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Technical Specification

Digital cellular telecommunications system (Phase 2+); In-band control of remote transcoders and rate adaptors for full rate traffic channels (3GPP TS 48.060 version 7.0.0 Release 7)

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

Reference

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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

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 adaptation shall be as specified in 3GPP TS 44.021 and 3GPP TS 48.020.

In the case where 16 kbit/s traffic channels are used for full rate speech, enhanced full rate speech, Adaptive Multi-Rate speech, Adaptive Multi-Rate Wideband speech or full rate data service, then the present document shall apply for frame structure and for control of remote transcoders and additional rate adaptors.

For Adaptive Multi-Rate speech the present document specifies the 16 kBit/s submultiplexing, both for the full and the half rate traffic channels (TCH/AFS, TCH/AHS, TCH/WFS and O-TCH/WHS). The specification for 8 kBit/s submultiplexing is given in 3GPP TS 48.061, both for the full and the half rate traffic channels (TCH/AFS and TCH/AHS).

Additionally, the present document specifies the 32 kBit/s submultiplexing for Adaptive Multi-Rate Wideband speech. However it reuses the frame structure of the 16 kBit/s submultiplexing for Adaptive Multi-Rate speech.

The use and general aspects of the Abis interface are given in 3GPP TS 48.051.

NOTE: The present document should be considered together with the 3GPP TS 06 series of specifications, 3GPP TS 44.021 (Rate Adaptation on the MS-BSS Interface) and 3GPP TS 48.020 (Rate Adaptation on the BS/MSC 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 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 44.006: "Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification".

[3] 3GPP TS 44.021: "Rate adaption on the Mobile Station

[4] Void.

[5] 3GPP TS 46.010: "Full rate speech; Transcoding".

[6] 3GPP TS 46.011: "Full rate speech; Substitution and muting of lost frames for full rate speech channels".

[7] 3GPP TS 46.012: "Full rate speech; Comfort noise aspect for full rate speech traffic channels".

[8] 3GPP TS 46.031: "Full rate speech; Discontinuous Transmission (DTX) for full rate speech traffic channels".

[9] 3GPP TS 46.032: "Voice Activity Detector (VAD)".

[10] 3GPP TS 48.020: "Rate adaption on the Base Station System - Mobile-services Switching Centre (BSS - MSC) interface".

[11] 3GPP TS 48.051: "Base Station Controller - Base Transceiver Station (BSC - BTS) interface; General aspects".

[12] 3GPP TS 48.054: "Base Station Controller - Base Transceiver Station (BSC - BTS) interface Layer 1 structure of physical circuits".

[13] 3GPP TS 48.058: "Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 3 specification".

[14] 3GPP TS 12.21: "Network Management (NM) procedures and message on the A-bis interface".

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

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

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

[18] Void.

[19] 3GPP TS 46.060: "Enhanced Full rate speech transcoding".

[20] 3GPP TS 46.061: "Substitution and muting of lost frames for Enhanced Full rate speech channels".

[21] 3GPP TS 46.062: "Comfort noise aspect for Enhanced Full rate speech traffic channels".

[22] 3GPP TS 46.081: "Discontinuous Transmission (DTX) for Enhanced Full rate speech traffic channel".

[23] 3GPP TS 46.082: "Voice Activity Detection (VAD)".

[24] Void.

[25] 3GPP TS 26.090: "Adaptive Multi-Rate speech transcoding".

[26] 3GPP TS 26.091: "Substitution and muting of lost frames for Adaptive Multi-Rate speech traffic channels".

[27] 3GPP TS 26.092: "Comfort noise aspect for Adaptive Multi-Rate speech traffic channels".

[28] 3GPP TS 26.093: "Discontinuous Transmission (DTX) for Adaptive Multi-Rate speech traffic channels".

[29] 3GPP TS 26.094: "Voice Activity Detection (VAD) for Adaptive Multi-Rate speech traffic channels ".

[30] 3GPP TS 45.009: "Link Adaptation".

[31] 3GPP TS 48.061: "Inband control of remote transcoders and rate adaptors (half rate)".

[32] 3GPP TS 28.062: "Inband Tandem Free Operation (TFO) of Speech Codecs".

[33] 3G 26.171: "Digital cellular telecommunications system; Adaptive Multi-Rate Wideband speech processing functions, General Description."

[34] 3G 26.190: "Digital cellular telecommunications system; Adaptive Multi-Rate Wideband speech transcoding".

[35] 3G 26.191: "Digital cellular telecommunications system; Substitution and muting of lost frames for Adaptive Multi-Rate Wideband speech traffic channels".

[36] 3G 26.192: "Digital cellular telecommunications system; Comfort noise aspect for Adaptive Multi-Rate Wideband speech traffic channels".

[37] 3G 26.193: "Digital cellular telecommunications system; Discontinuous Transmission (DTX) for Adaptive Multi-Rate Wideband speech traffic channels".

[38] 3G 26.194: "Digital cellular telecommunications system; Voice Activity Detection (VAD) for Adaptive Multi-Rate Wideband speech traffic channels ".

3 Abbreviations

Abbreviations used in the present document are listed in 3GPP TS 21.905. Additionally:

AMR Adaptive Multi-Rate
AMR-WB Adaptive Multi-Rate Wideband
CMC Codec_Mode_Command
CMI Codec_Mode_Indication
CMR Codec_Mode_Request
Onset Speech Onset Frame Classification
PAB Phase Alignment Bit
PAC Phase Alignment Command
RATSCCH Robust AMR Traffic Synchronised Control CHannel
RIF Request or Indication Flag
TAC Time Alignment Command
TAE Time Alignment Extension
TFO Tandem Free Operation
TFOE TFO Enable
UFE Uplink Frame Error

4 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 the present document, 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.

In case of 4,8 and 9,6 kbit/s channel coding when data is adapted to the 320 bit frames, a conversion function is required in addition to the conversion/rate adaption specified in 3GPP TS 48.020. This function constitutes the RAA. In case of 14,5 kbit/s channel coding, no RAA rate adaption is required because V.110 framing is not used.

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 the present document, 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 4.1, 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 in case of 4.8 and 9.6 kbit/s channel coding;
- The RAA" function in case of 14.5 kbit/s channel coding;
- The RA2 function;
- The transcoder function.

- Optionally the TFO functions (see 3GPP TS 28.062).

The functions inside the CCU are:

- "Transcoder and Rate Adaptor Control Function" (TRACF);
- "Speech Handler Function" (SHF);
- The RAA function in case of 4.8 and 9.6 kbit/s channel coding;
- The RA1/RA1' function in case of 4.8 and 9.6 kbit/s channel coding;
- The RA1"/RAA" function in case of 14.5 kbit/s channel coding;
- The channel codec function;
- If AMR or AMR-WB is supported, the Link Adaptation (see 3GPP TS 45.009).

The present document will not describe the procedures inside the TRAU and the CCU. The layout in figure 4.1 is only intended as a reference model.

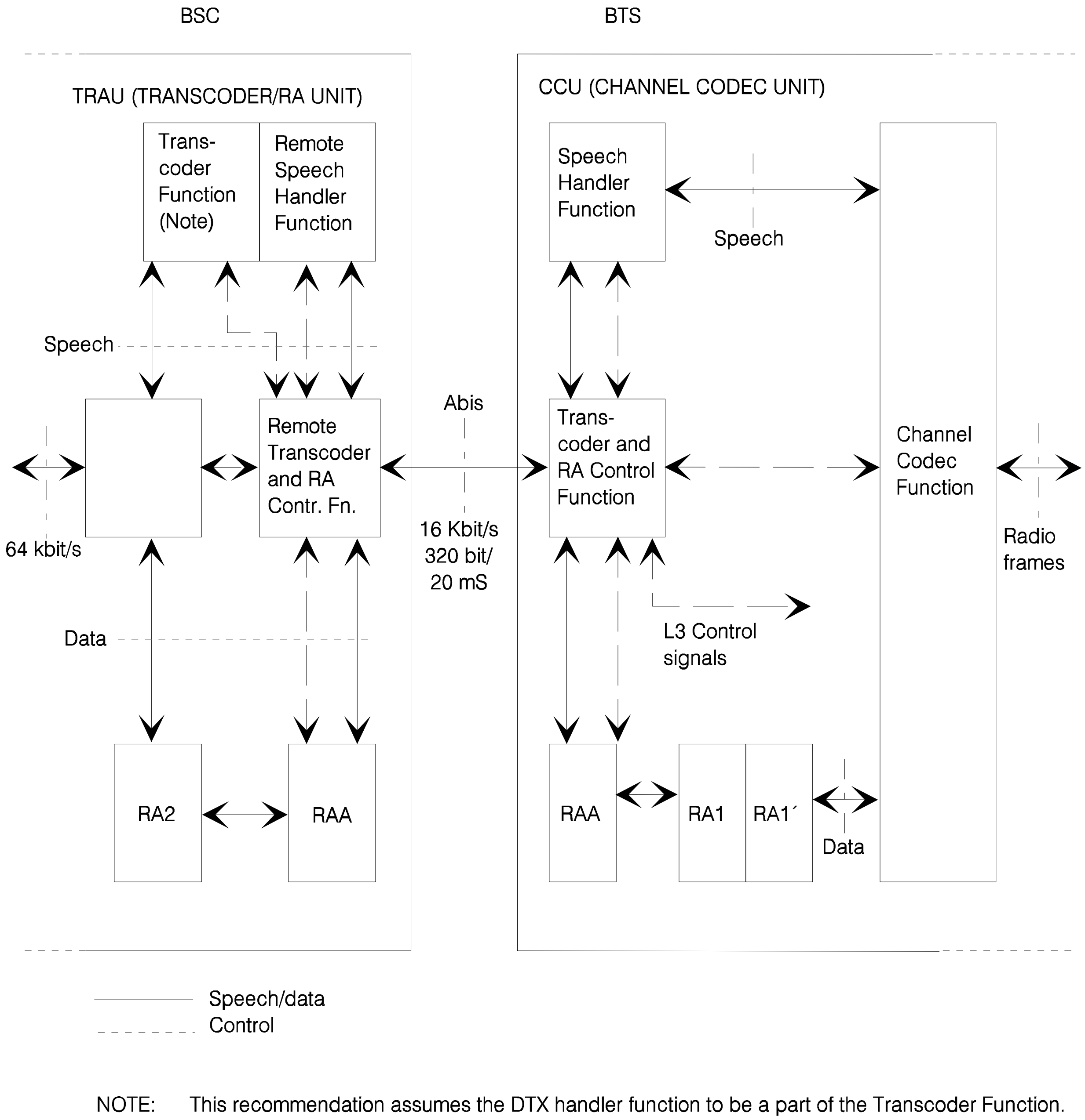

Figure 4.1: Functional entities for handling of remote control of remote transcoders and rate adaptors

NOTE: This figure applies only for 4,8 and 9,6 kbit/s channel coding.

5 Frame Structure

5.1 Frames for Speech Services

5.1.1 Frames for Full Rate and Enhanced Full Rate Speech

	Bit number							
Octet no.	**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

5.1.2 Frames for Adaptive Multi-Rate Speech (AMR-NB)

	Bit number							
Octet no.	**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	C16	C17	C18	C19	C20	C21	C22
5	C23	C24	C25	D1	D2	D3	D4	D5
6	1	D6	D7	D8	D9	D10	D11	D12
7	D13	D14	D15	D16	D17	D18	D19	D20
8	1	D21	D22	D23	D24	D25	D26	D27
9	D28	D29	D30	D31	D32	D33	D34	D35
10	1	D36	D37	D38	D39	D40	D41	D42
11	D43	D44	D45	D46	D47	D48	D49	D50
12	1	D52	D52	D53	D54	D55	D56	D57
13	D58	D59	D60	D61	D62	D63	D64	D65
14	1	D66	D67	D68	D69	D70	D71	D72
15	D73	D74	D75	D76	D77	D78	D79	D80
16	1	D81	D82	D83	D84	D85	D86	D87
17	D88	D89	D90	D91	D92	D93	D94	D95
18	1	D96	D97	D98	D99	D100	D101	D102
19	D103	D104	D105	D106	D107	D108	D109	D110
20	1	D111	D112	D113	D114	D115	D116	D117
21	D118	D119	D120	D121	D122	D123	D124	D125
22	1	D126	D127	D128	D129	D130	D131	D132
23	D133	D134	D135	D136	D137	D138	D139	D140
24	1	D141	D142	D143	D144	D145	D146	D147
25	D148	D149	D150	D151	D152	D153	D154	D155
26	1	D156	D157	D158	D159	D160	D161	D162
27	D163	D164	D165	D166	D167	D168	D169	D170
28	1	D171	D172	D173	D174	D175	D176	D177
29	D178	D179	D180	D181	D182	D183	D184	D185
30	1	D186	D187	D188	D189	D190	D191	D192
31	D193	D194	D195	D196	D197	D198	D199	D200
32	1	D201	D202	D203	D204	D205	D206	D207
33	D208	D209	D210	D211	D212	D213	D214	D215
34	1	D216	D217	D218	D219	D220	D221	D222
35	D223	D224	D225	D226	D227	D228	D229	D230
36	1	D231	D232	D233	D234	D235	D236	D237
37	D238	D239	D240	D241	D242	D243	D244	D245
38	1	D246	D247	D248	D249	D250	D251	D252
39	D253	D254	D255	D256	T1	T2	T3	T4

5.1.3 Frames for Adaptive Multi-Rate Wideband Speech (AMR-WB) (16 kbit/s)

The frame format for AMR-NB shall be used for all frames for AMR-WB as well, see chapters 5.1.2 and 5.5.1.3.

5.1.4 Frames for Adaptive Multi-Rate Wideband Speech (AMR-WB) (32 kbit/s)

The frame format for AMR-NB shall be used for all frames for AMR-WB as well, see chapters 5.1.2 and 5.5.1.3. In case of the AMR-WB modes 15.85 and 23.85 two 16kbit/s frames (channel 'a' and channel 'b') are used to compose a 32kbit/s frame.

5.1.5 Frames for Speech Codec Configuration Exchange

	Bit number							
Octet no.	**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	D1	D2
3	D3	D4	D5	D6	D7	D8	D9	D10
4	1							
5								D25
6	1							
7								D40
8	1							
9								D55
10	1							
11								D70
12	1							
13								D85
14	1							
15								D100
16	1							
17								D115
18	1							
19								D130
20	1							
21								D145
22	1							
23								D160
24	1							
25								D175
26	1							
27								D190
28	1							
29								D205
30	1							
31								D220
32	1							
33								D235
34	1							
35								D250
36	1							
37								D265
38	1							D272
39	D273	D274	D275	D276	T1	T2	T3	T4

5.2 O&M Frames

	Bit number							
Octet no.	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

5.3 Data Frames

5.3.1 Data Frame (for Synchronisation)

Bit number

Octet no.	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							.
5	1							.
6	1							.
7	1			Data frame position 1				
8	1			63 bits.				
9	1			(72 bits including bit position 1)				
10	1							
11	1							
12	1							
13	1							
14	1							
15	1							
161	1			Data frame position 2				
17	1							
18	1							
19	1							
20	1							
21	1							
22	1							
23	1							
24	1							
25	1			Data frame position 3				
26	1							
27	1							
28	1							
29	1							
30	1							
31	1							
32	1							
33	1			Data frame position 4				
34	1							
35	1							
36	1							
37	1							
38	1							
39	1							

5.3.2 Extended data frame (E-TRAU : data transport)

Bit number

Octet no.	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	M1	M2
4	D1	D2	...					
5								
6								
7			Data block of 288 data bits and M1, M2.					
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39						...	D287	D288

5.4 Idle Speech Frames

	Bit number							
Octet no.	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

5.5 Coding

In the following clauses, 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.

5.5.1 Coding of Frames for Speech Services

5.5.1.1 Coding of Frames for Full Rate and Enhanced Full Rate Speech

5.5.1.1.1 Coding of Control bits (C-bits)

<table>
<tr><th>Description</th><th>Uplink</th><th>Downlink</th></tr>
<tr><td>Frame type FR
(Bits C1 - C5). EFR</td><td>C1C2C3C4 C5
Speech: 0 0 0 1 0.
Speech: 1 1 0 1 0</td><td>C1C2C3C4 C5
Speech: 1 1 1 0 0
Speech: 1 1 0 1 0</td></tr>
<tr><td rowspan="2">Time
Alignment
(Bits C6 - C11)</td><td>Binary number indicating the required timing adjustment to be made in steps of 250/500 µs.</td><td>Binary number indicating the timing adjustment made.</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td rowspan="4">Frame indicators. The definition and coding of these indicators are given in 3GPP TS 46.031.

Bits C12 - C16

Downlink
Uplink Frame Error
(UFE) C12
(see clause 6.8.3)</td><td>C12: BFI
0 : BFI = 0
1 : BFI = 1</td><td rowspan="3">C12 - C15: Spare

IF FR. Speech

ELSE
C12: UFE
0 :UFE=0 bad uplink frame
1 : UFE=1 good up-link frame

C13 - C15: spare</td></tr>
<tr><td>C13 C14: SID
0 0 :SID = 0
0 1 :SID = 1
1 0 :SID = 2</td></tr>
<tr><td>C15: TAF
0 : TAF = 0
1 : TAF = 1</td></tr>
<tr><td>C16: Spare</td><td>C16: SP
0 : SP = 0
1 : SP = 1</td></tr>
<tr><td>DTX indicator</td><td>C17: DTXd
0 : DTX not applied
1 : DTX applied</td><td>C17: Spare</td></tr>
<tr><td>Bits C18 - C21</td><td>Spare</td><td>Spare</td></tr>
</table>

5.5.1.1.2 Coding of Data Bits (D-bits)

For Full Rate Speech:

Bits D1 .. D260: Speech block transferred in the same order as output from the transcoder (see 3GPP TS 46.010).

For Enhanced Full Rate Speech:

The speech block is subdivided in five subsets. The order within a given subset is the same as output from the transcoder (see ETS 300 726, 3GPP TS 46.060). Three parity bits are added at the end of each sub-set.

These parity bits are added to the bits of the subset, according to a degenerate (shortened) cyclic code using the generator polynomial:

$$g(D) = D^3 + D + 1$$

The encoding of the cyclic code is performed in a systematic form which means that, in GF(2), the polynomial:

$d(m)D^n + d(m+1)D^{n-1} + ...+ d(m + n-3)D^3 + p(0)D^2 + p(1)D + p(2)$

where p(0), p(1), p(2) are the parity bits, when divided by g(D), yields a remainder equal to:

$$1 + D + D^2$$

For every CRC, the transmission order is p(0) first followed by p(1) and p(2) successively.

Bit D1 : spare (binary "1").

Bits D2...D39 : Indexes of the LSF submatrices.

Bits D40...D42 : CRC over bits D1 to D22, D25 to D27 and D29.

Bits D43...D95 : Indexes of the parameters of first sub-frame.

Bits D96...D98 : CRC over bits D43 to D52, D91 and D92.

Bits D99...D148 : Indexes of the parameters of second sub-frame.

Bits D149...D151: CRC over bits D99 to D103, D105, D144 and D145.

Bits D152...D204: Indexes of the parameters of third sub-frame.

Bits D205...D207: CRC over bits D152 to D161, D200 and D201.

Bits D208...D257: Indexes of the parameters of fourth sub-frame.

Bits D258...D260: CRC over bits D208 to D212, D214, D253 and D254.

5.5.1.1.3 Time Alignment Bits (T1…T4)

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".

5.5.1.2 Coding of Frames for Adaptive Multi-Rate Speech (AMR-NB)

5.5.1.2.1 Coding of Control bits (C-bits)

Control Bits	Description Uplink	Description Downlink
C1...C5	Frame_Type (Codec_Type)	Frame_Type (Codec_Type)
C6...C11	Time Alignment Command (TAC) or Phase Alignment Control (PAC) or TFO Information or Handover Information	Time Alignment Command (TAC) or Phase Alignment Control (PAC) or TFO Information or Handover Information
C12	Request or Indication Flag (RIF)	Request or Indication Flag (RIF)
C13	spare, set to 1	Uplink Frame Error (UFE)
C14 . C15 . C16	Config_Prot	Config_Prot
C17 . C18	Message_No	Message_No
C19	DTX in downlink requested (DTXd)	spare, reserved for TFO (see 28.062)
C20	TFO Enabled (TFOE)	spare, reserved for TFO (see 28.062)
C21 . C22	Frame_Classification, Rx_Type	Frame_Classification, Tx_Type
C23 . C24 . C25	Codec_Mode_Indication (RIF == 0) or Codec_Mode_Request (RIF == 1) or 0.0.0 (Frame_Classification == 0.0)	Codec_Mode_Indication (RIF == 0) or Codec_Mode_Request (RIF == 1) or 0.0.0 (Frame_Classification == 0.0)

Detailed Description:
Frame Type:
The coding of the Frame_Type (also called "Codec_Type") for AMR is identical in uplink and downlink.
C1...C5:
0.0.1.1.0: Adaptive Multi-Rate Codec.

Time Alignment Field:
The Time Alignment Field (Bits C6...C11) is used to carry either the Time Alignment Command (TAC), the Phase Alignment Control (PAC) or the TFO and Handover Information. The Time Alignment Command is coded as for the Full Rate and Enhanced Full Rate (clause 5.5.1.1.1).

Time Alignment Command (TAC):
In the uplink direction (BTS to TRAU) the TAC indicates the required timing adjustment for the downlink TRAU frame to be made by the TRAU in 250/500µs steps.
C6...C11:
0.0.0.0.0.0 No change in frame timing
0.0.0.0.0.1 Delay frame 1 x 500µs (send four additional T-Bit-pairs after the end of the TRAU Frame)
0.0.0.0.1.0 Delay frame 2 x 500µs (send eight additional T-Bit-pairs after the end of the TRAU Frame)
…
1.0.0.1.1.1 Delay frame 39 x 500µs (send 156 additional T-Bit-pairs after the end of the TRAU Frame)
(1.0.1.0.0.0 to 1.1.0.1.1.1: 16 code-points, unused, reserved)
(1.1.1.0.0.0 to 1.1.1.0.1.1: 4 code-points, reserved for TFO)
(**1.1.1.1**.0.0 reserved for TFO)
(**1.1.1.1.0.1** reserved for AMR CMI/CMR Phase Alignment Command (PAC), no change in frame timing)
1.1.1.1.1.0 Delay frame by 250µs (send two additional T-Bit-pairs after the end of the TRAU Frame)
1.1.1.1.1.1 Advance frame by 250µs (do not send the two T-Bit-pairs at the end of the TRAU Frame).

Phase Alignment Command (PAC) (useful when TFO is not supported or disabled):
The Phase Alignment Command (PAC) can be used by the BTS to command the TRAU to change (invert) the phase of CMI/CMR, respectively RIF, in downlink TRAU frames, see clause 6.6.1.2.1.
C6...C11:
1.1.1.1.0.1 AMR CMI/CMR Phase Alignment Command (PAC), no change in frame timing.

In No_Speech frames the Phase Alignment Command may optionally be transmitted by one additional bit (PAB, see subclause 5.5.1.2.2) that allows a direct time and phase alignment in one step.

TFO Information (defined when TFO is supported, see 3GPP TS 28.062):
C6...C11
1.1.1.0.0.0
1.1.1.0.0.1

1.1.1.0.1.0
1.1.1.0.1.1
1.1.1.1.0.0
These five codes are reserved for Tandem Free Operation (see 3GPP TS 28.062). They result in no change in frame timing. If the BTS does not support TFO or TFO is disabled these codes shall not be used in uplink and shall be ignored in downlink. The procedure to exchange this information between BTS and TRAU is described in 3GPP TS 28.062.

Request or Indication Flag (RIF):
This flag indicates the phase of the Codec_Mode_Indication (RIF == 0) respectively the Codec_Mode_Request (RIF == 1). It has the same meaning in uplink and in downlink. Typically this flag toggles every frame. Exceptions may occur at handover and CMI/CMR phase alignment, see clause 6.6.1.2.1.

Uplink Frame Error (UFE):
In downlink the UFE indicates that the most recently received uplink TRAU frame had detectable errors.
In uplink this bit shall be set to "1".
UFE == 0: "Uplink Frame received with Errors";
UFE == 1: "Uplink Frame received without Errors".
Note: the UFE is not related to the frame classification (Rx_Type) as computed by the BTS radio receiver. It is related to inconsistencies in the TRAU frame synchronization, control bits or CRCs within the TRAU frame.

Config_Prot
This field is reserved for the Configuration Protocol in case of Tandem Free Operation (see 3GPP TS 28.062). If the BTS does not support TFO or TFO is disabled, then this field shall be set to "0.0.0".

Message_No
This field is reserved for the Configuration Protocol in case of Tandem Free Operation (see 3GPP TS 28.062). If the BTS does not support TFO or TFO is disabled, then this field shall be set to "0.0".

DTX in downlink requested (DTXd)
See clause 6.6.2.2.

TFO Enabled (TFOE)
This bit enables or disables Tandem Free Operation in the TRAU. If the BTS does not support TFO or TFO is disabled, then this bit shall be set to "0". Coding:
TFOE == 0: TFO Disabled;
TFOE == 1: TFO Enabled.

Frame_Classification:
This field classifies the contents of the TRAU frame as seen by the radio receiver, see 3GPP TS 26.093:
C21...C22:
1 1 "Speech_Good" the frame can be decoded without restriction
1 0 "Speech_Degraded" the frame might contain undetected errors
0 1 "Speech_Bad" the frame contains errors that can not be corrected
0 0 "No_Speech" the frame is not a speech frame, see below.

In the uplink direction the Frame_Classification is also called "Rx_Type" and is always set by the BTS.

In the downlink direction the Frame_Classification is also called "Tx_Type".
If Tandem Free Operation is not ongoing, then the codes "Speech_Degraded", and "Speech_Bad" shall not be used in the downlink direction. If Tandem Free Operation is ongoing, then all codes may be used in the downlink direction. For the handling within the downlink BTS, see 3GPP TS 28.062).

Codec_Mode_Indication / Codec_Mode_Request:
This 3-bit field has three different meanings, depending on the Frame_Classification field and the Request_or_Indication_Flag (RIF):
If Frame_Classification is different than "0.0" then this field contains
either the Codec_Mode_Indication (CMI), if RIF equals 0;
or the Codec_Mode_Request (CMR), if RIF equals 1.
If Frame_Classification is equal to "0.0", i.e. when a No_Speech frame is transmitted, then this field shall be set to "0.0.0". CMI and CMR are then simultaneously transmitted in the Data Bits.
The coding is identical in uplink and downlink.
C23 . C24. C25:
0 0 0 Codec_Mode 4,75 kBit/s
0 0 1 Codec_Mode 5,15 kBit/s

0	1	0	Codec_Mode 5,90 kBit/s
0	1	1	Codec_Mode 6,70 kBit/s
1	0	0	Codec_Mode 7,40 kBit/s
1	0	1	Codec_Mode 7,95 kBit/s
1	1	0	Codec_Mode 10,2 kBit/s
1	1	1	Codec_Mode 12,2 kBit/s

The CMI indicates the Codec_Mode to be used for decoding the associated speech parameters in the same and the next frame. The CMR indicates the highest allowed Codec_Mode to be used for encoding in the opposite direction.

Note 1: In the TRAU frames, the Codec_Mode_Request, respectively the Codec_Mode_Indication are coded absolutely (three bits for eight possible modes). On the radio interface, because of bandwidth limitation, these parameters are coded with two bits only. The CCU shall perform the required translation.

Note 2: In case of no Tandem Free Operation the uplink CMR is a Codec_Mode_Command (CMC) from the BTS to the TRAU and the TRAU shall try to follow the command as soon as possible. The only allowed exception is in case of DTX when SID or No_Data frames can be used during speech pauses. In the downlink direction the CMR is typically set by the TRAU to "1.1.1". This CMR from the TRAU must be combined with the corresponding CMR for the local uplink direction, see 3GPP TS 45.009 and 28.062, before it is sent down to the MS.

Note 3: In case of an ongoing Tandem Free Operation, the local uplink CMR is an indication from the local BTS to the TRAU, respectively to the distant BTS, on the highest allowed Codec_Mode in the local downlink direction. This indication must be combined with the corresponding CMR in the distant uplink direction to set the Codec Mode to use in that direction. The local downlink CMR is the indication from the distant radio link on the highest allowed Codec_Mode in the distant downlink direction. This CMR from the TRAU must be combined with the corresponding CMR for the local uplink direction, see 3GPP TS 45.009 and 28.062, before it is sent down to the MS.

5.5.1.2.2 Coding of Data bits (D-bits)

In Codec_Mode 10,2 kBit/s the bits D1…D20 and D234…D253 are reserved for Tandem Free Operation In all Codec_Modes below 10,2 kBit/s and in all No_Speech frames the bits D1…D31 (31 bits) and D203…D256 (54 bits) are reserved for Tandem Free Operation (see 3GPP TS 28.062).
In No_Speech frames additionally bits D44…D57 (14 bits) are reserved for TFO as well.
If the BTS does not support TFO or TFO is disabled, then the bits in these fields shall all be set to "1".

Coding of Speech Frames:
The contents of the Data bits for all eight AMR Codec_Modes are defined in the following, in cases when the Frame_Classification is either set to Speech_Good, Speech_Degraded, or Speech_Bad. The speech block is subdivided into four subsets. The order within a given subset is the same as output from the transcoder (see 3GPP TS 26.090). The four times three parity bits (CRC1 to CRC4), added at the end of each subset, are generated using the same cyclic code as defined for the Enhanced Full Rate (see clause 5.5.1.1.2). The TRAU frame formats in uplink and downlink direction are identical.

AMR_Mode 12,2 kBit/s, see 3GPP TS 26.090:

D1...D38:	Indexes of the LSF submatrices (s1…s38)
D39...D91:	Indexes of the parameters of first sub-frame (s39…s91)
D92...D94:	CRC1 over bits C1…C25, s1…s29, s39…s50, s87…s89.
D95...D144:	Indexes of the parameters of second sub-frame (s92…s141)
D145...D147:	CRC2 over bits s92…s100, s137…s139.
D148...D200:	Indexes of the parameters of third sub-frame (s142…s194)
D201...D203:	CRC3 over bits s142…s153, s190…s192.
D204...D253:	Indexes of the parameters of fourth sub-frame (s195….s244)
D254...D256:	CRC4 over bits s195…s199, s201…s203, s240…s242.

AMR_Mode 10,2 kBit/s, see 3GPP TS 26.090:

D21...D46:	Indexes of the LSF submatrices (s1...s26)
D47...D92:	Indexes of the parameters of first sub-frame (s27...s72)
D93...D95:	CRC1 over bits C1...C25, D1...D20, s1...s25, s27...s34, s66, s67, s69, s70.
D96...D138:	Indexes of the parameters of second sub-frame (s73...s115)
D139...D141:	CRC2 over bits s73...s76, s109, s110, s112, s113.
D142...D187:	Indexes of the parameters of third sub-frame (s116...s161)
D188...D190:	CRC3 over bits s116...s123, s155, s156, s158, s159.
D191...D233:	Indexes of the parameters of fourth sub-frame (s162...s204)
D254...D256:	CRC4 over bits s162...s165, s198, s199, s201, s202, D234...D253.

AMR_Mode 7,95 kBit/s, see 3GPP TS 26.090:

D32...D58:	Indexes of the LSF submatrices (s1...s27)
D59...D92:	Indexes of the parameters of first sub-frame (s28...s61)
D93...D95:	CRC1 over bits C1...C25, s1...s35, s53, s54, s57, s60.
D96...D127:	Indexes of the parameters of second sub-frame (s62...s93)
D128...D130:	CRC2 over bits s62...s65, s85, s86, s89...s92.
D131...D164:	Indexes of the parameters of third sub-frame (s94...s127)
D165...D167:	CRC3 over bits s94...s101, s119, s120, s123...s126.
D168...D199:	Indexes of the parameters of fourth sub-frame (s128...s159)
D200...D202:	CRC4 over bits s128...s131, s151, s152, s155...s158.

AMR_Mode 7,40 kBit/s, see 3GPP TS 26.090:

D32…34	spare (3 bits); set to "1"
D35...D60:	Indexes of the LSF submatrices (s1...s26)
D61...D92:	Indexes of the parameters of first sub-frame (s27...s58)
D93...D95:	CRC1: bits C1...C25, s1...s20, s22...s24, s27...s32, s52, s53, s55...s57.
D96...D124:	Indexes of the parameters of second sub-frame (s59...s87)
D125...D127:	CRC2 over bits s59...s61, s81, s82, s84...s86.
D128...D159:	Indexes of the parameters of third sub-frame (s88...s119)
D160...D162:	CRC3 over bits s88...s93, s113, s114, s116...s118.
D163...D191:	Indexes of the parameters of fourth sub-frame (s120...s148)
D192...D194:	CRC4 over bits s120...s122, s142, s143, s145, s146.
D195...D202:	spare (8 bits); set to "1".

AMR_Mode 6,70 kBit/s, see 3GPP TS 26.090:

D32…D37:	spare (6 bits); set to "1"
D38...D63:	Indexes of the LSF submatrices (s1...s26)
D64...D92:	Indexes of the parameters of first sub-frame (s27...s55)
D93...D95:	CRC1 over bits C1...C25, s1...s17, s20, s24, s27...s34, s49...s53.
D96...D120:	Indexes of the parameters of second sub-frame (s56...s80)
D121...D123:	CRC2 over bits s56...s59, s74...s78.
D124...D152:	Indexes of the parameters of third sub-frame (s81...s109)
D153...D155:	CRC3 over bits s81...s88, s103...s107.
D156...D180:	Indexes of the parameters of fourth sub-frame (s110...s134)
D181...D183:	CRC4 over bits s110...s113, s128...s132.
D184...D202:	spare (19 bits); set to "1".

AMR_Mode 5,90 kBit/s, see 3GPP TS 26.090:

D32…D41:	spare (10 bits); set to "1"
D42...D67:	Indexes of the LSF submatrices (s1...s26)
D68...D92:	Indexes of the parameters of first sub-frame (s27...s51)
D93...D95:	CRC1 over bits C1...C25, s1...s17, s27...s34, s48...s51.
D96...D116:	Indexes of the parameters of second sub-frame (s52...s72)
D117...D119:	CRC2 over bits s52...s54, s69...s72.
D120...D144:	Indexes of the parameters of third sub-frame (s73...s97)
D145...D147:	CRC3 over bits s73...s80, s94...s97.
D148...D168:	Indexes of the parameters of fourth sub-frame (s98...s118)
D169...D171:	CRC4 over bits s98...s100, s115...s118.
D172...D202:	spare (31 bits); set to "1".

AMR_Mode 5,15 kBit/s, see 3GPP TS 26.090:

D32…D46	spare (15 bits); set to "1"
D47...D69:	Indexes of the LSF submatrices (s1...s23)
D70...D92:	Indexes of the parameters of first sub-frame (s24...s46)
D93...D95:	CRC1 over bits C1...C25, s1...s16, s19...s29, s42...s46.
D96...D114:	Indexes of the parameters of second sub-frame (s47...s65)
D115...D117:	CRC2 over bits s47...s48, s61...s65.
D118...D136:	Indexes of the parameters of third sub-frame (s66...s84)
D137...D139:	CRC3 over bits s66...s67, s80...s84.
D140...D158:	Indexes of the parameters of fourth sub-frame (s85...s103)
D159...D161:	CRC4 over bits s85...s86, s99...s103.
D162...D202:	spare (41 bits); set to "1".

AMR_Mode 4,75 kBit/s, see 3GPP TS 26.090:

D32…D44:	spare (13 bits); set to "1"
D45...D67:	Indexes of the LSF submatrices (s1...s23)
D68...D92:	Indexes of the parameters of first sub-frame (s24...s48)
D93...D95:	CRC1 over bits C1...C25, s1...s16, s18, s19, s21...s29, s45...s48.
D96...D108:	Indexes of the parameters of second sub-frame (s49...s61)
D109...D111:	CRC2 over bits s49,s50.
D112...D132:	Indexes of the parameters of third sub-frame (s62...s82)
D133...D135:	CRC3 over bits s62, s63, s79...s82.
D136...D148:	Indexes of the parameters of fourth sub-frame (s83...s95)
D149...D151:	CRC4 over bits s83, s84.
D152...D202:	spare (51 bits); set to "1".

Coding of No_Speech Frames:
The following tables define the contents of the Data bits when the Frame_Classification is set to "No_Speech". The three parity bits (CRC1) added are generated using the same cyclic code as defined for the Enhanced Full Rate (see clause 5.5.1.1.2). The TRAU Frame Formats in uplink and downlink direction are identical.

SID_Update and SID_Bad Frame:

D32...D34:	No_Speech_Classification
D35...D37:	Codec_Mode_Indication_abs
D38...D40:	Codec_Mode_Request_abs
D41:	PAB: Phase Alignment Bit (optional)
D42...D43:	TAE: Time Alignment Extension (optional)
D44...D57:	reserved for TFO
D58...D60:	Moving average predictor, initial values (s1…s3)
D61...D86:	Indexes of LSF submatrices (s4...s29)
D87...D92:	Logarithmic frame energy (s30...s35)
D93...D95:	CRC1 over bits C1…C25, D32…D92.
D96...D207:	spare (112 bits); set to "1".

No_Data, SID_First and Onset Frame:

Bits D32...D34:	No_Speech_Classification
Bits D35...D37:	Codec_Mode_Indication_abs
Bits D38...D40:	Codec_Mode_Request_abs
Bit D41:	PAB: Phase Alignment Bit (optional)
Bits D42...D43:	TAE: Time Alignment Extension (optional)
Bits D44...D57:	reserved for TFO
Bits D58...D92:	spare (35 bits); set to "1"
Bits D93...D95:	CRC1 over bits C1…C25, D32…D92.
Bits D96...D207:	spare (112 bits); set to "1".

No_Speech_Classification:
If the Frame_Classification is set to "0.0", then the TRAU frame contains no speech parameters. The No_Speech_Classification is coded in the D-Bits:
D32...D34:

1.1.1:	Sid_First	
1.1.0:	Onset	
1.0.1:	Sid_Update	
1.0.0:	Sid_Bad	(SID_Update with bad parameters)
0.1.1:	spare	
0.1.0:	spare	
0.0.1:	spare	
0.0.0:	No_Data	(nothing received or frame has been stolen, e.g. by FACCH or RATSCCH).

Codec_Mode_Indication_abs (CMI_abs):
The meaning in uplink and downlink is identical. In No_Speech frames the CMI is always transmitted, independent of the setting of the RIF bit. Coding:
D35 . D36 . D37:

0.0.0	Codec_Mode 4,75 kBit/s
0.0.1	Codec_Mode 5,15 kBit/s
0.1.0	Codec_Mode 5,90 kBit/s
0.1.1	Codec_Mode 6,70 kBit/s

1.0.0	Codec_Mode 7,40 kBit/s
1.0.1	Codec_Mode 7,95 kBit/s
1.1.0	Codec_Mode 10,2 kBit/s
1.1.1	Codec_Mode 12,2 kBit/s

Codec_Mode_Request_abs (CMR_abs):
The meaning in uplink and downlink is identical. In No_Speech frames the CMR is always transmitted, independent of the setting of the RIF bit. Coding:
D38 . D39 . D40:

0.0.0	Codec_Mode 4,75 kBit/s
0.0.1	Codec_Mode 5,15 kBit/s
0.1.0	Codec_Mode 5,90 kBit/s
0.1.1	Codec_Mode 6,70 kBit/s
1.0.0	Codec_Mode 7,40 kBit/s
1.0.1	Codec_Mode 7,95 kBit/s
1.1.0	Codec_Mode 10,2 kBit/s
1.1.1	Codec_Mode 12,2 kBit/s

Phase Alignment Bit (PAB):
This bit is defined only in No_Speech frames. It is optional and shall be set to "0", if not used.
The PAB has exactly the same meaning and function as the Phase Alignment Command (PAC). For the exact procedure see clause 6.6.1.2.1.
PAB set to 0: CMI/CMR phase in downlink TRAU frames shall not be changed
PAB set to 1: CMI/CMR phase in downlink TRAU frames shall be inverted.
PAB shall only be used together with TAC values between **0.0.0.0.0.0** ("No change in frame timing") and **1.0.0.1.1.1** ("Delay frame 39 x 500µs").

Time Alignment Extension (TAE):
The TAE specifies optionally a Time Alignment Extension. Coding:

D42 . D43:	Meaning:
0.0:	No additional delay with respect to the Time Alignment Command
0.1	Additional delay of 125 µs
1.0	Additional delay of 250 µs
1.1	Additional delay of 375 µs

TAE together with the Time Alignment Command (TAC) allow a "one step" time alignment of 125 µs accuracy in No_Speech frames. TAE shall only be used together with TAC values between **0.0.0.0.0.0** ("No change in frame timing") and **1.0.0.1.1.1 (**"Delay frame 39 x 500µs").
The TAC_TAE combination **0.0.0.0.0.0_0.1** shall be interpreted as **"**Delay frame by 125µs".
The TAC_TAE combination **1.0.0.1.1.1_1.0** shall be interpreted as **"**Advance frame by 250µs".
The TAC_TAE combination **1.0.0.1.1.1_1.1** shall be interpreted as **"**Advance frame by 125µs".

5.5.1.2.3 Time Alignment Bits (T1…T4)

The coding and meaning is as described in 3.5.1.1.3 (Time Alignment Bits).

5.5.1.3 Coding of Frames for Adaptive Multi-Rate Wide Band Speech (AMR-WB) for 16kbit/s and 32kbit/s sub-multiplexing

5.5.1.3.1 Coding of Control bits (C-bits)

Control Bits	Description Uplink For the 16k main part	Description Downlink For the 16k main part	Description Uplink and Downlink for the 16k upper extension
C1...C5	Frame_Type (Codec_Type)	Frame_Type (Codec_Type)	Frame Type (Codec_Type)
C6...C11	Time Alignment Command (TAC) or Phase Alignment Control (PAC) or TFO Information or Handover Information	Time Alignment Command (TAC) or Phase Alignment Control (PAC) or TFO Information or Handover Information	Time Alignment Command (TAC) or Phase Alignment Control (PAC) or TFO Information or Handover Information
C12	Request or Indication Flag (RIF)	Request or Indication Flag (RIF)	spare, set to 1
C13	spare, set to 1	Uplink Frame Error (UFE)	spare, set to 1
C14 . C15 . C16	Config_Prot	Config_Prot	spare, set to 1.1.1
C17 . C18	Message_No	Message_No	spare, set to 1.1
C19	DTX in downlink requested (DTXd)	spare, reserved for TFO (see 28.062)	spare, set to 1
C20	TFO Enabled (TFOE)	spare, reserved for TFO (see 28.062)	spare, set to 1
C21 . C22	Frame_Classification, Rx_Type	Frame_Classification, Tx_Type	spare, set to 1.1
C23 . C24 . C25	Codec_Mode_Indication (RIF == 0) or Codec_Mode_Request (RIF == 1) or 0.0.0 (Frame_Classification == 0.0)	Codec_Mode_Indication (RIF == 0) or Codec_Mode_Request (RIF == 1) or 0.0.0 (Frame_Classification == 0.0)	spare, set to 1.1.1

Detailed Description:
Frame Type:
The coding of the Frame_Type (also called "Codec_Type") for AMR-WB is identical in uplink and downlink.
C1...C5:
0.1.0.1.0: Adaptive Multi-Rate Wide Band Codec, in lower 16k main part
0.1.0.1.1: Adaptive Multi-Rate Wide Band Codec, in upper 16k extension part.

Time Alignment Field:
As in case of AMR-NB.

Phase Alignment Command (PAC):
As in case of AMR-NB.

TFO Information:
As in case of AMR-NB.

Request or Indication Flag (RIF):
As in case of AMR-NB.

Uplink Frame Error (UFE):
As in case of AMR-NB.

Config_Prot:
This field is reserved and shall be set to "0.0.0".

Message_No:
This field is reserved and shall be set to "0.0".

DTX in downlink requested (DTXd):
As in case of AMR-NB.

TFO Enabled (TFOE):
As in case of AMR-NB.

Frame_Classification:
As in case of AMR-NB.

Codec_Mode_Indication / Codec_Mode_Request:
As in case of AMR-NB, except that the coding is adapted to the AMR-WB modes.
The coding is identical in uplink and downlink.

C23.C24.C25:	Coding for AMR-WB
0 0 0	Codec_Mode 6,60 kBit/s
0 0 1	Codec_Mode 8,85 kBit/s
0 1 0	Codec_Mode 12,65 kBit/s
0 1 1	Codec_Mode 15,85 kBit/s
1 0 0	Codec_Mode 23,85 kBit/s
1 0 1	undefined
1 1 0	undefined
1 1 1	undefined.

The CMI indicates the Codec_Mode to be used for decoding the associated speech parameters in the same and the next frame. The CMR indicates the highest allowed Codec_Mode to be used for encoding in the opposite direction.

Note 1: In the TRAU frames, the Codec_Mode_Request, respectively the Codec_Mode_Indication are coded absolutely (three bits for five possible modes). On the radio interface, because of bandwidth limitation, these parameters are coded with two bits only. The CCU shall perform the required translation.

Note 2: In case of no Tandem Free Operation the uplink CMR is a Codec_Mode_Command (CMC) from the BTS to the TRAU and the TRAU shall try to follow the command as soon as possible. The only allowed exception is in case of DTX when SID or No_Data frames can be used during speech pauses. In the downlink direction the CMR is typically set by the TRAU to "1.1.1". This CMR from the TRAU must be combined with the corresponding CMR for the local uplink direction, see 3GPP TS 45.009 and 28.062, before it is sent down to the MS.

Note 3: In case of an ongoing Tandem Free Operation, the local uplink CMR is an indication from the local BTS to the TRAU, respectively to the distant BTS, on the highest allowed Codec_Mode in the local downlink direction. This indication must be combined with the corresponding CMR in the distant uplink direction to set the Codec Mode to use in that direction. The local downlink CMR is the indication from the distant radio link on the highest allowed Codec_Mode in the distant downlink direction. This CMR from the TRAU must be combined with the corresponding CMR for the local uplink direction, see 3GPP TS 45.009 and 28.062, before it is sent down to the MS.

5.5.1.3.2 Coding of Data bits (D-bits)

Coding of Speech Frames for AMR-WB:
The contents of the Data bits for all five AMR-WB Codec_Modes are defined in the following, in cases when the Frame_Classification is either set to Speech_Good, Speech_Degraded, or Speech_Bad. The three parity bits are generated using the same cyclic code as defined for the Enhanced Full Rate (see subclause 5.5.1.1.2). The TRAU frame formats in uplink and downlink directions are identical.

All undefined bits are spare and set to 1.

AMR-WB Mode 23.85kbit/s (477 bits per frame):

For this codec mode the lower main 16k part is not sufficient to carry all data bit. The remaining bits are therefore transported in the upper 16k extension part.

16 k lower main part:

D15...D92:	s1, s2 ... s78 [first block and first sub-frame]
D93...D95:	CRC over bits C1 ... C25, D15 ... D92
D96...D148:	s157, s158 ... s209 [second sub-frames]
D149...D203:	s263, s264 ... s317 [third sub-frame]
D204...D256:	s372, s373 ... s424 [fourth sub-frame]

16k upper extension part:

D15...D92:	s79, s80 ... s156 [first block and first sub-frame]
D93...D95:	CRC over bits D15 ... D92
D96...D148:	s210, s211 ... s262 [second sub-frames]
D150...D203:	s318, s319 ... s371 [third sub-frame]
D204...D256:	s425, s426 ... s477 [fourth sub-frame]

AMR-WB Mode 15,85 kbit/s (317 bits per frame):

For this codec mode the lower main 16k part is not sufficient to carry all data bit. The remaining bits are therefore transported in the upper 16k extension part . The arrangement is such that the delay as well as the load in the upper extension part are minimised. Therefore only D-Bits in columns 3, 5, 7 of the TRAU Frame structure in the upper extension part are used. One 3-bit CRC is included in each part (lower main or upper extension) after the first sub-frame.

16 k lower main part:

D1...D92:	s1, s2, s3, … s92 [first block and first sub-frame]
D93...D95:	CRC over bits C1 … C25, s1 … s92
D96…D148:	s117, s118…s169 [second sub-frame]
D149…D203:	s183, s184…s237 [third sub-frame]
D204…D256:	s252, s253…s304 [fourth sub-frame]

16k upper extension part:

D32, D34...D86, D88:	s93, s94… s115, s116 [first block and first sub-frame]
D90.D92.D94:	CRC over bits s93…s116
D116, D120…D146:	s170…s182 [second sub-frame]
D169, D172…D202:	s238…s251 [third sub-frame]
D225, D227…D255:	s305…s317 [fourth sub-frame]

AMR-WB Mode 12,65 kbit/s (253 bits per frame):

The 253 bits of this mode fit well into the 256 D-bits of the lower main 16k part. One 3-bit CRC protects the first sub-frame.
The D-bits of 16k upper extension part (if present) are unused.

D1…D47:	VAD-flag and indices of the LSF submatrices (s1… s47)
D48...D100:	First sub-frame (s48… s100)
D101..D103:	CRC over bits C1 … C25, s1 … s100
D104 ... D256:	remaining sub-frames (s101 … s253)

AMR-WB Mode 8.85 kbit/s (177 bits per frame):

The 177 bits of this mode fit well into the 256 D-bits of the lower main 16k part. One 3-bit CRC protects the first sub-frame. The D-bits of 16k upper extension part (if present) are unused.

D12…D58:	VAD-flag and indices of the LSF submatrices (s1… s47)
D59...D92:	First sub-frame (s48… s81)
D93...D95:	CRC over bits C1 … C25, s1 … s81
D96...D191:	remaining sub-frames (s82 … s177)

AMR-WB Mode 6.60 kbit/s (132 bits per frame):

The 132 bits of this mode fit well into the 256 D-bits of the lower main 16k part. One 3-bit CRC protects the first sub-frame. The D-bits of 16k upper extension part (if present) are unused.

D30…D66: VAD-flag and indices of the LSF submatrices (s1… s37)
D67...D92: First sub-frame (s38… s63)
D93...D95: CRC over bits C1 … C25, s1 … s63
D96...D164: remaining sub-frames (s64 … s132)

Coding of No_Speech Frames:
The following tables define the contents of the Data bits when the Frame_Classification is set to "No_Speech". The three parity bits added are generated using the same cyclic code as defined for the Enhanced Full Rate (see subclause 5.5.1.1.2). The TRAU Frame Formats in uplink and downlink direction are identical. All unused D-bits are set to spare ('1').

SID_Update and SID_Bad Frame for AMR-WB:
D1…D31 spare, set to 1
D32...D34: No_Speech_Classification
D35...D37: Codec_Mode_Indication_abs
D38...D40: Codec_Mode_Request_abs
D41: PAB: Phase Alignment Bit (optional)
D42...D43: TAE: Time Alignment Extension (optional)
D44...D57: spare, set to "1"
D58...D85: Indexes of LSF submatrices (s1...s28)
D86...D91: Logarithmic frame energy (s29...s34)
D92...D92: CN_Dithering flag (s35)
D93...D95: CRC1 over bits C1…C25, D32…D92.
D96...D256: spare, set to "1".

No_Data, SID_First and Onset Frame for AMR-WB:
D1…D31 spare, set to 1
D32...D34: No_Speech _Classification
D35...D37: Codec_Mode_Indication_abs
D38...D40: Codec_Mode_Request_abs
D41: PAB: Phase Alignment Bit (optional)
D42...D43: TAE: Time Alignment Extension (optional)
D44...D57: spare, set to "1"
D58...D92: spare (35 bits); set to "1"
D93...D95: CRC1 over bits C1…C25, D32…D92.
D96...D256: spare, set to "1".

No_Speech_Classification:
As in case of AMR-NB.

Codec_Mode_Indication_abs (CMI_abs):
The meaning in uplink and downlink is identical. In No_Speech frames the CMI is always transmitted, independent of the setting of the RIF bit. Coding:
D35 . D36 . D37:
0.0.0 Codec_Mode 6,60 kBit/s
0.0.1 Codec_Mode 8,85 kBit/s
0.1.0 Codec_Mode 12,65 kBit/s
0.1.1 Codec_Mode 15,85 kBit/s
1.0.0 Codec_Mode 23,85 kBit/s
1.0.1 undefined
1.1.0 undefined
1.1.1 undefined

Codec_Mode_Request_abs (CMR_abs):
The meaning in uplink and downlink is identical. In No_Speech frames the CMR is always transmitted, independent of the setting of the RIF bit. Coding:
D38 . D39 . D40:
0.0.0 Codec_Mode 6,60 kBit/s
0.0.1 Codec_Mode 8,85 kBit/s
0.1.0 Codec_Mode 12,65 kBit/s
0.1.1 Codec_Mode 15,85 kBit/s
1.0.0 Codec_Mode 23,85 kBit/s
1.0.1 undefined
1.1.0 undefined
1.1.1 undefined

5.5.1.3.3 Time Alignment Bits (T1a…T4a)

Bits T1a…T4a Bits positioned at the end of the downlink and uplink frames. If the timing of the frame is to be advanced, these 2..4 bits are not transferred in order to reduce the frame length accordingly. When transferred, the bits are set to binary '1'.

5.5.1.4 void

5.5.1.5 Coding of Configuration Frames

Control bits (C-bits):

Description	Uplink	Downlink
Frame type Bits C1 - C5	C1C2C3C4 C5 1 1 1 1 0: Configuration	C1C2C3C4 C5 1 1 1 1 0: Configuration

Data Bits (D-bits):

Bits D1 ... D276:

These data bits are reserved for Configuration Exchange to support Tandem Free Operation.
They are defined in TS 28.062.

Time Alignment Bits (T1…T4)

Bits T1 .. T4:

Bits positioned at the end of the 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".

5.5.2 Coding of O&M Frames

Control bits (C-bits):

Description	Uplink	Downlink
Frame type Bits C1 - C5	C1C2C3C4 C5 0 0 1 0 1 : O&M	C1C2C3C4 C5 1 1 0 1 1 : O&M
Bits C6 - 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

5.5.3 Coding of Data Frames

Control bits (C-bits):

Description	**Uplink**	**Downlink**
Frame type. Bits C1 - C5	C1C2C3C4 C5 0 1 0 0 0 : Data except 14.5 1 0 1 0 0 : Data14.5[1)]	C1C2C3C4 C5 1 0 1 1 0 : Data except 14.5 1 0 1 0 0 : Data 14.5[1)]
Intermediate RA bit rate. Bit C6 for data services except 14.5 Spare for Data 14.5	0: 8 kbit/s 1: 16 kbit/s Spare	0: 8 kbit/s 1: 16 kbit/s Spare
Bits C7 - C15	Spare	Spare

NOTE 1: The Data frame is in case of data 14.5 kbit/s used only for synchronization purposes. The data bits are in this case set according to clause 6.5.1.

5.5.4 Coding of Extended Data Frames

Control bits (C-bits):

Description	**Uplink**	**Downlink**
Frame type. Bits C1 - C5	C1C2C3C4 C5 1 1 1 1 1 : Extended Data frame 14.5 kbit/s	C1C2C3C4 C5 1 1 1 1 1 : Extended data Frame 14.5
Bit C6 Idle/Data/UFE	Idle/data Frame indication	UFE
Bits C7 - C13	Spare	Bit C7 indicating idle/data frame. Bit C8-C13 spare
Multi Frame Structure defined in 3GPP TS 44.021 Bits M1, M2	M1, M2	M1, M2

5.5.5 Coding of Idle Speech Frames

Control bits (C-bits):

Description	Uplink	Downlink
Frame type. Bits C1 - C5	C1C2C3C4 C5 1 0 0 0 0 : Idle Speech	C1C2C3C4 C5 0 1 1 1 0 : Idle Speech
Bits C6 - C21	Coding as for Speech frames.	Coding as for Speech frames.

NOTE: Idle Speech frames shall not be used in AMR or AMR-WB; instead Frame_Classification set to "No_Data" shall be applied.

Time Alignment Bits:

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

5.6 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.

6 Procedures

In this clause, when nothing is particularly stated, procedures for AMR_WB apply to 16 kbit/s and 32 kbit/s multiplexing, and in the second case, to channel a and channel b.

6.1 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.
- Control of the rate adaption functions for data calls.
- Downlink frame timing for speech frames.
- Transfer of DTX information.

In addition, the following functions are provided in case of AMR or AMR-WB speech:

- Control of Codec Mode adaptation
- Transfer of TFO Configuration Parameters (optional, see 3GPP TS 28.062)
- Downlink Phase Alignment (optional)
- Transfer of Information on TFO Status (optional, see 3GPP TS 28.062)
- Transfer of Information on Pre-Handover Warning (optional)

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

6.2 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.

In case of FR and EFR Speech or Data (except 14.5 kbit/s):

> The CCU now starts sending uplink frames with the appropriate "Frame Type" and, for data calls, the intermediate 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" and, for data calls, the intermediate rate adaption bit rate set as an acknowledgement indication.

In case of Adaptive Multi-Rate or Adaptive Multi_rate Wideband speech: see clause 6.6.1.3.

In case of Data 14.5 kbit/s:

> The CCU starts sending uplink Data TRAU Frames with the appropriate "Frame Type" set to establish initial synchronization.
>
> When receiving the first frame, the TRAU sets the mode of operation accordingly and as an acknowledgement starts sending downlink Data TRAU Frames with the same 'Frame Type'.
>
> The CCU starts sending uplink Extended Data TRAU Frames with the appropriate "Frame Type" set upon reception of that acknowledge indication.
>
> When receiving the first frame, when the "Frame Type" is set to Extended Data TRAU frame, the TRAU sets the mode of operation accordingly and as an acknowledgement starts sending downlink Extended Data TRAU frames with the same 'Frame Type'.

6.3 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 3GPP TS 48.054 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 clause 6.8.2). 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) This second alternative does not apply to Enhanced Full Rate Speech, Adaptive Multi-Rate speech, Adaptive Multi-Rate Wideband speech and Data 14.5 kbit/s cases.

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).

6.4 In Call Modification

If the subscriber orders "In Call Modification", the CCU sets the "Frame 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" and, for data calls, the intermediate rate adaption bit rate in the downlink frames. The same procedure applies for mode change between Data 14,5 kbit/s.

In case of mode change to data 14,5 kbit/s from Speech or Data (other than 14.5 kbit/s) the same procedure as for 'Resource Allocation' is performed.

In case of mode change from any other speech or data service to **AMR or AMR-WB speech**, the same procedure as for "Resource Allocation" shall be performed. In case of mode change within AMR speech, i.e. a change of the AMR or AMR-WB Configuration, the BSC should take care that a smooth transition from the old AMR or AMR-WB configuration into the new one is performed, see 3GPP TS 45.009 and 3GPP TS 28.062.

6.5 Transfer of Idle Frames, Handling of Missing Data

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

6.5.1 In Full Rate data case

If no data is received from the MS (uplink direction) or no data is received from the MSC side of the interface (downlink direction), idle data frames shall be transferred instead of data frames. Idle data frames are data frames with all data bit positions set to binary "1". In addition, for data 14,5 kbit/s; the C6 bit shall be set to "1" in the uplink extended data frame. For each idle frame sent downlink for data 14.5 kbit/s the C7 bit is set to "1".

6.5.2 In Full Rate speech case

If no speech is received from the MS (uplink direction), the CCU shall send TRAU speech frames with BFI flag set to 1 (bad frame) or idle speech frames.If no speech is received from the MSC side of the interface (downlink direction), idle speech frames shall be transferred instead of speech frames.

6.5.3 In Enhanced Full Rate speech case

If no speech is received from the MS (uplink direction), the CCU shall send TRAU speech frames with BFI flag set to 1 (bad frame). If no speech is received from the MSC side of the interface (downlink direction), idle speech frames shall be transferred instead of speech frames.

6.5.4 In Adaptive Multi-Rate speech case

If no speech is received from the MS (uplink direction), or a speech frame is stolen on the radio interface (e.g. by FACCH) the CCU shall send TRAU No_Speech frames with Frame_Type set to "AMR" and with No_Speech_Classification set to "No_Data". The Code_Mode_Indication shall be set to the previously used value. CMI and CMR shall be set to the Initial_Codec_Mode, if at resource allocation.

If no speech is received from the MSC side (downlink direction), i.e. the "PCM_Idle" pattern is received instead, the TRAU shall send TRAU No_Speech frames with Frame_Type set to "AMR", and with No_Speech_Classification set to "No_Data". The Codec_Mode_Indication shall be set to the previously used value or to the Initial_Codec_Mode, if at resource allocation.

6.5.5 In Adaptive Multi-Rate Wideband speech case

If no speech is received from the MS (uplink direction), or a speech frame is stolen on the radio interface (e.g. by FACCH) the CCU shall send TRAU No_Speech frames with Frame_Type set to "AMR-WB" and with No_Speech_Classification set to "No_Data". The Code_Mode_Indication shall be set to the previously used value. CMI and CMR shall be set to the Initial_Codec_Mode, if at resource allocation.

If no speech is received from the MSC side (downlink direction), i.e. the "PCM_Idle" pattern is received instead, the TRAU shall send TRAU No_Speech frames with Frame_Type set to "AMR-WB", and with No_Speech_Classification set to "No_Data". The Codec_Mode_Indication shall be set to the previously used value or to the Initial_Codec_Mode, if at resource allocation.

6.6 Procedures for Speech Services

6.6.1 Time Alignment of Speech Service 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) long and will in the worst case be received at the BTS 318 bits out of phase.

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

- Different channels may be transferred on different transmission systems using different routes in the network. The transmission delay may therefore differ.

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 clauses 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 Abis transmission side, the speech coding and decoding functions in the transcoder should not be synchronized.

6.6.1.1 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 clause 6.3), 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 Time Alignment 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" (T-bits).

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 6.1.

Optionally, in case of AMR or AMR-WB speech, two additional bits (TAE) may be used in an uplink No_Speech frame to code a time alignment command with a precision of 125 µs. 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. It needs to send the TAE bits back only if the downlink frame is a No_Speech frame, too.

6.6.1.2 The Static Time Alignment State

In the Static Time Alignment state, the TRAU performs timing adjustments in single steps of 250 µs or 125 µs (AMR or AMR-WB only). The timing may either be delayed (time alignment code "Delay frame by 250 µs (125 µs)"), advanced (time alignment code "Advance frame by 250 µs (125 µs)") or not changed (time alignment code "No Change in Time Alignment" or all other codes that result in no change).

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

If the timing is to be advanced 250 µs (125 µs), the TRAU sets the "Time Alignment" field in the next downlink frame as ordered and then the 4 (2) last bits of the frame are not transferred (the T-bits).

If the timing is to be delayed, the TRAU sets the "Time Alignment" field in the next downlink frame as ordered and then delays the subsequent frame by adding the appropriate number of 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 and TFO is not ongoing (see 3GPP TS 28.062), 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.

In case of AMR or AMR-WB speech the time alignment may be done in steps of 125 µs by using the TAC and TAE. If TFO is ongoing in case of AMR or AMR-WB speech the TRAU shall not perform any time alignment in downlink direction.

6.6.1.2.1 Phase Alignment of Codec_Mode_Indication for AMR or AMR-WB

In the Static Time Alignment state for Adaptive Multi-Rate speech and Adaptive Multi-Rate Wideband, it might be necessary to align the phase of the Codec_Mode_Indication and Codec_Mode_Request as indicated in downlink TRAU frames by the RIF bit, to the phase of CMI / CMR on the radio interface. One of the following four alternative methods shall be applied:

Alternative 1: If TFO is not ongoing (see 3GPP TS 28.062), then the CCU may send one "Phase Alignment Command" (PAC) uplink (see 3.5.1.2.1). The TRAU shall send two consecutive TRAU frames with Codec_Mode_Indication (RIF set to "0" two times) and by this shall invert the phase of Codec_Mode_Indication and Codec_Mode_Request in downlink on the Abis/Ater interface (consider the round trip delay).

Alternative 2: Similar to Alternative 1: If TFO is not ongoing (see 3GPP TS 28.062), then the CCU may send one No_Speech frame with the Phase Alignment Bit (PAB) set accordingly. This may be done already within the initial time alignment state together with the initial time alignment command (TAC and TAE). By this the DL TRAU frames can be aligned in time and phase within one step to a precision of 125 µs.

Alternative 3: If TFO is ongoing (see 3GPP TS 28.062) no time and phase alignment shall be performed on the Abis/Ater interface. Instead, the CCU shall buffer (up to 40ms) the downlink speech frames, until they can be sent on the radio interface. If the TRAU receives a time or phase alignment command while in TFO it may ignore it.

Alternative 4: The CCU may send a specific RATSCCH Message downlink to the mobile station (see 3GPP TS 45.009) and by that invert the phase of the CMI / CMC on the radio interface and thus avoid the buffer delay (20ms). This alternative is especially useful in TFO, but may be used also without TFO.

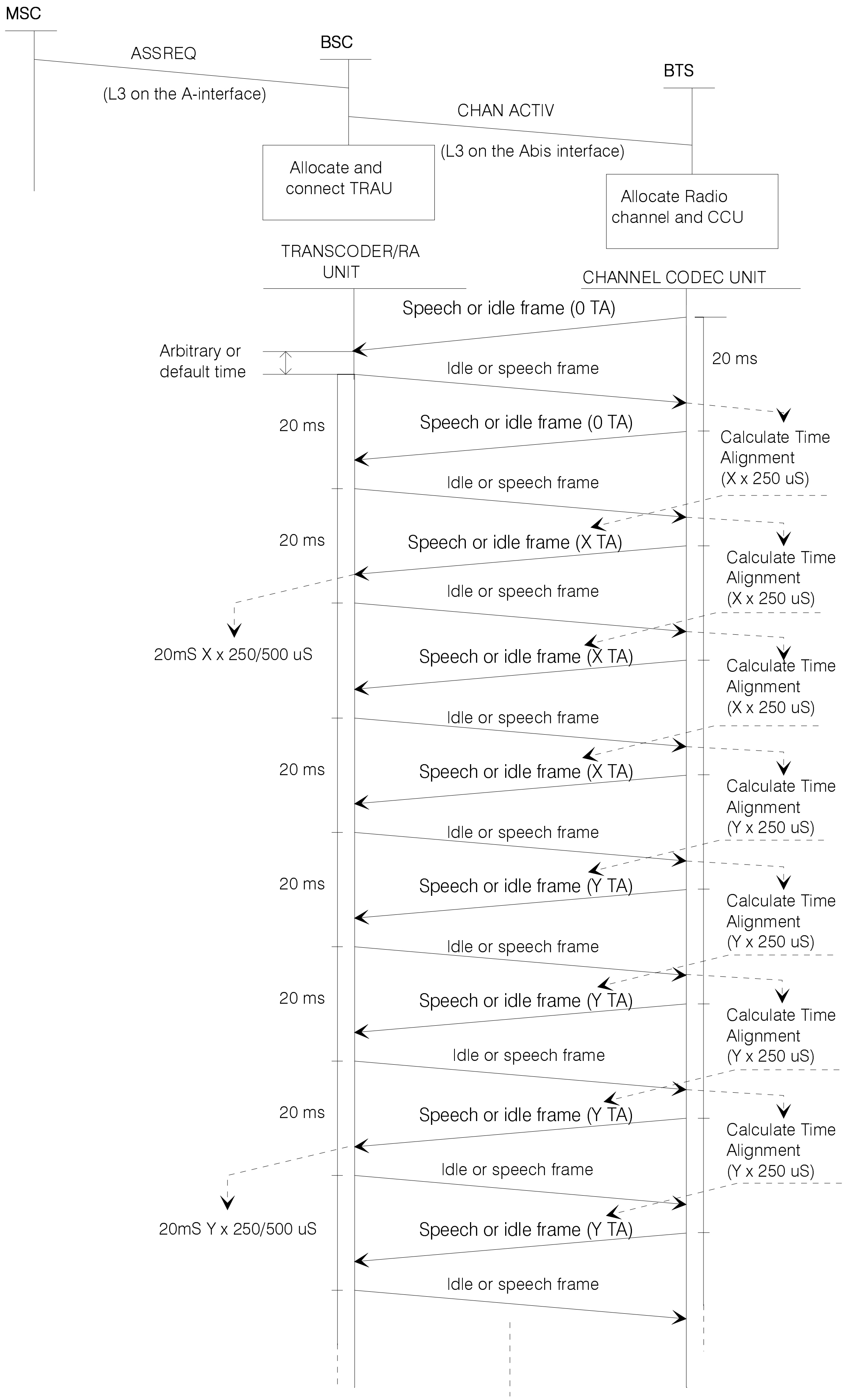
MSC
BSC
BTS
ASSREQ
(L3 on the A-interface)
CHAN ACTIV
(L3 on the Abis interface)
Allocate and connect TRAU
Allocate Radio channel and CCU
TRANSCODER/RA UNIT
CHANNEL CODEC UNIT
Speech or idle frame (0 TA)
Arbitrary or default time
Idle or speech frame
20 ms
Speech or idle frame (0 TA)
Calculate Time Alignment (X x 250 uS)
Idle or speech frame
20 ms
Speech or idle frame (X TA)
Calculate Time Alignment (X x 250 uS)
Idle or speech frame
20mS X x 250/500 uS
Speech or idle frame (X TA)
Calculate Time Alignment (X x 250 uS)
Idle or speech frame
20 ms
Speech or idle frame (X TA)
Calculate Time Alignment (Y x 250 uS)
Idle or speech frame
20 ms
Speech or idle frame (Y TA)
Calculate Time Alignment (Y x 250 uS)
Idle or speech frame
20 ms
Speech or idle frame (Y TA)
Calculate Time Alignment (Y x 250 uS)
Idle or speech frame
20 ms
Speech or idle frame (Y TA)
Calculate Time Alignment (Y x 250 uS)
Idle or speech frame
20mS Y x 250/500 uS
Speech or idle frame (Y TA)
Idle or speech frame

Figure 6.1: Initial Time Alignment Procedure

6.6.1.3 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). **In case of FR or EFR** 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.

In case of AMR or AMR-WB the CCU shall initiate sending of TRAU No_Speech frames towards the transcoder with normal frame phase for the TDMA channel in question unless speech is received on the radio interface. The "Time Alignment" field shall be set to "no change", the TAE shall be set to "0.0" and PAB shall be set to "0". The RIF shall correspond to the phase of the uplink radio interface. The CMI / CMR shall be set to "Initial_Codec_Mode". Consequently, speech transmission will start in uplink and downlink in this mode. In case the BTS supports TFO it shall send the TFO Configuration parameters uplink (see 3GPP TS 28.062). The TRAU will now be in the Initial Time Alignment state. When receiving the first UL TRAU frame it shall start sending No_Speech frames (or speech frames, if speech is received from the MSC side) towards the BTS with arbitrary or default phase related to the uplink frame phase. After receiving downlink TRAU frames the CCU may perform time alignment and phase alignment (optionally using TAC, TAE and PAB). The CCU shall keep the Codec_Mode in uplink and downlink fixed to the Initial_Codec_Mode until the correct time and phase alignment in downlink TRAU frames is achieved. Then the Codec_Mode adaptation may be enabled, see also 3GPP TS 45.009.

6.6.1.4 Time Alignment During Handover

6.6.1.4.1 BSS External Handover

For BSS external handover, the procedure described in clause 6.6.1.3 should be used by the new BSC/BTS at resource allocation.

6.6.1.4.2 BSS Internal Handover

If TFO is not ongoing and a BSS internal handover has been performed, the timing of the downlink frames may have to be adjusted several steps of 125, 250 or 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 clause 6.6.1.2. 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.

In case of AMR or AMR-WB, when TFO is ongoing, the BTS shall not send any time alignment or phase alignment commands and the TRAU shall not perform any time or phase alignment in downlink direction. Instead the BTS shall buffer the speech frames accordingly (see clause 6.6.1.2.1, alternative 3). Alternatively the BTS may perform a phase alignment on the radio interface by sending a RATSCCH message (see clause 6.6.1.2.1, alternative 4), thus avoiding the buffer delay (20ms).

Please note that optionally before and after handover the AMR or AMR-WB link adaptation should be frozen to the Intial_Codec_Mode, until all necessary time and phase alignments have been performed. CMI and CMC should therefore be identical during that period. Consequently a phase mismatch does not matter until the adaptation is enabled.

6.6.2 Procedures for Discontinuous Transmission (DTX)

The procedures for comfort noise are described in 3GPP TS 46.012, for Full rate speech and in 3GPP TS 46.062 for Enhanced Full rate speech, the overall operation of DTX is described in 3GPP TS 46.031 and in 3GPP TS 46.081 for respectively Full rate speech and Enhanced Full rate speech and the Voice Activity Detector is described in 3GPP TS 46.032 and 3GPP TS 46.082 for respectively Full rate speech and Enhanced full rate speech. The relevant procedures for Adaptive Multi-Rate speech are described in 3GPP TS 26.092, 3GPP TS 26.093 and 3GPP TS 26.094 and for Adaptive Multi-Rate Wideband speech in 3GPP TS 26.192, 3GPP TS 26.193 and 3GPP TS 26.194. For the case of DTX in ongoing TFO see 3GPP TS 28.062.

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 3GPP TS 46.031 for Full rate speech, in 3GPP TS 46.081 for Enhanced Full Rate speech, in 3GPP TS 26.093 for Adaptive Multi-Rate speech and in 3G 26.193 for Adaptive Multi-Rate Wideband speech.

6.6.2.1 DTX procedures in the uplink direction

In case of the Full Rate and Enhanced Full Rate speech: 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 3GPP TS 46.031 and 3GPP TS 46.081).

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 in case of Full Rate Speech and speech frames with BFI set to "1" in case of Enhanced Full rate Speech.

In case of the Adaptive Multi-Rate or Adaptive Multi-rate Wideband speech all frames are classified by the Rx_Type, see also 3GPP TS 26.093 and 3GPP TS 26.193. In the comfort noise states, the MS will transmit a new SID_Update frame only about every 160 ms (8 frames). These frames are transferred in the normal way between the CCU and the TRAU. Between these SID_Update frames the CCU and TRAU shall transfer "No_Data" frames uplink.

6.6.2.2 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 case of Full Rate and Enhanced Full Rate, C19 in case of Adaptive Multi-Rate and Adaptive Multi-Rate Wideband speech in 16 kbit/s and 32 kbit/s multiplexing) in the uplink speech frame is used. The coding is as follows:

DTXd = 0 : downlink DTX is not applied ("not requested" in case of AMR or AMR-WB);

DTXd = 1 : downlink DTX is applied ("requested" in case of AMR or AMR-WB).

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

In case of Full Rate and Enhanced Full Rate speech in the downlink frames the SP (Speech) indicator is set as output from the TX DTX handler (see 3GPP TS 46.031 and 3GPP TS 46.081).

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

In case of the Adaptive Multi-Rate and Adaptive Multi-Rate Wideband speech all downlink frames are classified by the Tx_Type, see also 3GPP TS 26.093 and 3GPP TS 26.193. In ongoing TFO, in case the distant side uses uplink DTX, downlink DTX may be applied by the TRAU, although DTXd is set to "not requested". For handling in the downlink BTS see 3GPP TS 26.093 and 3GPP TS 26.193 and 28.062.

6.7 Procedures for Data Frames

6.7.1 9.6 and 4.8 kbit/s channel coding

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 GSM. 48.020. This is illustrated in figure 6.2.

```
       +-------+               +-------------+
    -┼-| RA2   +-----┼------| RA1   │ RA1' +---┼----
     │ +-------+     │         +------┴------+    │
  64 Kbit/s     CCITT V.110                  Channel
                80 bits                     codec
                frame                       frame
```

Figure 3GPP TS 48.060/4.2: 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 6.3.

```
    +-------+        +---+ Abis  +---+   +---------+
  -┼-| RA2  +---┼----|RAA+---┼---|RAA+-┼-| RA1│RA1'+--┼--
   │ +-------+   │    +---+   │   +---+ │ +---┴----+   │
64 Kbit/s   CCITT         TRAU       CCITT           Channel
            V.110      4 X 72 + 32   V.110           codec
            80 bits        bits      80 bits         frame
            frame          frame     frame
```

Figure 3GPP TS 48.060/4.3: Rate adaption when 16 kbit/s traffic channels are used

6.7.1.1 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 clause 5.3.

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 6.4, and the modified 72 bits frame is illustrated in figure 6.5.

	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 3GPP TS 48.060/4.4: CCITT V.110 80 bits frame

Octet no.	Bit number 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 3GPP TS 48.060/4.5: Modified CCITT V.110 72 bits frame transferred in a TRAU data frame position

6.7.1.2 The RA1/RA1' Function

This function is described in 3GPP TS 44.021.

6.7.1.3 The RA2 Function

This function is described in 3GPP TS 44.021.

6.7.1.4 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 clause 5.3).

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".

6.7.1.5 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".

6.7.1.6 Support of Non-Transparent Bearer Applications

In 3GPP TS 48.020, 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 clauses 4.7.4 and 4.7.5.

6.7.2 14.5 kbit/s channel coding

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 as described in 3GPP TS 48.020.

When sub-64 kbit/s traffic channels are used, up to eight 36 bits frames are transferred in each E-TRAU frame. In order to convert between the E-TRAU frame format and the 36 bits frame format used for the radio interface an additional intermediate rate adaption function, RA1"/RAA", is applied. This is illustrated in figure 6.3.1 (see also 3GPP TS 48.020).

```
     +------+         +----+ Abis          +----------+
  -┼-│ RA2  +---┼----│RAA'+---┼----------│ RAA'│RA1'+--┼--
   │ +------+   │     +----+   │           +----┴-----+  │
64 Kbit/s   A-TRAU        E-TRAU             Radio
           8 X 36 + 32    320                Interface
             bits         bits               frame
            frame         frame
```

Figure 3GPP TS 48.060/4.3.1: Rate adaption when 16 kbit/s traffic channels are used

6.7.2.1 The RAA" Function

See 3GPP TS 48.020

6.7.2.2 The RA1"/RAA' Function

This function is described in 3GPP TS 48.020.

6.7.2.3 The RA2 Function

This function is described in 3GPP TS 44.021.

6.8 Frame Synchronization

6.8.1 Search for Frame Synchronization

Case of Full Rate, Enhanced Full Rate, Adaptive Multi-Rate (AMR-NB) and Adaptive Multi-Rate Wide Band (AMR-WB):

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
```

6.8.2 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 clauses 4.6.1.1 and 4.6.1.2. The frame synchronization unit shall change its frame synchronization window accordingly.

6.8.3 Frame Synchronization Monitoring and Recovery

The monitoring of the frame synchronization shall be a continuous process.

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

In case of Full Rate speech:

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 clause 6.10.2.

The exception from this procedure is when "Resource Release" is detected while Tsync is running (see clause 6.3). In this case, the procedure in clause 6.3 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.

In case of Enhanced Full Rate speech, Adaptive Multi-Rate speech and Adaptive Multi-Rate Wideband speech with 16 kbit/s multiplexing:

When it detects a framing bit error, the TRAU uses the control bit UFE (uplink Frame Error) in the next downlink TRAU frame to indicate it to the CCU. When the CCU receives a TRAU frame indicating an Uplink Frame Error and which has no errors on the synchronization pattern and the control bits, it starts a timer TsyncU.

If loss of frame synchronization is detected by the CCU it starts a timer TsyncD. If TsyncD or TsyncU expires before frame synchronization is again obtained, the call shall be released as specified in 3GPP TS 48.058 with the case field set to " Remote Transcoder Failure".

TsyncD is reset every time frame synchronisation is again obtained.

TsyncU is reset every time three consecutive TRAU frames are received without Uplink Frame Error indication, without errors on the frame synchronisation pattern and on the control bits.

TsyncD and TsyncU are parameters set by O&M (default value = 1 second).

In case of Adaptive Multi-Rate Wideband speech with 32 kbit/s multiplexing:

When it detects a framing bit error in channel a or channel b, the TRAU uses the control bit UFE (uplink Frame Error) in the next downlink TRAU frame to indicate it to the CCU. When the CCU receives a TRAU frame indicating an Uplink Frame Error in channel a or in channel b which has no errors on the synchronization pattern and the control bits, it starts a timer TsyncU.

If loss of frame synchronization is detected by the CCU it starts a timer TsyncD. If TsyncD or TsyncU expires before frame synchronization is again obtained, the call shall be released as specified in GSM 08.58 with the case field set to " Remote Transcoder Failure".

TsyncD is reset every time frame synchronisation is again obtained.

TsyncU is reset every time three consecutive TRAU frames are received without Uplink Frame Error indication, without errors on the frame synchronisation pattern and on the control bits in channel a AND in channel b.

TsyncD and TsyncU are parameters set by O&M (default value = 1 second).

In case of Data 14.5 kbit/s:

The following 17 bit alignment pattern of the Extended Data TRAU Frame is used for Frame Synchronization Monitoring:

```
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
```

When it detects a framing bit error, the TRAU uses the control bit UFE (uplink Frame Error) in the next downlink Extended Data TRAU Frame to indicate it to the CCU. When the CCU receives an Extended Data TRAU Frame indicating an Uplink Frame Error and which has no errors on the synchronization pattern and the control bits, it starts a timer TsyncU and TsyncR.

If loss of frame synchronization is detected by the CCU it starts a timer TsyncD and starts sending Data TRAU Frames in the uplink direction to trigger the TRAU to start sending Data TRAU Frames in the downlink direction to be used for downlink Synchronization Recovery.

If TsyncR expires before frame synchronization is again obtained, the CCU starts sending Data TRAU Frames in the uplink direction to be used for uplink Synchronization Recovery.

If TsyncD or TsyncU expires before frame synchronization is again obtained, the call shall be released as specified in 3GPP TS 48.058 with the case field set to " Remote Transcoder Failure".

TsyncD is reset every time frame synchronization is again obtained.

TsychU and TsyncR is reset every time three consecutive TRAU frames are received without Uplink Frame Error indication, without errors on the frame synchronization pattern and on the control bits.

TsyncD and TsyncU are parameters set by O&M (default value = 1 second)

TsyncR are a parameter set by O&M (default value = 60 milliseconds).

6.9 Correction/detection of bit errors on the terrestrial circuits

6.9.1 Error Detection on the Control Bits

For the control bits, (C-bits), no error coding is made. Exception: In case of AMR or AMR-WB the C-Bits are protected by CRC. However, in order to reduce the possibility of misinterpretation of control information due to bit errors, the following procedure should be followed.

6.9.1.1 General Procedure

If any undefined combination of the C-bits is received (see clause 5.5), the frame should be reacted upon as received with errors.

6.9.1.2 Frames for Speech Services

In addition to the general procedure described in the previous clause, the following procedure should be followed:

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 clauses 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, this value should be interpreted as "no change".

6.9.2 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 may be handled as if no error had been detected.

If frame synchronisation has been lost (see clause 6.8.3) in the uplink direction the TRAU shall:

- for speech, mute the decoded speech as if it has received frames with errors (cf. 3GPP TS 46.011 and 3GPP TS 46.061 and 3GPP TS 26.091);

- for data, send idle frames as defined in 3GPP TS 48.020 to the MSC/interworking.

6.9.2.1 In case of Full Rate speech

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.

6.9.2.2 In case of Enhanced Full Rate, Adaptive Multi-Rate and Adaptive Multi-Rate Wideband speech

For speech calls, the CCU shall transmit a layer two fill frame on the air interface if frame synchronization has been lost in the downlink direction.

If a CRC error is detected in a downlink TRAU speech frame a solution can be to transmit a layer two fill frame on the air interface, another solution can be to replace the bad part of the TRAU speech frame only. The choice of the solution is left open.

If a CRC error is detected in a uplink TRAU speech frame, the TRAU speech frame shall be regarded as bad or partly bad and the TRAU shall apply the procedure defined in 3GPP TS 46.061, 3GPP TS 26.091 or 3GPP TS 26.191 respectively.

6.10 Procedures for Operation & Maintenance

The general procedures for Operation and Maintenance are described in 3GPP TS 12.21.

If the transcoders are positioned outside the BTS, some O&M functions will be required for the TRAU and the CCU. In particular 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.

6.10.1 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 clauses 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.

6.10.2 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.

6.10.3 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.

6.10.3.1 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.

6.10.4 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 3GPP TS 44.006) 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 3GPP TS 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 3GPP TS 48.058 with the cause field set to "Remote Transcoder Failure".

Annex A (informative): Change History

Change history					
TSG #	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**New**
GP-04	-	-	-	April 2001. Conversion to 3GPP layout and number. References have been updated.	48.060 v4.0.0
-	-	-	-	Figure 4.1 now made visible...	4.0.1
GP-08	GP-020182	001		Handover_Complete	4.1.0
GP-09	GP-020523	002		Generic Configuration Frames for TFO	5.0.0
GP-09	GP-021251	003	3	Introduction of WB-AMR	5.0.0
GP-10	GP-022071	005	1	Simplifications for AMR-WB TRAU Frames	5.1.0
GP-11	GP-022534	006		Correction of References in Clause 5.5.1	5.2.0
GP-23				Version for Release 6	6.0.0
GP-35	GP-071207	0009		Forgotten bits in TRAU frame for AMR-WB	6.1.0
GP-35	GP-071247	0011		Editorial correction of DTXd bit position for AMR-WB speech in 16 kbit/s multiplexing	6.1.0
GP-35				Version for Release 7	7.0.0

History

Document history		
V7.0.0	October 2007	Publication