermediate rate: for higher AIURs it indicates the intermediate rate. NOTE 2: One substream over two air interface timeslots. No multislot intermediate rate.			

16.2.4 Handling of status bits X and SB

The X and SB bits are carried over the A interface in a multiframe structure as described in subclause 8.1.1.1 of 3GPP TS 04.21. SA bit is not carried over the A interface.

The handling of the status bits will comply with the synchronisation procedures for transparent services which are as described in 3GPP TS 09.07 (MSC), 3GPP TS 04.21 (BSS), 3GPP TS 07.01 (MS).

17 Frame Formats

Octet No.	Bit number							
	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	1	D1	D2	D3	D4	D5	D6	S1
2	1	D7	D8	D9	D10	D11	D12	X
3	1	D13	D14	D15	D16	D17	D18	S3
4	1	D19	D20	D21	D22	D23	D24	S4
5	1	E1	E2	E3	E4	E5	E6	E7
6	1	D25	D26	D27	D28	D29	D30	S6
7	1	D31	D32	D33	D34	D35	D36	X
8	1	D37	D38	D39	D40	D41	D42	S8
9	1	D43	D44	D45	D46	D47	D48	S9

Figure 2: The CCITT V.110 80 bit frame for Transparent Data

octet no.	bit number							
	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	1	D1	D2	D3	D4	D5	D6	D'1
2	1	D7	D8	D9	D10	D11	D12	D'2
3	1	D13	D14	D15	D16	D17	D18	D'3
4	1	D19	D20	D21	D22	D23	D24	D'4
5	1	E1	E2	E3	D'5	D'6	D'7	D'8
6	1	D25	D26	D27	D28	D29	D30	D'9
7	1	D31	D32	D33	D34	D35	D36	D'10
8	1	D37	D38	D39	D40	D41	D42	D'11
9	1	D43	D44	D45	D46	D47	D48	D'12

Figure 3: The modified CCITT V.110 80 bit frame for Non-Transparent Data

D1	D2	D3	D4	D5	D6	D'1
D7	D8	D9	D10	D11	D12	D'2
D13	D14	D15	D16	D17	D18	D'3
D19	D20	D21	D22	D23	D24	D'4
D'5	D'6	D'7	D'8	D25	D26	D27
D28	D29	D30	D'9	D31	D32	D33
D34	D35	D36	D'10	D37	D38	D39
D40	D41	D42	D'11	D43	D44	D45
D46	D47	D48	D'12			

Figure 4: Modified CCITT V.110 60 bit frame for Non-Transparent Data

octet number	bit number 0	1	2	3	4	5	6	7	
0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	
2	1	**C1**	**C2**	**C3**	**C4**	**C5**	**M1**	**M2**	
3	**Z1**	D1	D2	D3	D4	D5	D6	D7	
4	D8	D9	D10	D11	D12	D13	D14	D15	36 bit data field 1
5	D16	D17	D18	D19	D20	D21	D22	D23	
6	D24	D25	D26	D27	D28	D29	D30	D31	
7	D32	D33	D34	D35	D36	**Z2**	D1	D2	
8	D3	D4	D5	D6	D7	D8	D9	D10	
9	D11	D12	D13	D14	D15	D16	D17	D18	36 bit data field 2
10	D19	D20	D21	D22	D23	D24	D25	D26	
11	D27	D28	D29	D30	D31	D32	D33	D34	
12	D35	D36	**Z3**	D1	D2	D3	D4	D5	
13	D6	D7	D8	D9	D10	D11	D12	D13	
14	D14	D15	D16	D17	D18	D19	D20	D21	36 bit data field 3
15	D22	D23	D24	D25	D26	D27	D28	D29	
16	D30	D31	D32	D33	D34	D35	D36	**Z4**	
17	D1	D2	D3	D4	D5	D6	D7	D8	
18	D9	D10	D11	D12	D13	D14	D15	D16	36 bit data field 4
19	D17	D18	D19	D20	D21	D22	D23	D24	
20	D25	D26	D27	D28	D29	D30	D31	D32	
21	D33	D34	D35	D36	**Z5**	D1	D2	D3	
22	D4	D5	D6	D7	D8	D9	D10	D11	
23	D12	D13	D14	D15	D16	D17	D18	D19	36 bit data field 5
24	D20	D21	D22	D23	D24	D25	D26	D27	
25	D28	D29	D30	D31	D32	D33	D34	D35	
26	D36	**Z6**	D1	D2	D3	D4	D5	D6	
27	D7	D8	D9	D10	D11	D12	D13	D14	
28	D15	D16	D17	D18	D19	D20	D21	D22	36 bit data field 6
29	D23	D24	D25	D26	D27	D28	D29	D30	
30	D31	D32	D33	D34	D35	D36	**Z7**	D1	
31	D2	D3	D4	D5	D6	D7	D8	D9	
32	D10	D11	D12	D13	D14	D15	D16	D17	
33	D18	D19	D20	D21	D22	D23	D24	D25	36 bit data field 7
34	D26	D27	D28	D29	D30	D31	D32	D33	
35	D34	D35	D36	**Z8**	D1	D2	D3	D4	
36	D5	D6	D7	D8	D9	D10	D11	D12	
37	D13	D14	D15	D16	D17	D18	D19	D20	36 bit data field 8
38	D21	D22	D23	D24	D25	D26	D27	D28	
39	D29	D30	D31	D32	D33	D34	D35	D36	

Figure 5: A-TRAU 320 bit frame

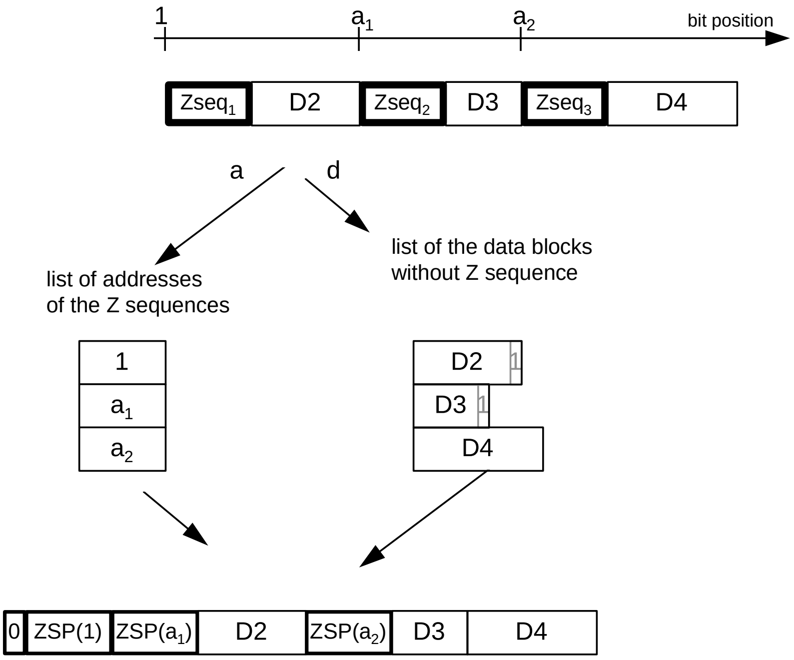
octet no.	bit number							
	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	1	D1	D2	D3	D4	D5	D6	S1
2	1	D7	D8	D9	D10	D11	D12	X
3	1	D13	D14	D15	D16	D17	D18	S3
4	1	D19	D20	D21	D22	D23	D24	S4
5	1	E1	E2	E3	E4	E5	E6	E7
6	1	1	1	1	1	1	1	S6
7	1	1	1	1	1	1	1	X
8	1	1	1	1	1	1	1	S8
9	1	1	1	1	1	1	1	S9

Figure 6: The modified CCITT V.110 80 bit frame padded for 4,8 kbit/s transparent data at intermediate rate 16 kbit/s

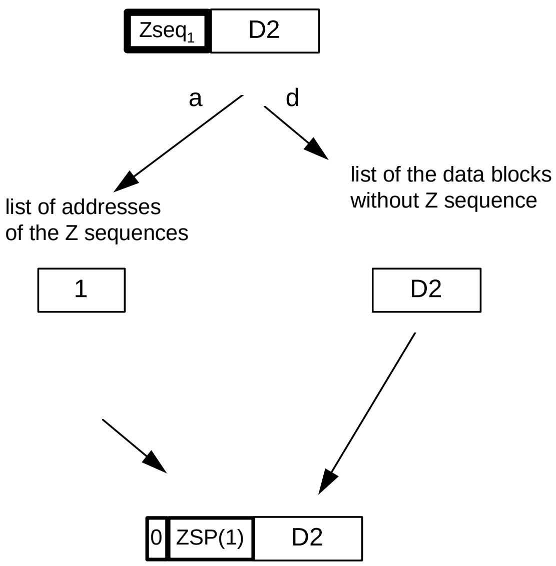
Annex A (informative): Frame Pattern Substitution

A.1 Special cases

If the sub frame starts with a Zseq, D1 is empty. With the above example, the resulting input and output sub frames are the following :



In the same case as above but with only one ZSP, the resulting input and output sub frames are the following:



A.2 False Z sequence detection

The Framing Pattern Substitution algorithm presented in subclause 10.2 ensures sure that all the Z sequences found in the original sub frame are removed, but it must be checked that the transformations performed do not introduce new unwanted Z sequences.

The goal of this subclause is to show that the transformed sub frame will not contain new Z sequences introduced by the algorithm itself.

The coding of the ZSP is the key point to avoid such an emulation. The different cases are considered below.

1 : Sequence ZSP

The worst case is when the address is equal to 1 :

1	C	A0	A1	A2	A3	A4	1
1	0	0	0	0	0	1	1

There is a maximum of 5 zeroes.

2 : Sequence Di / ZSP.

By definition, a data block always ends up with a one (except the last one of the message) and the ZSP always starts with a 1.

3 : Sequence ZSP / Di

ZSP always ends up with a 1 and Di has a maximum of 7 zeroes : it is not possible to find 16 zeroes in a row.

4 : Sequence Di / Dj

Di is not the last data block of the message.

As already mentioned, Di ends up with a one (except the last one) : this is the same case as 3.

5 : Sequence Zi / D or D / Zi

This case only occurs when there is no substitution. In this case, the Zi bit close to the D field is always a one: this does not change the number of zeroes in sequence.

6 : Sequence last Di / new framing pattern

The last D sequence can end up with up to 7 zeroes, followed by the 16 zeroes of the next frame.

There is anyhow no ambiguity, when considering that the framing pattern is made up of 16 zeroes *followed* by a one.

7 : Sequence last Di / Z bit of the next sub frame

The last D sequence can end up with up to 7 zeroes, followed in the worst case by Z=0 and then a ZSP. As a ZSP starts with a one, this makes a maximum of 8 zeroes in a row.

8 : Sequence ZSP / ZSP (not shown on the figure)

This case arrives when the original message has at least 16 zeroes in a row.

As the ZSP element always starts and ends up with a one, this always induces two consecutive ones.

Annex B (informative): Change History

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
	s27		A005		Synchronisation	5.3.0	7.0.0
	s29		A006		Introduction of EDGE channel codings into the specifications	7.0.0	8.0.0
	s30		A007		Asymmetric channel coding	8.0.0	8.1.0
09-2000	TSG#09	NP-000551	A008	1	32 kbit/s UDI/RDI multimedia in GSM	8.1.0	8.2.0

History

Document history		
V8.2.0	September 2000	Publication