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Digital cellular telecommunications system (Phase 2+) (GSM); Functions related to Mobile Station (MS) in idle mode and group receive mode (3GPP TS 43.022 version 16.0.0 Release 16)

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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 gives an overview of the tasks undertaken by a GSM Mobile Station (MS) when in idle mode, that is, switched on but not having a dedicated channel allocated (e.g. not making or receiving a call), when in group receive mode, that is, receiving a voice group call or voice broadcast call but not having a dedicated connection or when in broadcast/multicast receive mode, that is, receiving an MBMS session but not having a dedicated channel allocated. It also describes the corresponding network functions. The idle mode functions are also performed by a GPRS MS as long as no dedicated channel is allocated to the MS. The idle mode functions are also performed by a CTS MS as long as the CTS MS is in manual mode GSM only or in automatic mode under PLMN coverage.

NOTE: The term GSM MS is used for any type of MS supporting one, or combinations, of the frequency bands specified in 3GPP TS 45.005.

The present document outlines how the requirements of the 3GPP TS 22 series Technical Specifications (especially 3GPP TS 22.011) on idle mode operation shall be implemented. Further details are given in 3GPP TS 44.018 and 3GPP TS 45.008.

Clause 2 of the present document gives a general description of the idle mode process. Clause 3 outlines the main requirements and technical solutions of those requirements. Clause 4 describes the processes used in idle mode. There is inevitably some overlap between these clauses. Clause 5 describes the cell change procedures for a MS in group receive mode. Clause 5a describes the cell change procedures for a MS in broadcast/multicast receive mode.

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 TS 21.905: "Vocabulary for 3GPP Specifications".

[2] (void)

[3] (void)

[4] (void)

[5] (void)

[6] (void)

[7] (void)

[8] (void)

[9] 3GPP TS 22.011: " Service accessibility".

[10] (void)

[11] (void)

[12] (void)

[13] (void)

[14] (void)

[15] (void)

[16] (void)

[17] (void)

[18] (void)

[19] (void)

[20] (void)

[21] (void)

[22] (void)

[23] 3GPP TS 44.018: "Mobile radio interface layer 3 specification; Radio Resource Control (RRC) protocol".

[24] (void)

[25] 3GPP TS 45.008: "Radio subsystem link control".

[26] 3GPP TS 22.060: "General Packet Radio Service (GPRS); Service description; Stage 1".

[27] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[28] 3GPP TS 43.064: "General Packet Radio Service (GPRS); Overall description of the GPRS Radio Interface; Stage 2".

[29] (void)

[30] (void)

[31] 3GPP TS 23.122: " Non-Access-Stratum functions related to Mobile Station (MS) in idle mode".

[32] 3GPP TS 24.008: " Mobile radio interface layer 3 specification; Core Network Protocols - Stage 3".

[33] 3GPP TS 31.102: "Characteristics of the USIM application".

[34] 3GPP TS 43.068: "Voice Group Call Service (VGCS); Stage 2".

[35] 3GPP TS 43.069: "Voice Broadcast service (VBS); Stage 2".

[36] 3GPP TS 45.005: "Radio transmission and reception".

[37] 3GPP TS 51.011: "Specification of the Subscriber Identity Module - Mobile Equipment (SIM-ME) interface" (Release 4).

[38] 3GPP TS 43.246: "Multimedia Broadcast Multicast Service (MBMS) in the GERAN; Stage 2".

[39] 3GPP TS 22.268: "Public Warning System (PWS) requirements; Stage 1".

[40] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

1.2 Definitions and abbreviations

For the purposes of the present document, the terms and definitions given in 3GPP TS 21.905 [1] and the following apply.

Selected PLMN This is the PLMN that has been selected according to subclause 3.1, either manually or automatically.

Available PLMN This is a PLMN where the MS has found a cell that satisfies conditions (ii) and (iv) of subclause 3.2.1.

Home PLMN (HPLMN) See 3GPP TS 23.122 [31].

Registered PLMN (RPLMN) This is the PLMN on which certain LR outcomes have occurred (see 3GPP TS 23.122 [31]).

Equivalent PLMN A PLMN contained in the stored list of equivalent PLMNs. These PLMNs are considered equivalent to the selected PLMN regarding PLMN selection, cell selection, cell re-selection and handover (see 3GPP TS 23.122 [31]).

Registration This is the process of camping on a cell of the PLMN and doing any necessary LRs.

Camped on a cell The MS (ME if there is no SIM) has completed the cell selection/reselection process and has chosen a cell from which it plans to receive all available services. Note that the services may be limited, and that the PLMN may not be aware of the existence of the MS (ME) within the chosen cell.

Current serving cell This is the cell on which the MS is camped.

Suitable Cell This is a cell on which an MS may camp. It must satisfy criteria defined in subclause 3.2.1. For an MS in group receive mode, the suitable cell is determined by the criteria defined in subclause 5.2.3.

Acceptable Cell This is a cell that the MS may camp on to make emergency calls and to receive warning notifications. It must satisfy criteria defined in sub clause 3.2.2.

EC operation See 3GPP TS 43.064 [28].

Group call A communication in which several MSs can receive, but at most one may be allowed to transmit on a radio channel. Examples of group calls are those established for the voice group call service (VGCS, see 3GPP TS 43.068 [34]).

Broadcast call A communication in which several MSs can receive, but only the originator of the call is allowed to transmit on the radio channel. Examples of the broadcast call are those established for the voice broadcast service (VBS, see 3GPP TS 43.069 [35]).

Group receive mode State of the MS when it is engaged in a voice group or voice broadcast call as a listener.

GPRS MS An MS capable of GPRS services is a GPRS MS.

CTS MS An MS capable of CTS services is a CTS MS.

Location Registration (LR) An MS which is IMSI attached to non-GPRS services only performs location registration by the Location Updating procedure. A GPRS MS which is IMSI attached to GPRS services or to GPRS and non-GPRS services performs location registration by the Routing Area Update procedure only when in a network of network operation mode I. Both procedures are performed independently by the GPRS MS when it is IMSI attached to GPRS and non-GPRS services in a network of network operation mode II or III (see 3GPP TS 23.060 [27]).

Localised Service Area (LSA) A localised service area consists of a cell or a number of cells. The cells constituting a LSA may not necessarily provide contiguous coverage.

Power Efficient Operation See 3GPP TS43.064 [28].

Power Saving Mode (PSM): Mode allowing the MS to reduce its power consumption, as defined in TS 24.008 [32], TS 23.060 [27], TS 23.682 [40].

SoLSA exclusive access Cells on which normal camping is allowed only for MS with Localised Service Area (LSA) subscription.

Registration Area A registration area is an area in which mobile stations may roam without a need to perform location registration. The registration area corresponds to location area (LA) for performing location updating procedure and it corresponds to routing area for performing the routing area update procedure.

The PLMN to which a cell belongs (PLMN identity) is given in the system information transmitted on the BCCH (MCC + MNC part of LAI).

2 General description of idle mode

See 3GPP TS 23.122.

When NAS indicates that PSM starts (as defined in 3GPP TS 23.682 [40]) the MS shall suspend all AS functions and consequently all idle mode tasks until when NAS indicates that PSM ends the MS shall resume all AS functions and all idle mode tasks.

3 Requirements and technical solutions

The following subclauses list the main requirements of idle mode operation and give an outline of the technical solution.

3.1 PLMN selection and roaming

See 3GPP TS 23.122.

3.2 Camping on a cell

3.2.1 Normal camping

For normal service, the MS has to camp on a suitable cell, tune to that cell's control channel(s), and possibly register within the PLMN so that the MS can:

a) Receive system information from the PLMN , e.g., the cell options ;

b) Receive paging messages from the PLMN, e.g., when there is an incoming call for the MS;

c) Initiate call setup for outgoing calls or other actions from the MS (where possible, see subclauses 3.5.3 and 3.5.4).

The choice of such a suitable cell for the purpose of receiving normal service is referred to as "normal camping". There are various requirements that a cell must satisfy before an MS can perform normal camping on it:

i) It should be a cell of the selected PLMN or, if the selected PLMN is equal to the last registered PLMN, an equivalent PLMN;

ii) It should not be "barred" (see subclause 3.5.1);

iii) It should not be in an LA which is in the list of "forbidden LAs for roaming";

iv) The radio path loss between MS and BTS must be below a threshold set by the PLMN operator. This is estimated as shown in subclause 3.6;

v) It should not be a SoLSA exclusive cell to which MS does not subscribe. This requirement is only valid for MSs supporting SoLSA.

Initially, the MS looks for a cell which satisfies these 5 constraints ("suitable cell") by checking cells in descending order of received signal strength. If a suitable cell is found, the MS camps on it and performs any registration necessary. Cells can have two levels of priority, suitable cells which are of low priority are only camped on if there are no other suitable cells of normal priority. (This is called "cell selection").

When camped on a cell the MS regularly looks to see if there is a better cell in terms of a cell re-selection criterion, and if there is, the better cell is selected. Also if one of the other criteria changes, (e.g., the current serving cell becomes barred), or there is a downlink signalling failure (see subclause 3.6), a new cell is selected. (This is called "cell reselection"). A MS that has enabled PEO or EC operation has relaxed requirements for how often it verifies the suitability of its serving cell and the suitability of neighbour cells for re-selection (see 3GPP TS 45.008 [25] and 3GPP TS 44.018 [23]).

In order to speed up these processes, a list of the RF channels containing BCCH or CPBCCH carriers of the same PLMN is broadcast in the system information messages, see subclause 4.8. Also, the MS does not need to search all possible RF channels to find a suitable cell. If, after searching the number of RF channels, given for each frequency band below, with the strongest received signal level, a BCCH or CPBCCH carrier has been found but no suitable cell of the selected PLMN has been found, the MS can stop the attempt to find a suitable cell of the selected PLMN.

The number of channels to be searched are 15 for T-GSM 380, 15 for T-GSM 410, 15 for GSM 450, 15 for GSM 480, 25 for GSM 710, 25 for GSM 750, 25 for T-GSM 810, 30 for GSM 850 Band, 30 for GSM 900, 15 for T-GSM 900 and 40 for DCS 1800 and PCS 1900.

3.2.2 "Camp on any cell"

If the MS cannot find a suitable cell, it attempts to camp on any acceptable cell and enter a "limited service state", as defined in subclause 3.7. An MS attempting to camp on any acceptable cell shall not scan for CPBCCH.

There are various requirements that a cell must satisfy before being considered an acceptable cell to be camped on in "limited service state":

i) It should not be "barred" (see subclause 3.5.1);

ii) The radio path loss between MS and BTS must be below a threshold set by the PLMN operator. This is estimated as shown in subclause 3.6.

3.3 Regional provision of service

See 3GPP TS 23.122.

3.4 Borders between registration areas

If the MS is moving in a border area between registration areas, it might repeatedly change between cells of different registration areas. Each change of registration area would require an LR, which would cause a heavy signalling load and increase the risk of a paging message being lost. To prevent this, a "CELL_RESELECT_HYSTERESIS" (CRH) parameter is used. A cell in a different registration area is only selected if it is "better", in terms of the path loss criterion (see subclause 3.6), than all the cells in the current registration area by at least the value of CRH. The CRH parameter is broadcast as system information. As the value of CRH broadcast may be different on different cells, the CRH parameter to be used is that broadcast on the current serving cell. There is also a lower limit on the time interval between reselection of cells on different registration areas. Instead of CRH a GPRS MS uses a "GPRS_CELL_RESELECT_HYSTERESIS" if provided.

3.5 Barred cells and access control

3.5.1 Barred cells

The PLMN operator may decide not to allow MSs to camp on certain cells. (These cells may, for example, only be used for hand over traffic, i.e. calls which need to be handed over to other cells). Barred cell information is broadcast as system information to instruct MSs not to camp on these cells. The barred cell status may in fact change dynamically; hence the MS needs to regularly check the system information for this parameter.

The barred status of a cell depends on the parameters CELL_BAR_ACCESS and CELL_BAR_QUALIFY, further described in 3GPP TS 45.008 [25]. For a MS that has enabled EC operation, the barred status of a cell is given by the Implicit Reject Status broadcast in EC-SCH, see 3GPP TS 44.018 [23].

If a cell is barred this applies both for cell selection and reselection.

3.5.2 Prioritizing cells

In general, cell prioritization is a means of encouraging MSs to select some suitable cells in preference to others. Since the priority comparison is only between suitable cells, prioritization does not affect coverage. Operators may prefer a

certain type of cell not to be selected unless it is the only suitable type. For example, umbrella cells due to their large frequency reuse distance, or microcells because the MS could be travelling too fast for them.

3.5.2.1 For cell selection

During cell selection (see subclause 3.2.1), a cell with low priority indication will only be selected if a suitable cell of normal priority cannot be found.

3.5.2.2 For cell reselection

Cell prioritization can also be achieved during cell reselection by the use of the reselection parameters optionally broadcast. Cells are reselected on the basis of a parameter called C2 and the C2 value for each cell is given a positive or negative offset to encourage or discourage MSs to reselect that cell. A full range of positive and negative offsets is provided to allow the incorporation of this feature into already operational networks. Instead of C2 a GPRS MS uses the GPRS cell reselection parameter if provided.

An MS supporting SoLSA with SoLSA subscription shall use the SoLSA cell re-selection parameters.

3.5.3 Access control

Due to problems in certain areas, Network Operators may decide to restrict access from some MSs (e.g., in case of congestion on the AGCH), and for this reason the access control mechanism is provided.

At subscription one or more access control classes are allocated to the subscriber and stored in the SIM. The information providing all authorized classes is broadcast as system information (together with a bit indicating whether emergency calls may be made). This information is modified dynamically and therefore the MS has to check the system information before each attempt to access.

The MS ignores the Access Control information when selecting a cell to camp on, i.e. it shall not reject a cell for camping on because access on that cell is not allowed.

3.5.4 Forbidden LA for regional provision of service

If the MS has received the cause "LA not allowed", it shall ignore this fact when selecting a cell to camp on, i.e. it shall not reject a cell for camping on because that cell is part of a LA where this cause has been received.

3.5.5 Barred cell due to failed network authentication check

If upper layers have determined that the network has failed an authentication check (3GPP TS 24.008), the MS shall treat this cell as if the barred status broadcasted in the system information is set and reselect another cell. The MS shall treat the cell as barred for a period equal to the MM timer T3212 minus 60 seconds if the MM authentication procedure was performed or equal to the GMM timer T3302 minus 60 seconds if the GMM authentication was performed (see 3GPP TS 24.008). If the timer T3212 or T3302 are disabled by the network a default value of 12 hours shall be used.

3.6 Radio constraints

The MS uses a "path loss criterion" parameter C1 to determine whether a cell is suitable to camp on. C1 depends on 4 parameters:

i) The received signal level (suitably averaged);

ii) The parameter RXLEV_ACCESS_MIN, which is broadcast as system information, and is related to the minimum signal that the operator wants the network to receive when being initially accessed by an MS;

iii) The parameter MS_TXPWR_MAX_CCH, which is also broadcast as system information, and is the maximum power that an MS may use when initially accessing the network;

iv) The maximum power of the MS.

The formula for determining C1 is given in 3GPP TS 45.008 [25].

Use of the parameter C1 enables the MS to determine whether communication is possible with the network in the absence of interference. However because of the possibility of interference degrading the communications, an additional safeguard is used. This is to monitor the success rate of the MS in decoding signalling blocks of the paging subchannel except when EC operation is enabled in which case the MS monitors the time required to decode the EC-SCH. If there is a downlink signalling failure, i.e. the success rate drops too low (or, in case EC operation is enabled, the maximum time to decode EC-SCH is exceeded), this indicates probable interference on the downlink, and the MS attempts to find another suitable cell. Downlink signalling failure monitoring is specified in 3GPP TS 45.008 [25].

In order to optimize cell reselection, additional cell reselection parameters can be broadcast as system information of each cell. The cell reselection process employs a parameter C2 which depends on these parameters.

The parameters used to calculate C2 are as follows:

i) CELL_RESELECT_OFFSET (see subclause 3.5.2.2);

ii) PENALTY_TIME;

When the MS places the cell on the list of the strongest carriers as specified in 3GPP TS 45.008 [25], it starts a timer which expires after the PENALTY_TIME. This timer will be reset when the cell is taken off the list. For the duration of this timer, C2 is given a negative offset. This will tend to prevent fast moving MSs from selecting the cell.

iii) TEMPORARY_OFFSET;

This is the amount of the negative offset described in (ii) above. An infinite value can be applied, but a number of finite values are also possible.

The permitted values of these parameters and the way in which they are combined to calculate C2 are defined in 3GPP TS 45.008 [25].

Instead of the parameter C2, a GPRS MS applies the corresponding GPRS parameter if provided.

A MS that supports EC-GSM-IoT applies EC-specific C1 and C2 parameters.

An MS supporting SoLSA with SoLSA subscription shall use the SoLSA cell re-selection parameters.

3.7 No suitable cell (limited service state)

If the MS is unable to obtain normal service from a PLMN (see 3GPP TS 23.122), the MS attempts to camp on an acceptable cell, irrespective of its PLMN identity, so that emergency calls can be made or warning notifications can be received if necessary. To minimize the time taken to find new available PLMNs while maintaining battery life, discontinuous search schemes may be used, see 3GPP TS 22.011. Cell reselection takes place as normal, except that a zero dB value of CRH will be used.

3.8 CTS fixed part selection

See 3GPP TS 23.122

4 Overall process structure

4.1 Process goal

The aim of the idle mode processes is to achieve the following conditions ("normal service state"):

a) The selected PLMN is one of the equivalent PLMNs;

b) The MS is camped on a suitable cell of the registration area on which the last successful LR was performed, and that cell has the highest value of C2 for any unbarred cell in that registration area;

c) The value of C2 for the MS is not lower than the value of C2 for any suitable cell in another registration area of an equivalent PLMN by more than the hysteresis value CRH.

Instead of the parameter C2, a GPRS MS applies the corresponding GPRS parameter if provided.

An MS supporting SoLSA with SoLSA subscription shall use the SoLSA cell re-selection parameters.

Registration is not performed by MSs only capable of services which need no registration.

There may be temporary conditions under which not all these are fully satisfied, e.g., during cell selection on a PLMN, while in the process of reselecting another cell or, in case EC operation is enabled, when none of the criteria triggering neighbour cell measurements are fulfilled (see 3GPP TS 45.008 [25]). However, if the above cannot be satisfied for a certain period of time, the MS will normally enter a "limited service state" in which it will try to camp on an acceptable cell. In this state, only emergency calls and warning notifications are possible.

4.2 States description

Each of the processes of PLMN selection, cell selection and location registration can be described by a set of states. The overall state of the mobile is thus a composite of the states of the three processes. In some cases, an event which causes a change of state in one process may trigger a change of state in another process, e.g., camping on a cell in a new registration area triggers an LR request. The relationship between the processes is illustrated in figure 1 in 3GPP TS 23.122.

In the event of any conflict between the diagrams and the text in this ETS, the text takes precedence.

4.3 List of states

4.3.1 List of states for the PLMN selection process

See 3GPP TS 23.122.

4.3.2 List of States for the cell selection process (figure 3)

C1 Normal Cell Selection - This is the process of initial cell selection, searching all RF channels.

C2 Stored List Cell Selection - This is the process of initial cell selection where BCCH carrier information (e.g. a BA list) for the selected PLMN is stored in the MS.

C3 Camped Normally - This is where the MS is camped on a cell of the registered PLMN and may be able to make and receive calls. (Whether or not the MS can make and receive calls depends on the state within the location registration process). The MS monitors received level and the system information and checks whether cell reselection is needed.

C4 Normal Cell Reselection - This is where the MS has determined that cell reselection is needed and an attempt is being made to reselect a new cell.

C5 Choose Cell - This is where the MS has returned to idle mode from "connected mode" and is choosing a suitable cell to camp on.

C6 Any Cell Selection - This is where the MS is unable to camp normally on any cell of the selected PLMN, or cannot obtain service because of certain responses to a location registration (LR) attempt. It is searching for a cell of any PLMN to camp on (so that emergency calls can be made and warning notifications can be received).

C7 Camped on any Cell - This is where the MS has camped on a cell irrespective of its PLMN identity, so that emergency calls can be made and warning notifications can be received.

C8 Any Cell Reselection - This is where the MS is attempting to reselect a cell, irrespective of PLMN identity.

C9 Choose Any Cell - This is where the MS is returning to idle mode, after having entered "connected mode" from the "camped on any cell" state to make an emergency call. It is attempting to find an acceptable cell to camp on.

For detailed description of the behaviour in the above states see 3GPP TS 45.008.

4.3.3 List of states for location updating

See 3GPP TS 23.122.

4.3.4 List of states for location registration

See 3GPP TS 23.122.

4.4 PLMN selection process

4.4.1 Introduction

See 3GPP TS 23.122.

4.4.2 Registration on a PLMN

An MS successfully registers on a PLMN if:

a) The MS has found a suitable cell of the PLMN to camp on; and

b) An LR request from the MS has been accepted in the registration area of the cell on which the MS is camped (see 3GPP TS 23.122).

It should be noted that if registration is unsuccessful because no suitable cell could be found, the MS will have had to search at least the number, given in subclause 3.2.1, of the strongest RF channels (see subclause 3.2) and therefore all the available PLMNs will potentially have been detected. If registration is unsuccessful because of an LR failure or an LR rejection, the MS need not necessarily have already searched the number, given in subclause 3.2.1, of the strongest RF channels, and would need to do so before being in a position to display to the user all available PLMNs (see 3GPP TS 23.122).

4.4.3 PLMN selection

See 3GPP TS 23.122.

A PLMN shall be understood to be received with high quality signal if the signal level is above -85 dBm.

4.4.4 Abnormal cases

See 3GPP TS 23.122.

4.4.5 Roaming not allowed in this LA

See 3GPP TS 23.122.

4.5 Cell selection process

Whenever a PLMN is selected, the MS attempts to find a suitable cell of that PLMN to camp on. Two methods of searching for a suitable cell are possible:

a) Normal cell selection ("Normal cell selection" state) - Here the MS has no prior knowledge of which RF channels are BCCH or CPBCCH carriers. It searches at least the number, given in subclause 3.2.1, of the

strongest RF channels in descending order of received signal level to see which are BCCH or CPBCCH carriers. (If no BCCH or CPBCCH carriers have yet been found, searching will continue until at least one BCCH or CPBCCH carrier is found.). The first BCCH or CPBCCH carrier found which is from a suitable cell and on which there is a normal priority indication is taken and that cell is camped on. If at least the number, given in subclause 3.2.1, of the strongest RF channels have been tried and the only suitable cells found have low priority indication the MS shall camp on the strongest of these cells.

b) Stored list cell selection (optional) ("Stored list cell selection" state)- Here the MS has a list of the BCCH and CPBCCH carriers used by the PLMN. (This list may be derived by the MS from information gathered during previous selections of the PLMN). The BCCH and CPBCCH carriers in the list are searched in descending order of received signal level, and the first BCCH or CPBCCH carrier found which is from a suitable cell and on which there is a normal priority indication is taken, and that cell is camped on. If an MS decodes system information from a cell of the selected PLMN but is unable to camp on that cell, the BA of that cell shall be examined and any BCCH and CPBCCH carriers in the BA which are not in the list of BCCH or CPBCCHcarriers to be searched shall be added to the list. If all these BCCH and CPBCCH carriers have been tried and the only suitable cells found have low priority indication, the MS shall camp on the strongest of these cells. When required to search for CPBCCH, the stored list cell selection is mandatory for CPBCCH carrier from the HPLMN. A MS supporting EC-GSM-IoT may store a separate list of BCCH carriers of cells supporting EC-GSM-IoT.

If no suitable cell is found using method b), method a) is then tried.

An MS with GSM voice capability shall not search for CPBCCH carriers. An MS supporting GSM circuit-switched data without supporting GSM voice may search for CPBCCH carriers.

NOTE: Since CPBCCH carriers are not transmitting continuously, another measurement algorithm than the one used for BCCH carriers must be followed when measuring signal strength of CPBCCH carriers (see 3GPP TS 45.008).

While camped on a cell of the registered PLMN ("camped normally"), the MS may need to select a different cell ("normal cell reselection" state). The following events trigger a cell reselection:

i) The path loss criterion parameter C1 (see subclause 3.6) indicates that the path loss to the cell has become too high (subclause 3.6);

ii) There is a downlink signalling failure (subclause 3.6 and 3GPP TS 45.008);

iii) The cell camped on (current serving cell) has become barred;

iv) There is a better cell (in terms of the path loss criterion C2) in the same registration area, or a much better cell in another registration area of an equivalent PLMN (using the CRH parameter, subclause 3.4);

v) A random access attempt is still unsuccessful either after "Max retrans" repetitions; "Max retrans" being a parameter broadcast on control channel, or in case the time given for the packet access procedure expires before the mobile station receives any response from the network;

vi) Upper layers have determined that the network has failed an authentication check (see subclause 3.5.5).

In addition, for PEO and EC operation the following events also trigger a cell reselection:

vii) The difference between the highest recorded C1 since the last cell reselection, and the latest C1 exceeds C1_DELTA;

viii) At least 24 hours has elapsed since the last cell reselection was triggered.

A GPRS MS in Ready state applies the READY_STATE CELL RESELECTION HYSTERESIS together with the path loss criterion when reselecting the cell within the registration area. The GPRS MS in Ready state shall inform the network about cell reselection within the registration area by the cell update procedure. The network may control cell reselection of a GPRS MS in Ready state (see 3GPP TS 43.064).

Instead of the parameter C2, a GPRS MS applies the corresponding GPRS parameter if provided. If this GPRS parameter is provided the cell shall also broadcast a list BA(GPRS) indicating BCCH or CPBCCH carriers to be monitored by GPRS MSs for cell re-selection purpose.

A MS that supports EC-GSM-IoT applies EC-specific C1 and C2 parameters.

An MS supporting SoLSA with SoLSA subscription shall use the SoLSA cell re-selection parameters.

The MS will then reselect a new cell in order to fulfil the process goal (see subclause 4.1).

Before camping on the cell after re-selection, the MS shall attempt to decode the full set of system information. The MS shall check that the parameters affecting cell re-selection are unchanged. If a change is detected the MS shall check if the cell re-selection criterion is still valid using the changed parameters. If the cell selection criteria are still valid, the MS shall camp on the cell. If they are not still valid, the MS shall repeat this process for the cell with the next highest value of C2 or corresponding GPRS parameter or SoLSA parameters, respectively.

Once the MS has re-tuned to the chosen cell, it shall monitor its paging subgroup (if known) for that cell. If the MS and the cell support group or broadcast calls, it shall also monitor the notification channel. A GPRS MS shall monitor the relevant GPRS control channel(s). If the MS receives a page before having decoded the relevant system information for the new cell, the MS shall store the page and respond, if permitted, once the relevant system information has been decoded. If not permitted, no page response shall be made.

When the MS leaves "connected mode" (e.g., after a call), and returns to idle mode, a cell must be chosen ("choose cell" state) as soon as possible (e.g., to allow a new call to be made). The chosen cell will not necessarily be the same cell as the MS was camped on when the call started e.g., if the MS moved a significant distance while the call was in progress. Two cases are distinguished in 3GPP TS 45.008, for which the algorithm is slightly different:

a) Normal case - The call is terminated, either because the user (or network) has terminated the call, or because a radio link failure has occurred and call re-establishment is not being attempted.

b) Call re-establishment - A radio link failure has occurred and a call re-establishment is being attempted. (The MS returns to idle mode to start the call re-establishment attempt and needs to select a new cell on which to make the attempt as soon as possible in order to minimize the interruption to the call).

If no suitable cell is found by either the stored list cell selection, normal cell reselection or choose cell tasks (all of which use a limited search), the normal cell selection task (which searches all RF channels for a suitable cell) is entered.

If no suitable cell is found by the normal cell selection task, or if there is no valid SIM in the MS, the MS attempts to find an "acceptable cell" on which it may camp so that emergency calls may be made and warning notifications may be received ("any cell selection" state). The MS ignores the PLMN information when selecting an acceptable cell, and no attempt at location registration is made. This task is also entered if an LR reject is received with one of the following cause values:

- "IMSI unknown in HLR" (only for non-GPRS MS as this impacts only the non-GPRS update state, MSs capable of GPRS and non-GPRS services take a cell selection state according to the outcome of the routing area update);
- "Illegal MS";
- "illegal ME";
- "PLMN not allowed" (However, this will trigger a new PLMN selection if the MS is in automatic mode);
- "GPRS not allowed" (only for MS capable of GPRS only, where this will trigger a new PLMN selection if the MS is in automatic mode; MSs capable of GPRS and non-GPRS services take a cell selection state according to the outcome of location updating as "GPRS not allowed" has only impact on the GPRS update status).

NOTE: Some cause values will lead the mobile station to consider the SIM as invalid, see 3GPP TS 24.008.

If an acceptable cell is found, the MS camps on it ("Camped on any cell" state). If one of the cell reselection trigger events (i) to (v) above occurs, the MS attempts to find a new acceptable cell to camp on ("any cell reselection" state) but using a zero dB value of CRH. If no acceptable cell can be found, the "any cell selection" task is re-entered.

If while camped on an acceptable cell:

i) an emergency call origination is made, the MS enters a connected mode and at the end of the call, chooses an acceptable cell ("choose any cell" state) so that it is ready for the next emergency call origination;

ii) a warning notification is received, the MS continues to perform cell reselection to an acceptable cell.

In all cases, if a new PLMN is selected and there is a valid SIM in the MS, the MS searches for a suitable cell of that PLMN. However, if the MS has recently searched the strongest RF channels while a previous PLMN was selected, it may already have information about other PLMNs.

The user may request a search of RF channels to determine which PLMNs are available. This search shall be done in such a way as to minimize interruptions to the MS's monitoring of its paging subchannel.

4.6 Location registration process

See 3GPP TS 23.122.

4.7 Service indication

See 3GPP TS 23.122.

4.8 BCCH allocation broadcasting and storage

The BCCH allocation is the list of BCCH or CPBCCH carriers in use by a given PLMN (or co-operating PLMNs) in a given geographical area. (It indicates the RF channels that the MS is required to monitor while camped on a cell of that PLMN.) It is broadcast in the system information messages, and is referred to as the BA(BCCH).

When the MS is first switched on in a PLMN, and has no knowledge of which RF channels are BCCH or CPBCCH carriers of that PLMN, it has to search the strongest RF channels in order to find which are BCCH or CPBCCH carriers. It then has to determine which BCCH or CPBCCH carriers belong to the selected PLMN. Once it has found a BCCH or CPBCCH carrier of the selected PLMN, it can read the BA(BCCH). It then knows which RF channels to monitor for cell selection and reselection purposes.

Cells supporting GPRS may broadcast a list BA(GPRS) as system information. It indicates the BCCH or CPBCCH carriers to be monitored by a GPRS MS for cell re-selection.

Whilst switched on in the PLMN, the MS can gain knowledge of the preferable carriers to use in subsequent cell selections in that PLMN. This knowledge may come from previously decoded BA(BCCH)s and from transmitted information from the network.

When the MS switches off, it has the option of storing the last known BA(BCCH) in a non volatile store so that on a subsequent switch on in that PLMN, it does not need to search to find the BA(BCCH), and so can camp on a cell more quickly. If the BA(BCCH) is stored in the (U)SIM, it shall be stored in the format specified either in 3GPP TS 51.011 (if the mobile station supports the SIM) or 3GPP TS 31.102 (if the mobile station supports the USIM). Any other information used by the MS in cell selection shall be stored in a non volatile store on the ME.

The BA(BCCH) may or may not be the total list of BCCH or CPBCCH carriers in use throughout the PLMN coverage area. For example there may be differences in different geographical areas, and there may be "umbrella cells" which are only used for hand over traffic and hence are not to be camped on.

NOTE: The PLMN operator cannot expect the ME to store the BCCH or CPBCCH carrier frequency of the serving cell in the SIM unless the BA(BCCH) includes the BCCH or CPBCCH carrier frequency on which it is broadcast.

A stored BA(BCCH) is not necessarily valid when the MS is switched on again e.g., if the system operator has made a change in BA(BCCH) or if the MS is switched on in a different geographical area. In these cases, the MS may not find a suitable cell for camping on using the stored BA(BCCH). However, the MS may use other stored information to find a suitable cell before searching all the strongest RF channels.

It should also be noted that the BA(BCCH) only applies to the PLMN on which it was received. If a new PLMN is selected, only a BA(BCCH) previously obtained from that PLMN should be used.

There is another BCCH or CPBCCH carrier list, called BA(SACCH), which is sent on the SACCH when in connected mode. This contains the list of BCCH or CPBCCH carriers to be monitored by the MS for hand over purposes. The BA(BCCH) and BA(SACCH) need not necessarily be the same. For example, the BA(SACCH) might contain umbrella cells, or the BCCH or CPBCCH carrier of the serving cell might be omitted.

If the MS stores a BA list in the SIM, and there is a valid stored LAI, the BA list must be of the PLMN indicated by the stored LAI.

4.9 Pageability of the mobile subscriber

See 3GPP TS 23.122.

4.10 MM Restart procedure

See 3GPP TS 23.122 .

5 Group receive mode

5.1 General description

The purpose of the group receive mode process is for a MS to determine the most suitable cell while listening to a group or broadcast call.

There are various requirements that a cell must satisfy before an MS can perform group receive mode on it:

i) The radio path loss between MS and BTS must be below a threshold set by the PLMN operator. This is estimated as shown in subclause 3.6. That means that the cell is suitable for transmission and reception.

ii) It should not be "barred" (see subclause 3.5.1);

iii) The NCC of the PLMN should be permitted;

The choice of a cell is based on the C2 criterion, as defined in 3GPP TS 45.008. . When in group receive mode on a cell the MS regularly looks to see if there is a better cell in terms of the cell reselection criterion C2, as defined in 3GPP TS 45.008. C2 is determined by the MS from reception measurements on the BCCH frequency on the cell and reselection parameters relative to the cell. The reselection parameters are the same as those used in idle mode.

If there is a better cell which is suitable, the better cell is selected. (This is called "cell reselection in group receive mode").

The switching from idle or dedicated or group transmit mode to group receive mode is controlled by the Radio Interface Layer 3 protocols, see 3GPP TS 44.018.

If no suitable cell can be found the MS immediately returns to idle mode by choosing a cell like releasing a dedicated channel (see 3GPP TS 45.008).

5.2 Requirements and technical solutions

5.2.1 Network provisions

For group and broadcast calls, the network provides a BA list in the SI TYPE 5, 5bis or 5ter message on the SACCH of the channel used for the group or broadcast call. The BA list indicates the BCCH carriers of the surrounding cells that MSs engaged in the call should monitor. The list shall include the cell on which it is sent. The cells in the list may belong to different PLMNs.

The network also provides the SI TYPE 6 message including an NCC permitted information element on the SACCH of the channel used for the group or broadcast call.

The network shall provide in SI TYPE 10 messages the necessary information for computation of the cell reselection criterion for all neighbour cells as given by SI TYPE 5, 5 bis and /or 5ter.

5.2.2 Group receive mode cell monitoring

A MS in group receive mode shall perform synchronization, identification and receive signal strength measurements of the BCCH carriers in the BA(SACCH) list of BCCH frequencies which was provided by the network in the serving cell. The regularity for performing synchronization and identification of the BCCH carriers shall be performed with a regularity as specified in 3GPP TS 45.008 for a MS in dedicated mode. The regularity of performing receive signal strength measurements of the BCCH carriers shall be as specified in 3GPP TS 45.008 for a MS in idle mode.

As long as no BA(SACCH) list is available on the SACCH, the last received BA(BCCH) list of the current cell shall be used instead if available.

The MS does not have to monitor cells for with NCC not permitted. The NCC permitted information is provided on the SACCH of the current cell. As long as no NCC permitted information is available on the SACCH, the last received NCC permitted information on the BCCH of the current cell shall be used instead if available.

The MS must also read the parameters affecting cell reselection of the surrounding cells. These parameters are:

- MS txpwr max cch;
- rxlev access min;
- cell reselect offset;
- temporary offset;
- penalty time;
- location identity.

The MS receives this information in SI TYPE 10 messages on the SACCH, however if the necessary information for a neighbour cell is not available, the MS shall get the information from the BCCH of that neighbour cell.

The MS shall attempt to decode this information within 15s after there are less than six stronger suitable cells and the MS is allowed to discard up to 6 speech frames during this period. The MS shall attempt to update the information at least every five minutes.

If ciphering is not used in the call then, before selecting a cell in group receive mode the MS must have read the information which is presented in SI TYPE 1 and 3 messages transmitted in the target cell, or have received in the serving cell valid information relating to the target cell obtained from a SI TYPE 10bis, SI TYPE 10ter, or VGCS Neighbour Cell Information message. SI TYPE 3 information shall override information received in SI10.

If ciphering is used in the call then, before selecting a cell in group receive mode the MS must have read the information which is presented in SI TYPE 3 messages transmitted in the target cell and either:

- have received in the serving cell valid information relating to the target cell obtained from a SI TYPE 10bis, SI TYPE 10ter, or VGCS Neighbour Cell Information message, or
- have read the information which is presented in SI TYPE 1 messages transmitted in the target cell.

On this basis, the MS determines which of the cells in the list are suitable and computes their reselection criterion, and decides on its own whether one of the surrounding cells should be selected instead of the current one, as described in the next subclause.

The procedures above do not consider whether the cell supports the call or not.

To perform cell change, the MS shall at least have performed measurements on cells of the BA-list received and read the corresponding BSIC.

5.2.3 Group receive mode cell change

Either of the following events trigger a cell change by a MS in group receive mode:

(i) The pass loss parameter C1 indicates that the path loss to the serving cell has become too high.

(ii) There is a radio link time-out.

(iii) There is a better cell (in terms of the criterion C2) in the same LA, or a much better cell in another LA (using CRH parameter, subclause 3.4) and with NCC permitted.

After cell change, the MS either

- leaves the group receive mode and goes to idle mode in order to establish a dedicated connection with the network to perform a location update if the cell belongs to a new LA
- detects that the selected cell does not belong to an equivalent PLMN and therefore leaves the group receive mode and goes to idle mode;
- detects that no NCH is present and therefore leaves the group receive mode and goes to idle mode;
- reads the NCH but does not receive any notification message for the current group or broadcast call and therefore leaves the group receive mode and goes to idle mode;
- reads the NCH and receives a notification message for the current group or broadcast call with the related channel position. If the channel is found, the MS changes to it and stays in group receive mode;
- reads the NCH and receives a notification message for the current group or broadcast call without information on the related channel position. The MS leaves the group receive mode and goes to idle mode in order to establish a dedicated connection with the network to become informed on the related channel position.
- moves directly to the group channel, if it had valid information describing the location of the group call which was received in the old cell.

During these procedures, the MS may not be able to listen to the group or broadcast call, in which case it should mute the downlink.

For all procedures, which require that the MS leaves group receive mode, the MS goes to idle mode by choosing a cell like releasing a dedicated channel (see 3GPP TS 45.008).

5.2.4 Uplink access in group calls

A MS assigned the uplink for the user to talk switches to group transmit mode.

It thus performs synchronisation, identification and measurements of the BCCH carriers according to the BA(SACCH) list as well as radio link measurements and reporting and is subject to hand over control from the network as for dedicated mode.

5a Broadcast/multicast receive mode

5a.1 General description

The purpose of the broadcast/multicast receive mode process is for a MS to determine the most suitable cell while listening to an MBMS session. The broadcast/multicast receive mode is a substate of packet idle mode, and can only be entered by mobile stations that are GPRS attached.

If no suitable cell can be found the MS immediately returns to packet idle mode.

5a.2 Requirements and technical solutions

5a.2.1 Network provisions

If the PBCCH is not allocated in the serving cell, the necessary information for the computation of the cell reselection criterion for all neighbour cells in the neighbour cell list shall not be read by the mobile station from the system information of the neighbour cells. Instead, this information shall be provided by the network (see 3GPP TS 44.018 and/or 3GPP TS 44.060).

NOTE: If the PBCCH is allocated in the cell, this information is read by the MS from PSI TYPE 3 messages.

5a.2.2 Broadcast/multicast receive mode cell monitoring

The MS shall not read the parameters affecting cell reselection from the BCCH of the surrounding cells. Instead, this information shall be provided by the network. If the necessary information for a neighbour cell has not been received after entering broadcast/multicast receive mode, the MS shall use the the information read from the BCCH or PBCCH of that neighbour cell while in packet idle mode or, if not available, default parameters.

If the information is not available for a suitable cell within 30 seconds after it has become one of the six stronger cells, the mobile station shall read this information from the BCCH of the neighbouring cell. The MS is allowed to interrupt the reception of the MBMS session during this period. The MS shall not attempt to perform periodic updates of this information while in broadcast/multicast receive mode.

The MS determines which of the cells in the list are suitable and computes their reselection criterion, and decides on its own whether one of the surrounding cells should be selected instead of the current one. In computing the cell reselection criterion, the mobile station shall obey the intra-RAT and inter-RAT cell reselection algorithms defined for the GMM Ready state (see 3GPP TS 45.008).

To perform cell change, the MS shall at least have performed measurements on cells of the BA(GPRS) list and read the corresponding BSIC.

5a.2.3 Broadcast/multicast receive mode cell change

Either of the following events trigger a cell change by a MS in broadcast/multicast receive mode:

(i) The pass loss parameter C1 indicates that the path loss to the serving cell has become too high.

(ii) There is a better cell (in terms of the criterion C2 or of the GPRS cell reselection criterion) in the same LA/RA, or a much better cell in another LA/RA and with NCC permitted.

After cell change, the MS either

- leaves the broadcast/multicast receive mode and goes to packet idle mode in order to establish a dedicated connection with the network to perform a location update or routing area update if the cell belongs to a new LA/RA;

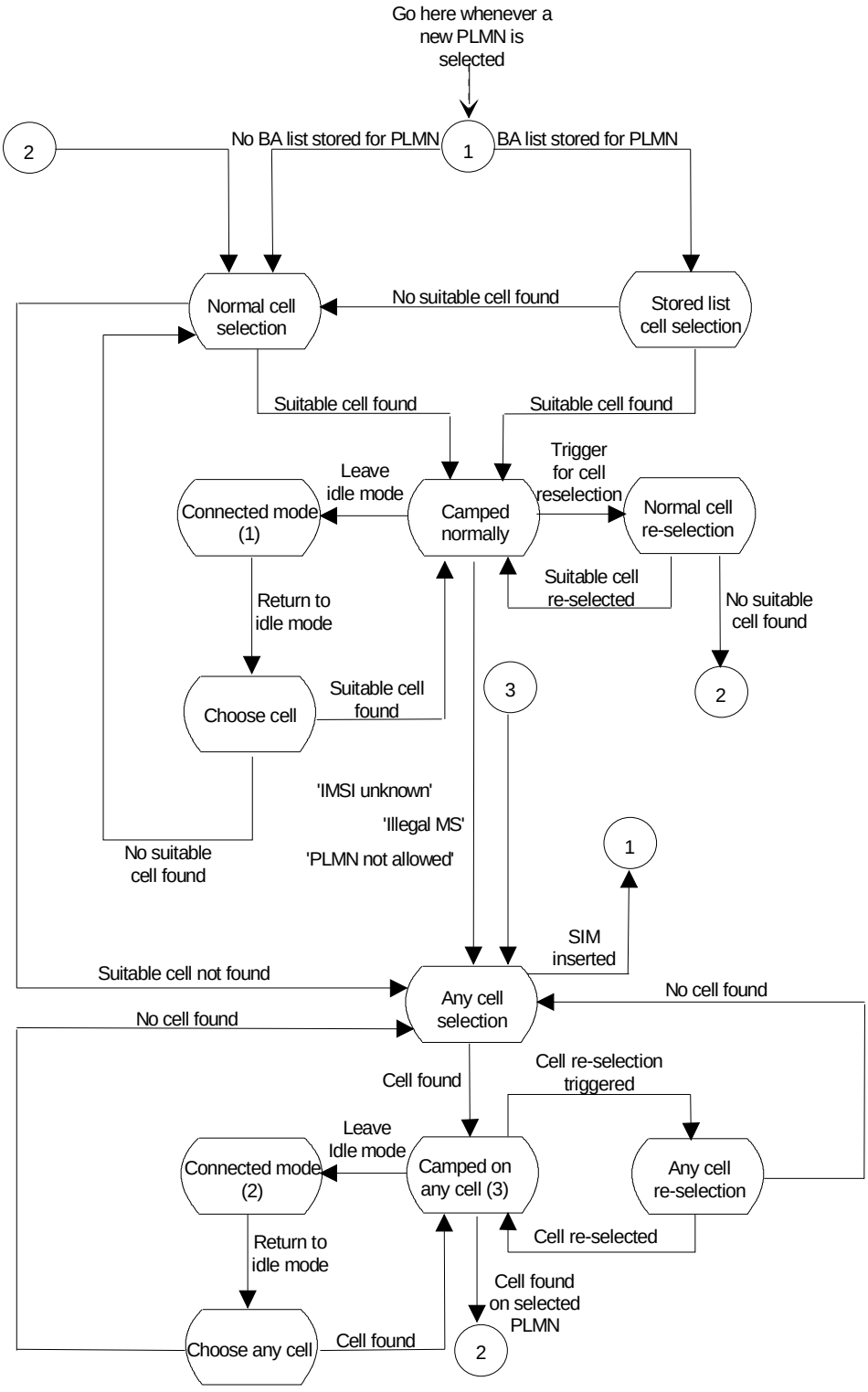
- detects that the selected cell does not belong to the MBMS Service Area and therefore leaves the broadcast/multicast receive mode and goes to packet idle mode;

- detects that the selected cell does not belong to an equivalent PLMN and therefore leaves the broadcast/multicast receive mode and goes to packet idle mode;

During these procedures, the MS may not be able to listen to the broadcast or multicast session.

If the mobile station has received information about the location of the p-t-m bearer in the cell that it has reselected to, the mobile station can resume the reception of the MBMS session without the need to complete the acquisition of the system information.

6 Tables and figures



NOTE 1: To make or receive call
NOTE 2: To make an emergency call
NOTE 3: Reception of warning notifications are possible
In any state, a new PLMN selection causes an exit to 1 if a valid SIM is present in the MS
Go to 3 if no valid SIM in MS

Figure 3: Cell Selection State diagram

Annex A (informative): Change history

SMG#	SPEC	CR	REV	PHASE	VERS	SUBJECT	CAT	NEW_VERS	WORKITEM
S29	03.22	A036	1	R98	7.0.0	GSM 400 spectrum update	F	7.1.0	GSM400
S30	03.22	A041		R99	8.0.0	Clarification of SoLSA exclusive cells	A	8.1.0	SoLSA
S30	03.22	A045	1	R99	8.0.0	Clarification of SoLSA exclusive cells	A	8.1.0	SoLSA
S30bis	03.22	A046		R99	8.1.0	COMPACT Cell Selection part 2	B	8.2.0	EDGE
S30bis	03.22	A043	2	R99	8.1.0	COMPACT Cell Selection part 1	B	8.2.0	EDGE
	03.22				8.2.0	Editorial correction to headers		8.2.1	
S31	03.22	A048		R99	8.2.1	Removal of CN procedures from 03.22	F	8.3.0	TEI
GERAN#						September 2000 - 3G Release 4			
G01	03.22	A049	1	R00	8.3.0	CR 03.22-A049 rev 1 Check selected cell deduced by SI10 information with SI3 ones (Release 4)	F	4.0.0	ASCI
G01	43.022	A050		R00	8.3.0	CR 03.22-A050 GSM 700 spectrum update (Release 4)	B	4.0.0	GSM 700
October 2000					4.0.0	GSM references revert to pre-Release-4 spec number format.		4.0.1	
G02	43.022	001	1	Rel-4	4.0.1	Mandatory usage of SYSTEM INFORMATION TYPE 10 messages for VGCS and VBS	C	4.1.0	ASCI
					4.1.0	Front page layout correction		4.1.1	
January 2001									
G03	43.022	002		Rel-4	4.1.1	Removal of Anonymous Access	A	4.2.0	GPRS
June 2001									
G05	43.022	003	1	Rel-4	4.2.0	Remaining errors from the split	A	4.3.0	TEI
G05	43.022	004	1	Rel-4	4.2.0	Clarifications due to equivalent PLMN	A	4.3.0	GSM/UMTS interworking
June 2002									
G10	43.022	007	1	Rel-4	4.3.0	Removal of CBQ2	A	4.4.0	COMPACT
G10	43.022	008	1	Rel-5	4.3.0	Removal of CBQ2	A	5.0.0	COMPACT
August 2002									
G11	43.022	011		Rel-5	5.0.0	MS behaviour in case of a failed authentication of the network	A	5.1.0	TEI

Change history							
Date	**TSG GERAN#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2002-11	12	GP-023318	009	2	Implementation of new frequency ranges	5.1.9	6.0.0
2004-11	22	GP-042456	014		Removal of PTM-M	6.0.0	6.1.0
2005-01	23	GP-050592	015	3	Introduction of MBMS	6.1.0	6.2.0
2005-01	23	GP-050491	016	1	Correction of references	6.1.0	6.2.0
2005-04	24	GP-050773	018		GSM 750 corrections	6.2.0	6.3.0
2005-04	24	GP-050774	019		Introduction of GSM 710	6.3.0	7.0.0
2005-06	25	GP-051713	021	1	Introduction of T-GSM 810	7.0.0	7.1.0
2006-09	31	GP-061610	0022	1	Clarification on mobile behaviour in "limited service" state	7.1.0	7.2.0
2006-09	31	GP-061881	0023	1	The failure of random access attempt	7.1.0	7.2.0
2007-08	35	GP-071519	0024	4	TCRT: Enhanced Cell Reselection for VGCS	7.2.0	8.0.0
2008-05	38	GP-080584	0025		TCRT: Correction to requirements for Cell Reselection for ciphered group calls	8.0.0	8.1.0
2009-12	44				Release 9 version	8.1.0	9.0.0
2010-03	45	GP-100591	0027	1	Reception of PWS warning notifications in an acceptable cell	9.0.0	9.1.0
2010-09	47	GP-101319	0031		Correction to "Camped on any cell" state	9.1.0	9.2.0
2011-03	49				Release 10 version	9.2.0	10.0.0
2012-09	55				Release 11 version	10.0.0	11.0.0
2014-08	63	GP-140540	0033	2	Introduction of support for MS Power Saving Mode	11.0.0	12.0.0
2015-11	68	GP-151152	0036	1	Introduction of EC-EGPRS and PEO	12.0.0	13.0.0

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2016-05	RP-70	GP-160464	0037	1	F	Updates to cell reselection behaviour for EC-GSM-IoT	13.1.0
2016-09	RP-73	RP-161392	0039	1	F	Miscellaneous corrections to EC-GSM-IoT	13.2.0
2017-03	RP-75					Release 14 version	14.0.0
2018-06	RP-80					Release 15 version	15.0.0
2020-07	RP-88e	-	-	-	-	Upgrade to Rel-16 version without technical change	16.0.0

History

Document history		
V16.0.0	September 2020	Publication