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GLOBAL SYSTEM FOR
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Foreword

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Contents

Foreword

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

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1 Scope

The present document specifies the Radio sub-system link control implemented in the Mobile Station (MS), Base Station System (BSS) and Mobile Switching Centre (MSC) of the digital cellular telecommunications systems GSM.

Unless otherwise specified, references to GSM also include include operation in any 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 23.003: 'Numbering, addressing and identification'.

[3] 3GPP TS 23.009: 'Handover procedures'.

[4] 3GPP TS 23.122: 'NAS Functions related to Mobile Station (MS) in idle mode'.

[5] 3GPP TS 25.101: 'UE Radio transmission and reception (FDD)'.

[6] 3GPP TS 25.123: 'Requirements for support of Radio Resource Management (TDD)'.

[7] 3GPP TS 25.133: 'Requirements for support of Radio Resource Management (FDD)'.

[8] 3GPP TS 25.304: 'UE Procedures in Idle Mode and Procedures for Cell Reselection in Connected Mode'.

[9] 3GPP TS 25.331: 'Radio Resource Control (RRC); Protocol Specification'.

[10] 3GPP TS 26.093: 'AMR Speech Codec; Source Controlled Rate operation'.

[11] 3GPP TS 43.022: 'Functions related to Mobile Station (MS) in idle mode and group receive mode'.

[12] 3GPP TS 43.064: 'Overall description of the GPRS Radio Interface; Stage 2'.

[13] 3GPP TS 43.246: 'Multimedia Broadcast Multicast Service (MBMS) in the GERAN; Stage 2'.

[14] 3GPP TS 43.068: 'Voice Group Call Service (VGCS); Stage 2'.

[15] 3GPP TS 44.004: 'Layer 1; General requirements'.

[16] 3GPP TS 44.006: 'Mobile Station - Base Station System (MS - BSS) interface; Data Link (DL) layer specification'.

[17] 3GPP TS 44.018: 'Mobile radio interface layer 3 specification; Radio Resource Control Protocol'.

[18] 3GPP TS 44.056: 'GSM Cordless Telephony System (CTS), Phase 1; CTS radio interface layer 3 specification'.

[19] 3GPP TS 44.060: 'General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control (RLC) / Medium Access Control (MAC) protocol'.

[20] 3GPP TS 44.118: 'Mobile radio interface layer 3 specification, Radio Resource Control (RRC) Protocol, Iu Mode'.

[21] 3GPP TS 44.160: 'Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol; Iu mode'.

[22] 3GPP TS 45.002: 'Multiplexing and multiple access on the radio path'.

[23] 3GPP TS 45.003: 'Channel coding'

[24] 3GPP TS 45.005: 'Radio transmission and reception'.

[25] 3GPP TS 45.010: 'Radio subsystem synchronization'.

[26] 3GPP TS 45.056: 'CTS-FP radio subsystem'.

[27] 3GPP TR 45.902: 'Flexible Layer One'.

[28] 3GPP TS 46.011: 'Full rate speech; Substitution and muting of lost frames for full rate speech channels'.

[29] 3GPP TS 46.012: 'Full rate speech; Comfort noise aspect for full rate speech traffic channels'.

[30] 3GPP TS 46.031: 'Full rate speech; Discontinuous Transmission (DTX) for full rate speech traffic channels'.

[31] 3GPP TS 48.008: 'Mobile-services Switching Centre - Base Station System (MSC - BSS) interface, Layer 3 specification'.

[32] 3GPP TS 48.058: 'Base Station Controller - Base Transceiver Station (BSC - BTS) interface; Layer 3 specification'.

[33] 3GPP TS 51.010: 'Mobile Station (MS) conformity specification'.

[34] 3GPP TS 51.011: 'Specification of the Subscriber Identity Module - Mobile Equipment (SIM - ME) interface'.

[35] TIA/EIA/IS-2000-5-A: 'Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems'.

[36] TIA/EIA/IS-833: 'Multi-Carrier Specification for Spread Spectrum Systems on GSM MAP (MC-MAP) (Lower Layers Air Interface)'.

1.2 Abbreviations

Abbreviations used in the present document are listed in 3GPP TR 21.905.

2 General

The radio sub-system link control aspects that are addressed are as follows:

- Handover;
- RF Power control in *A/Gb mode*, including fast power control for E-TCH and enhanced power control for TCH and O-TCH;
- RF Power control in *Iu mode*, including fast power control for E-TCH and enhanced power control for DBPSCH (in MAC-Dedicated and MAC-DTM states);
- Radio link Failure;
- Cell selection and re-selection in Idle mode, in Group Receive mode, in GPRS mode and in broadcast/multicast receive mode (see 3GPP TS 43.022);

- CTS mode tasks.

NOTE: A distinction is made between *A/Gb mode* and *Iu mode* only when necessary. Procedures and mechanisms described in this TS apply to both modes of operation unless otherwise stated. In *Iu mode*, unless otherwise stated, DBPSCH covers TCH, PDTCH and FLO.

Handover is required to maintain a call in progress as a MS engaged in a point-to-point call or with access to the uplink of a channel used for a voice group call passes from one cell coverage area to another and may also be employed to meet network management requirements, e.g. relief of congestion.

Handover may occur during a call from one TCH or multiple TCHs (in the case of multislot configuration) to another TCH or multiple TCHs. It may also occur from DCCH to DCCH or from DCCH to one or multiple TCH(s), e.g. during the initial signalling period at call set-up. Additionally in *Iu mode*, handover may occur in MAC-Dedicated and MAC-DTM states:

- on PDTCH or multiple PDTCHs (in the case of multislot configuration) on DBPSCH(s) to another PDTCH or multiple PDTCHs on DBPSCH(s);

- for FLO, from one DBPSCH or multiple DBPSCHs (in the case of multislot configuration) to another DBPSCH or multiple DBPSCHs.

The handover may be either from channel(s) on one cell to other channel(s) on a surrounding cell, or between channels on the same cell which are carried on the same frequency band. Examples are given of handover strategies, however, these will be determined in detail by the network operator.

For a multiband MS, the handover described is also allowed between any channels on different cells which are carried on different frequency bands, e.g. between a GSM 900/TCH and a DCS 1 800/TCH. Handover between two co-located cells, carried on different frequency bands, is considered as inter-cell handover irrespective of the handover procedures used.

For a multi-RAT MS, i.e. an MS supporting multiple radio access technologies, handover is allowed between GSM and other radio access technologies.

NOTE: At handover, the MS will normally not be able to verify the PLMN of the target cell and will thus assume that the same system information apply after the handover unless the network provides new system information.

Adaptive control of the RF transmit power from an MS and optionally from the BSS is implemented in order to optimize the uplink and downlink performance and minimize the effects of co-channel interference in the system.

The criteria for determining radio link failure are specified in order to ensure that calls which fail either from loss of radio coverage or unacceptable interference are satisfactorily handled by the network. Radio link failure may result in either re-establishment or release of the call in progress. For channels used for a voice group call, an radio uplink failure results in the freeing up of the uplink.

Procedures for cell selection and re-selection whilst in Idle mode (i.e. not actively processing a call), are specified in order to ensure that a mobile is camped on a cell with which it can reliably communicate on both the radio uplink and downlink. The operations of an MS in Idle Mode are specified in 3GPP TS 43.022.

Cell re-selection is also performed by the MS when attached to GPRS, except when the MS simultaneously has a circuit switched connection. Optional procedures are also specified for network controlled cell re-selection for GPRS. Cell re-selection for GPRS is defined in subclause 10.1.

For a multi-RAT MS, cell selection and re-selection is allowed between GSM and other radio access technologies.

An MS listening to a voice group call or a voice broadcast use cell re-selection procedures to change cell. This may be supported by a list of cells carrying the voice group or voice broadcast call downlink, provided to the MS by the network. The operations of an MS in Group Receive Mode are specified in 3GPP TS 43.022.

Information signalled between the MS and BSS is summarized in tables 1, 2 and 3. A full specification of the Layer 1 header is given in 3GPP TS 44.004, of the Layer 3 fields in 3GPP TS 44.018 and 3GPP TS 44.118, and of the Layer 2 fields in 3GPP TS 44.060 and 3GPP TS 44.160.

For CTS, information signalled between the CTS-MS and CTS-FP is summarized in tables 4, 5 and 6. A full specification of the CTS Layer 3 fields is given in 3GPP TS 44.056.

For COMPACT, specific procedures are defined in clause 12.

During the reception of an MBMS session, the mobile station is in broadcast/multicast receive mode. In this state, the MS performs autonomous cell re-selection.

3 Handover

3.1 Overall process

The overall handover process is implemented in the MS, BSS and MSC. Measurement of radio subsystem downlink performance and signal levels received from surrounding cells, is made in the MS. These measurements are signalled to the BSS for assessment. The BSS measures the uplink performance for the MS being served and also assesses the signal level of interference on its idle traffic channels. Initial assessment of the measurements in conjunction with defined thresholds and handover strategy may be performed in the BSS. Assessment requiring measurement results from other BTS or other information resident in the MSC, may be performed in the MSC.

3GPP TS 23.009 describes the handover procedures to be used in PLMNs.

3.2 MS measurement procedure

A procedure shall be implemented in the MS by which it monitors the downlink RX signal level and quality from its serving cell and the downlink RX signal level and BSIC of surrounding BTS. The method of identification of surrounding BTS is described in subclause 7.2. The requirements for the MS measurements are given in subclause 8.1.

3.3 BSS measurement procedure

A procedure shall be implemented in the BSS by which it monitors the uplink RX signal level and quality from each MS being served by the cell. In the case of a multislot configuration the evaluation shall be performed on a timeslot per timeslot basis. A procedure shall be implemented by which the BSS monitors the levels of interference on its idle traffic channels.

3.4 Strategy

The handover strategy employed by the network for radio link control determines the handover decision that will be made based on the measurement results reported by the MS/BSS and various parameters set for each cell. Network directed handover may also occur for reasons other than radio link control, e.g. to control traffic distribution between cells. The exact handover strategies will be determined by the network operator, a detailed example of a basic overall algorithm appears in annex A. Possible types of handover are as follows:

Inter-cell handover:

Intercell handover from the serving cell to a surrounding cell will normally occur either when the handover measurements show low RXLEV and/or RXQUAL on the current serving cell and a better RXLEV available from a surrounding cell, or when a surrounding cell allows communication with a lower TX power level. This typically indicates that an MS is on the border of the cell area.

Intercell handover may also occur from the DCCH on the serving cell to a TCH or multislot configuration on another cell during call establishment. This may be used as a means of providing successful call establishment when no suitable TCH resource is available on the current serving cell.

Inter-cell handover between cells using different frequency bands is allowed for a multi band MS.

Inter-cell handover between cells using different radio access technologies is allowed for a multi-RAT MS.

Intra-cell handover:

Intra-cell handover from one channel/timeslot configuration in the serving cell to another channel/timeslot configuration in the same cell will normally be performed if the handover measurements show a low RXQUAL,

but a high RXLEV on the serving cell. This indicates a degradation of quality caused by interference even though the MS is situated within the serving cell. The intra-cell handover should provide a channel with a lower level of interference. Intra-cell handover can occur either to a timeslot on a new carrier or to a different timeslot on the same carrier. Similarly, intra-cell handover may occur between different multislot configurations in the same cell. These multislot configurations may comprise different number of timeslots and may partly overlap.

Intra-cell handover from one of the bands of operation to another one is allowed for a multiband MS.

3GPP TS 48.008 defines the causes for handover that may be signalled from BSS to MSC.

4 RF power control

4.1 Overall process

RF power control is employed to minimize the transmit power required by MS or BSS whilst maintaining the quality of the radio links. By minimizing the transmit power levels, interference to co-channel users is reduced.

4.2 MS implementation

RF power control shall be implemented in the MS.

In *A/Gb mode*, the power control level to be employed by the MS on each uplink channel, except PDCH, is indicated by means of the power control information sent either in the layer 1 header of each SACCH message block (see 3GPP TS 44.004) on the corresponding downlink channel, or in a dedicated signalling block (see 3GPP TS 44.018). Power control for PDCH is defined in subclause 10.2.

Similarly in *Iu mode* in MAC-Dedicated state and MAC-DTM state, the power control level to be employed by the MS on each uplink channel, is indicated by means of the power control information sent either in the layer 1 header of each SACCH message block (see 3GPP TS 44.004) on the corresponding downlink channel, or in a dedicated signalling block (see 3GPP TS 44.118). Power control for MAC-Shared state is defined in subclause 10.2.

The MS shall employ the most recently commanded power control level appropriate to each channel for all transmitted bursts on either a TCH (including handover access burst), FACCH, SACCH, PDTCH or SDCCH. For FLO in *Iu mode* the MS shall employ the most recently commanded power control level appropriate to each DBPSCH for all transmitted bursts (including radio packets, handover access burst and SACCH).

The MS shall confirm the power control level that it is currently employing in the SACCH L1 header on each uplink channel. The indicated value shall be the power control level actually used by the mobile for the last burst of the previous SACCH period.

When on an E-TCH, the MS shall, if so indicated by the BSS in the SACCH L1 header (see 3GPP TS 44.004) or Assignment command (see 3GPP TS 44.018 and 3GPP TS 44.118)), use FPC (fast power control). The MS shall employ the most recently commanded fast power control level on each uplink E-TCH channel. The power control level to be employed by the MS is indicated by means of the power control information sent via E-IACCH once every FPC reporting period (see subclause 4.7). If FPC is in use, the MS shall report, in the SACCH L1 header, the power control level used at the end of the normal power control reporting period.

When on an E-TCH using 8 PSK for the uplink, the MS shall use the E-IACCH in the uplink for fast measurement reporting.

In *A/Gb mode*, when assigned a TCH or O-TCH, the MS shall configure the channel in enhanced power control (EPC) mode if so commanded by BSS in the channel assignment (see 3GPP TS 44.018). On such a channel, EPC may be used for uplink power control and/or downlink power control.

Similarly in *Iu mode*, when assigned a DBPSCH, the MS shall configure the channel in enhanced power control (EPC) mode if so commanded by BSS in the channel assignment (see 3GPP TS 44.118). On such a channel, EPC may be used for uplink power control and/or downlink power control.

The enhanced power control (EPC) is part of the GERAN Feature Package 2 (see 3GPP TS 24.008).