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*Technical Specification*

## **Universal Mobile Telecommunications System (UMTS); UE Procedures in Idle Mode and Procedures for Cell Reselection in Connected Mode (3GPP TS 25.304 version 5.1.0 Release 5)**



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# Foreword

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# 1 Scope

The present document specifies the Access Stratum (AS) part of the Idle Mode procedures applicable to a UE. The non-access stratum (NAS) part of Idle mode procedures and processes is specified in [5].

The present document also specifies cell reselection processes applicable to UEs in connected mode. Invocation of these processes is described in [4].

The present document specifies the model for the functional division between the NAS and AS in a UE.

The present document applies to all UEs that support at least UTRA, including multi-RAT UEs as described in 3GPP specifications, in the following cases:

- When the UE is camped on a UTRA cell;
- When the UE is searching for a cell to camp on;

NOTE: The details for those cases are described in the specifications of the other RAT.

The present document presents also examples of inter-layer procedures related to the idle mode processes and describes idle mode functionality of a dual RAT UTRA/GSM UE.

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# 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 43.022: "Functions related to Mobile Station in idle mode and group receive mode".
- [2] 3GPP TS 25.301: "Radio Interface Protocol Architecture".
- [3] 3GPP TS 25.303: "Interlayer Procedures in Connected Mode".
- [4] 3GPP TS 25.331: "Radio Resource Control (RRC); protocol specification".
- [5] 3GPP TS 23.122: "NAS functions related to Mobile Station (MS) in idle mode".
- [6] 3GPP TR 25.922: "Radio Resource Management Strategies".
- [7] 3GPP TS 25.211: "Physical channels and mapping of transport channels onto physical channels (FDD)".
- [8] 3GPP TS 25.221: "Physical channels and mapping of transport channels onto physical channels (TDD)".
- [9] 3GPP TS 22.011: "Service accessibility".
- [10] 3GPP TS 25.133: "Requirements for Support of Radio Resource Management (FDD)".
- [11] 3GPP TS 25.123: "Requirements for Support of Radio Resource Management (TDD)".
- [12] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [13] 3GPP TS 45.008: "Radio subsystem link control".

- [14] 3GPP TS 25.214: "Physical layer procedures (FDD)".
- [15] 3GPP TS 25.224: "Physical Layer Procedures (TDD)".
- [16] 3GPP TS 24.008: "Mobile radio interface layer 3 specification, Core Network Protocols - Stage 3".

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the following definitions and the definitions in [12] apply.

**Acceptable Cell:** A cell that satisfies certain conditions as specified in 4.3. A UE can always attempt emergency calls on an acceptable cell.

**Available PLMN:** A PLMN for which the UE has found at least one cell and read its PLMN identity.

**Barred Cell:** A cell a UE is not allowed to camp on.

**Camped on a cell:** UE is in idle mode and has completed the cell selection/reselection process and has chosen a cell. The UE monitors system information and (in most cases) paging information.

**Camped on any cell:** UE is in idle mode and has completed the cell selection/reselection process and has chosen a cell irrespective of PLMN identity.

**DRX cycle:** Individual time interval between monitoring Paging Occasion for a specific UE.

**Equivalent PLMN:** A PLMN considered as equivalent to the selected PLMN by the UE for PLMN selection, cell selection, cell reselection and handover according to the information provided by the NAS.

**Home PLMN:** A PLMN where the Mobile Country Code (MCC) and Mobile Network Code (MNC) of the PLMN identity are the same as the MCC and MNC of the IMSI.

**Location Registration (LR):** UE registers its presence in a registration area, for instance regularly or when entering a new registration area.

**Maximum DRX cycle:** Time interval for the longest possible DRX cycle in a cell.

**Paging Block Periodicity (PBP):** Period of the occurrence of Paging Blocks. (For FDD, PBP = 1).

**Paging Message Receiving Occasion (TDD only):** The frame where the UE receives actual paging message.

**Paging occasion:**

(FDD) The SFN of the PICH frame where the UE monitors its paging indicator (i.e. the SFN of the PCCPCH frame in which the PICH frame begins).

(TDD) The paging block, which consists of several frames. The value of Paging Occasion is equal to the first frame of the Paging Block.

**Process:** A local action in the UE invoked by a RRC procedure or an Idle Mode procedure.

**Radio Access Mode:** Radio access mode of the cell, FDD or TDD.

**Radio Access Technology:** Type of technology used for radio access, for instance UTRA or GSM.

**Registration Area:** (NAS) registration area is an area in which the UE may roam without a need to perform location registration, which is a NAS procedure.

**Reserved Cell:** A cell on which camping is not allowed, except for particular UEs, if so indicated in the system information.

**Restricted Cell:** A cell on which camping is allowed, but access attempts are disallowed for UEs whose access classes are indicated as barred.



**Selected PLMN:** This is the PLMN that has been selected by the NAS, either manually or automatically.

**Serving cell:** The cell on which the UE is camped.

**Strongest cell:** The cell on a particular carrier that is considered strongest according to the layer 1 cell search procedure [14][15]. As the details of the layer 1 cell search are implementation dependent, the precise definition of 'strongest cell' is also implementation dependent.

**Suitable Cell:** This is a cell on which an UE may camp. For a UTRA cell, the criteria are defined in subclause 4.3, and for a GSM cell the criteria are defined in [1].

## 3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

|       |  |
|-------|--|
| AS    | Access Stratum                             |
| BCCH  | Broadcast Control Channel                  |
| CM    | Connection Management                      |
| CN    | Core Network                               |
| DRX   | Discontinuous Reception                    |
| DSCH  | Downlink Shared Channel                    |
| FDD   | Frequency Division Duplex                  |
| GC    | General Control (SAP)                      |
| GPRS  | General Packet Radio Service               |
| GSM   | Global System for Mobile Communications    |
| HCS   | Hierarchical Cell Structure                |
| IMSI  | International Mobile Subscriber Identity   |
| MCC   | Mobile Country Code                        |
| MM    | Mobility Management                        |
| MNC   | Mobile Network Code                        |
| NAS   | Non-Access Stratum                         |
| PCH   | Paging Channel                             |
| PI    | Page Indicator                             |
| PICH  | Page Indication Channel                    |
| PLMN  | Public Land Mobile Network                 |
| RAT   | Radio Access Technology                    |
| RRC   | Radio Resource Control                     |
| SAP   | Service Access Point                       |
| TDD   | Time Division Duplex                       |
| UE    | User Equipment                             |
| UMTS  | Universal Mobile Telecommunications System |
| UTRA  | UMTS Terrestrial Radio Access              |
| UTRAN | UMTS Terrestrial Radio Access Network      |

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## 4 General description of Idle mode

### 4.1 Overview

When a UE is switched on, a public land mobile network (PLMN) is selected and the UE searches for a suitable cell of this PLMN to camp on. Criteria for cell selection and cell re-selection between radio access technologies (RATs) described in this document only consider radio criteria. In addition to RAT, the PLMN type may differ as well. In this specification, the term PLMN is used as a generic term covering both GSM MAP and ANSI-41 type of PLMNs. According to the type of PLMN, the way to identify it can be different. If the PLMN type is GSM, the PLMN is identified by 'PLMN identity' and if the PLMN type is ANSI-41, the PLMN is identified by 'SID'

The NAS shall provide a list of equivalent PLMNs, if available, that the AS shall use for cell selection and cell reselection.

The UE searches for a suitable cell of the chosen PLMN and chooses that cell to provide available services, and tunes to its control channel. This choosing is known as "camping on the cell". The UE will, if necessary, then register its presence, by means of a NAS registration procedure, in the registration area of the chosen cell.

If the UE finds a more suitable cell, it reselects onto that cell and camps on it. If the new cell is in a different registration area, location registration is performed.

If necessary, the UE will look for more suitable cells on other PLMNs at regular time intervals, which is referred to as PLMN-reselection. This is described in [9].

If the UE loses coverage of the registered PLMN, either a new PLMN is selected automatically (automatic mode), or an indication of which PLMNs are available is given to the user, so that a manual selection can be made (manual mode).

Registration is not performed by UEs only capable of services that need no registration.

The purpose of camping on a cell in idle mode is fourfold:

- a) It enables the UE to receive system information from the PLMN.
- b) When registered and if the UE wishes to establish an RRC connection, it can do this by initially accessing the network on the control channel of the cell on which it is camped.
- c) If the PLMN receives a call for the registered UE, it knows (in most cases) the registration area of the cell in which the UE is camped. It can then send a "paging" message for the UE on control channels of all the cells in the registration area. The UE will then receive the paging message because it is tuned to the control channel of a cell in that registration area and the UE can respond on that control channel.
- d) It enables the UE to receive cell broadcast services.

If the UE is unable to find a suitable cell to camp on, or the USIM is not inserted, or if the location registration failed (except for LR rejected with cause #14 or cause #15, see [5] and [16]), it attempts to camp on a cell irrespective of the PLMN identity, and enters a "limited service" state in which it can only attempt to make emergency calls.

The idle mode tasks can be subdivided into three processes:

- PLMN selection and reselection;
- Cell selection and reselection;
- Location registration.

The relationship between these processes is illustrated in Figure 1.

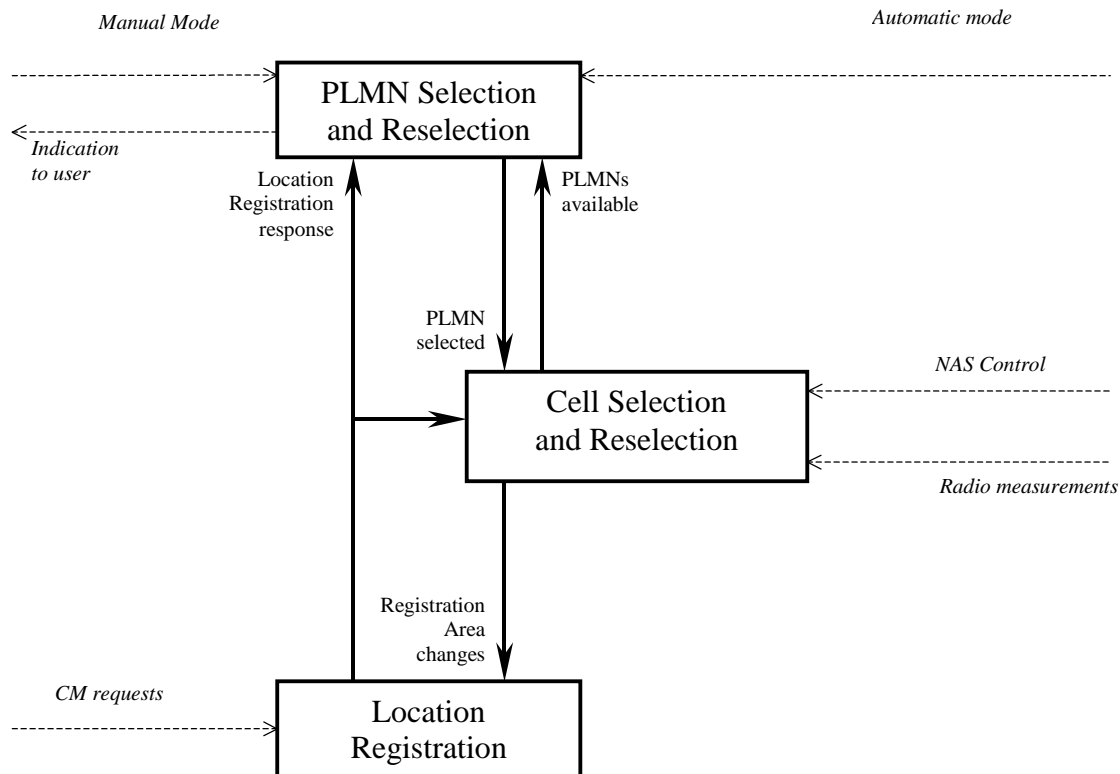


Figure 1: Overall Idle Mode process

## 4.2 Functional division between AS and NAS in Idle mode

Table 1 presents the functional division between UE non-access stratum (NAS) and UE access stratum (AS) in idle mode. The NAS part is specified in [5] and the AS part in the present document. Examples of different idle mode procedures are presented in Clause 10.

Table 1: Functional division between AS and NAS in idle mode

| Idle Mode Process              | UE Non-Access Stratum  | UE Access Stratum  |
|--------------------------------|--|--|
| PLMN Selection and Reselection | <p>Maintain the list of allowed PLMN types. It can be GSM-MAP only, ANSI-41 only or both.</p> <p>Maintain a list of PLMNs in priority order according to [5]. Select a PLMN using automatic or manual mode as specified in [5] and request AS to select a cell belonging to this PLMN. For each PLMN, associated RAT(s) may be set.</p> <p>Evaluate reports of available PLMNs from AS for PLMN selection.</p> <p>Maintain a list of equivalent PLMN identities.</p> | <p>Search for available PLMNs.</p> <p>If associated RAT(s) is (are) set for the PLMN, search in this (these) RAT(s) and other RAT(s) for that PLMN as specified in [5].</p> <p>Perform measurements to support PLMN selection.</p> <p>Synchronise to a broadcast channel to identify found PLMNs.</p> <p>Report available PLMNs with associated PLMN type and RAT to NAS on request from NAS or autonomously.</p> <p>It shall respect allowed PLMN types indications from NAS.</p>   |
| Cell Selection                 | <p>Control cell selection for example by indicating RAT(s) associated with the selected PLMN to be used initially in the search of a cell in the cell selection. NAS is also maintaining lists of forbidden registration areas.</p>  | <p>Perform measurements needed to support cell selection.</p> <p>Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.</p> <p>Search for a suitable cell belonging to the PLMN requested by NAS. The cells broadcast their 'PLMN identity' (GSM-MAP) or 'SID' in the system information. Respond to NAS whether such cell is found or not.</p> <p>If associated RATs is (are) set for the PLMN, perform the search in this (these) RAT(s) and other RATs for that PLMN as specified in [5].</p> <p>If such a cell is found, the cell is selected to camp on.</p> |
| Cell Reselection               | <p>Control cell reselection by for example, maintaining lists of forbidden registration areas.</p> <p>Maintain a list of equivalent PLMN identities and provide the list to AS.</p> <p>Maintain a list of forbidden LAs and provide the list to AS</p>   | <p>Perform measurements needed to support cell reselection.</p> <p>Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.</p> <p>Change cell if a more suitable cell is found.</p>  |
| Location registration          | <p>Register the UE as active after power on.</p> <p>Register the UE's presence in a registration area, for instance regularly or when entering a new registration area.</p> <p>Maintain lists of forbidden LAs.</p> <p>Deregister UE when shutting down.</p>   | <p>Report registration area information to NAS.</p>  |

## 4.3 Service type in Idle and Connected Mode

This clause defines the level of service that may be provided by the network to a UE in Idle mode and Connected Mode.

The action of camping on a cell is necessary to get access to some services. Three levels of services are defined for UE:

- Limited service (emergency calls on an acceptable cell)
- Normal service (for public use on a suitable cell)
- Operator service (for operators only on a reserved cell)

Furthermore, the cells are categorised according to which services they offer:

### acceptable cell:

An "acceptable cell" is a cell on which the UE may camp to obtain limited service (originate emergency calls). Such a cell shall fulfil the following requirements, which is the minimum set of requirements to initiate an emergency call in a UTRAN network:

- The cell is not barred, see subclause 5.3.1.1;
- The cell selection criteria are fulfilled, see subclause 5.2.3.1.2;

### suitable cell:

A "suitable cell" is a cell on which the UE may camp on to obtain normal service. Such a cell shall fulfil all the following requirements.

- The cell is part of the selected PLMN or, of a PLMN considered as equivalent by the UE according to the information provided by the NAS.
- The cell is not barred, see subclause 5.3.1.1;
- The cell is not part of the list of "forbidden LAs for roaming" [9];
- The cell selection criteria are fulfilled, see subclause 5.2.3.1.2.

### barred cell:

A cell is barred if it is so indicated in the system information [4].

### reserved cell:

A cell is reserved if it is so indicated in system information [4].

Exceptions to these definitions are applicable for UEs during emergency calls.

If a UE has an ongoing emergency call, all acceptable cells of that PLMN are treated as suitable for cell reselection for the duration of the emergency call.

---

# 5 Process and procedure descriptions

## 5.1 PLMN selection and reselection

### 5.1.1 General

In the UE, the AS shall report available PLMNs to the NAS on request from the NAS or autonomously.

UE shall maintain a list of allowed PLMN types. The allowed PLMN type can be GSM-MAP only, ANSI-41 only or both. During PLMN selection and reselection, based on the list of allowed PLMN types and a list of PLMN identities in priority order, the particular PLMN may be selected either automatically or manually. Each PLMN in the list of PLMN

identities can be identified by either 'PLMN identity' (GSM-MAP) or 'SID'. In the system information on the broadcast channel, the UE can receive a 'PLMN identity' (GSM-MAP) or a 'SID' or a 'PLMN identity' (GSM-MAP) and a 'SID', in a given cell. The result of the PLMN selection is an identifier of the chosen PLMN, the choice being based on the allowed PLMN types, UE capability or other factors. This identifier is one of either 'PLMN identity' for GSM-MAP type of PLMNs or 'SID' for ANSI-41 type of PLMNs.

In case that the list of allowed PLMN types includes GSM-MAP, the non-access part of the PLMN selection and reselection process is specified in [5]. In the case that list of allowed PLMN types includes ANSI-41, the non-access part of the PLMN selection and reselection is specified in TIA/EIA/IS-2000.5 and TIA/EIA/IS-707.

## 5.1.2 Support for PLMN Selection

### 5.1.2.1 General

On request of the NAS the AS should perform a search for available PLMNs and report them to NAS.

### 5.1.2.2 UTRA case

The UE shall scan all RF channels in the UTRA bands according to its capabilities to find available PLMNs. On each carrier, the UE shall search for the strongest cell and read its system information, in order to find out which PLMN the cell belongs to. If the UE can read the PLMN identity, the found PLMN shall be reported to the NAS as a high quality PLMN (but without the RSCP value), provided that the following high quality criterion is fulfilled:

1. For an FDD cell, the measured primary CPICH RSCP value shall be greater than or equal to -95 dBm.
2. For a TDD cell, the measured P-CCPCH RSCP shall be greater than or equal to -84 dBm.

Found PLMNs that do not satisfy the high quality criterion, but for which the UE has been able to read the PLMN identities are reported to the NAS together with the CPICH RSCP value for UTRA FDD cells and P-CCPCH RSCP for UTRA TDD cells.

The search for PLMNs on the rest of the carriers may be stopped on request of the NAS. The UE may optimise this search by using stored information of carrier frequencies and optionally also information on cell parameters, e.g. scrambling codes, from previously received measurement control information elements.

Once the UE has selected a PLMN, the cell selection procedure shall be performed in order to select a suitable cell of that PLMN to camp on.

### 5.1.2.3 GSM case

Support for network selection in GSM is described in [1].

## 5.2 Cell selection and reselection in idle mode

### 5.2.1 Introduction

As stated in clause 1, the present document applies to UEs that support at least UTRA.

Different types of measurements are used in different RATs and modes for the cell selection and reselection. The performance requirements for the measurements are specified in [10] and [11].

The NAS can control the RAT(s) in which the cell selection should be performed, for instance by indicating RAT(s) associated with the selected PLMN, and by maintaining a list of forbidden registration area(s) and a list of equivalent PLMNs. The UE shall select a suitable cell and the radio access mode based on idle mode measurements and cell selection criteria.

In order to speed up the cell selection process, stored information for several RATs may be available in the UE.

When camped on a cell, the UE shall regularly search for a better cell according to the cell reselection criteria. If a better cell is found, that cell is selected. The change of cell may imply a change of RAT. Details on performance requirements for cell reselection can be found in [10] and [11].

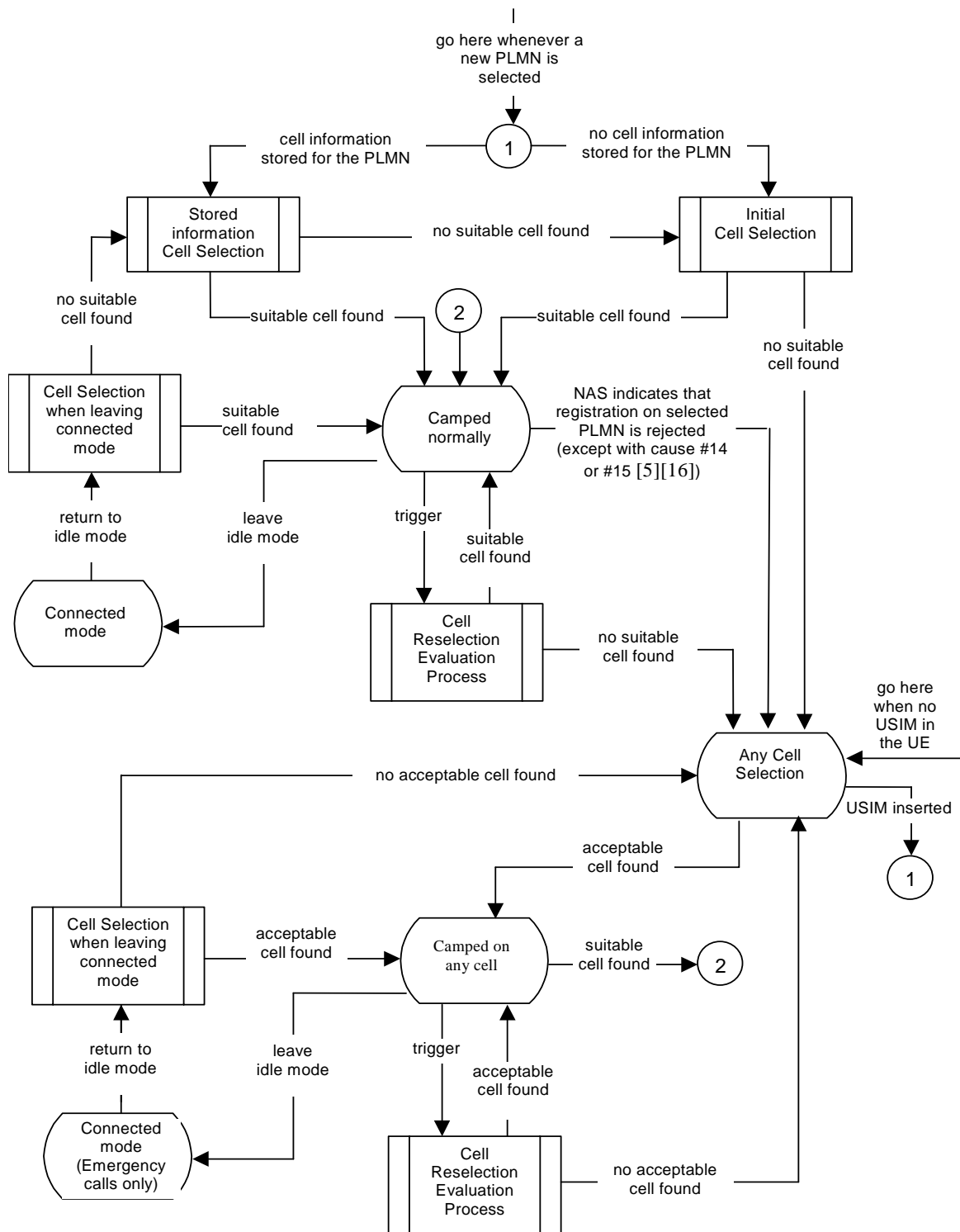
The NAS is informed if the cell selection and reselection results in changes in the received system information.

For normal service, the UE has to camp on a suitable cell, tune to that cell's control channel(s) so that the UE can:

- Receive system information from the PLMN;
- Receive registration area information from the PLMN, e.g., location area and routing area; and
- Receive other AS and NAS Information;
- If registered:
  - receive paging and notification messages from the PLMN; and
  - initiate call setup for outgoing calls or other actions from the UE.

## 5.2.2 States and state transitions in Idle Mode

Figure 2 shows the states and procedures in Idle Mode.



**Figure 2: Idle Mode Cell Selection and Reselection**  
**In any state, a new PLMN selection causes an exit to number 1**

### 5.2.2.1 Cell Selection process overview

Whenever a PLMN has been selected by NAS, the UE shall attempt to find a suitable cell to camp on.



The NAS may control the cell selection by:

- providing information on RAT(s) associated with the selected PLMN;
- maintaining lists of forbidden registration areas;
- providing a list of equivalent PLMNs;

One or several RATs may be associated with the selected PLMN. In [5] it is specified which RAT a UE shall select to search for a suitable cell of the selected PLMN.

The AS shall attempt to find a suitable cell to camp on as specified in clause 5.2.3.

If a suitable cell is found, the UE shall select this cell to camp on, and report this event to NAS so that the necessary NAS registration procedures can be performed. When the registration is successful, the UE enters in state *Camped normally* in order to obtain normal service.

If the UE is unable to find any suitable cell of selected PLMN the UE shall enter the *Any cell selection* state.

#### 5.2.2.2 Camped normally state overview

In this state, the UE obtains normal service and performs the tasks specified in 5.2.5.

If after a *Cell reselection evaluation process* a better cell is found, the *Cell reselection procedure* is performed. If no suitable cell is found, the UE shall enter the state *Any cell selection*.

If a necessary NAS registration is rejected, the UE shall enter the *Any cell selection* state, except if the LR is rejected with cause #14 or cause #15. In this case the UE shall behave as specified in [5] and [16].

When UE leaves idle mode in order to enter the state *Connected mode*, the UE shall attempt to access the current serving cell. If the access attempt to the serving cell fails, the UE shall use the *Cell reselection evaluation procedure*.

#### 5.2.2.3 Connected mode State overview

The procedures in *Connected mode* state are specified in [4]

When returning to idle mode, the UE shall use the procedure *Cell selection when leaving connected mode* in order to find a suitable cell to camp on and enter state *Camped normally*. If a suitable cell is found, then the AS reports this event to NAS to be capable to perform necessary NAS registration procedures. If no suitable cell is found, the *Stored information cell selection* procedure shall be used.

If no suitable cell is found in *cell reselection evaluation* process, the UE enters the state *Any cell selection*.

#### 5.2.2.4 Any cell selection State overview

In this state the UE performs the tasks specified in subclause 5.2.8

The state *Any cell selection* is also entered if the NAS indicates that a location registration is rejected except if the LR is rejected with cause #14 or cause #15, see [5], or if there is no USIM in the UE.

If the UE received an LR reject with cause #14 or cause #15 the UE shall behave as specified in [5] and [16].

If an acceptable cell is found, the UE shall inform the NAS and camp on this cell and obtain limited service, state *Camped on any cell*. The subsequent actions of the NAS regarding the PLMN selection are specified in [5].

#### 5.2.2.5 Camped on any cell State overview

In this state the UE obtains limited service and shall behave as specified in subclause 5.2.9. The UE shall regularly attempt to find a suitable cell of the selected PLMN, trying RATs that are supported by the UE. If a suitable cell is found, this causes an exit to number 2 in figure 2.

NOTE: The 'PLMN selection and reselection' process may select a new PLMN at any time in idle mode, which in Figure 2 causes an exit to number 1.

## 5.2.3 Cell Selection Process

### 5.2.3.1 UTRA case

#### 5.2.3.1.1 Description

The UE shall use one of the following two search procedures:

##### a) Initial Cell Selection

This procedure requires no prior knowledge of which RF channels are UTRA carriers. The UE shall scan all RF channels in the UTRA bands according to its capabilities to find a suitable cell of the selected PLMN. On each carrier, the UE need only search for the strongest cell. Once a suitable cell is found this cell shall be selected.

##### b) Stored Information Cell Selection

This procedure requires stored information of carrier frequencies and optionally also information on cell parameters, e.g. scrambling codes, from previously received measurement control information elements. Once the UE has found a suitable cell for the selected PLMN the UE shall select it. If no suitable cell of the selected PLMN is found the Initial cell selection procedure shall be started.

#### 5.2.3.1.2 Criteria

The cell selection criterion S is fulfilled when:

|                |                                    |
|----------------|------------------------------------|
| for FDD cells: | $S_{rxlev} > 0$ AND $S_{qual} > 0$ |
| for TDD cells: | $S_{rxlev} > 0$                    |

Where:

|   |
|---|
| $S_{qual} = Q_{qualmeas} - Q_{qualmin}$                       |
| $S_{rxlev} = Q_{rxlevmeas} - Q_{rxlevmin} - P_{compensation}$ |

|                           |   |
|---------------------------|---|
| S <sub>qual</sub>         | Cell Selection quality value (dB)<br>Applicable only for FDD cells.   |
| S <sub>rxlev</sub>        | Cell Selection RX level value (dB)  |
| Q <sub>qualmeas</sub>     | Measured cell quality value. The quality of the received signal expressed in CPICH E <sub>c</sub> /N <sub>0</sub> (dB) for FDD cells. CPICH E <sub>c</sub> /N <sub>0</sub> shall be averaged as specified in [10]. Applicable only for FDD cells. |
| Q <sub>rxlevmeas</sub>    | Measured cell RX level value. This is received signal, CPICH RSCP for FDD cells (dBm) and P-CCPCH RSCP for TDD cells (dBm).   |
| Q <sub>qualmin</sub>      | Minimum required quality level in the cell (dB). Applicable only for FDD cells.   |
| Q <sub>rxlevmin</sub>     | Minimum required RX level in the cell (dBm)   |
| P <sub>compensation</sub> | max(UE_TXPWR_MAX_RACH - P_MAX, 0) (dB)  |
| UE_TXPWR_MAX_RACH         | Maximum TX power level an UE may use when accessing the cell on RACH (read in system information) (dBm)   |
| P_MAX                     | Maximum RF output power of the UE (dBm)   |

### 5.2.3.2 GSM case

The cell selection criteria and procedures in GSM are specified in [1].

### 5.2.4 Void

## 5.2.5 Camped Normally State

### 5.2.5.1 UTRA case

When camped normally, the UE shall perform the following tasks:

- select and monitor the indicated PICH and PCH of the cell as specified in clause 8 according to information sent in system information;
- monitor relevant System Information. This is specified in [4];
- perform necessary measurements for the cell reselection evaluation procedure;
- execute the cell reselection evaluation process on the following occasions/triggers:
  - 1) UE internal triggers, so as to meet performance as specified in [10] and [11];
  - 2) When information on the BCCH used for the cell reselection evaluation procedure has been modified

### 5.2.5.2 GSM case

The Camped Normally State is specified in [1].

## 5.2.6 Cell Reselection Evaluation Process

### 5.2.6.1 UTRA case

The cell reselection process is specified in the following sub-clauses:

#### 5.2.6.1.1 Measurement rules for cell re-selection when HCS is not used

If the system information broadcast in the serving cell indicates that HCS is not used, then for intra-frequency and inter-frequency measurements and inter-RAT measurements, the UE shall:

- use Squal for FDD cells and Srxlev for TDD for Sx and apply the following rules.
  1. If  $S_x > S_{\text{intrasearch}}$ , UE need not perform intra-frequency measurements.  
If  $S_x \leq S_{\text{intrasearch}}$ , perform intra-frequency measurements.  
If  $S_{\text{intrasearch}}$  is not sent for serving cell, perform intra-frequency measurements.
  2. If  $S_x > S_{\text{intersearch}}$ , UE need not perform inter-frequency measurements  
If  $S_x \leq S_{\text{intersearch}}$ , perform inter-frequency measurements.  
If  $S_{\text{intersearch}}$  is not sent for serving cell, perform inter-frequency measurements.
  3. If  $S_x > S_{\text{search}_{\text{RAT } m}}$ , UE need not perform measurements on cells of RAT "m".  
If  $S_x \leq S_{\text{search}_{\text{RAT } m}}$ , perform measurements on cells of RAT "m".  
If  $S_{\text{search}_{\text{RAT } m}}$  is not sent for serving cell, perform measurements on cells of RAT "m".

If HCS is not used and if  $S_{\text{limit,Search}_{\text{RAT } m}}$  is sent for serving cell, UE shall ignore it.

### 5.2.6.1.2 Measurement rules for cell re-selection when HCS is used

If the system information broadcast in the serving cell indicates that HCS is used, then for intra-frequency and inter-frequency measurements, the UE shall:

1. For intra-frequency and inter-frequency threshold-based measurement rules

use Squal for FDD cells and Srxlev for TDD cells for  $S_x$  and apply the following rules.

IF ( $S_{rxlev_s} \leq S_{search_{HCS}}$ ) or (if FDD and  $S_x \leq S_{intersearch}$ ) THEN

measure on all intra-frequency and inter-frequency cells

ELSE

IF ( $S_x > S_{intrasearch}$ ) THEN

measure on all intra-frequency and inter-frequency cells, which have higher HCS priority level than the serving cell unless measurement rules for fast-moving UEs are triggered

ELSE

measure on all intra-frequency and inter-frequency cells, which have equal or higher HCS priority level than the serving cell unless measurement rules for fast-moving UEs are triggered

ENDIF

ENDIF

If HCS is used and if  $S_{intrasearch}$  or  $S_{search_{HCS}}$  or  $S_{intersearch}$  (in FDD) are not sent for the serving cell, UE shall:

- measure on all intra-frequency and inter-frequency cells.

2. For intra-frequency and inter-frequency measurement rules for fast-moving UEs:

If the number of cell reselections during time period  $T_{CRmax}$  exceeds  $N_{CR}$ , high-mobility has been detected. In this high-mobility state, UE shall

- measure intra-frequency and inter-frequency neighbouring cells, which have equal or lower HCS priority than serving cell.
- prioritise re-selection of intra-frequency and inter-frequency neighbouring cells on lower HCS priority level before neighbouring cells on same HCS priority level.

When the number of cell reselections during time period  $T_{CRmax}$  no longer exceeds  $N_{CR}$ , UE shall

- continue these measurements during time period  $T_{CRmaxHyst}$  and
- revert to measurements according to the threshold based measurement rules.

When serving cell belongs to a hierarchical cell structure, the UE shall follow these rules for Inter-RAT measurements:

1. Inter-RAT threshold-based measurement rules

use Squal for FDD cells and Srxlev for TDD cells for  $S_x$  and apply the following rules.

IF ( $S_{rxlev_s} \leq S_{HCS,RATm}$ ) or (if FDD and  $S_{qual} \leq S_{SearchRATm}$ ) THEN

UE shall measure on all inter-RATm cells

ELSE

IF ( $S_x > S_{limit,SearchRATm}$ ) THEN

UE need not measure neighbouring cells in RAT "m"

ELSE

UE shall measure on all neighbouring cells in RAT "m", which have equal or higher HCS priority level than the serving cell unless measurement rules for fast-moving UEs are triggered

ENDIF

ENDIF

If HCS is used and if  $S_{\text{HCS,RAT}_m}$  is not sent for the serving cell, UE shall measure on all inter-RAT<sub>m</sub> cells.

## 2. Inter-RAT measurement rules for fast-moving UEs

- If the number of cell reselections during time period  $T_{\text{CRmax}}$  exceeds  $N_{\text{CR}}$ , high-mobility has been detected. In this high-mobility state, UE shall
  - measure the neighbouring cells in RAT "m", which have an equal or lower HCS priority than the serving cell
  - prioritise re-selection of neighbouring cells in RAT "m" on lower HCS priority level before neighbouring cells in RAT "m" on same HCS priority level.

When the number of cell reselections during time interval  $T_{\text{CRmax}}$  no longer exceeds  $N_{\text{CR}}$ , UE shall

- continue these measurements during time period  $T_{\text{CRmaxHyst}}$ , and
- revert to measure according to the threshold-based measurement rules.

### 5.2.6.1.3 Highest ranked cells with access restrictions

For the highest ranked cell (including serving cell) according to cell reselection criteria specified in subclause 5.2.6.1.4, the UE shall check if the access is restricted according to the rules in subclause 5.3.1.1.

If that cell and other cells have to be excluded from the candidate list, as stated in subclause 5.3.1.1, the UE shall not consider these as candidates for cell reselection. This limitation is removed when the highest ranked cell changes.

### 5.2.6.1.4 Cell Reselection Criteria

The following cell re-selection criteria are used for intra-frequency cells, inter-frequency cells and inter-RAT cells:

The quality level threshold criterion H for hierarchical cell structures is used to determine whether prioritised ranking according to hierarchical cell re-selection rules shall apply, and is defined by:

$$H_s = Q_{\text{meas},s} - Q_{\text{hcs}_s}$$

$$H_n = Q_{\text{meas},n} - Q_{\text{hcs}_n} - \text{TO}_n * L_n$$

If it is indicated in system information that HCS is not used, the quality level threshold criterion H is not applied.

The cell-ranking criterion R is defined by:

$$R_s = Q_{\text{meas},s} + Q_{\text{hyst}_s}$$

$$R_n = Q_{\text{meas},n} - Q_{\text{offset}_{s,n}} - \text{TO}_n * (1 - L_n)$$

where:

$$TO_n = TEMP\_OFFSET_n * W(PENALTY\_TIME_n - T_n)$$

$$L_n = 0 \quad \text{if } HCS\_PRIO_n = HCS\_PRIO_s$$

$$L_n = 1 \quad \text{if } HCS\_PRIO_n \neq HCS\_PRIO_s$$

$$W(x) = 0 \quad \text{for } x < 0$$

$$W(x) = 1 \quad \text{for } x \geq 0$$

TEMP\_OFFSET<sub>n</sub> applies an offset to the H and R criteria for the duration of PENALTY\_TIME<sub>n</sub> after a timer T<sub>n</sub> has started for that neighbouring cell.

TEMP\_OFFSET<sub>n</sub> and PENALTY\_TIME<sub>n</sub> are only applicable if the usage of HCS is indicated in system information.

The timer T<sub>n</sub> is implemented for each neighbouring cell. T<sub>n</sub> shall be started from zero when one of the following conditions becomes true:

- if HCS\_PRIO<sub>n</sub> ≠ HCS\_PRIO<sub>s</sub> and

$$Q_{meas,n} > Q_{hcs,n}$$

Or

- if HCS\_PRIO<sub>n</sub> = HCS\_PRIO<sub>s</sub> and

- for serving FDD and neighbour FDD cells if the quality measure for cell selection and reselection is set to CPICH RSCP in the serving cell, and:

$$Q_{meas,n} > Q_{meas,s} + Q_{offset1,s,n}$$

- for serving FDD and neighbour FDD cells if the quality measure for cell selection and reselection is set to CPICH Ec/No in the serving cell, and:

$$Q_{meas,n} > Q_{meas,s} + Q_{offset2,s,n}$$

- for all other serving and neighbour cells:

$$Q_{meas,n} > Q_{meas,s} + Q_{offset1,s,n}$$

T<sub>n</sub> for the associated neighbour cell shall be stopped as soon as any of the above conditions are no longer fulfilled. Any value calculated for TO<sub>n</sub> is valid only if the associated timer T<sub>n</sub> is still running else TO<sub>n</sub> shall be set to zero.

At cell-reselection, a timer T<sub>n</sub> is stopped only if the corresponding cell is not a neighbour cell of the new serving cell, or if the criteria given above for starting timer T<sub>n</sub> for the corresponding cell is no longer fulfilled with the parameters of the new serving cell. On cell re-selection, timer T<sub>n</sub> shall be continued to be run for the corresponding cells but the criteria given above shall be evaluated with parameters broadcast in the new serving cell if the corresponding cells are neighbours of the new serving cell.

|                   |   |
|-------------------|---|
| S <sub>n</sub>    | Cell Selection value of the neighbouring cell, (dB)   |
| Q <sub>meas</sub> | Quality value. The quality value of the received signal derived from the averaged CPICH Ec/No or CPICH RSCP for FDD cells, from the averaged P-CCPCH RSCP for TDD cells and from the averaged received signal level for GSM cells. The averaging of these measurement quantities are performed as specified in [10] and [11]. For FDD cells, the measurement that is used to derive the quality value is set by the Cell_selection_and_reselection_quality_measure information element. |

Cell reselection parameters broadcast in system information are listed in subclause 5.2.6.1.5.

The cell selection criterion  $S$  used for cell reselection is fulfilled when:

|                |                                    |
|----------------|------------------------------------|
| for FDD cells: | $S_{rxlev} > 0$ AND $S_{qual} > 0$ |
| for TDD cells: | $S_{rxlev} > 0$                    |
| for GSM cells: | $S_{rxlev} > 0$                    |

Where :

|   |
|---|
| $S_{qual} = Q_{qualmeas} - Q_{qualmin}$                       |
| $S_{rxlev} = Q_{rxlevmeas} - Q_{rxlevmin} - P_{compensation}$ |

|                        |  |
|------------------------|--|
| $S_{qual}$             | Cell Selection quality value (dB)<br>Applicable only for FDD cells.  |
| $S_{rxlev}$            | Cell Selection RX level value (dB)   |
| $Q_{qualmeas}$         | Measured cell quality value. The quality of the received signal expressed in CPICH $E_c/N_0$ (dB) for FDD cells. CPICH $E_c/N_0$ shall be averaged as specified in [10].<br>Applicable only for FDD cells.   |
| $Q_{rxlevmeas}$        | Measured cell RX level value. This is received signal, CPICH RSCP for FDD cells (dBm), P-CCPCH RSCP for TDD cells (dBm) and the averaged received signal level as specified in [10] for GSM cells (dBm). CPICH RSCP, P-CCPCH RSCP and the received signal level for GSM cells shall be averaged as specified in [10] and [11]. |
| $Q_{qualmin}$          | Minimum required quality level in the cell (dB). Applicable only for FDD cells.  |
| $Q_{rxlevmin}$         | Minimum required RX level in the cell (dBm)  |
| $P_{compensation}$     | $\max(UE\_TXPWR\_MAX\_RACH - P\_MAX, 0)$ (dB)  |
| $UE\_TXPWR\_MAX\_RACH$ | Maximum TX power level an UE may use when accessing the cell on RACH (read in system information) (dBm)  |
| $P\_MAX$               | Maximum RF output power of the UE (dBm)  |

The UE shall perform ranking of all cells that fulfil the  $S$  criterion among

- all cells that have the highest HCS\_PRIO among those cells that fulfil the criterion  $H \geq 0$ . Note that this rule is not valid when UE high-mobility is detected (see subclause 5.2.6.1.2).
- all cells, not considering HCS priority levels, if no cell fulfil the criterion  $H \geq 0$ . This case is also valid when it is indicated in system information that HCS is not used, that is when serving cell does not belong to a hierarchical cell structure.

The cells shall be ranked according to the  $R$  criteria specified above, deriving  $Q_{meas,n}$  and  $Q_{meas,s}$  and calculating the  $R$  values using CPICH RSCP, P-CCPCH RSCP and the averaged received signal level as specified in [10] and [11] for FDD, TDD and GSM cells, respectively.

The offset  $Q_{offset1_{s,n}}$  is used for  $Q_{offset_{s,n}}$  to calculate  $R_n$ , the hysteresis  $Q_{hyst1_s}$  is used for  $Q_{hyst_s}$  to calculate  $R_s$ .

If the usage of HCS is indicated in system information,  $TEMP\_OFFSET1_n$  is used for  $TEMP\_OFFSET_n$  to calculate  $TO_n$ . If it is indicated in system information that HCS is not used,  $TEMP\_OFFSET_n$  is not applied when calculating  $R_n$ . The best ranked cell is the cell with the highest  $R$  value.

If a TDD or GSM cell is ranked as the best cell, then the UE shall perform cell re-selection to that TDD or GSM cell.

If an FDD cell is ranked as the best cell and the quality measure for cell selection and re-selection is set to CPICH RSCP, the UE shall perform cell re-selection to that FDD cell.

If an FDD cell is ranked as the best cell and the quality measure for cell selection and re-selection is set to CPICH  $E_c/N_0$ , the UE shall perform a second ranking of the FDD cells according to the  $R$  criteria specified above, but using

the measurement quantity CPICH Ec/No for deriving the  $Q_{\text{meas},n}$  and  $Q_{\text{meas},s}$  and calculating the R values of the FDD cells. The offset  $Q_{\text{offset}2_{s,n}}$  is used for  $Q_{\text{offset},s,n}$  to calculate  $R_n$ , the hysteresis  $Q_{\text{hyst}2_s}$  is used for  $Q_{\text{hyst},s}$  to calculate  $R_s$ . If the usage of HCS is indicated in system information,  $\text{TEMP\_OFFSET}2_n$  is used to calculate  $\text{TO}_n$ . If it is indicated in system information that HCS is not used,  $\text{TEMP\_OFFSET}_n$  is not applied when calculating  $R_n$ . Following this second ranking, the UE shall perform cell re-selection to the best ranked FDD cell.

In all cases, the UE shall reselect the new cell, only if the following conditions are met:

- the new cell is better ranked than the serving cell during a time interval  $T_{\text{reselection}}$ .
- more than 1 second has elapsed since the UE camped on the current serving cell.

#### 5.2.6.1.5 Cell reselection parameters in system information broadcasts

The selection of values for network controlled parameters can be optimised by means of different methods. Examples of methods are described in [6]. Cell reselection parameters are broadcast in system information and are read in the serving cell as follows:

##### **$Q_{\text{offset}1_{s,n}}$**

This specifies the offset between the two cells. It is used for TDD and GSM cells and for FDD cells in case the quality measure for cell selection and re-selection is set to CPICH RSCP.

##### **$Q_{\text{offset}2_{s,n}}$**

This specifies the offset between the two cells. It is used for FDD cells in case the quality measure for cell selection and re-selection is set to CPICH Ec/No.

##### **$Q_{\text{hyst}1_s}$**

This specifies the hysteresis value ( $Q_{\text{hyst}}$ ). It is used for TDD and GSM cells and for FDD cells in case the quality measure for cell selection and re-selection is set to CPICH RSCP.

##### **$Q_{\text{hyst}2_s}$**

This specifies the hysteresis value ( $Q_{\text{hyst}}$ ). It is used for FDD cells if the quality measure for cell selection and re-selection is set to CPICH Ec/No.

##### **$\text{HCS\_PRIO}_s, \text{HCS\_PRIO}_n$**

This specifies the HCS priority level (0-7) for serving cell and neighbouring cells.

##### **$Q_{\text{hcs}_s}, Q_{\text{hcs}_n}$**

This specifies the quality threshold levels for applying prioritised hierarchical cell re-selection.

##### **$Q_{\text{qualmin}}$**

This specifies the minimum required quality level in the cell in dB. It is not applicable for TDD cells or GSM cells.

##### **$Q_{\text{rxlevmin}}$**

This specifies the minimum required RX level in the cell in dBm.

##### **$\text{PENALTY\_TIME}_n$**

This specifies the time duration for which the  $\text{TEMPORARY\_OFFSET}_n$  is applied for a neighbouring cell.

##### **$\text{TEMPORARY\_OFFSET}1_n$**

This specifies the offset applied to the H and R criteria for a neighbouring cell for the duration of  $\text{PENALTY\_TIME}_n$ . It is used for TDD and GSM cells and for FDD cells in case the quality measure for cell selection and re-selection is set to CPICH RSCP.

##### **$\text{TEMPORARY\_OFFSET}2_n$**



This specifies the offset applied to the H and R criteria for a neighbouring cell for the duration of  $PENALTY\_TIME_n$ . It is used for FDD cells in case the quality measure for cell selection and re-selection is set to CPICH Ec/No.

#### $T_{CRmax}$

This specifies the duration for evaluating allowed amount of cell reselection(s).

#### $N_{CR}$

This specifies the maximum number of cell reselections.

#### $T_{CRmaxHyst}$

This specifies the additional time period before the UE can revert to low-mobility measurements.

#### $T_{reselection_s}$

This specifies the cell reselection timer value.

#### $S_{search_{HCS}}$

This threshold is used in the measurement rules for cell re-selection when HCS is used. It specifies the limit for  $S_{rxlev}$  in the serving cell below which the UE shall initiate measurements of all neighbouring cells of the serving cell.

#### $S_{search_{RAT1}} - S_{search_{RATk}}$

This specifies the RAT specific threshold in the serving cell used in the inter-RAT measurement rules.

#### $S_{HCS,RATm}$

This threshold is used in the measurement rules for cell re-selection when HCS is used. It specifies the RAT specific threshold in the serving cell used in the inter-RAT measurement rules.

#### $S_{intra_{search}}$

This specifies the threshold (in dB) for intra frequency measurements and for the HCS measurement rules.

#### $S_{inter_{search}}$

This specifies the threshold (in dB) for inter-frequency measurements and for the HCS measurement rules.

#### $S_{limit,Search_{RATm}}$

This threshold is used in the measurement rules for cell re-selection when HCS is used. It specifies the RAT specific threshold (in dB) in the serving UTRA cell above which the UE need not perform any inter-RAT measurements in RAT "m".

### 5.2.6.2 GSM case

The cell reselection procedure in GSM, including reselection from GSM to UTRA, is specified in [1].

## 5.2.7 Cell Selection when leaving connected mode

### 5.2.7.1 UTRA case

When returning to idle mode from connected mode, the UE shall select a suitable cell to camp on. Candidate cells for this selection are the cell(s) used immediately before leaving connected mode. If no suitable cell is found, the UE shall use the Stored information cell selection procedure in order to find a suitable cell to camp on.

When returning to idle mode after an emergency call on any PLMN, the UE shall select an acceptable cell to camp on. Candidate cells for this selection are the cell(s) used immediately before leaving connected mode. If no acceptable cell is found, the UE shall continue to search for an acceptable cell of any PLMN in state Any cell selection.

### 5.2.7.2 GSM case

Cell selection when leaving connected mode in GSM is specified in [1].

## 5.2.8 Any Cell Selection state

In this state, the UE shall attempt to find an acceptable cell of an any PLMN to camp on, trying all RATs that are supported by the UE and searching first for a high quality cell, as defined in subclause 5.1.2.2.

The UE, which is not camped on any cell, shall stay in this state until an acceptable cell is found.

## 5.2.9 Camped on Any Cell State

### 5.2.9.1 UTRA case

In this state, the UE shall perform the following tasks:

- select and monitor the indicated PICH and PCH of the cell as specified in clause 8;
- monitor relevant System Information; This is specified in [4];
- perform necessary measurements for the cell reselection evaluation procedure;
- Execute the cell reselection evaluation process on the following occasions/triggers:
  - 1) UE internal triggers, so as to meet performance as specified in [10] and [11];
  - 2) When information on the BCCH used for the cell reselection evaluation procedure has been modified;
- regularly attempt to find a suitable cell of the selected PLMN trying all RATs that are supported by the UE. If a suitable cell is found, this causes an exit to number 2 in Figure 2.

### 5.2.9.2 GSM case

The camped on any cell state in GSM is specified in [1].

## 5.3 Cell Reservations and Access Restrictions

### 5.3.1 UTRA cells

There are two mechanisms which allow an operator to impose cell reservations or access restrictions. The first mechanism uses indication of cell status and special reservations for control of cell selection and re-selection procedures. The second mechanism, referred to as Access Control, shall allow to prevent selected classes of users from sending initial access messages for load control reasons. At subscription, one or more Access Classes are allocated to the subscriber and stored in the USIM [9], which are employed for this purpose.

#### 5.3.1.1 Cell status and cell reservations

Cell status and cell reservations are indicated with the *Cell Access Restriction* Information Element in the System Information Message [4] by means of three Information Elements:

- Cell barred (IE type: "barred" or "not barred"),
- Cell Reserved for operator use (IE type: "reserved" or "not reserved"),
- Cell reserved for future extension (IE type: "reserved" or "not reserved").

When cell status is indicated as "not barred", "not reserved" for operator use and "not reserved" for future extension (Cell Reservation Extension),

- the UE may select/re-select this cell during the cell selection and cell re-selection procedures in Idle mode and in Connected mode.

When cell status is indicated as "not barred", "not reserved" for operator use and "reserved" for future extension (Cell Reservation Extension),

- UEs shall behave as if cell status "barred" is indicated using the value "not allowed" in the IE "Intra-frequency cell re-selection indicator" and the maximum value for  $T_{\text{barred}}$ , see [4] (see also below).

When cell status is indicated as "not barred" and "reserved" for operator use,

- UEs assigned to Access Class 11 or 15 may select/re-select this cell if in the home PLMN.
- UEs assigned to an Access Class in the range 0 to 9 and 12 to 14 shall behave as if cell status "barred" is indicated using the value "not allowed" in the IE "Intra-frequency cell re-selection indicator" and the maximum value for  $T_{\text{barred}}$ , see [4] (see also below).

When cell status "barred" is indicated,

- The UE is not permitted to select/re-select this cell, not even for emergency calls.
- The UE shall ignore the "Cell Reserved for future extension (Cell Reservation Extension) use" IE.
- The UE shall select another cell according to the following rule:
  - If the "Intra-frequency cell re-selection indicator" IE in Cell Access Restriction IE is set to value "allowed", the UE may select another cell on the same frequency if selection/re-selection criteria are fulfilled.
  - If the UE is camping on another cell, the UE shall exclude the barred cell from the neighbouring cell list until the expiry of a time interval  $T_{\text{barred}}$ . The time interval  $T_{\text{barred}}$  is sent via system information in a barred cell together with Cell status information in the Cell Access Restriction IE.
  - If the UE does not select another cell, and the barred cell remains to be the "best" one, the UE shall after expiry of the time interval  $T_{\text{barred}}$  again check whether the status of the barred cell has changed.
  - If the "Intra-frequency cell re-selection indicator" IE is set to "not allowed" the UE shall not re-select a cell on the same frequency as the barred cell. For emergency call, the Intra-frequency cell re-selection indicator IE shall be ignored, i.e. even if it is set to "not allowed" the UE may select another intra-frequency cell.
  - If the barred cell remains to be the "best" one, the UE shall after expiry of the time interval  $T_{\text{barred}}$  again check whether the status of the barred cell has changed.

The reselection to another cell may also include a change of RAT.

### 5.3.1.2 Access Control

Information on cell access restrictions associated with the Access Classes is broadcast as system information, [4].

The UE shall ignore Access Class related cell access restrictions 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 for any of the Access Classes of the UE. A change of the indicated access restriction shall not trigger cell re-selection by the UE.

Access Class related cell access restrictions shall be checked by the UE before sending an RRC CONNECTION REQUEST message when entering Connected Mode from UTRAN Idle mode. Cell access restrictions associated with the Access Classes shall not apply when the initial access for entering Connected Mode is triggered by an Inter-RAT cell re-selection to UTRAN, and for a UE which already is in Connected Mode.

### 5.3.1.3 Emergency Call

Emergency calls shall be allowed in all cells whose barred status is not barred, independent of restrictions due to cell reservations.

A restriction on emergency calls, if needed, shall be indicated in the "Access class barred list" IE [4]. If access class 10 is indicated as barred in a cell, UEs with access class 0 to 9 or without an IMSI are not allowed to initiate emergency

calls in this cell. For UEs with access classes 11 to 15, emergency calls are not allowed if both access class 10 and the relevant access class (11 to 15) are barred. Otherwise, emergency calls are allowed for those UEs.

Full details of operation under "Access class barred list" are described in [9].

### 5.3.2 GSM cells

The cell access restrictions applicable to GSM are specified in [1].

## 5.4 Cell Reselection Processes in RRC Connected Mode

### 5.4.1 Void

### 5.4.2 Void

### 5.4.3 Cell Reselection Process

The *cell reselection* process in Connected Mode is the same as *cell reselection evaluation process* used for idle mode, described in subclause 5.2.6.

## 5.5 Location Registration

In the UE, the AS shall report registration area information to the NAS.

The non-access part of the location registration process is specified in [5].

Actions for the UE AS upon reception of Location Registration reject are specified in [9] and [16].

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## 6 Broadcast information receiving

### 6.1 Reception of System Information

Requirements are specified in [4].

### 6.2 Cell Broadcast in Idle Mode, CELL\_PCH and URA\_PCH

A UE supporting Cell Broadcast Service (CBS) shall be capable to receive BMC messages in the Idle mode, in URA\_PCH and CELL\_PCH. When several PCHs exist in the cell, the FACH which carries the CTCH may be mapped to a different SCCPCH than the PCH selected by the UE for paging in Idle mode (as specified in Sec. 8.1). In this case, UEs with basic service capabilities shall be capable to change from the SCCPCH that carries the PCH selected for paging to another SCCPCH which carries Cell Broadcast messages (i.e. the CTCH mapped to an FACH) and receive BMC messages during time intervals which do not conflict with the UE specific paging occasions.

NOTE: In case certain BMC messages conflict with the UE specific paging occasions the reception of CBS cannot be guaranteed and depends on UE capabilities.

---

## 7 Void

## 8 Paging and SCCPCH selection

### 8.1 Paging Channel selection

System information block type 5 (SIB 5) defines common channels to be employed in Idle mode [4]. In a cell, a single or several PCHs may be established. Each Secondary Common Control Physical Channel (SCCPCH) indicated to the UE in system information may carry up to one PCH. Thus, for each defined PCH there is one uniquely associated PICH also indicated.

In case that more than a single PCH and associated PICH are defined in SIB 5, the UE shall perform a selection according to the following rule:

- The UE shall select a SCCPCH from the ones listed in SIB 5 based on IMSI as follows:

$$\text{"Index of selected SCCPCH"} = \text{IMSI} \bmod K,$$

where K is equal to the number of listed SCCPCHs which carry a PCH (i.e. SCCPCHs carrying FACH only shall not be counted). These SCCPCHs shall be indexed in the order of their occurrence in SIB 5 from 0 to K-1.

For GSM-MAP, i.e. "IMSI (GSM-MAP)" is given as sequence of digits of type Integer(0..9), IMSI shall in the formula above be interpreted as a decimal integer number, where the first digit given in the sequence represents the highest order digit.

For DS-41, i.e. "IMSI (DS-41)" is given as octet string, IMSI shall in the formulae above correspond to the decoded decimal representation of the IMSI-S part included in the octet string (see TIA/EIA/IS-2000-5).

For example:

$$\text{IMSI (GSM-MAP)} = 12 \text{ (digit1=1, digit2=2)}$$

In the calculations, this shall be interpreted as the decimal integer "12", not " $1 \times 16 + 2 = 18$ ".

"Index of selected SCCPCH" identifies the selected SCCPCH with the PCH and the uniquely associated PICH to be used by the UE.

If the UE has no IMSI, for instance when making an emergency call without USIM, the UE shall use as default number IMSI = 0.

### 8.2 SCCPCH selection when entering Connected mode

When entering Connected mode from Idle mode by sending an RRC CONNECTION REQUEST message, the UE shall select the S-CCPCH which carries an FACH to be used for reception of the RRC CONNECTION SETUP message according to the following rule:

- the UE shall select an SCCPCH from the SCCPCHs listed in System Information Block type 5 (SIB 5) based on "Initial UE Identity" as follows:

$$\text{"Index of selected SCCPCH"} = \text{"Initial UE Identity"} \bmod K,$$

where K is equal to the number of listed SCCPCHs which carry a FACH (i.e. SCCPCHs carrying PCH only shall not be counted). These SCCPCHs shall be indexed from 0 to K-1 in the order of their occurrence in SIB 5, and "Index of selected SCCPCH" identifies the selected SCCPCH. "Initial UE Identity" refers to the Information Element included by the UE into the RRC CONNECTION REQUEST message. In the above formula, the parameter "Initial UE Identity" shall be interpreted as follows, depending on the choice of UE-Id type of the respective IE:

For UE-Id type "IMSI (GSM-MAP)", i.e. the IE is given as sequence of digits of type Integer(0..9), "Initial UE Identity" shall be interpreted as an integer number, where the first digit given in the sequence represents the highest order digit.

For UE-Id types "TMSI and LAI (GSM-MAP)" or "P-TMSI and RAI (GSM-MAP)", only the TMSI or P-TMSI parts given as Bitstring(32) shall be used, and "Initial UE Identity" shall be interpreted as a binary representation of an integer number, where the first bit in the Bitstring represents the highest order bit.

For UE-Id type "IMEI", i.e. the IE is given as sequence of hexadecimal digits of type Integer(0..15), "Initial UE Identity" shall be interpreted as a hexadecimal representation of an integer number, where the first digit given in the sequence represents the highest order digit.

For UE-Id type "IMSI (DS-41)", i.e. the IE is given as octet string, "Initial UE Identity" shall correspond to the decoded decimal representation of the IMSI-S part included in the octet string (see TIA/EIA/IS-2000-5).

For UE-Id types "ESN (DS-41)" or "TMSI (DS-41)", i.e. the IE is given as Bitstring(32), "Initial UE Identity" shall be interpreted as a binary representation of an integer number, where the first bit in the Bitstring represents the highest order bit.

For UE-Id type "IMSI and ESN (DS-41)" only the ESN part shall be used as "Initial UE Identity", as defined above.

## 8.3 Discontinuous Reception

The UE may use Discontinuous Reception (DRX) in idle mode in order to reduce power consumption. When DRX is used the UE needs only to monitor one Page Indicator, PI, (see definition in [7] and [8]) in one Paging Occasion per DRX cycle.

The DRX cycle length shall be  $\text{MAX}(2^k, \text{PBP})$  frames, where  $k$  is an integer and PBP is the Paging Block Periodicity. PBP is only applicable for TDD and is equal to the PICH repetition period that is broadcast in system information. For FDD,  $\text{PBP}=1$ .

The UE may be attached to different CN domains with different CN domain specific DRX cycle lengths. The UE shall store each CN domain specific DRX cycle length for each CN domain the UE is attached to and use the shortest of those DRX cycle lengths. The CS CN specific DRX cycle length coefficient shall be updated locally in the UE using information given in system information. On the other hand, the PS CN specific DRX cycle length coefficient shall be updated after the negotiation between the UE and PS CN by NAS procedure. If no specific value "k" is negotiated in NAS procedure, the UE and PS CN shall use the DRX cycle length given for PS CN domain in system information.

The DRX cycle lengths to use for UTRAN connected mode is the shortest of the following:

- UTRAN DRX cycle length;
- any of the stored CN domain specific DRX cycle length for the CN domains the UE is only attached to with no signalling connection established.

The UE shall use the IMSI, the number of available SCCPCH which carry a PCH (K) as derived according to subclause 8.1, the Cell System Frame Number (SFN),  $N_p$  (for FDD,  $N_p$  is the number of page indicators within a frame; for TDD,  $N_p$  is the number of page indicators within a paging block), Frame offset (For FDD, Frame offset = 0; for TDD, PICH frame offset values are given in system information), PBP and the DRX cycle length to determine the Paging Occasions.

In FDD the UE shall monitor its paging indicator in the PICH frame with SFN given by the Paging Occasion

In TDD the UE shall monitor its paging indicator in the paging block given by the Paging Occasion. The Paging Occasion gives the SFN of the first frame of the paging block.

The value of the Paging Occasion is determined as follows:

$$\text{Paging Occasion} = \{(\text{IMSI div } K) \bmod (\text{DRX cycle length div PBP})\} * \text{PBP} + n * \text{DRX cycle length} + \text{Frame Offset}$$

Where  $n = 0, 1, 2, \dots$  as long as SFN is below its maximum value.

The actual Page Indicator within a Paging Occasion that the UE shall read is similarly determined based on IMSI.

The Page Indicator to use is calculated by using the following formula:

$$\text{PI} = \text{DRX Index mod } N_p$$

where  $\text{DRX Index} = \text{IMSI div } 8192$

In FDD mode,  $N_p = (18,36,72,144)$  is the number of Page Indicators per frame, and is given in IE "Number of PI per frame", part of system information in FDD mode. In TDD mode,  $N_p$  is the number of Page Indicators per paging block and is calculated by the Paging Indicator Length  $L_{PI}$ , the Burst Type (long or short midamble for 3.84 Mcps TDD) and the PICH repetition length, which are given in system information.

If the UE has no IMSI, for instance when making an emergency call without USIM, the UE shall use as default numbers, IMSI = 0 and DRX cycle length = 256 (2.56 s), in the formulas above.

For FDD, see [7] for details about the timing between a PICH frame and when the paging message is transmitted on the PCH in the associated S-CCPCH frame.

In TDD mode, the Paging Message Receiving Occasion is calculated using the following formula:

$$\text{Paging Message Receiving Occasion} = \text{Paging Occasion} + N_{\text{PICH}} + N_{\text{GAP}} + \{(\text{DRX Index mod } N_p) \text{ mod } N_{\text{PCH}}\} * 2$$

The value  $N_{\text{PICH}}$  is the number of frames for PICH transmission and is equal to the PICH repetition length given in system information. The value  $N_{\text{GAP}}$  is the number of frames between the last frame carrying PICH for this Paging Occasion and the first frame carrying paging messages for this Paging Occasion. The value  $N_{\text{PCH}}$  is the number of Paging Groups.  $N_{\text{PCH}}$  and  $N_{\text{GAP}}$  are given in system information.

For GSM-MAP, i.e. "IMSI (GSM-MAP)" is given as sequence of digits of type Integer(0..9), IMSI shall in the formulae above be interpreted as a decimal integer number, where the first digit given in the sequence represents the highest order digit.

For DS-41, i.e. "IMSI (DS-41)" is given as octet string, IMSI shall in the formulae above correspond to the decoded decimal representation of the IMSI-S part included in the octet string (see TIA/EIA/IS-2000-5).

For example:

$$\text{IMSI (GSM-MAP)} = 12 \text{ (digit1=1, digit2=2)}$$

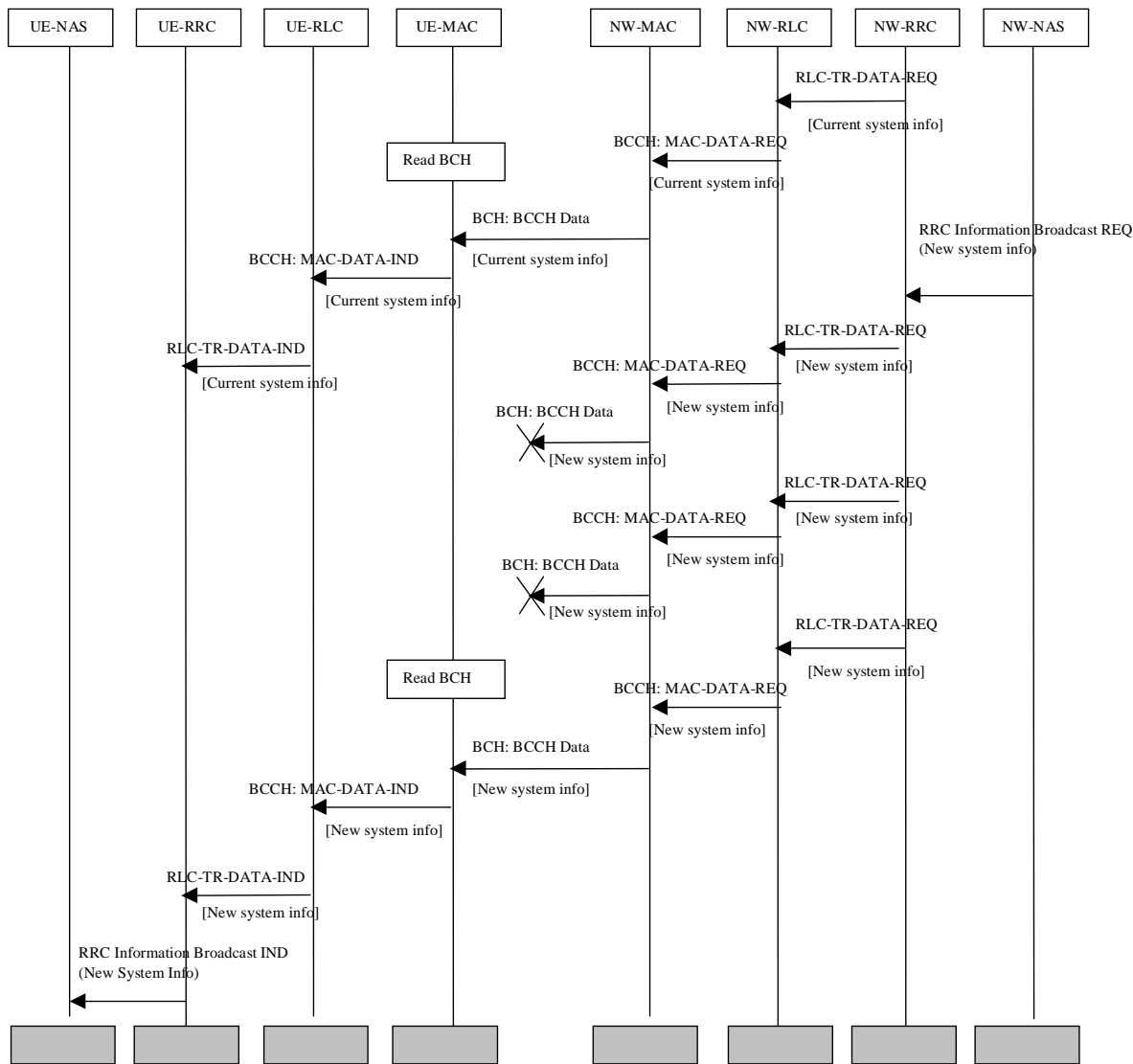
In the calculations, this shall be interpreted as the decimal integer "12", not " $1 \times 16 + 2 = 18$ ".

## 9 Void

# 10 Examples of Procedures

## 10.1 NAS initiated change of system information

The sequence in Figure 5 shows the change of broadcast system information initiated from the NAS.



**Figure 5: Example sequence, NAS initiated change of broadcast system info**

A NAS entity in the network issues a request for change of the broadcast system information, by issuing a RRC Information Broadcast REQ primitive over the General Control (GC) SAP.

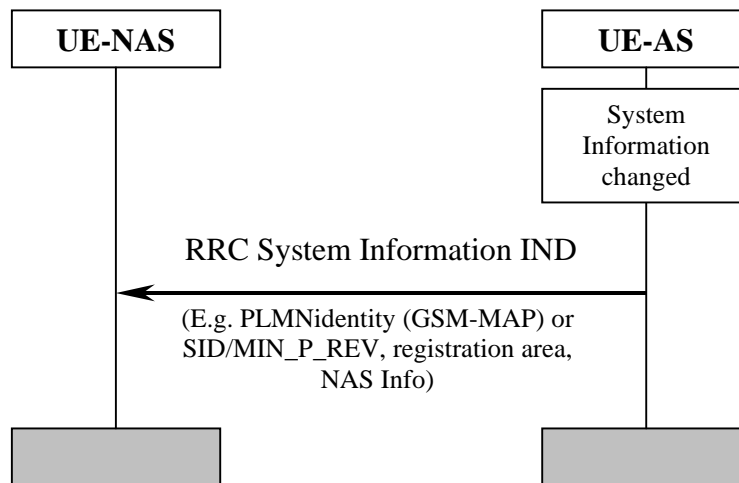
The change in system information in this example is such that it is not necessary for the UEs to be forced to receive BCCH immediately after the change. All UEs will eventually read the new system information either at e.g. cell reselection or at UE state change.

When the UE reads system information on BCCH and the RRC layer finds out that the non-access part of the information has been changed, an RRC Information Broadcast IND primitive is issued to the NAS entity in the UE over the General Control (GC) SAP.

**NOTE:** The network may force the UEs in a paging group to read system information by sending a page request message, but this is not shown in the example above.



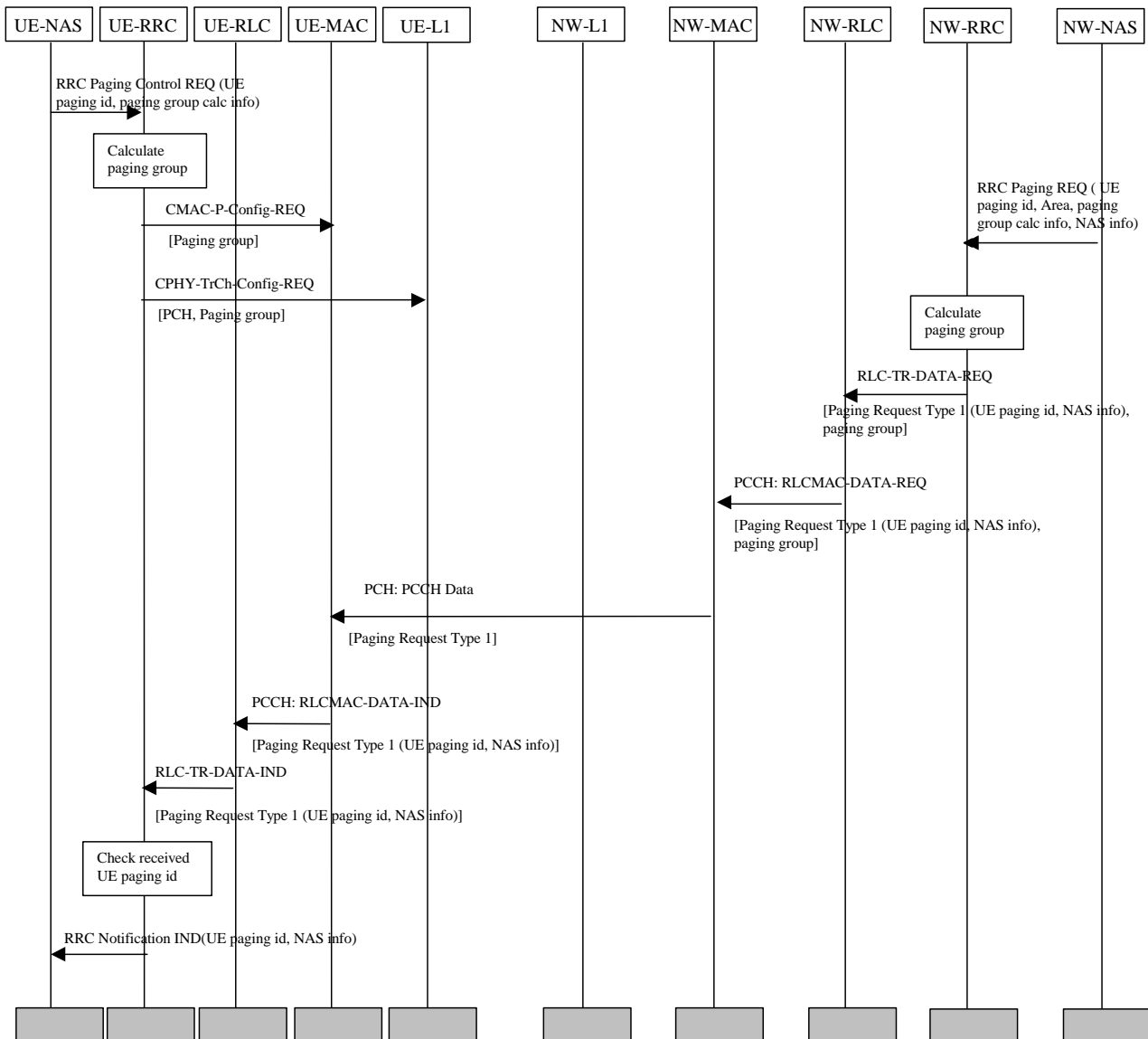
## 10.2 System Information Update to NAS



**Figure 6: System Information Update to NAS**

AS sends system information to NAS when a change of system information is detected in the cell currently camped on. This happens for instance when a new cell is selected due to cell reselection. The information sent can include PLMN identity (GSM-MAP or SID, registration area and NAS information).

### 10.3 CN originated paging in idle mode



**Figure 7: Example sequence of CN initiated paging request in idle mode**

Figure 7 illustrates a CN originated paging request when the UE is in idle mode.

In the UE, a NAS entity issues the primitive RRC Paging Control REQ, which tells RRC to listen to paging and notifications addressed to a given UE paging identity and on a paging group which can be calculated using information given from NAS.

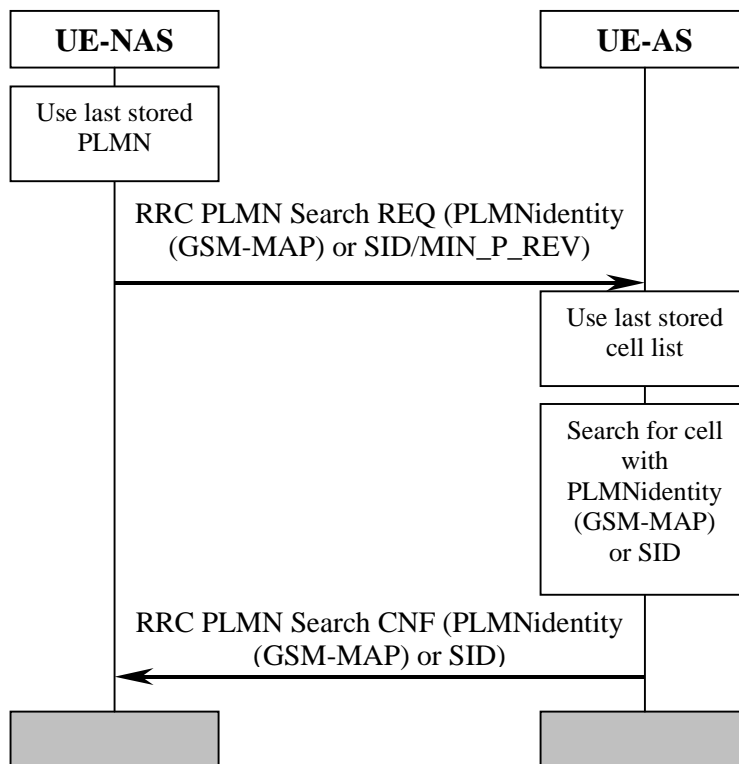
NOTE: The paging group calculation info can e.g. be the IMSI of the UE.

A NAS entity on the network side requests paging of an UE using the RRC Paging REQ primitive over the Nt-SAP. The primitive contains a UE paging identity, an area where the page request is to be broadcast, information for calculation of the paging group and NAS information to be transparently transmitted to the UE by the paging request.

The RRC layer calculates the paging group, and formats a Paging Request Type 1 message containing the UE paging identity and the NAS information. The RRC layer then requests MAC to transmit the message on a specific PCH on the selected paging group. The PCH to be used for transmission of the paging message is selected based on the IMSI of the UE.

In the UE, the RRC layer continuously monitors the paging group, compares the UE paging identities in received paging request messages with its own identities. A match occurs, and in this case the UE paging identity and the NAS information is forwarded to the NAS entity of the UE.

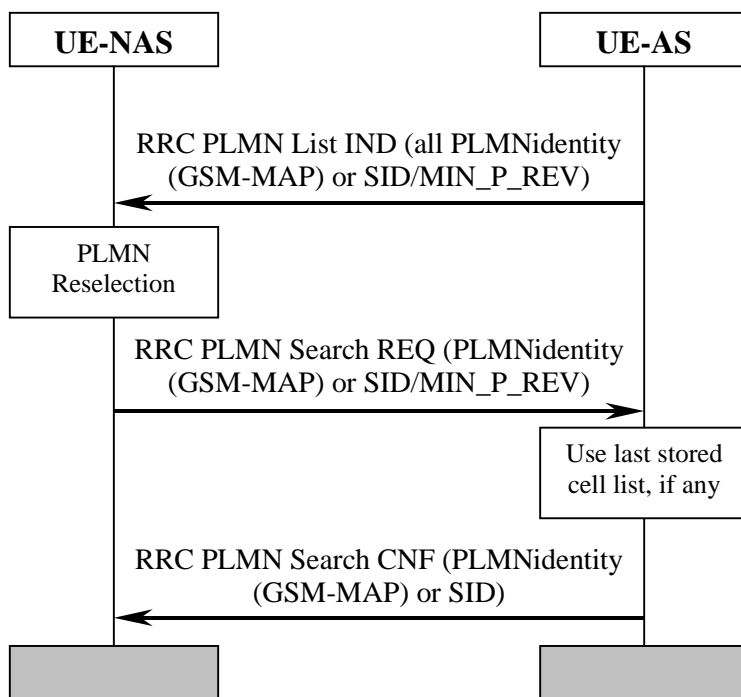
### 10.4 PLMN Selection, automatic mode, normal case



**Figure 8: PLMN Selection, automatic mode, normal case**

At power-on, NAS selects the PLMN according to the priority defined in [5]. The AS is requested to find a cell belonging to that PLMN. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information stored prior to previous power-off. When a suitable cell belonging to the requested PLMN is found, that cell is selected and NAS is notified that the PLMN was found.

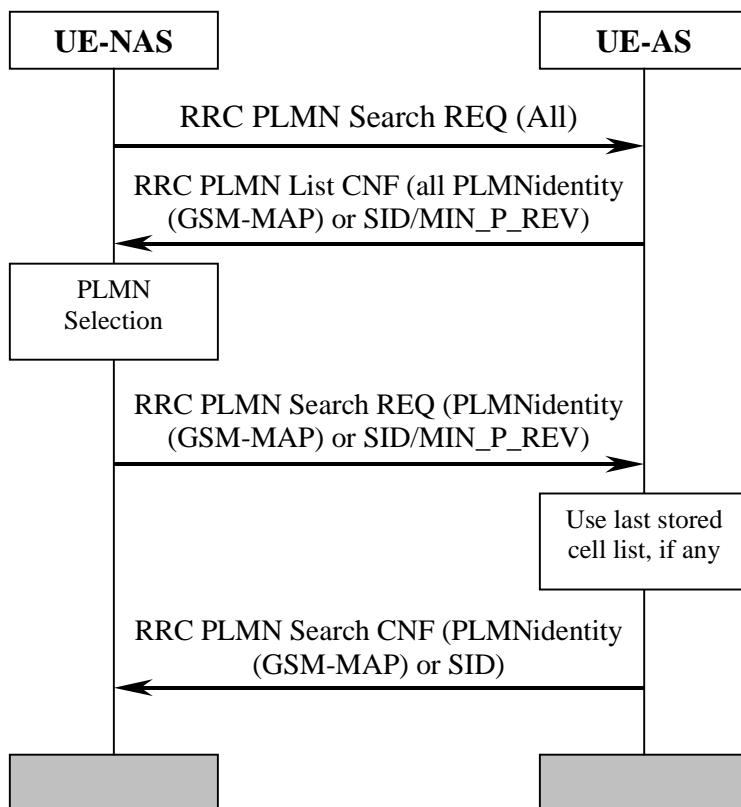
## 10.5 PLMN Reselection, automatic mode



**Figure 9: PLMN Reselection, automatic mode**

Triggered by, for instance, a timer in NAS, AS is requested to send a list to NAS with all PLMNs currently available. The list includes the identities of available PLMNs. Assuming that a PLMN with higher priority is found, NAS requests AS to select a suitable cell belonging to the PLMN with highest priority. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information previously stored. When a suitable cell belonging to the requested PLMN is found, that cell is selected and NAS is notified that the PLMN was found.

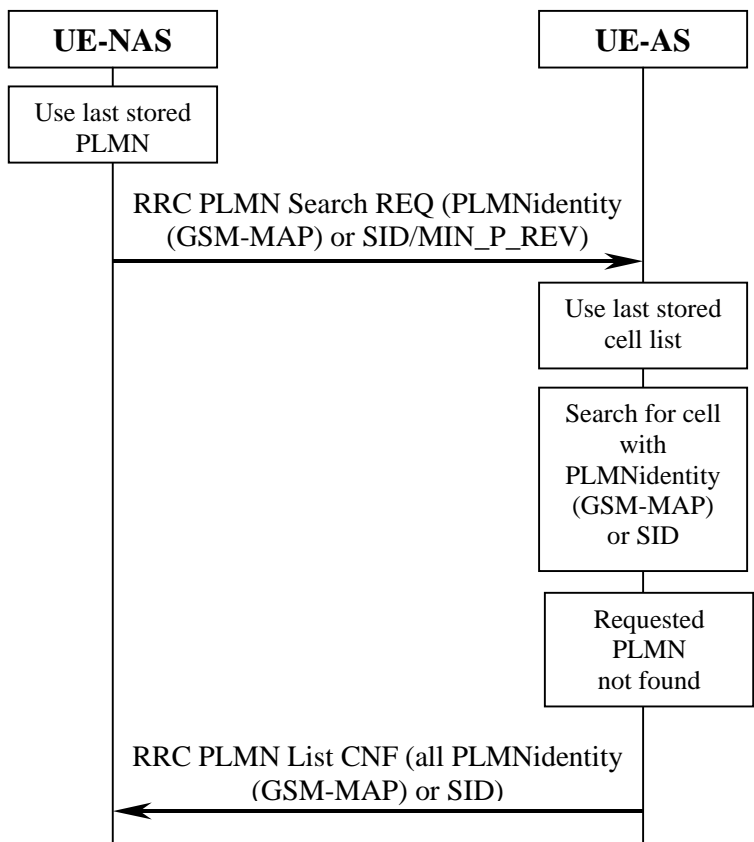
## 10.6 PLMN Reselection, manual mode



**Figure 10: PLMN Reselection, manual mode**

NAS requests AS to report all PLMNs currently available, for instance as a response to a user request. AS sends a list to NAS with all PLMNs currently available. The list includes the identities of available PLMNs. Assuming that a PLMN with higher priority is selected by for instance the user, NAS requests AS to select a suitable cell belonging to the PLMN with highest priority. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information previously stored. When a suitable cell belonging to the requested PLMN is found, that cell is selected and NAS is notified that the PLMN was found.

### 10.7 PLMN Selection, automatic mode, selected PLMN not found

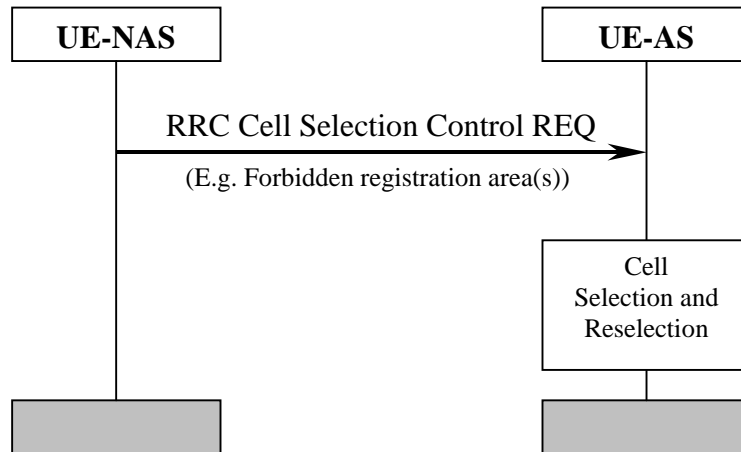


**Figure 11: PLMN Selection, automatic mode, selected PLMN not found**

At power-on, NAS selects the PLMN according to the priority defined in [5]. The AS is requested to find a suitable cell belonging to that PLMN. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information stored prior to previous power-off. If no suitable cell is found belonging to the requested PLMN, a list of available PLMNs is sent to NAS.

## 10.8 NAS Controlled Cell Selection

### 10.8.1 Execution in AS

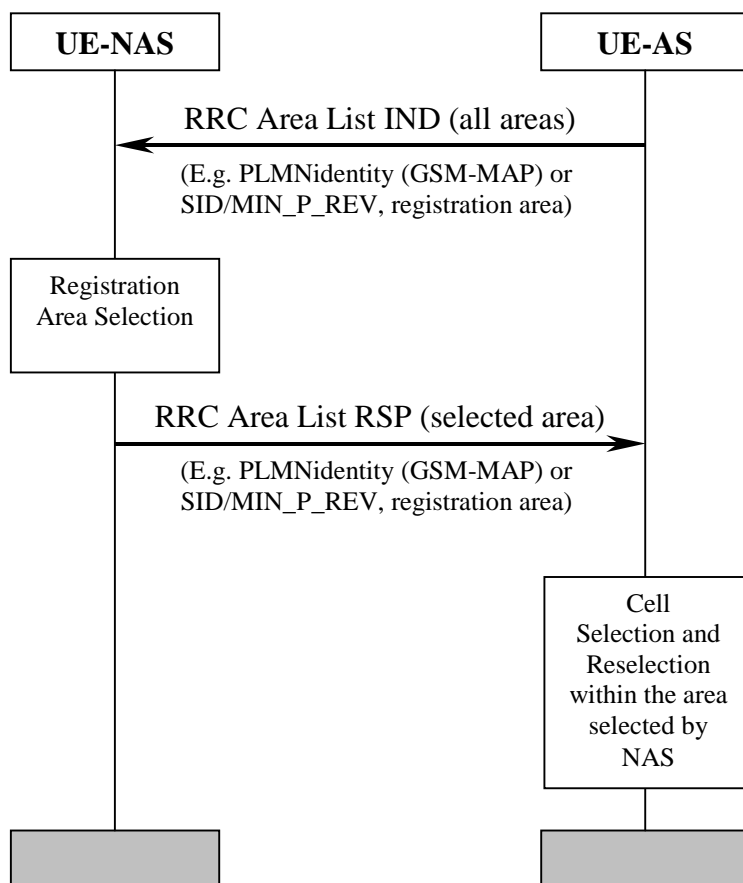


**Figure 12: NAS Controlled Cell Selection, execution in AS**

NAS may influence the cell selection and reselection by sending control information to AS. This information can include, for example, lists of forbidden registration areas. The control information is used by AS in cell selection and reselection:

- Cells belonging to a forbidden registration area will only be selected if no better cell is found. At this point, the services provided the UE might be limited.

## 10.8.2 Execution in NAS



**Figure 13: NAS Controlled Cell Selection, execution in NAS**

As an alternative to the example in subclause 10.8.1, AS sends cell selection information to NAS. This information can include PLMN identity (GSM-MAP) or SID and registration area. The information contains the full set of available registration areas. The information is typically sent when there is a change of available areas, for instance when a neighbour cell belonging to a new registration area.

AS performs cell selection and reselection for the selected registration area without interaction with NAS. However, before reselecting a cell in another registration area, AS shall check with NAS.



## Annex A (informative): Change history

| Change history |       |           |     |     |  |       |       |
|----------------|-------|-----------|-----|-----|--|-------|-------|
| Date           | TSG # | TSG Doc.  | CR  | Rev | Subject/Comment  | Old   | New   |
| 10/1999        | RP-05 | RP-99464  | -   | -   | Approved at TSG-RAN #5 and placed under Change Control                         | -     | 3.0.0 |
| 12/1999        | RP-06 | RP-99632  | 001 | 2   | Modification and editorial changes   | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99633  | 002 | 3   | Specification of Cell reselection procedures in                                | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99633  | 003 | 2   | Integration of Cell Broadcast Service (CBS)                                    | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99633  | 004 | 2   | Measurement used as a quality estimate for cell                                | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99632  | 006 |     | Discontinuous reception  | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99633  | 008 | 3   | Barred Cells and Access Control  | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99633  | 009 |     | Introduction of network control of UE measurement                              | 3.0.0 | 3.1.0 |
|                | RP-06 | RP-99631  | 011 |     | Editorial issues   | 3.0.0 | 3.1.0 |
| 03/2000        | RP-07 | RP-000037 | 007 | 2   | Cell Selection for DS-41 mode  | 3.1.0 | 3.2.0 |
|                | RP-07 | RP-000037 | 014 |     | Modified description of cell search procedure                                  | 3.1.0 | 3.2.0 |
|                | RP-07 | RP-000037 | 018 | 1   | UE individual DRX cycles in CELL_PCH and URA_PCH states                        | 3.1.0 | 3.2.0 |
|                | RP-07 | RP-000037 | 019 | 1   | Cell re-selection criteria including HCS                                       | 3.1.0 | 3.2.0 |
|                | RP-07 | RP-000037 | 021 |     | Modified description of DRX  | 3.1.0 | 3.2.0 |
| 06/2000        | RP-08 | RP-000217 | 025 |     | Triggering of inter-system measurements for cell re-selection when HCS is used | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 026 | 5   | Cell re-selection  | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 027 | 4   | Access Control   | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 028 |     | Downlink signalling failure  | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 029 |     | Cell-reselection parameter signalling  | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 030 |     | Cell Selection and Reselection   | 3.2.0 | 3.3.0 |
|                | RP-08 | RP-000217 | 031 | 1   | CN DRX cycle coefficient   | 3.2.0 | 3.3.0 |
| 09/2000        | RP-09 | RP-000355 | 035 | 2   | Paging channel selection   | 3.3.0 | 3.4.0 |
|                | RP-09 | RP-000355 | 037 | 1   | Editorial corrections  | 3.3.0 | 3.4.0 |
|                | RP-09 | RP-000355 | 039 |     | HCS measurement rules  | 3.3.0 | 3.4.0 |
|                | RP-09 | RP-000355 | 042 | 2   | Usage of Ec/N0 measurement quantity for cell ranking                           | 3.3.0 | 3.4.0 |
|                | RP-09 | RP-000355 | 044 |     | Correction and restructuring   | 3.3.0 | 3.4.0 |
| 12/2000        | RP-10 | RP-000565 | 046 | 1   | Support for PLMN selection   | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 049 | 1   | Correction of algorithm for paging channel selection                           | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 050 |     | Alignment of use of TEMP_OFFSET parameters with TS 25.331                      | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 051 | 2   | Clarifications and Editorial Corrections                                       | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 052 | 1   | Clarifications to cell selection and reselection procedures                    | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 053 |     | Removal of immediate cell evaluation   | 3.4.0 | 3.5.0 |
|                | RP-10 | RP-000565 | 054 |     | One step cell selection  | 3.4.0 | 3.5.0 |
| 03/2001        | RP-11 | RP-010022 | 055 | 1   | Usage of HCS Parameters in Cell Reselection                                    | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 056 |     | Clarification of usage of "Initial UE-Id" for SCCPCH selection                 | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 058 |     | Clarification of paging occasion   | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 059 | 1   | Correction in Any Cell Selection State   | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 061 |     | Correction to the definition of a suitable cell                                | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 062 |     | Correction to discontinuous reception in TDD                                   | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 063 | 1   | Correction of PI calculation for Paging DRX                                    | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010200 | 064 | 3   | Equivalent PLMN codes  | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 065 |     | High quality cell in PLMN selection  | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010022 | 066 |     | Clean-up   | 3.5.0 | 3.6.0 |
|                | RP-11 | RP-010037 | 057 | 1   | Support of 1.28Mcps TDD  | 3.6.0 | 4.0.0 |
| 06/2001        | RP-12 | RP-010305 | 072 |     | Corrections to 25.304  | 4.0.0 | 4.1.0 |
|                | RP-12 | RP-010435 | 074 | 1   | Emergency calls in barred cells  | 4.0.0 | 4.1.0 |
|                | RP-12 | RP-010305 | 078 |     | Clarification to usage of measurement thresholds                               | 4.0.0 | 4.1.0 |
| 09/2001        | RP-13 | RP-010539 | 080 |     | Clarification to usage of measurement thresholds for HCS                       | 4.1.0 | 4.2.0 |
|                | RP-13 | RP-010539 | 082 |     | Definition of strongest cell in cell search procedures                         | 4.1.0 | 4.2.0 |
|                | RP-13 | RP-010539 | 084 | 1   | Miscellaneous corrections  | 4.1.0 | 4.2.0 |
|                | RP-13 | RP-010539 | 086 |     | Correction to cells reserved for operator use                                  | 4.1.0 | 4.2.0 |
|                | RP-13 | RP-010539 | 088 | 1   | Service type also valid in connected mode                                      | 4.1.0 | 4.2.0 |
|                | RP-13 | RP-010539 | 090 |     | Cell Access Restrictions for emergency calls                                   | 4.1.0 | 4.2.0 |
| 12/2001        | RP-14 | RP-010756 | 092 |     | Clarification on DRX cycle length in connected mode                            | 4.2.0 | 4.3.0 |
|                | RP-14 | RP-010756 | 094 |     | Correction to search for available PLMNs                                       | 4.2.0 | 4.3.0 |
| 03/2002        | RP-15 | RP-020063 | 096 |     | Correction to TDD paging message receiving occasion                            | 4.3.0 | 4.4.0 |
|                | RP-15 | RP-020063 | 098 |     | Clarification of IMSI at Paging channel selection and DRX calculation          | 4.3.0 | 4.4.0 |
|                | RP-15 | -         | -   |     | Upgrade to Release 5 - no technical change                                     | 4.4.0 | 5.0.0 |
| 06/2002        | RP-16 | RP-020324 | 101 |     | Limitations of CBS reception   | 5.0.0 | 5.1.0 |

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# History

| <b>Document history</b> |            |             |
|-------------------------|------------|-------------|
| V5.0.0                  | March 2002 | Publication |
| V5.1.0                  | June 2002  | Publication |
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