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Contents

Foreword

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

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

Version 8.x.y

where:

8 indicates release 1999.

x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

y the third digit is incremented when editorial only changes have been incorporated in the specification.

1 Scope

The requirements described in the present document are mandatory for implementation in all GSM MSs and BSSs capable of supporting the Adaptive Multi-Rate speech traffic channel, unless otherwise stated.

Unless otherwise specified, references to GSM include GSM at any frequency band.

1.1 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. 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 TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 44.018: "Mobile radio interface layer 3 specification, Radio Resource Control Protocol".

[3] 3GPP TS 45.002: "Multiplexing and multiple access on the radio path".

[4] 3GPP TS 45.003: "Channel Coding".

[5] 3GPP TS 45.005: "Radio transmission and reception".

[6] 3GPP TS 48.008: "Mobile-services Switching Centre - Base Station System (MSC - BSS) interface, Layer 3 specification".

[7] 3GPP TS 28.062: "Inband Tandem Free Operation (TFO) of Speech Codecs".

1.2 Abbreviations

For the purposes of the present document, the following abbreviations apply. Further GSM related abbreviations are listed in 3GPP TR 21.905.

AMR	Adaptive Multi-Rate
AMR-WB	Adaptive Multi-Rate Wideband
ACS	Active Codec Set
CMC	Codec Mode Command
CMI	Codec Mode Indication
CMR	Codec Mode Request
ICM	Initial Codec Mode
RATSCCH	Robust AMR Traffic Synchronized Control Channel

2 General

The present document gives the detailed requirements for the correct operation of in call service specific link adaptation and control for GSM services implemented in GSM Mobile Stations (MS)s and Base Station Systems (BSS)s.

In this specification the term AMR refers to both narrow-band and wide-band AMR codecs if not otherwise stated.

For the Adaptive Multi-Rate (AMR) speech service, the detailed description and requirements for the associated inband signaling, AMR codec mode adaptation, and AMR codec configuration are given.

An inband signalling channel is defined for AMR which enables the MS and the BTS to exchange messages on applied or requested speech and channel codec modes. Codec mode adaptation for AMR is based on received channel quality estimation in both MS and BTS, followed by a decision on the most appropriate speech and channel codec mode to apply at a given time.

The overall operation of AMR, in terms of used codec modes as well as general adaptation behaviour is controlled by the network.

3 Adaptive Multi-Rate inband control and link adaptation

3.1 General operation

3.1.1 Operation without Tandem Free Operation

A high-level block diagram of the complete AMR system is depicted in figure 1. The system consists of the major components TRAU and BTS on the network side and the MS. On the network side, speech encoder (SPE) and channel encoder (CHE) as well as channel decoder (CHD) and speech decoder (SPD) are connected via the serial A-bis interface. For each link, quality information is derived by estimating the current channel state. Based on the channel state, and also taking into consideration possible constraints from network control, the codec mode control, which is located on the network side, selects the codec modes to be applied.

The channel mode to use (TCH/AFS, TCH/AHS, O-TCH/AHS, TCH/WFS, O-TCH/WFS or O-TCH/WHS) is controlled by the network. Uplink and downlink always apply the same channel mode.

For codec mode adaptation the receiving side performs link quality measurements of the incoming link. The measurements are processed yielding a Quality Indicator. For uplink adaptation, the Quality Indicator is directly fed into the UL mode control unit. This unit compares the Quality Indicator with certain thresholds and generates, also considering possible constraints from network control, a Codec Mode Command indicating the codec mode to be used on the uplink. The Codec Mode Command is then transmitted inband to the mobile side where the incoming speech signal is encoded in the corresponding codec mode. For downlink adaptation, the DL Mode Request Generator within the mobile compares the DL Quality indicator with certain thresholds and generates a Codec Mode Request indicating the preferred codec mode for the downlink. The Codec Mode Request is transmitted inband to the network side where it is fed into the DL Mode Control unit. This unit generally grants the requested mode. However, considering possible constraints from network control, it may also override the request. The resulting codec mode is then applied for encoding of the incoming speech signal in downlink direction. Both for uplink and downlink, the presently applied codec mode is transmitted inband as Codec Mode Indication together with the coded speech data. At the decoder, the Codec Mode Indication is decoded and applied for decoding of the received speech data.

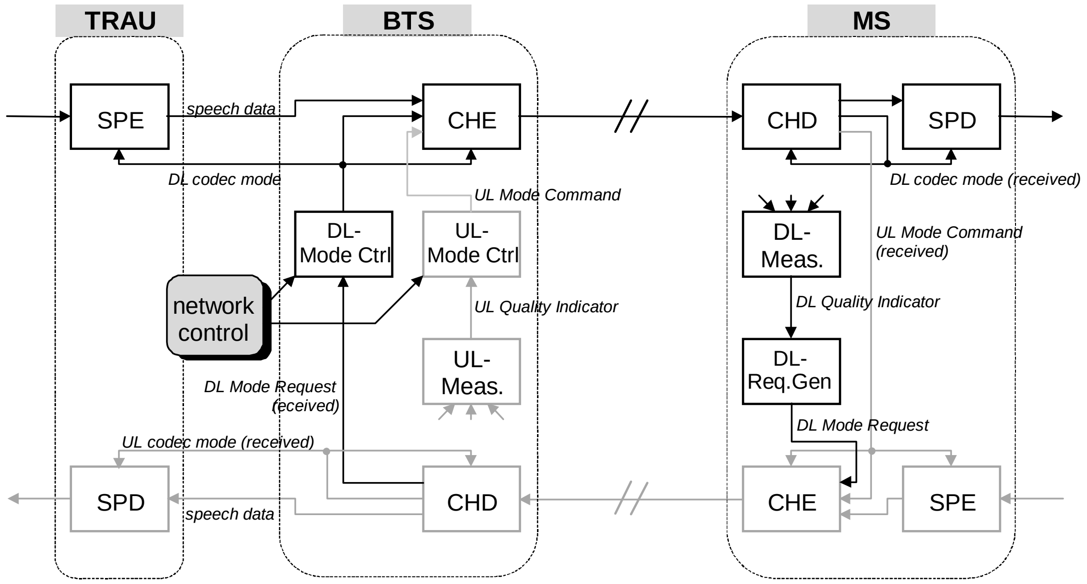

Figure 1: High level AMR block diagram

Codec mode selection is done from a set of codec modes (ACS, Active Codec Set), which may include 1 to 4 AMR codec modes. Associated with this set is a list of 1 to 3 switching thresholds and hysteresis used by the DL Mode Request Generator and the UL mode control unit to generate the Codec Mode Requests and Codec Mode Commands. These configuration parameters (ACS, thresholds, hysteresis) are defined at call set-up and can be modified at handover or during a call.

3.1.2 Operation with ongoing Tandem Free Operation

If tandem free operation is ongoing (see 3GPP TS 28.062) then the speech signal has to be transmitted over two radio links, first uplink (MS1 to BTS1) and then downlink (BTS2 to MS2), respectively symmetrically in the reverse direction. The optimal Codec Mode in direction MS1 to MS2 shall be derived from the Codec Mode Command for the first uplink (CMC1, within BTS1) and the Codec Mode Request derived for the second downlink (CMR2 within MS2) in the following way: MS2 shall send the CMR2 back to BTS2 in the usual way. BTS2 shall either accept this CMR2 (default) or may modify it according to network control needs: CMR2´. Then BTS2 shall send the CMR2´ further uplink to its TRAU2, to TRAU1 and downlink to BTS1 (see 3GPP TS 28.062 on how this transmission shall be handled on Abis and A interfaces). BTS1 combines the received CMR2´ with its own derived CMC1 by taking the minimum of both values. If needed, BTS1 may modify this minimum value according to own network control (--> CMC1´´) and shall send it finally downlink to MS1 as CMC. The identical procedure shall be performed in the reverse direction. Annex C gives an informative description.

3.1.3 Operation at handover with ongoing Tandem Free Operation

Before and during an handover at one or both sides of the MS-to-MS connection, it may be needed to freeze the codec mode adaptation for a short while, e.g. to optimise the common Active Codec Set, or to allow fast (re-)synchronisation between BTS and TRAU or to optimise the CMI Phase in downlink. Both BTSs may therefore enable or disable the codec mode adaptation (see 3GPP TS 28.062). As long as the codec mode adaptation is frozen to a specific codec mode, then this codec mode shall be used in both directions as long as tandem free operation is ongoing, or tandem free operation shall be discontinued. The Codec Mode Requests from the MSs may be taken into account to decide whether to continue TFO or not, but not for codec mode adaptation.

3.2 Inband Signalling

The AMR inband signalling consists of two parts:

- Frequent signalling, used for Codec Mode Indication and Codec Mode Command/Request.
- Robust, less frequent signalling, based on frame stealing, used for changing the AMR configuration (RATSCCH).

3.2.1 Frequent inband signalling for AMR codec mode adaptation

3.2.1.1 General aspects

The codec mode information, which has to be transmitted on each link, consists of Codec Mode Indications and Codec Mode Commands in the downlink, respectively Codec Mode Indications and Codec Mode Requests in the uplink. Codec Mode Indications inform the receiver about the currently applied codec mode. Codec Mode Commands inform the other end about the codec mode to be applied on the other link. Codec Mode Requests inform the other end about the preferred codec mode on the other link.

Codec mode information is transmitted inband in the speech traffic channel, using a part of its transmission capacity. The coding of codec modes in the inband signalling is given in subclause 3.4.1. Channel coding of codec mode information is specified in 3GPP TS 45.003 [4] for all frame types.

Codec modes are constrained to change only every second speech frame. Codec Mode Commands/Requests and Codec Mode Indications are sub-sampled such that they occur only every second frame. Codec Mode Indications and Codec Mode Commands/Requests shall be transmitted alternating within consecutive speech frames.

Both, Codec Mode Indication and Codec Mode Command/Request, shall be transmitted together within every RATSCCH frame.

3.2.1.2 Operation with DTX enabled

For SID_FIRST frames, the Codec Mode Indication or Codec Mode Command/Request in phase with the alternating transmission shall be transmitted (same phase as in speech frames).

Both, Codec Mode Indication and Codec Mode Command/Request, shall be transmitted together in every SID_UPDATE frame (as in RATSCCH frames).

For ONSET frames the Codec Mode Indication for the subsequent speech frame shall be transmitted, regardless of the phase of the inband signalling. The general phase of the inband signalling shall not be changed by that.

3.2.1.3 Transmitter/Receiver Synchronisation

The alternating transmission of the codec mode information requires synchronisation of transmitting and receiving ends, such that Codec Mode Indications and Codec Mode Commands/Requests are decoded in correct order. To ensure proper synchronisation, the codec mode information shall be transmitted aligned to the 26-multiframe structure of the GSM system.

The default transmission phase for TCH/AFS, TCH/WFS, and O-TCH/WFS shall be such that Codec Mode Indications are sent with speech frames having their first burst sent on TDMA frames according to table 3.2.1.3-1.

Table 3.2.1.3-1. TDMA frames for Codec Mode Indication for TCH/AFS, TCH/WFS and O-TCH/WFS.

Downlink	Uplink
4, 13, 21 (modulo 26)	0, 8, 17 (modulo 26)
NOTE: TDMA frame numbering defined in 3GPP TS 45.002 [3]	

The default transmission phase for TCH/AHS, O-TCH/AHS, and O-TCH/WHS shall be such that Codec Mode Indications are sent with speech frames having their first burst sent on TDMA frames according to table 3.2.1.3-2.

Table 3.2.1.3-2. TDMA frames for Codec Mode Indication for TCH/AHS, O-TCH/AHS and O-TCH/WHS.

Downlink(1)	Uplink(1)
4, 13, 21 (modulo 26), or, 5, 14, 22 (modulo 26)	0, 8, 17 (modulo 26), or, 1, 9, 18 (modulo 26)
NOTE 1: The mapping is dependent on the subchannel as defined in 3GPP TS 45.002 [3]. NOTE 2: TDMA frame numbering defined in 3GPP TS 45.002 [3]	

For a mobile station indicating support for VAMOS, the default transmission phase for TCH/AFS and TCH/WFS shall be such that Codec Mode Indications are sent with speech frames having their first burst sent on TDMA frames according to table 3.2.1.3-3.