EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 597

September 1994

Source: ETSI TC-SMG

Reference: GSM 08.60

ICS: 33.060.30

Key words: European digital cellular telecommunications system, Global System for Mobile communications (GSM)

European digital cellular telecommunications system (Phase 2); Inband control of remote transcoders and rate adaptors (GSM 08.60)

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI).

This ETS specifies the inband control of remote transcoders and rate adaptors for the European digital cellular telecommunications system (Phase 2).

This ETS corresponds to GSM technical specification, GSM 08.60 version 4.1.3.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI/PNE rules.

Reference is made within this ETS to GSM Technical Specifications (GSM-TSs) (NOTE).

NOTE: TC-SMG has produced documents which give the technical specifications for the implementation of the European digital cellular telecommunications system. Historically, these documents have been identified as GSM Technical Specifications (GSM-TS). These TSs may have subsequently become I-ETSs (Phase 1), or ETSs (Phase 2), whilst others may become ETSI Technical Reports (ETRs). GSM-TSs are, for editorial reasons, still referred to in GSM ETSs.

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1. Introduction

1.1. Scope

When 64 kbit/s traffic channels are used on the Abis interface the speech shall be coded according to CCITT Recommendation G.711 and the data rate adaption shall be as specified in TS GSM 04.21 and TS GSM 08.20.

In the case where sub-64 kbit/s traffic channels are used, then this specification shall apply for frame structure and for control of remote transcoders and additional rate adaptors.

This Specification covers the full rate speech service and both full and half rate data services.

The use and general aspects of the Abis interface are given in TS GSM 08.51.

NOTE: This specification should be considered together with the GSM 06 series of specifications, TS GSM 04.21 (Rate Adaption on the MS-BSS Interface) and TS GSM 08.20 (Rate Adaption on the BS/MSC Interface).

1.2. Normative references

This ETS 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 ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 100): "European digital cellular telecommunciations system (Phase 2); Abbreviations and acronyms".

[2] GSM 04.06 (prETS 300 555): "European digital cellular telecommunciations system (Phase 2); Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification".

[3] GSM 04.21 (prETS 300 562): "European digital cellular telecommunciations system (Phase 2); Rate adaption on the Mobile Station - Base Station System (MS - BSS) interface".

[4] GSM 06.01 (prETS 300 580-1): "European digital cellular telecommunciations system (Phase 2); Full rate speech processing functions".

[5] GSM 06.10 (prETS 300 580-2): "European digital cellular telecommunciations system (Phase 2); Full rate speech transcoding".

[6] GSM 06.11 (prETS 300 580-3): "European digital cellular telecommunciations system (Phase 2); Substitution and muting of lost frames for full rate speech channels".

[7] GSM 06.12 (prETS 300 580-4): "European digital cellular telecommunciations system (Phase 2); Comfort noise aspect for full rate speech traffic channels".

[8] GSM 06.31 (prETS 300 580-5): "European digital cellular telecommunciations system (Phase 2); Discontinuous Transmission (DTX) for full rate speech traffic channel".

[9] GSM 06.32 (prETS 300 580-6): "European digital cellular telecommunciations system (Phase 2); Voice Activity Detection (VAD)".

[10] GSM 06.02 (prETS 300 581-1): "European digital cellular telecommunciations system (Phase 2); Half rate speech processing functions".

[11] GSM 06.20 (prETS 300 581-2): "European digital cellular telecommunciations system (Phase 2); Half rate speech transcoding".

[12] GSM 06.21 (prETS 300 581-3): "European digital cellular telecommunciations system (Phase 2); Substitution and muting of lost frames for half rate speech traffic channels".

[13] GSM 06.22 (prETS 300 581-4): "European digital cellular telecommunciations system (Phase 2); Comfort noise aspects for half rate speech traffic channels".

[14] GSM 06.41 (prETS 300 581-5): "European digital cellular telecommunciations system (Phase 2); Discontinuous Transmission (DTX) for half rate speech traffic channels".

[15] GSM 06.42 (prETS 300 581-6): "European digital cellular telecommunciations system (Phase 2); Voice Activity Detection (VAD) for half rate speech traffic channels".

[16] GSM 08.20 (prETS 300 591): "European digital cellular telecommunciations system (Phase 2); Rate adaption on the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".

[17] GSM 08.51 (prETS 300 592): "European digital cellular telecommunciations system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface General aspects".

[18] GSM 08.54 (prETS 300 594): "European digital cellular telecommunciations system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 1 structure of physical circuits".

[19] GSM 08.58 (prETS 300 596): "European digital cellular telecommunciations system (Phase 2); Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 3 specification".

[20] GSM 12.21 (prETS 300 623): "European digital cellular telecommunciations system (Phase 2); Network Management (NM) procedures and message on the A-bis interface".

[21] CCITT Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

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

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

1.3. Definitions and abbreviations

Abbreviations used in this specification are listed in GSM 01.04

2. General Approach

When the transcoders/rate adaptors are positioned remote to the BTS the information between the Channel Codec Unit (CCU) and the remote Transcoder/Rate Adaptor Unit (TRAU) is transferred in frames with a fixed length of 320 bits (20 mS). In this specifi cation these frames are denoted "TRAU frames". Within these frames both the speech/data and the TRAU associated control signals are transferred.

The Abis interface should be the same if the transcoder is positioned 1) at the MSC site of the BSS or if it is positioned 2) at the BSC site of the BSS. In case 1) the BSC should be considered as transparent for 16 kbit/s channels.

When data is adapted to the 320 bit frames, a conversion function is required in addition to the conversion/rate adaption specified in TS GSM 08.20. This function constitute the RAA.

The TRAU is considered a part of the BSC, and the signalling between the BSC and the TRAU (e.g. detection of call release, handover and transfer of O&M information) may be performed by using BSC internal signals. The signalling between the CCU and the TRAU, using TRAU frames as specified in this specification, is mandatory when the Abis interface is applied.

NOTE: If standard 64 kbit/s switching is used in the BSC, multiplexing according to CCITT Recommendation I.460 should apply at both sides of the switch.

In figure 2.1 a possible configuration of the TRAU and the CCU is shown.

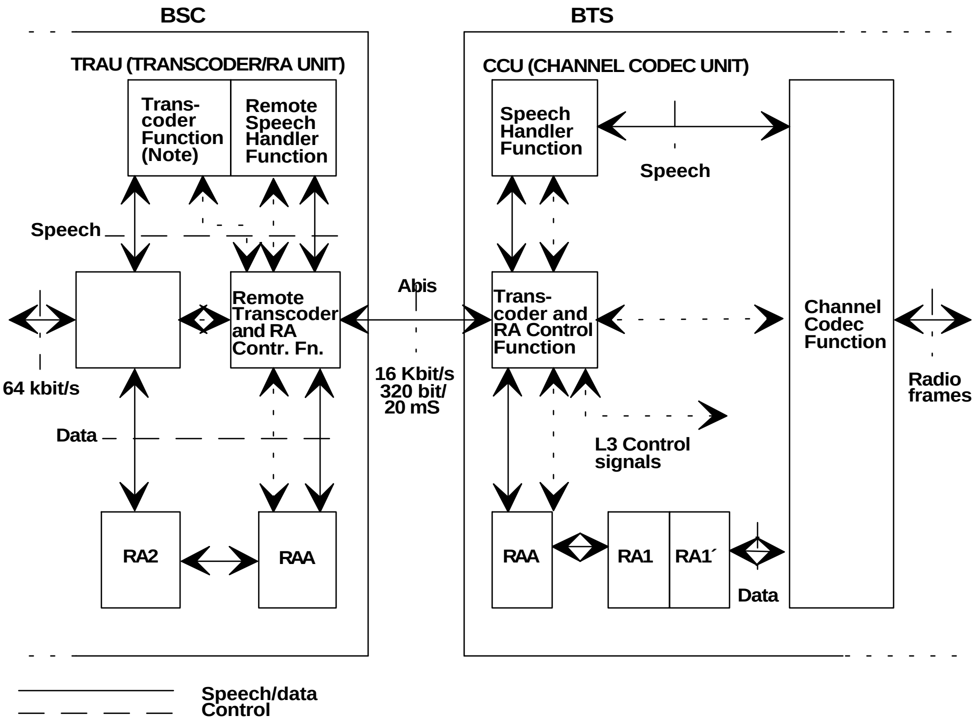
The functions inside the TRAU are:

- "Remote Transcoder and Rate Adaptor Control Function" (RTRACF);
- "Remote Speech Handler Function" (RSHF);
- The RAA function;
- The RA2 function;
- The transcoder function.

The functions inside the CCU are:

- "Transcoder and Rate Adaptor Control Function" (TRACF);
- "Speech Handler Function" (SHF);
- The RAA function;
- The RA1/RA1' function;
- The channel codec function.

This specification will not describe the procedures inside the TRAU and the CCU. The layout in figure 2.1 is only intended as a reference model.



NOTE: This recommendation assumes the DTX handler function to be a part of the Transcoder Function.

Figure GSM 08.60/2.1: Functional entities for handling of remote control of remote transcoders and rate adaptors

3 Frame Structure

3.1. Speech Frames

Octet no.	Bit number 1	2	3	4	5	6	7	8
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	C6	C7
3	C8	C9	C10	C11	C12	C13	C14	C15
4	1	D1	D2	D3	D4	D5	D6	D7
5	D8	D9	D10	D11	D12	D13	D14	D15
6	1	D16	D17	D18	D19	D20	D21	D22
7	D23	D24	D25	D26	D27	D28	D29	D30
8	1	D31	D32	D33	D34	D35	D36	D37
9	D38	D39	D40	D41	D42	D43	D44	D45
10	1	D46	D47	D48	D49	D50	D51	D52
11	D53	D54	D55	D56	D57	D58	D59	D60
12	1	D61	D62	D63	D64	D65	D66	D67
13	D68	D69	D70	D71	D72	D73	D74	D75
14	1	D76	D77	D78	D79	D80	D81	D82
15	D83	D84	D85	D86	D87	D88	D89	D90
16	1	D91	D92	D93	D94	D95	D96	D97
17	D98	D99	D100	D101	D102	D103	D104	D105
18	1	D106	D107	D108	D109	D110	D111	D112
19	D113	D114	D115	D116	D117	D118	D119	D120
20	1	D121	D122	D123	D124	D125	D126	D127
21	D128	D129	D130	D131	D132	D133	D134	D135
22	1	D136	D137	D138	D139	D140	D141	D142
23	D143	D144	D145	D146	D147	D148	D149	D150
24	1	D151	D152	D153	D154	D155	D156	D157
25	D158	D159	D160	D161	D162	D163	D164	D165
26	1	D166	D167	D168	D169	D170	D171	D172
27	D173	D174	D175	D176	D177	D178	D179	D180
28	1	D181	D182	D183	D184	D185	D186	D187
29	D188	D189	D190	D191	D192	D193	D194	D195
30	1	D196	D197	D198	D199	D200	D201	D202
31	D203	D204	D205	D206	D207	D208	D209	D210
32	1	D211	D212	D213	D214	D215	D216	D217
33	D218	D219	D220	D221	D222	D223	D224	D225
34	1	D226	D227	D228	D229	D230	D231	D232
35	D233	D234	D235	D236	D237	D238	D239	D240
36	1	D241	D242	D243	D244	D245	D246	D247
37	D248	D249	D250	D251	D252	D253	D254	D255
38	1	D256	D257	D258	D259	D260	C16	C17
39	C18	C19	C20	C21	T1	T2	T3	T4

3.2. O&M Frames

Octet no.	Bit number 1	2	3	4	5	6	7	8
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	C6	C7
3	C8	C9	C10	C11	C12	C13	C14	C15
4	1	D1	D2	D3	D4	D5	D6	D7
5	D8	D9	D10	D11	D12	D13	D14	D15
6	1	D16	D17	D18	D19	D20	D21	D22
7	D23	D24	D25	D26	D27	D28	D29	D30
8	1	D31	D32	D33	D34	D35	D36	D37
9	D38	D39	D40	D41	D42	D43	D44	D45
10	1	D46	D47	D48	D49	D50	D51	D52
11	D53	D54	D55	D56	D57	D58	D59	D60
12	1	D61	D62	D63	D64	D65	D66	D67
13	D68	D69	D70	D71	D72	D73	D74	D75
14	1	D76	D77	D78	D79	D80	D81	D82
15	D83	D84	D85	D86	D87	D88	D89	D90
16	1	D91	D92	D93	D94	D95	D96	D97
17	D98	D99	D100	D101	D102	D103	D104	D105
18	1	D106	D107	D108	D109	D110	D111	D112
19	D113	D114	D115	D116	D117	D118	D119	D120
20	1	D121	D122	D123	D124	D125	D126	D127
21	D128	D129	D130	D131	D132	D133	D134	D135
22	1	D136	D137	D138	D139	D140	D141	D142
23	D143	D144	D145	D146	D147	D148	D149	D150
24	1	D151	D152	D153	D154	D155	D156	D157
25	D158	D159	D160	D161	D162	D163	D164	D165
26	1	D166	D167	D168	D169	D170	D171	D172
27	D173	D174	D175	D176	D177	D178	D179	D180
28	1	D181	D182	D183	D184	D185	D186	D187
29	D188	D189	D190	D191	D192	D193	D194	D195
30	1	D196	D197	D198	D199	D200	D201	D202
31	D203	D204	D205	D206	D207	D208	D209	D210
32	1	D211	D212	D213	D214	D215	D216	D217
33	D218	D219	D220	D221	D222	D223	D224	D225
34	1	D226	D227	D228	D229	D230	D231	D232
35	D233	D234	D235	D236	D237	D238	D239	D240
36	1	D241	D242	D243	D244	D245	D246	D247
37	D248	D249	D250	D251	D252	D253	D254	D255
38	1	D256	D257	D258	D259	D260	D261	D262
39	D263	D264	S1	S2	S3	S4	S5	S6

3.3. Data Frames

Octet no.	Bit number 1	2	3	4	5	6	7	8
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	C6	C7
3	C8	C9	C10	C11	C12	C13	C14	C15
4	1	Data frame position 1 63 bits (72 bits including bit position 1)						
5	1							
6	1							
7	1							
8	1							
9	1							
10	1							
11	1							
12	1							
13	1	Data frame position 2						
14	1							
15	1							
16	1							
17	1							
18	1							
19	1							
20	1							
21	1							
22	1	Data frame position 3						
23	1							
24	1							
25	1							
26	1							
27	1							
28	1							
29	1							
30	1							
31	1	Data frame position 4						
32	1							
33	1							
34	1							
35	1							
36	1							
37	1							
38	1							
39	1							

3.4. Idle Speech Frames

Octet no.	Bit number 1	2	3	4	5	6	7	8
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	C6	C7
3	C8	C9	C10	C11	C12	C13	C14	C15
4	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1
26	1	1	1	1	1	1	1	1
27	1	1	1	1	1	1	1	1
28	1	1	1	1	1	1	1	1
29	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1
31	1	1	1	1	1	1	1	1
32	1	1	1	1	1	1	1	1
33	1	1	1	1	1	1	1	1
34	1	1	1	1	1	1	1	1
35	1	1	1	1	1	1	1	1
36	1	1	1	1	1	1	1	1
37	1	1	1	1	1	1	1	1
38	1	1	1	1	1	1	C16	C17
39	C18	C19	C20	C21	T1	T2	T3	T4

3.5. Coding

In the following sections the coding of the frames is described. Any spare or not used control bits should be coded binary "1".

For all frame types the octet 0, 1 and the first bit of octets 2, 4, 6, 8, ... 38 are used as frame sync.

3.5.1. Coding of Speech Frames

Control bits (C-bits):

Description	Uplink	Downlink
Frame type (Bits C1 - C4)	C1C2C3C4 Speech:0 0 0 1	C1C2C3C4 Speech:1 1 1 0
Channel type (Bit C5)	0: Full rate 1: Reserved for half rate	0: Full rate 1: Reserved for half rate
Time Alignment (Bits C6 - C11)	Binary number indicating the required timing adjustment to be made in steps of 250/500 µs.	Binary number indicating the timing adjustment made.
	The following values apply for the coding C6C7. . . C11 0 0 0 0 0 0 No change in frame timing 0 0 0 0 0 1 Delay frame 1 x 500 µs 0 0 0 0 1 0 Delay frame 2 x 500 µs . . . . 1 0 0 1 1 1 Delay frame 39 x 500 µs 1 0 1 0 0 0 Not used . . . . 1 1 1 1 0 1 Not used 1 1 1 1 1 0 Delay frame 1 x 250 µs 1 1 1 1 1 1 Advance frame 250 µs	
Frame indicators. The definition and coding of these indicators are given in TS GSM 06.31. Bits C12 - C16	C12: BFI 0: BFI = 0 1: BFI = 1	C12 - C15: Spare
	C13 C14: SID 0 0: SID = 0 0 1: SID = 1 1 0: SID = 2	
	C15: TAF 0: TAF = 0 1: TAF = 1	
	C16: Spare	C16: SP 0: SP = 0 1: SP = 1
DTX indicator	C17: DTXd 0: DTX not applied 1: DTX applied	C17: Spare
Bits C18 - C21	Spare	Spare

Data Bits (D-bits):

Bits D1 .. D260: Speech block transferred in the same order as output from the transcoder (see TS GSM 06.10).

Time Alignment Bits:

Bits T1 .. T4: Bits positioned at the end of the downlink frames. If the timing of the frame is to be advanced 250 µS, these 4 bits are not transferred in order to reduce the frame length accordingly. When transferred the bits are set to binary "1".

3.5.2. Coding of O&M Frames.

Control bits (C-bits):

Description	Uplink	Downlink
Frame type Bits C1 - C4	C1C2C3C4 0 0 1 0: O & M	C1C2C3C4 1 1 0 1: O & M
Bits C5 - C15	Spare	Spare

Data Bits (D-bits):

Bits D1 .. D264: Bits used for transfer of O&M information. The coding and use of these bits are left to the manufacturer of the BSC/TRAU.

Spare Bits:

Bits S1 .. S6: Spare

3.5.3. Coding of Data Frames

Control bits (C-bits):

Description	Uplink	Downlink
Frame type. Bits C1 - C4	C1C2C3C4 0 1 0 0: Data	C1C2C3C4 1 0 1 1: Data
Channel type. Bit C5	0: Full rate 1: Half rate	0: Full rate 1: Half rate
Intermediate RA bit rate. Bit C6	0: 8 kbit/s 1: 16 kbit/s	0: 8 kbit/s 1: 16 kbit/s
Bits C7 - C15	Spare	Spare

3.5.4. Coding of Idle Speech Frames.

Control bits (C-bits):

Description	Uplink	Downlink
Frame type. Bits C1 - C4	C1C2C3C4 1 0 0 0: Idle Speech	C1C2C3C4 0 1 1 1: Idle Speech
Channel type (Bit C5)	0: Full rate 1: Reserved for half rate	0: Full rate 1: Reserved for half rate
Bits C6 - C21	Coding as for Speech frames.	Coding as for Speech frames.

Time Alignment Bits:

Bits T1 .. T4: Coding as for Speech frames.

3.6. Order of Bit Transmission.

The order of bit transmission is:

The first octet is transferred first with the bit no. 1 first, bit no. 2 next etc.

4. Procedures

4.1. Remote Control of Transcoders and Rate Adaptors.

When the transcoder is positioned remote to the BTS, the Channel Codec Unit (CCU) in the BTS has to control some of the functions in the remote Transcoder/Rate Adaptor Unit (TRAU) in the BSC.

This remote control is performed by inband signalling carried by the control bits (C-bits) in each TRAU frame.

The following functions in the TRAU are remotely controlled by the CCU:

- Shift between speech and data.
- Shift between half and full rate radio channels.
- Control of the rate adaption functions for data calls.
- Downlink frame timing for speech frames.
- Transfer of DTX information.

In addition the inband signalling also provides means for transfer of O&M signals between the TRAU and the BSC/BTS.

4.2. Resource Allocation

At reception of the ASSIGNMENT REQUEST message, e.g. at call setup, when a circuit switched connection is required, the BSC provides an appropriate TRAU to the circuit to be used between the BSC and the BTS and sends the CHANNEL ACTIVATION message to the BTS.

When receiving the CHANnel ACTIVation message, the BTS allocates the appropriate radio resources and a Channel Codec Unit (CCU) to be used.

The CCU now starts sending uplink frames with the appropriate "Frame Type", "Channel Type" and, for data calls, the inter mediate rate adaption bit rate set.

When receiving the first frame, the TRAU sets the mode of operation accordingly and starts sending downlink frames with the "Frame Type", "Channel Type" and, for data calls, the inter mediate rate adaption bit rate set as an acknowledgement indication.

4.3. Resource Release

At release of circuit switched resources, e.g. at call release, the connection between the CCU and the TRAU will be released by the BSC. The BSC has to indicate that the connection has been released. How this is performed is a BSC internal matter. However, three methods have been identified.

i) The BSC indicates the call release to the TRAU by inserting the PCM idle bit pattern described in TS GSM 08.54 on the circuits towards the TRAU. The TRAU shall be able to detect this idle bit pattern. When received at the TRAU, the TRAU will loose frame synchronization and will start timer Tsync (see section 4.8.2). If, when Tsync expires, the idle bit pattern has been detected, the TRAU shall terminate the operation (go idle) until a valid frame is again received.

ii) After a call release, the TRAU downlink channel is switched to the TRAU uplink channel (16 kbit/s side).

The TRAU shall be able to detect the looped downlink frame. When it is detected, the TRAU shall terminate the normal operation (go idle) until a valid uplink TRAU frame is again received.

iii) It is handled by BSC internal signals (e.g. if the BSC and TRAU are collocated).

4.4. In Call Modification

If the subscriber orders "In Call Modification" the CCU sets the "Frame Type", "Channel Type" and, for data calls, the inter mediate rate adaption bit rate in the uplink frames to the new mode of operation. When receiving this information, the TRAU changes the mode of operation accordingly and sets the new "Frame Type", "Channel Type" and, for data calls, the intermediate rate adaption bit rate in the downlink frames.

4.5. Transfer of Idle Frames

Between the TRAU and the CCU a TRAU frame shall be transferred every 20 mS.

If no speech/data is received from the MS (uplink direction) or no speech/data is received from the MSC side of the interface (downlink direction), idle frames shall be transferred instead of speech/data frames.

For speech mode this is the idle speech frames and for data mode it is data frames with all data bit positions set to binary "1".

4.6. Procedures for Speech Frames

4.6.1. Time Alignment of Speech Frames

The time alignment needed for obtaining minimum buffer delay will differ from call to call. The reasons for this are:

- The BSC will have no information about the radio timing at the BTS, and will start sending frames at an arbitrary or default time. Each TRAU frame is 320 bits (20 mS) and will in the worst case be received at the BTS 319 bits out of phase.

- The different timeslots on one carrier is sent at different times (max 4.04 mS which equals 7 timeslots in a TDMA radio frame).

- Different channels may be transferred on different trans mission systems using different routes in the network. The transmission delay may therefore differ (the total one way transmission time is assumed to be in the order of approxi mately 1 mS).

The required time alignment between radio frames and TRAU frames is considered to be an internal BTS matter for uplink frames. However, the buffer delay for these frames should be kept to a minimum.

For downlink frames the procedures in the following sections should apply. In order to describe the time alignment procedure in the TRAU, two time alignment states are described (Initial Time Alignment state and Static Time Alignment state).

In order to achieve optimum timing between the radio TDMA frames and the frames on the transmission side, the speech coding and decoding function in the transcoder should not be synchronized.

4.6.1.1. Initial Time Alignment State

The TRAU shall enter the Initial Time Alignment state at the switching-on of the system, when it goes idle (e.g. when receiving the PCM idle pattern after a call release as described in section 4.3), if loss of frame synchronization is detected, in call modification from data to speech is performed or if BSS internal handover is detected.

In the initial state the frames shall only be delayed (or no change)(see note). The transcoder is able to adjust the time for transmitting the speech frames in steps of 125 µS (one speech sample). The CCU calculates the required timing adjustment and returns a frame including the number of 250/500 µS steps by which the frames in the downlink direction have to be delayed (binary number in the "Time Alignment" field).

When receiving this information, the TRAU processes this data and sets the "Time Alignment" field in the next downlink frame as ordered and then delays the subsequent frame accordingly.

NOTE: If the TRAU, in this state, receives an order to advance the next frame 250 µS, this order shall be interpreted as "Delay frame 39*500 µS".

When a frame is delayed due to timing adjustments, the TRAU shall fill in the gap between the frames with the appropriate number of binary "1".

After having adjusted the timing, the TRAU shall receive at least three new frames before a new adjustment is made. This in order to avoid oscillation in the regulation.

The TRAU shall change from the Initial Time Alignment state to the Static Time Alignment state when it has performed two subsequent timing adjustments which are less than 500 µS (including no change).

The procedure is illustrated in figure 4.1.

4.6.1.2. The Static Time Alignment State

In the Static Time Alignment state, the TRAU performs timing adjustments in single steps of 250 µS. The timing may either be delayed (time alignment code 111110, advanced (time alignment code 111111) or not changed (time alignment code 000000).

When receiving an order for adjusting the timing, the transcoder skips or repeats two speech samples in order to achieve the correct timing.

If the timing is to be advanced 250 µS, the TRAU sets the "Time Alignment" field in the next downlink frame as ordered and then the 4 last bits of the frame are not transferred (the T-bits).

If the timing is to be delayed, the TRAU sets the "Time Align ment" field in the next downlink frame as ordered and then delays the subsequent frame by adding four binary "1" between the frames.

After having adjusted the timing, the TRAU shall receive at least three new frames before a new adjustment is made.

If, in this state, the TRAU detects a change in the timing of the uplink frames bigger than n x 250 µS, where n = 4, it shall enter the Initial Time Alignment state and in that state it may perform an adjustment on the downlink equal to the change detected on the uplink.

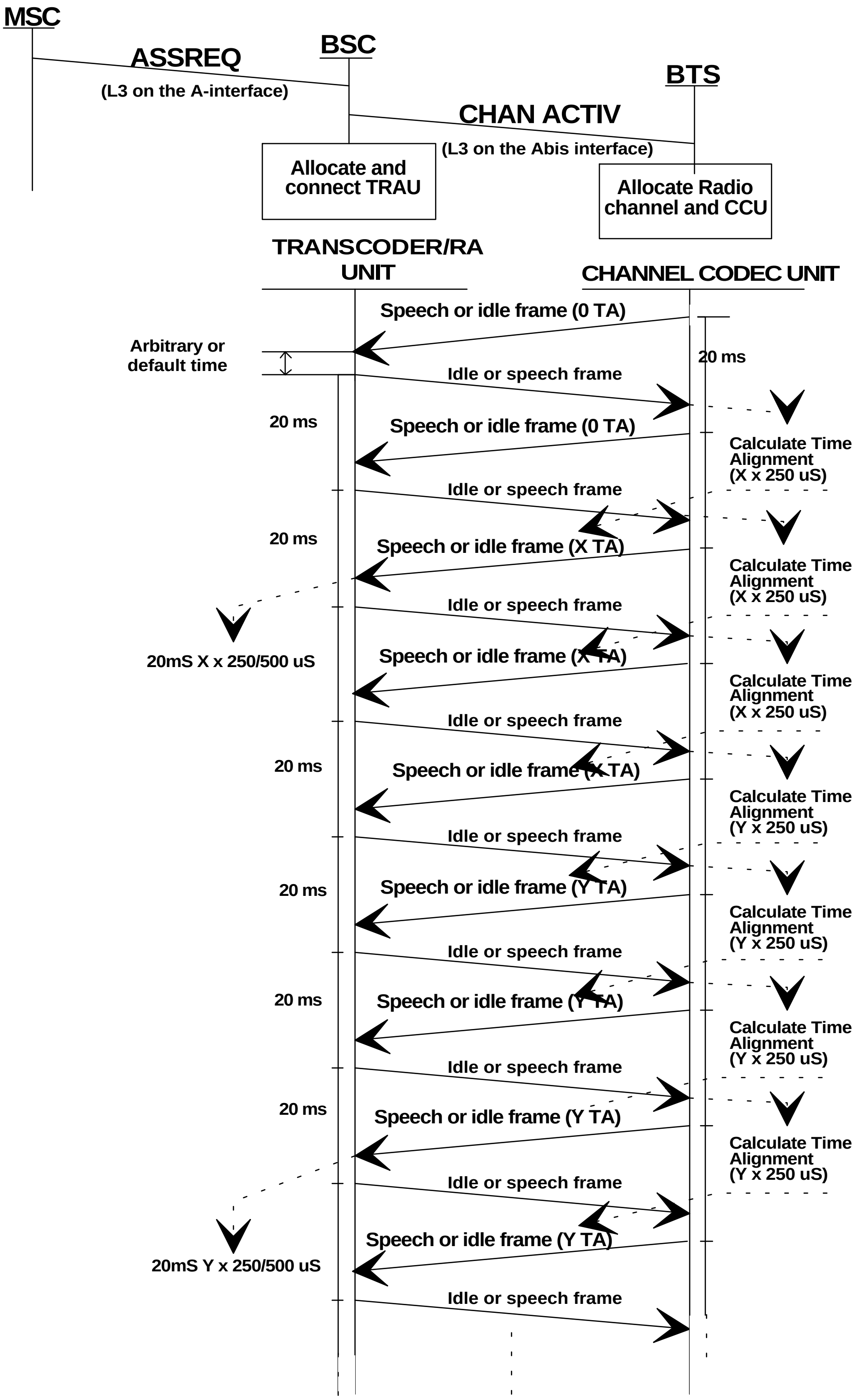


Figure GSM 08.60/4.1: Initial Time Alignment procedure

4.6.1.3. Initiation at Resource Allocation

When the BTS receives the CHANNEL ACTIVATION message from the BSC, it allocates the appropriate radio resources and a Channel Codec Unit (CCU). The CCU then initiates sending of speech frames (or idle speech frames if speech is not received from the MS) towards the transcoder with normal frame phase for the TDMA channel in question. The "Time Alignment" field in these frames is set to "no change".

The TRAU will now be in the Initial Time Alignment state. When receiving the first frame it shall start sending speech frames (or idle speech frames) towards the BTS with arbitrary or default phase related to the uplink frame phase.

When receiving these frames the CCU calculates the timing adjustment required in order to achieve minimum buffer delay and sets the "Time Alignment" field in the uplink frames accordingly.

The procedures described for the Initial and for the Static Time Alignment states are then followed during the call.

4.6.1.4. Time Alignment During Handover

4.6.1.4.1. BSS External Handover

For BSS external handover the procedure described in section 4.6.1.3 should be used by the new BSC/BTS at resource allocation.

4.6.1.4.2. BSS Internal Handover

If a BSS internal handover has been performed, the timing of the downlink frames may have to be adjusted several steps of 250/500 µS. In order to speed up the alignment of the downlink frames, this must be detected by the TRAU, e.g. by detecting the change in the uplink frame timing as described in section 4.6.1.2. The TRAU should then enter the Initial Time Alignment state and in that state it may perform an adjustment on the downlink equal to the change detected on the uplink.

4.6.2. Procedures for Discontinuous Transmission (DTX)

The procedures for comfort noise are described in TS GSM 06.12, the overall operation of DTX is described in TS GSM 06.31 and the Voice Activity Detector is described in TS GSM 06.32.

The DTX Handler function is considered as a part of the TRAU when remote transcoders are applied. The specification of the DTX Handler is given in TS GSM 06.31.

4.6.2.1. DTX procedures in the uplink direction

In all frames in the uplink direction, the BFI (Bad Frame Indicator), the SID (Silence Descriptor) indicator and the TAF (Time Alignment Flag) indicator is set as output from the RSS (see TS GSM 06.31).

In the comfort noise states, the MS will transmit a new frame only every 480 ms (24 frames). These frames are transferred in the normal way between the CCU and the TRAU. Between these frames the CCU shall transfer uplink idle speech frames.

4.6.2.2. DTX procedures in the downlink direction

To inform the DTX handler in the remote transcoder whether downlink DTX may be applied or not, the DTXd bit (C17) in the uplink speech frame is used. The coding is as follows:

DTXd = 0 : downlink DTX is not applied;
DTXd = 1 : downlink DTX is applied.

Though this parameter is linked with the resource allocation in the BTS at call setup, its value may vary during the connection.

In the downlink frames the SP (Speech) indicator is set as output from the TX DTX handler (see TS GSM 06.31).

If downlink DTX is not used, the SP indicator should be coded binary "1".

4.7. Procedures for Data Frames

When rate adaption to 64 Kbit/s is performed at the BTS (sub-64 kbit/s traffic channels are not used), the rate adaption between the format used on the radio interface and the 64 Kbit/s format is made by the RA1/RA1' and the RA2 function as described in TS GSM. 08.20. This is illustrated in figure 4.2.

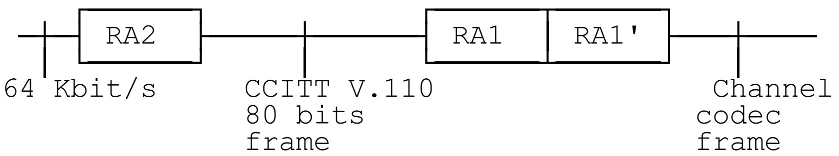


Figure TS GSM 08.60/4.2: Rate adaption when performed at the BTS.

When sub-64 kbit/s traffic channels are used, up to four data frames are transferred in each TRAU frame. In order to convert between the TRAU frame format and the CCITT 80 bits frame format an additional intermediate rate adaption function, RAA, is applied. This is illustrated in figure 4.3.

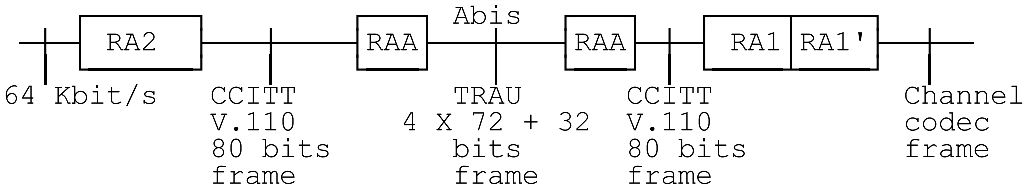


Figure TS GSM 08.60/4.3: Rate adaption when sub-64 kbit/s traffic channels are used.

4.7.1. The RAA Function

The RAA function is used to convert between the CCITT V.110 80 bits frame format and the TRAU frame format. When going from the V.110 format to the TRAU frame format the first octet (all bits coded binary "0") in the CCITT V.110 80 bits frame is stripped off. Up to four such frames are then transferred in each TRAU frame as shown in section 3.3.

When going from the TRAU frame format to the V.110 format the data frames are separated and the synchronization octet (all bits coded binary "0") is again included.

The 80 bits V.110 frame is illustrated in figure 4.4, and the modified 72 bits frame is illustrated in figure 4.5.

	Bit number							
Octet no.	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	1	D1	X	X	X	X	X	X
2	1	X	X	X	X	X	X	X
3	1	X	X	X	X	X	X	X
4	1	X	X	X	X	X	X	X
5	1	X	X	X	X	X	X	X
6	1	X	X	X	X	X	X	X
7	1	X	X	X	X	X	X	X
8	1	X	X	X	X	X	X	X
9	1	X	X	X	X	X	X	X

Figure TS GSM 08.60/4.4: CCITT V.110 80 bits frame

	Bit number							
Octet no.	1	2	3	4	5	6	7	8
0	1	D1	X	X	X	X	X	X
1	1	X	X	X	X	X	X	X
2	1	X	X	X	X	X	X	X
3	1	X	X	X	X	X	X	X
4	1	X	X	X	X	X	X	X
5	1	X	X	X	X	X	X	X
6	1	X	X	X	X	X	X	X
7	1	X	X	X	X	X	X	X
8	1	X	X	X	X	X	X	X

Figure TS GSM 08.60/4.5:
Modified CCITT V.110 72 bits frame transferred in a TRAU data frame position.

4.7.2. The RA1/RA1' Function

This function is described in TS GSM 04.21.

4.7.3. The RA2 Function

This function is described in TS GSM 04.21.

4.7.4. Procedures for 8 kbit/s intermediate rate adaption rate

For 8 kbit/s intermediate rate adaption rate up to two data frames are transferred in each TRAU frame. The first data frame is transferred in TRAU data frame position 1 and the subsequent data frame is transferred in TRAU data frame position 3 (see section 3.3).

In TRAU data frame position 2 and 4 all bits are coded binary "1".

If the data transfer terminates before the TRAU frame has been completed, the remaining data bit positions in the TRAU frame should be coded binary "1".

4.7.5. Procedures for 16 kbit/s intermediate rate adaption rate

For 16 kbit/s intermediate rate adaption rate, up to four data frames are transferred in each TRAU frame. The first data frame is transferred in TRAU data frame position 1, the next in data frame position 2 etc.

If the data transfer terminates before the TRAU frame has been completed, the remaining data bit positions in the TRAU frame should be coded binary "1".

4.7.6. Support of Non-Transparent Bearer Applications

In GSM Rec. 08.20 the procedures for transfer of non-transparent bearer applications are specified. The 240 bit RLP frame is converted to four modified V.110 80 bit frames.

The same conversion is applied when transferred in a TRAU frame. The frames are coded as specified in sections 4.7.4 and 4.7.5.

4.8. Frame Synchronization

4.8.1. Search for Frame Synchronization

The frame synchronization 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, 4, 6, 8, ... 38 coded binary "1". The following 35 bit alignment pattern is used to achieve frame synchronization:

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

4.8.2. Frame Synchronization After Performing Downlink Timing Adjustments

If the timing of the downlink speech frames is adjusted, the adjustment is indicated in bits C6 - C11 as described in sections 4.6.1.1 and 4.6.1.2. The frame synchronization unit shall change its frame synchronization window accordingly.

4.8.3. Frame Synchronization Monitoring and Recovery

The monitoring of the frame synchronization shall be a continuous process using the same procedure as for initial detection.

Loss of frame synchronization shall not be assumed unless at least three consecutive frames, each with at least one framing bit error, are detected.

If the TRAU looses its frame synchronization it starts a timer Tsync = 1 second. If Tsync expires before frame synchronization is again obtained the TRAU initiates sending of the urgent alarm pattern described in section 4.10.2.

The exception from this procedure is when "Resource Release" is detected while Tsync is running (see section 4.3). In this case the procedure in section 4.3 shall be followed.

If loss of frame synchronization is detected by the CCU it starts a timer Tsync. If Tsync expires before frame synchronization is again obtained the call shall be released and an indication given to O&M.

Tsync is reset every time frame synchronization is again obtained.

4.9. Correction/detection of bit errors on the terrestrial circuits

4.9.1. Error Detection on the Control Bits

For the control bits, (C-bits), no error coding is made. However, in order to reduce the possibility of misinterpretation of control information due to bit errors, the following procedure should be followed.

4.9.1.1. General Procedure

If any undefined combination of the C-bits is received (see section 3.5), the frame should be reacted upon as received with errors.

4.9.1.2. Speech Frames

In addition to the general procedure described in the previous section, the following procedure should be followed for the speech frames:

Bits C6 - C11: Time Alignment.

The full range of the time alignment adjustment should only be applied when the TRAU is in the Initial Time Alignment state (see sections 4.6.1.1 and 4.6.1.2).

If, in the Static Time Alignment state, a time alignment order is received indicating an adjustment of more than 250 µS, the next downlink frame should be delayed only one 250 µS step.

If an uplink frame is received with the "Time Alignment" field set to an unused value (101000 ... 111101), this value should be interpreted as "no change".

4.9.2. Handling of frames received with errors

If TRAU frame is received in the uplink or downlink with detectable errors in the control bits, then the control information shall be ignored. The speech or data bits shall be handled as if no error had been detected.

If frame synchronisation has been lost (see section 4.8.3) in the uplink direction the TRAU shall:

- for speech, mute the decoded speech as if it has received frames with errors (cf. TS GSM 06.11);
- for data, send idle frames as defined in TS GSM 08.20 to the MSC/interworking.

If frame synchronisation has been lost in the downlink direction then the same procedure shall be followed as when frame synchronisation is lost on the PCM link.

4.10. Procedures for Operation & Maintenance

The general procedures for Operation and Maintenance are described in TS GSM 12.21.

If the transcoders are positioned outside the BTS, some O&M functions will be required for the TRAU and the CCU. In par ticular this applies for transcoders positioned at the MSC site.

The transcoders outside the BTS are considered a part of the BSC, and the O&M functions for the TRAU should therefore be implemented in the BSC.

The CCU is a part of the BTS and the O&M functions for this unit should therefore be implemented in the BTS.

4.10.1. Transfer of O&M Information Between the TRAU and the BSC

The transfer of O&M information between the BSC and the TRAU is possible to do in two ways. Either it is handled directly between the BSC and the TRAU or a BTS is used as a message transfer point. The choice between the two methods is up to the manufacturer of the BSC:

i) The transfer of O&M information between the BSC and the TRAU is handled internally by the BSC. The O&M signalling between the TRAU and the BSC may either be handled by proprietary BSC solutions or the O&M TRAU frames defined in sections 3.2 and 3.5.2 could be used. In the latter case the BSC has to act as a terminal for the O&M TRAU frames sent between the TRAU and the BSC.

ii) The O&M information between the TRAU and the BSC is transferred using O&M TRAU frames between the TRAU and the CCU in a BTS. The BTS then acts as a relay function between the O&M TRAU frames and the associated O&M messages sent between the BTS and the BSC.

4.10.2. Procedures in the TRAU

In case of urgent fault conditions in the TRAU, e.g. loss of frame synchronization, non-ability of the transcoder to process data etc., this should if possible, be signalled to the BTS/BSC as an urgent alarm pattern. The urgent alarm pattern is a continuous stream of binary "0".

If O&M TRAU frames information between the TRAU and the BSC is transferred using O&M frames between the CCU in a BTS and the TRAU, the TRAU sends O&M frames periodically until the identical O&M TRAU frame is received for acknowledgement. The period is at least 64*20ms (1,28 sec).

In case of minor fault conditions, when no immediate action is required, the TRAU may send O&M frames indicating the fault instead of the urgent alarm pattern.

4.10.3. Procedures in the BSC

The BSC should be able to detect a faulty TRAU, take it out of service and give an indication to O&M. A faulty TRAU could be detected e.g. by routine tests, alarms from the TRAU, release of call initiated by the BTS due to remote transcoder failure etc. How this is handled by the BSC is regarded as a BSC internal matter.

4.10.3.1. Use of O&M Frames

The use and coding of O&M TRAU frames is left to the implementor of the BSC/TRAU.

If O&M TRAU frames are used, they are always carrying 264 data bits.

Any corresponding O&M message between the BSC and the BTS shall always carry all 264 O&M data bits.

4.10.4. Procedures in the BTS

If a CCU in a BTS receives O&M TRAU frames from the TRAU, the BTS shall:

- send the identical frame to the TRAU for acknowledgement, and
- put the 264 data bits from the received frames into an appropriate O&M message and send it to the BSC.

If the CCU receives O&M frames during a call then "stolen frames" shall be indicated to the MS and layer 2 frames of format A (see TS GSM 04.06) shall be transmitted.

If the CCU receives O&M frames during a data call, then the same procedure shall be used as when V.110 frame is lost.

If receiving an O&M message from the BSC, carrying TRAU O&M information, the BTS puts the 264 data bits from the received message into an O&M TRAU frame and then the CCU allocated to the addressed connection sends the frame to the TRAU in one single O&M TRAU frame. Repetition is done according to TS GSM 12.21.

In case of a faulty CCU, the O&M procedures are BTS internal.

If the CCU receives the urgent alarm pattern, the BTS shall initiate release of the call as specified in TS GSM 08.58 with the cause field set to "Remote Transcoder Failure".

History

Document history	
September 1994	First Edition
April 1996	Converted into Adobe Acrobat Portable Document Format (PDF)