# TSG-RAN Meeting #10 *RP-000565*
# Bangkok, Thailand, 6 - 8 December 2000

**Title:** **Agreed CRs to TS 25.304**

**Source:** **TSG-RAN WG2**

**Agenda item:** **5.2.3**

| Doc-1st- | Status- | Spec | CR | Rev | Subject | Cat | Version | Versio |
|---|---|---|---|---|---|---|---|---|
| R2-002365 | agreed | 25.304 | 046 | 1 | Support for PLMN selection | F | 3.4.0 | 3.5.0 |
| R2-002357 | agreed | 25.304 | 049 | 1 | Correction of algorithm for paging channel selection | F | 3.4.0 | 3.5.0 |
| R2-002284 | agreed | 25.304 | 050 | | Alignment of use of TEMP_OFFSET parameters with TS 25.331 | F | 3.4.0 | 3.5.0 |
| R2-002425 | agreed | 25.304 | 051 | 2 | Clarifications and Editorial Corrections | F | 3.4.0 | 3.5.0 |
| R2-002412 | agreed | 25.304 | 052 | 1 | Clarifications to cell selection and reselection procedures | F | 3.4.0 | 3.5.0 |
| R2-002350 | agreed | 25.304 | 053 | | Removal of immediate cell evaluation | F | 3.4.0 | 3.5.0 |
| R2-002367 | agreed | 25.304 | 054 | | One step cell selection | F | 3.4.0 | 3.5.0 |

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| 25.304 | CR | 046r1 | Current Version: | 3.4.0 |
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*GSM (AA.BB) or 3G (AA.BBB) specification number ↑* *↑ CR number as allocated by MCC support team*

| For submission to: | TSG-RAN #10 | for approval | X | strategic | | (for SMG use only) |
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**Proposed change affects:** *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

**Source:** TSG-RAN WG2 **Date:** 13/10/00

**Subject:** Support for PLMN selection

**Work item:**

**Category:** *(only one category shall be marked with an X)*

| | | | | | |
|---|---|---|---|---|---|
| F | Correction | X | **Release:** | Phase 2 | |
| A | Corresponds to a correction in an earlier release | | | Release 96 | |
| B | Addition of feature | | | Release 97 | |
| C | Functional modification of feature | | | Release 98 | |
| D | Editorial modification | | | Release 99 | X |
| | | | | Release 00 | |

**Reason for change:** Support for PLMN ranking at automatic and manual network selection is missing.

**Clauses affected:** 5.1, 5.1.1 (new), 5.1.2 (new), 5.1.2.1 (new), 5.1.2.2 (new), 5.1.2.3 (new)

**Other specs affected:**

| | | |
|---|---|---|
| Other 3G core specifications | | → List of CRs: |
| Other GSM core specifications | | → List of CRs: |
| MS test specifications | | → List of CRs: |
| BSS test specifications | | → List of CRs: |
| O&M specifications | | → List of CRs: |

**Other comments:** Values on threshold limits (marked as tbd) are to be provided by R4.

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# 5 Process and procedure descriptions

## 5.1 ~~5.1~~ PLMN selection and reselection

### 5.1.1 General

In the UE, the access stratum shall report available PLMNs to the non-access stratum on request from the non-access stratum 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 identities of multiple PLMNs of either or both types, i.e. 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 stratum 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 Network Selection

#### 5.1.2.1 General

PLMN selection for GSM-MAP is described in [5].
PLMN Selection for ANSI-41 is described in TIA/EIA/IS-2000.5 and TIA/EIA/IS-707.

On request of the non-access stratum the access stratum should perform a search for available PLMNs and report them to the non-access stratum.

#### 5.1.2.2 UTRA

The UE shall scan all RF channels in the UTRA band according to its capabilities to find available PLMNs. On each carrier, the UE shall search for the "strongest" cell (according to the cell search procedures for FDD, see [TS 25.214], and TDD, see [TS 25.224]) and read its system information, in order to find out which PLMN the cell belongs to. If UE can read the PLMN identity, the found PLMN is reported to the non-access stratum, provided that the following conditions are fulfilled:

1. For an FDD cell, the measured primary CPICH $E_C/I_0$ value shall be greater than or equal to [tbd] dB, and the measured primary CPICH RSCP value shall be greater than or equal to [tdb] dBm.
2. For a TDD cell, the measured P-CCPCH RSCP shall be greater than or equal to [tbd] dBm.

The search for PLMNs on the rest of the carriers may be stopped on request of the non-access stratum. 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 is performed in order to select a suitable cell of that PLMN to camp on.

#### 5.1.2.3 GSM

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

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**25.304 CR 049r1** Current Version: 3.4.0

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑* *↑ CR number as allocated by MCC support team*

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**Proposed change affects:** *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

**Source:** TSG-RAN WG2 **Date:** 15/11/00

**Subject:** Correction of algorithm for paging channel selection

**Work item:**

**Category:** *(only one category shall be marked with an X)*

| | | |
|---|---|---|
| F | Correction | X |
| A | Corresponds to a correction in an earlier release | |
| B | Addition of feature | |
| C | Functional modification of feature | |
| D | Editorial modification | |

**Release:**

| | |
|---|---|
| Phase 2 | |
| Release 96 | |
| Release 97 | |
| Release 98 | |
| Release 99 | X |
| Release 00 | |

**Reason for change:**

The current algorithm for paging channel selection in idle mode needs to be revised for the following reason: In idle mode, the UE may be connected towards more than one CN domain, each CN domain having specific DRX cycle length. In idle mode, however, UTRAN has no knowledge of the DRX cycle length applied by the UE, hence it cannot perform the corresponding SCCPCH (and paging channel) selection as in the UE.

Here a simplification of the idle mode SCCPCH selection algorithm is proposed which however requires a modification of the present scheme used for calculation of paging occasions and page indicators. Basically SCCPCH selection, paging occasion and page indicator are calculated based on different parts of the IMSI, in order to derive the desired uniform distribution of users onto SCCPCHs, and uniform usage of all available paging occasions, and page indicators on all available SCCPCHs.

**Clauses affected:** 8.1, 8.2, 8.3

**Other specs affected:**

| | | |
|---|---|---|
| Other 3G core specifications | [ ] | → List of CRs: |
| Other GSM core specifications | [ ] | → List of CRs: |
| MS test specifications | [ ] | → List of CRs: |
| BSS test specifications | [ ] | → List of CRs: |
| O&M specifications | [ ] | → List of CRs: |

**Other comments:**

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# 8 Paging and SCCPCH selection in Idle mode

## 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 is 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:

  "Index of selected SCCPCH" = (IMSI div (("DRX cycle length" div PBP)*Np*$N_{PICH}$)) mod 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.

"Index of selected SCCPCH" identifies the selected SCCPCH with the PCH and the uniquely associated PICH to be used by the UE. "DRX cycle length", PBP, Np and $N_{PICH}$ shall be determined as specified Section 8.3.

## 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:

  "Index of selected SCCPCH" = "Initial UE Identity" mod 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.

## 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 $2^k$ *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, 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 Sec. 8.~~2~~1, the Cell System Frame Number (SFN), Np (for FDD, Np is the number of page indicators within a frame; for TDD, Np 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.

The value of the Paging Occasion (i.e. the SFN of the first frame of the Paging Block) is determined as follows:

Paging Occasion= {(IMSI div K) mod (DRX cycle length div PBP)} * PBP + n * DRX cycle length + Frame Offset

Where n = 0,1,2… 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:

PI = DRX Index mod Np

where DRX Index = {(IMSI div K) div (DRX cycle length div PBP)}

In FDD mode, Np = (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, Np 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) 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 a default number, IMSI = 0, 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:

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

The value $N_{PICH}$ is the number of frames for PICH transmission and is equal to the PICH repetition length given in system information. The value $N_{GAP}$ 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 $N_{PCH}$ is the number of Paging Groups. $N_{PCH}$ and $N_{GAP}$ are given in system information.

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**Proposed change affects:** *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

**Source:** TSG-RAN WG2 **Date:** 13/10/00

**Subject:** Alignment of use of TEMP_OFFSET parameters with TS 25.331

**Work item:**

**Category:** *(only one category shall be marked with an X)*

| | | | | | |
|---|---|---|---|---|---|
| F | Correction | X | **Release:** | Phase 2 | |
| A | Corresponds to a correction in an earlier release | | | Release 96 | |
| B | Addition of feature | | | Release 97 | |
| C | Functional modification of feature | | | Release 98 | |
| D | Editorial modification | | | Release 99 | X |
| | | | | Release 00 | |

**Reason for change:** According to TS 25.331, parameters $TEMP\_OFFSET_n$ and PENALTY_TIME are only available in system information in case HCS is used.

**Clauses affected:** 5.2.6.1.4

**Other specs affected:**

| | | |
|---|---|---|
| Other 3G core specifications | [ ] | → List of CRs: |
| Other GSM core specifications | [ ] | → List of CRs: |
| MS test specifications | [ ] | → List of CRs: |
| BSS test specifications | [ ] | → List of CRs: |
| O&M specifications | [ ] | → List of CRs: |

**Other comments:**

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#### 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:

$$H_s = Q_{meas\_LEV,s} - Qhcs_s$$

$$H_n = Q_{meas\_LEV,n} - Qhcs_n - TO_n * L_n$$

The cell-ranking criterion R is defined by:

$$R_s = Q_{map,s} + Qhyst_s$$

$$R_n = Q_{map,n} - Qoffset_{s,n} - TO_n * (1 - L_n)$$

where:

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

$L_n = 0$ if $HCS\_PRIO_n = HCS\_PRIO_s$
$L_n = 1$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

$W(x) = 0$ for $x < 0$
$W(x) = 1$ for $x >= 0$

$T_n$ is a timer implemented for each neighbouring cell. $T_n$ shall be started from zero when one of the following conditions becomes true:

$Q_{meas\_LEV,n} > Qhcs_n$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

or

For TDD cells, GSM cells and FDD cells if the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH RSCP:

$Q_{map,n} > Q_{map,s} + Qoffset1_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

or

For FDD cells if the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH Ec/No:

$Q_{meas\_LEV,n} > Q_{meas\_LEV,s} + Qoffset2_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

$T_n$ shall be stopped as soon as these conditions are no longer fulfilled.

At cell-reselection, a timer $T_n$ is stopped only if the corresponding cell is not a neighbour cell of the new serving cell, or if the criterion given above for starting timer $T_n$ for the corresponding cell is no longer fulfilled with the parameters of the new serving cell.

$TEMP\_OFFSET_n$ applies an offset to H and R criteria for the duration of $PENALTY\_TIME_n$ after the timer $T_n$ has started for that cell. $TEMP\_OFFSET_n$ and $PENALTY\_TIME_n$ are only applicable when HCS is applied, that is when serving cell belongs to a hierarchical cell structure.

| | |
|---|---|
| $S_n$ | Cell Selection value of the neighbouring cell, (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive quality measures $Q_{map,n}$ and $Q_{map,s}$, (read in system information). |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells, from P-CCPCH for TDD cells and from RXLEV for GSM cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH for TDD cells. 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. |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH_Ec/No or CPICH_RSCP_LEV for FDD cells as set by the Cell_selection_and_reselection_quality_measure information element, P-CCPCH_RSCP_LEV for TDD cells and RXLEV for GSM cells. |
| $Qoffset1_{s,n}$ | Offset value 1between the two cells considered in the evaluation (read in system information). |
| $Qoffset2_{s,n,}$ | Offset value 2 between the two cells considered in the evaluation (read in system information). |
| $Qhyst1_s$ | Hysteresis value of the serving cell. |
| $Qhyst2_s$ | Hysteresis value of the serving cell. |
| $HCS\_PRIO_s$, $HCS\_PRIO_n$ | HCS priority level (0-7) for serving cell and neighbouring cells |
| $PENALTY\_TIME_n$ | Duration for applying $TEMP\_OFFSET_n$ to H and R criteria (s) |
| $Qhcs_s$, $Qhcs_n$ | Quality threshold level for applying prioritised hierarchical cell re-selection |
| $TEMP\_OFFSET1_n$ | Offset to H and R criteria for the duration of $PENALTY\_TIME_n$ |
| $TEMP\_OFFSET2_n$ | Offset to H and R criteria for the duration of $PENALTY\_TIME_n$ |
| $T_{Crmax}$ | Duration for evaluating allowed amount of cell reselections (s). |
| $N_{CR}$ | Maximum number of cell reselections |
| $T_{CrmaxHyst}$ | Additional time period before UE reverts to low-mobility measurements (s) |
| $Treselection_s$ | Time-to-trigger for cell reselection, (s) |

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

The UE shall perform ranking of all cells that fulfil the S criterion (see subclause 5.2.6.1.4) among

- all cells that have the highest HCS_PRIO among those cells that fulfil the criterion H >= 0**.** Note that this rule is not valid when UE high-mobility is detected (see subclause 5.2.6,1,4).

- all cells, not considering HCS priority levels, if no cell fulfil the criterion H >= 0. This case is also valid when HCS is not applied, 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, using CPICH RSCP, P-CCPCH RSCP and RXLEV for deriving $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD, TDD and GSM cells, respectively. The offset $Qoffset1_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst1_s$ is used to calculate $R_s$ and $TEMP\_OFFSET1_n$ is used to calculate $TO_{n.}$ 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 a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH RSCP, the UE shall perform cell re-selection to that FDD cell.

If a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH Ec/No, 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 as given in cell_selection_and_reselection-quality_measure for deriving the $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD cells. In this case, default mapping function $Q_{map} = Q_{meas\_LEV}$ is used

and the offset $Qoffset2_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst2_s$ is used to calculate $R_s$ and $TEMP\_OFFSET2_n$ is used to calculate $TO_n$. Then the UE shall perform cell re-selection to the best ranked FDD cell.

The UE shall reselect the new cell, if the cell reselection criteria are fulfilled during a time interval Treselection.

#### 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 as follows:

**$Qoffset1_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qoffset2_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$Qhyst1_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qhyst2_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$HCS\_PRIO_s$, $HCS\_PRIO_n$**

HCS priority level (0-7) for serving cell and neighbouring cells are read in system information of serving cell.

**$Qhcs_s$, $Qhcs_n$**

Quality threshold levels for applying prioritised hierarchical cell re-selection are read in system information of serving cell.

**Qqualmin**

Minimum required quality level in the cell, (dB). Not applicable for TDD cells or GSM cells.

**Qrxlevmin**

Minimum required RX level in the cell. (dBm)

**$PENALTY\_TIME_n$**

Time duration for which the $TEMPORARY\_OFFSET_n$ is applied for a neighbouring cell is read in system information of serving cell.

**$TEMPORARY\_OFFSET1_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$TEMPORARY\_OFFSET2_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$T_{CRmax}$**

Duration for evaluating allowed amount of cell reselection(s) is read in system information of

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| **25.304** | **CR** | **051r2** | Current Version: | 3.4.0 |
|---|---|---|---|---|

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑* *↑ CR number as allocated by MCC support team*

For submission to: TSG-RAN #10 *list expected approval meeting # here ↑* for approval **X** for information strategic non-strategic *(for SMG use only)*

*Form: CR cover sheet, version 2 for 3GPP and SMG* *The latest version of this form is available from:* ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

**Proposed change affects:** *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

**Source:** TSG-RAN WG2 **Date:** Nov. 13, 2000

**Subject:** Clarifications and editorial corrections

**Work item:**

**Category:** *(only one category shall be marked with an X)*

| | | | | | |
|---|---|---|---|---|---|
| F | Correction | X | **Release:** | Phase 2 | |
| A | Corresponds to a correction in an earlier release | | | Release 96 | |
| B | Addition of feature | | | Release 97 | |
| C | Functional modification of feature | | | Release 98 | |
| D | Editorial modification | | | Release 99 | X |
| | | | | Release 00 | |

**Reason for change:**

- A reference to TR 21.905 has been included in section 3.1 (definitions).
- 'Barred Cell' and 'Camped on any cell' have been added to the list of definitions.
- ~~The idle mode process PLMN reselection is not existent in TS 23.122. It is therefore proposed to align TS 25.304 with TS 23.122.~~
- It is proposed to add some clarifications in table1 (functional division between AS and NAS in idle mode) in order to illustrate the relation between PLMN and cell selection and to provide some references to TS 23.122 where appropriate.
- Some text was misleading with respect to the handling of RAT information storage which is specified in TS 23.122 and is therefore proposed to be clarified.
- It has been decided in R2-001750 to merge states *any cell selection* and *any cell* reselection to one state ~~*any cell search*~~*any cell selection*. This change has now been consistently implemented.
- The handling of mapping functions has been clarified (i.e. in which formulas the mapped values are evaluated).
- The terms radio access technology and radio access mode have been added where appropriate to be more precise.
- A minor correction was needed in the formula for paging channel selection.
- Some references to other sections were incorrect.
- Some editorial corrections have been made.

**Clauses affected:** 2, 3.1, 4.1, 4.2, 4.3, 5.2.1, 5.2.2, 5.2.3.1.1, 5.2.3.1.2, 5.2.4.1.1, 5.2.4.1.2, 5.2.6.1.2, 5.2.6.1.4, 5.2.6.1.5, 5.4.1, 6.1, 7.1, 8.1

**Other specs** Other 3G core specifications [ ] → List of CRs:

| **affected:** | | | |
|---|---|---|---|
| | Other GSM core specifications | | → List of CRs: |
| | MS test specifications | | → List of CRs: |
| | | | → List of CRs: |
| | O&M specifications | | → List of CRs: |

| **Other comments:** | |
|---|---|

help.doc

<--------- double-click here for help and instructions on how to create a CR.

# 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.


[1] GSM TS 03.22: "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: "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] GSM TS 05.08: “Radio subsystem link control”


# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the ~~[~~following~~]~~ ~~terms and~~ definitions ~~[given in ... and the following]~~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.

**Allowable PLMN:** a PLMN, which is not in the list of forbidden PLMNs in the UE.

**Available PLMN:** a PLMN for which the UE has found at least one acceptable cell.

**Barred Cell**: A cell is barred if it is so indicated in the system information ~~[4]~~.

**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.

**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.

**LSA:** Localised Service Area. A LSA is an operator-defined group of cells for which specific access conditions applies. This may correspond to an area in which the Core Network offers specific services. A LSA may be defined within a PLMN or globally. Therefore, a LSA may offer non-contiguous radio coverage.

**LSA exclusive access cell:** UE may only camp on this cell if the cell belongs to the LSAs to which the user has subscribed. Nevertheless, if no other cells are available, the UE of non-LSA users may originate emergency calls from this cell.

**LSA ID:** Localised Service Area Identity.

**LSA only access:** when LSA only access applies to the user, the UE can only access cells that belong to the LSAs to which the user has subscribed. Outside the coverage area of the subscribed LSAs, the UE may camp on other cells and limited services apply.

**LSA preferential access cell:** LSA preferential access cell is a cell, which is part of the LSA. UEs of users that have subscribed to a LSA of an LSA-preferential-access cell have higher priority to resources than non-LSA users in the same cell. The availability of LSA preferential access cells impacts the radio resource allocation (controlled by UTRAN-Access Stratum). This function is out of the scope of the standards.

**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:** frame where the UE receives actual paging message.

**Paging occasion:**
(FDD) The frame where the UE monitors the PICH.
(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.

**Registered PLMN (RPLMN):** this is the PLMN on which the UE has performed a location registration successfully.

**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.

**Selected PLMN:** this is the PLMN that has been selected by the non-access stratum, either manually or automatically.

**Suitable Cell:** a cell on which an UE may camp. It shall satisfy certain conditions, see subclause 4.3.

**Visited PLMN of home country:** a PLMN, different from the home PLMN, where the MCC part of the PLMN identity is the same as the MCC of the IMSI.

# 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. ~~it searches and selects a public land mobile network (PLMN) using a certain radio access technology (RAT)~~. Criteria for cell selection and cell re-selection between radio access technologies (RATs) described in this document only consider radio criteria. In addition to radio access technology, 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 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 then register its presence, by means of a NAS registration procedure, in the registration area of the chosen cell, if necessary.

If the UE finds a more suitable cell of the selected PLMN, 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 moresuitable 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, 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.

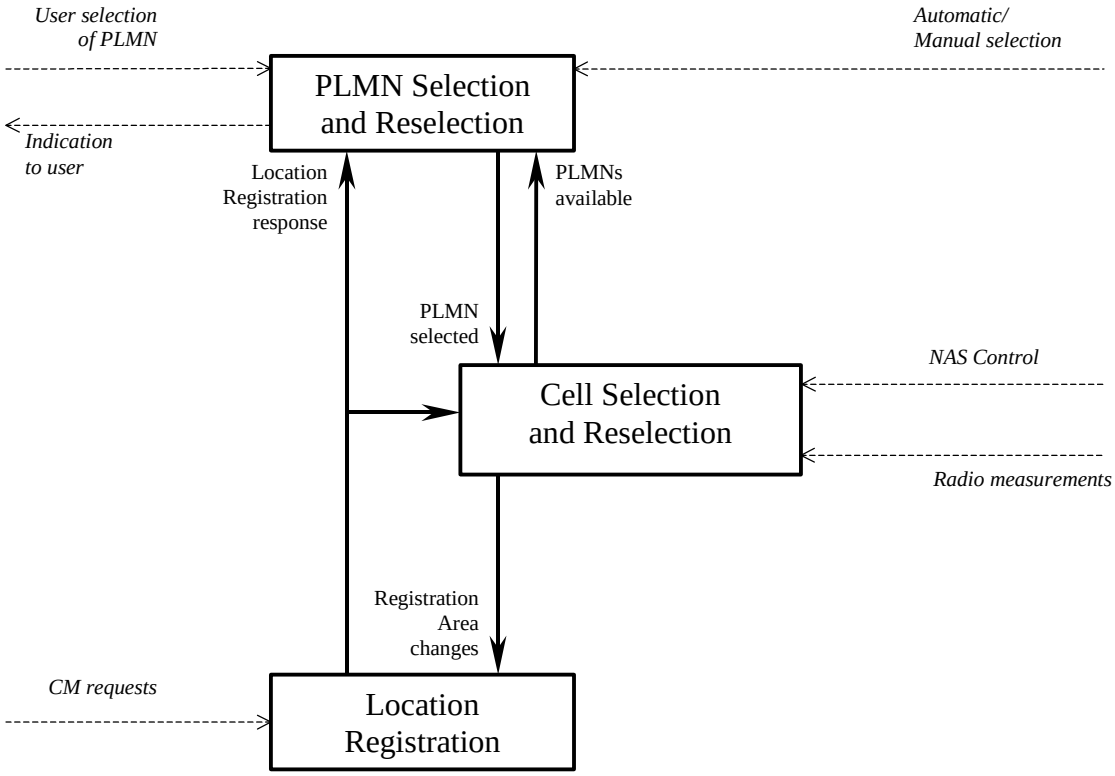



**Figure 1: Overall Idle Mode process**

NOTE: The impact of NAS defined service areas is FFS.

## 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 non-access stratum part is specified in [5] and the access stratum 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 | Maintain the list of allowed PLMN types. It can be GSM-MAP only, ANSI-41 only or both.<br><br>Maintain a list of PLMNs in priority order according to [5]. Select a PLMN using automatic or manual mode as specified in [5] and ~~R~~ request AS to select a cell ~~either~~ belonging to ~~the~~ this PLMN. ~~having the highest priority (in automatic mode) or belonging to the manually selected PLMN.~~ For each PLMN, associated radio access technology(ies) may be set.<br><br>~~In automatic mode, if a PLMN with higher priority is found, request AS to select a cell belonging to that PLMN.~~Evaluate reports of available PLMNs from AS for PLMN selection. | Search for a suitable cell belonging to the PLMN requested by NAS. Perform cell selection process as described below.<br><br>If associated radio access technology(ies) is (are) set ~~available~~ for the PLMN, search in this (these)~~at~~ radio access technology(ies) and other radio access technologies for that PLMN ~~in cell selection~~as specified in [5].<br><br>Report available PLMNs with associated PLMN type and radio access technology to NAS on request from NAS or autonomously.<br><br>It must respect allowed PLMN types indications from NAS. |
| Cell Selection | Control cell selection for example by indicating ~~associated~~ radio access technology(ies) 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 and a list of NAS defined service areas in priority order. | Perform measurements needed to support cell selection.<br><br>Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.<br><br>Search for a suitable cell ~~in the associated radio access technology(ies)~~ 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.<br><br>If associated radio access technology(ies) is (are) set for the PLMN, perform the search in this (these) radio access technology(ies) and other radio access technologies for that PLMN as specified in [5].<br><br>If such a cell is found, the cell is selected to camp on. |
| Cell Reselection | Control cell reselection by for example, maintaining lists of forbidden registration areas and a list of NAS defined service areas in priority order. | Perform measurements needed to support cell reselection.<br><br>Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.<br><br>Change cell if a more suitable cell is found. |
| Location registration | Register the UE as active after power on.<br><br>Register the UE's presence in a registration area, for instance regularly or when entering a new registration area.<br><br>Deregister UE when shutting down. | Report registration area information to NAS. |

## 4.3 Service type in Idle mode

This chapter defines the level of service that may be provided by the network to a UE in Idle mode.

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

- 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 5.3.4.1
- 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.
- The cell is not barred, see subclause 5.3.4.1.
- The cell is not part of a forbidden registration area.
- The cell selection criteria are fulfilled, see subclause 5.2.3.1.2.
- The SoLSA criteria are fulfilled [SoLSA support is not in the current release].

barred cell:

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

# 5 Process and procedure descriptions

## 5.1 PLMN selection and reselection

In the UE, the access stratum shall report available PLMNs to the non-access stratum on request from the non-access stratum 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 identities of multiple PLMNs of either or both types, i.e. 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 stratum part of the PLMN selection and reselection is specified in TIA/EIA/IS-2000.5 and TIA/EIA/IS-707.

# 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 radio access technologies and modes for the cell selection and reselection. Whenever a direct comparison of these measurements is required, mapping functions will be applied that are defined in [4]. The use of the mapping functions is defined in subclause 7.1. Measured values are marked with the index 'meas', whereas the index 'map' is used whenever mapping functions have been applied onto a measured value. The performance requirements for the measurements are specified in [10][11].

~~The UE shall select a suitable cell and the radio access mode based on idle mode measurements and cell selection criteria.~~ The non-access stratum can control the radio access technology(ies) in which the cell selection should be performed, for instance by indicating ~~associated~~ radio access technology(ies) associated with the selected PLMN, and by maintaining a list of forbidden registration area(s) and a list of NAS defined service area(s) in priority order. The UE shall select a suitable cell and the radio access mode based on idle mode measurements and cell selection criteria.

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.

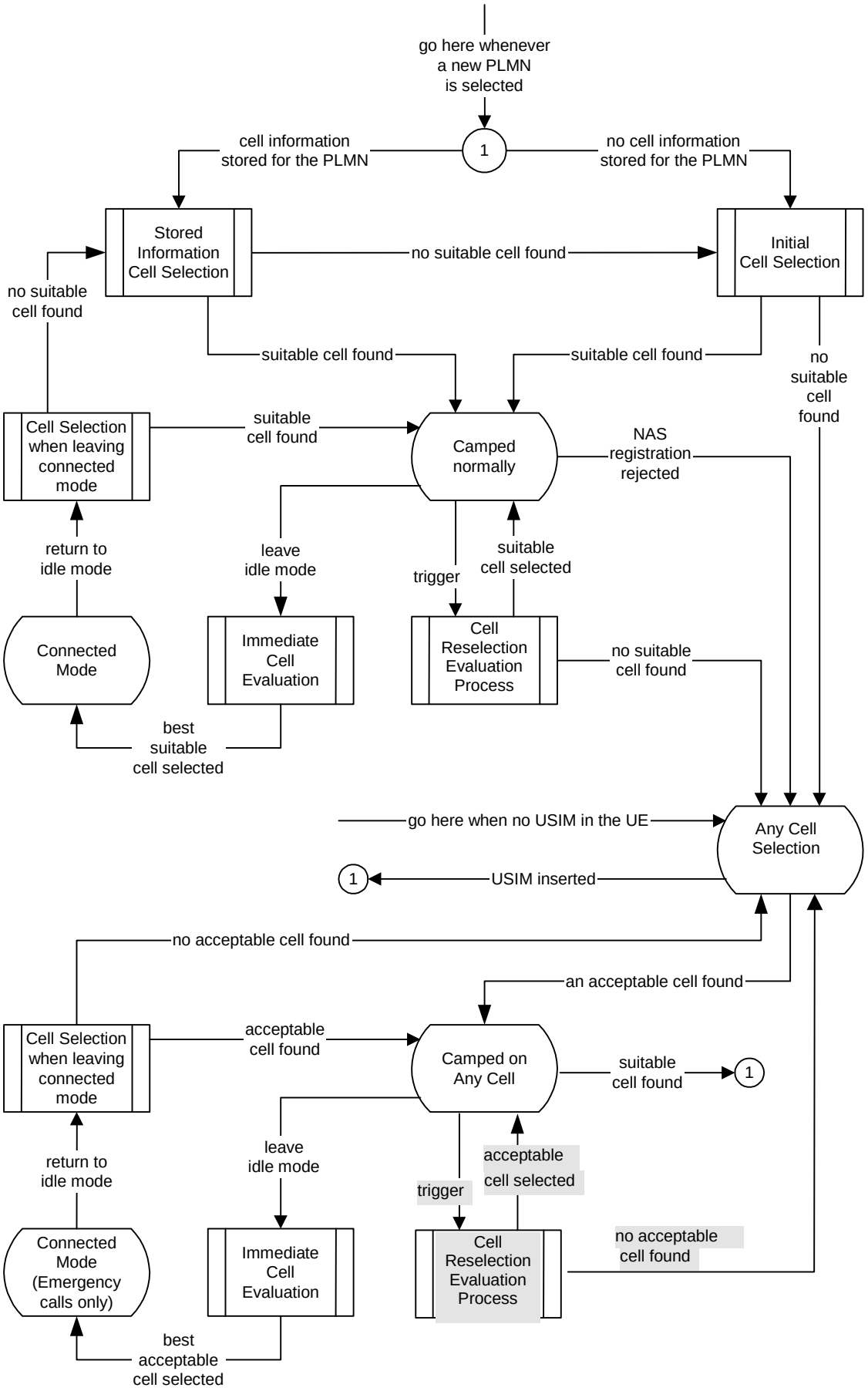
The non-access stratum is informed if the cell selection and reselection results in changes in the received system information.

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
  - Identify the NAS defined service area(s) to which the serving cell belongs;
  - 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.


go here whenever a new PLMN is selected
1
cell information stored for the PLMN
no cell information stored for the PLMN
Stored Information Cell Selection
Initial Cell Selection
no suitable cell found
no suitable cell found
suitable cell found
suitable cell found
no suitable cell found
Cell Selection when leaving connected mode
suitable cell found
Camped normally
NAS registration rejected
return to idle mode
leave idle mode
trigger
suitable cell selected
Connected Mode
Immediate Cell Evaluation
Cell Reselection Evaluation Process
no suitable cell found
best suitable cell selected
go here when no USIM in the UE
Any Cell Selection
1
USIM inserted
no acceptable cell found
an acceptable cell found
Cell Selection when leaving connected mode
acceptable cell found
Camped on Any Cell
suitable cell found
1
return to idle mode
leave idle mode
trigger
acceptable cell selected
Connected Mode (Emergency calls only)
Immediate Cell Evaluation
Cell Reselection Evaluation Process
no acceptable cell found
best acceptable cell selected

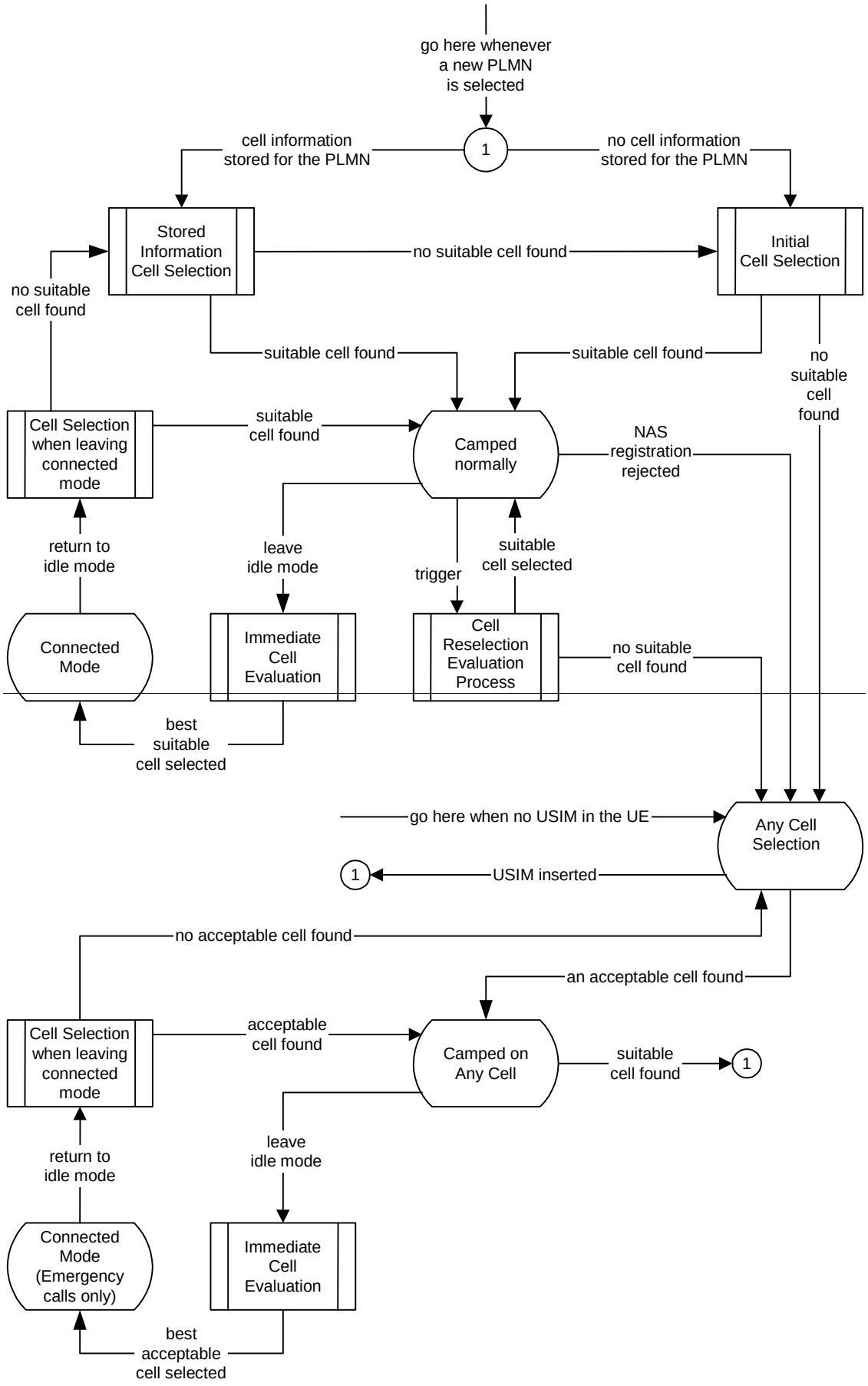



**Figure 2: Idle Mode Cell Selection and Reselection**
**In any state, a new PLMN selection causes an exit to number 1**

Whenever a PLMN has been selected, the UE shall attempt to find a suitable cell to camp on using one of the two procedures, *Initial cell selection* or *Stored information cell selection*. The *Initial cell selection* procedure requires no knowledge about the selected PLMN, but the *Stored information cell selection* procedure requires information to have been stored about the selected PLMN during a previous selection of that PLMN. This stored information makes the search for a suitable cell faster. The information may contain information about several radio access technologies. The non-access stratum may control the cell selection by:

- providing information on radio access technology(ies) associated with the selected PLMN; ~~;~~

~~- association with the selected PLMN;~~

- maintaining lists of forbidden registration areas;
- a list of NAS defined service areas in priority order.

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

When a suitable cell has been found, the UE shall perform necessary NAS registration procedures. When the UE has registered successfully, the UE shall camp on the cell, state *Camped normally*. In this state, the UE shall monitor paging information, monitor system information and perform radio measurements. The measurements shall be used in evaluation of the ~~cell selection,~~ immediate cell evaluation (UTRA only) and cell reselection criteria. The network controls what the UE shall measure by sending measurement control information in the system information. The measurement control information may contain intra-frequency, inter-frequency and inter-radio-access- technology measurements.

The UE shall evaluate the cell reselection criteria based on radio measurements, and if a better cell is found that cell is selected, procedure *Cell reselection*. The change of cell may imply a change of radio access technology.

When UE leaves idle mode, state *Camped normally*, in order to enter connected mode, state *Connected mode*, the UE shall use the *Immediate cell evaluation* procedure (UTRA only) in order to select the best cell on the current frequency for the access attempt. This procedure allows the UE to reduce power consumption spent on radio measurements, still enabling the UE to select the best cell for access, thus minimising the interference in the system. If no suitable cell is found, the UE shall use the *Cell reselection* procedure. 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, state *Camped normally*. If no suitable cell is found, the *Stored information cell selection* procedure shall be used.

If no suitable cell is found, the UE shall attempt to find an acceptable cell of any PLMN, state *Any cell ~~search~~selection*. This state is also entered if a non-access stratum registration procedure is rejected, see [5], or if there is no USIM in the UE. If an acceptable cell is found, the UE shall camp on this cell and obtain limited service, state *Camped on any cell*. In this state, the UE shall behave as specified for state *Camped normally*, but typically with a different PLMN. Additionally, the UE shall regularly attempt to find a suitable cell using stored information, trying all radio access technologies that are supported by the UE. If a suitable cell is found, the PLMN is reselected which causes an exit to number 1.

When a cell reselection is triggered, the UE shall evaluate the cell reselection criteria based on radio measurements, and if a better cell is found that cell is selected~~, procedure *Any cell search*~~. The change of cell may imply a change of radio access technology.

If no acceptable cell is found, the UE shall continue to search for an acceptable cell of any PLMN in state *Any cell selection* trying all radio access technologies that are supported by the UE.

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

#### 5.2.3.1.1 Description

Whenever a PLMN is selected [5], the UE shall attempt to find a suitable cell of that PLMN to camp on according to the following steps.

1) Create a candidate list of potential cells to camp on by using one of the 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 band to find a suitable cell. On each carrier, the UE searches first for the strongest cell and reads its system information, in order to find out which PLMN the cell belongs to. If the selected PLMN is found, the search of the rest of carriers may be stopped. Once the UE has found a suitable cell for the selected PLMN, the UE shall create a candidate list consisting of this cell and its neighbouring cells, as received in measurement control information via the selected cell.

   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. After the UE has found one suitable cell for a selected PLMN the UE shall create the candidate list consisting of this cell and its neighbouring cells, using information from the selected cells' measurement control information.

2) For each cell on the candidate list calculate the cell selection value Srxlev and Squal (Squal is used for FDD cells only), defined in subclause 5.2.3.1.2. Cells which do not fulfil the criteria S are removed from the candidate list.

3) Evaluate the cells as follows;

   - For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section 5.2.4.1.2 by the Cell_selection_and_reselection_quality measure in system information.

   - If mapping information is provided in system information, the specified mapping function is used in the UE for determining $Q_{map,s}$ and $Q_{map,n}$ in~~following~~ the formula in clause 5.2.4.1.2 ~~for cell ranking~~.

   - If mapping information is not provided in system information, the UE shall use the default mapping function $Q_{map}$~~map~~ = $Q_{meas\_LEV}$ ~~in~~ for determining $Q_{map,s}$ and $Q_{map,n}$ in the formula in clause 5.2.4.1.2 ~~and apply it for cell ranking~~.

4) Select the cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criterion in 5.2.4.1.2 best. If no cell fulfils the criteria, the UE should select the initial suitable cell. Check if the selected cell fulfils all requirements for a suitable cell. If so, choose this cell to camp on. If this cell does not fulfil all requirements for a suitable cell, this cell and all cells on the same frequency shall be removed as candidates for cell selection in case the barred cell does not accept intra-frequency cell selection and re-selection. On the other hand, in case the selected cell accepts intra-frequency cell selection and re-selection, only the barred cell shall be removed as candidate for cell selection (see also subclause 5.~~2~~.3), and step 3 shall be repeated for the remaining cells.

NOTE: $Q_{map,s}$ and $Qoffset_{s,n}$ in this case apply to the cell from which system information was read.

5) Move to state *camped normally*

~~If different radio access modes are involved in the procedure,~~The use of ~~specific~~ mapping functions ~~shall be applied~~is indicated in system information. For each radio access mode and radio access technology, such a mapping function is defined and its parameters are broadcast in system information. The mapping function maps a certain range of measurement values $Q_{meas\_LEV}$ to a representative quality value $Q_{map}$ that ranges between 0 and 99 with a granularity of 1. These quality values $Q_{map}$ ~~can~~ are then ~~be compared with each other~~used to evaluate the formula in 5.2.4.1.2 ~~and the cell with the highest $Q_{map}$ value is chosen (among those cells fulfilling 5.2.3.1.2)~~.

If no suitable cell of selected PLMN is found and the stored information cell selection procedure was used in step 1, the Initial cell selection procedure shall be started and the steps are repeated. If the UE is unable to find any suitable cell of selected PLMN using the Initial cell selection procedure, it shall attempt to camp on highest ranked acceptable cell and enter the Camped on any cell state, where it can only obtain limited service. In PLMN selection, automatic mode, this would normally result in a new PLMN selection [5].

### 5.2.3.1.2 Criteria

The cell selection criteria S are defined as follows.

$$Squal = Q_{qualmeas} - Qqualmin$$

$$Srxlev = Q_{rxlevmeas} - Qrxlevmin - Pcompensation$$

| | |
|---|---|
| Squal | Cell Selection quality value, (dB)<br>Not applicable for TDD cells or GSM cells. |
| Srxlev | Cell Selection RX level value (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) to use as quality measure $Q_{meas\_LEV}$ (read in system information) |
| $Q_{qualmeas}$ | Measured cell quality value. The quality of the received signal expressed in CPICH $E_c/N_0$ (dB) for FDD cells. Not applicable for TDD cells or GSM 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 RXLEV for GSM cells (dBm). |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH_$E_c/N_0$ or CPICH_RSCP_LEV for FDD cells, P-CCPCH_RSCP_LEV for TDD cells and RXLEV for GSM cells ~~(dBm)~~ (cf. [10], [11], [13]) . |
| Qqualmin | Minimum required quality level in the cell (dB). Not applicable for TDD cells or GSM cells. |
| Qrxlevmin | Minimum required RX level in the cell. (dBm) |
| Pcompensation | 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 cell selection criterion S is fulfilled when:

$$Squal > 0$$

$$Srxlev > 0$$

Squal has to be evaluated for FDD cells only.

### 5.2.3.2 GSM

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

## 5.2.4 Immediate Cell Evaluation Process

### 5.2.4.1 UTRA

#### 5.2.4.1.1 Description

The Immediate Cell Evaluation procedure is used by the UE to perform a quick evaluation of the quality of the intra-frequency cells. Based on this information, the UE shall select the best cell among the cells on the same frequency, according to the criteria defined in the next subclause.

The following steps shall be carried out when an immediate cell evaluation has been triggered.

1) The candidate list of potential cells to camp on consists of the cells in the current registration area listed for intra-frequency measurements in system information of the serving cell.

2) For each cell on the candidate list calculate the cell selection values, Srxlev and Squal (for FDD cells only), defined in subclause 5.2.3.1.2. Cells, which do not fulfil criteria S, are removed from the candidate list.

3) Evaluate the cells as follows;

- For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section 5.2.~~6.1.4~~4.1.2 based on Cell_selection_and_reselection_quality_ measure in system information.

- If mapping information is provided in system information, the specified mapping function is used in the UE for determining $Q_{map,s}$ and $Q_{map,n}$ in ~~and~~ the formula in section 5.2.~~6.1.4~~4.1.2 ~~for cell ranking is applied~~.

- If mapping information is not provided in system information, UE shall use default mapping function $Q_{map}$~~map~~ = $Q_{meas\_LEV}$ for determining $Q_{map,s}$ and $Q_{map,n}$ in the formula in section 5.2.~~6.1.4~~4.1.2 ~~and use it for cell ranking~~.

4) Select the neighbouring cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criteria in 5.2.4.1.2~~6.1.4~~ best. If the best cell does not fulfil all other requirements for a suitable cell, UE shall trigger cell re-selection Otherwise select the serving cell if $Q_{map,s} > Q_{map,n} - Qoffset_{s,n}$.

NOTE: Whether the calculation of the $Q_{map}$ value should require the immediate decoding (e.g. in case the UL load value is used for the calculation) of a set of neighbouring cell BCHs is FFS.

#### 5.2.4.1.2 Criteria

The UE shall select a new cell if the following criteria are fulfilled.

$$Squal_n > 0$$

$$Srxlev_n > 0$$

$$Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$$

$Squal_n$ has to be evaluated for FDD cells only.

| | |
|---|---|
| $Squal_n$ | Cell Selection quality value of the neighbouring cell, (dB)<br>Not applicable for TDD cells or GSM cells. |
| $Srxlev_n$ | Cell Selection RX level value of the neighbouring cell, (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive $Q_{map,n}$ and $Q_{map,s}$, (read in system information). |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH_~~-~~$E_C/N_0$ or CPICH_RSCP_LEV for FDD cells and P-CCPCH_RSCP~~*RSCP*~~_LEV for TDD cells. |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH RSCP for TDD cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied. 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. |
| $Qoffset_{s,n}$ | Offset between the two cells considered in the evaluation (read in system information). |

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

If more than one neighbouring cell fulfils the criteria, the UE shall choose the cell where the difference between $Q_{map,n}$ and ($Q_{map,s}$ + Qoffset) is highest. If no neighbouring cell fulfils the criteria, the UE shall keep the serving cell.

### 5.2.4.2 GSM

Immediate Cell Evaluation procedure is not applicable for GSM.

## 5.2.5 Camped Normally State

### 5.2.5.1 UTRA

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

The Camped Normally State is specified in [1].

## 5.2.6 Cell Reselection Evaluation Process

### 5.2.6.1 UTRA

The cell reselection process is described by the following sub-clauses:

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

When serving cell does not belong to a hierarchical cell structure, UE shall follow these rules for intra- and inter-frequency measurements and inter-RAT measurements:

The UE shall use Squal for FDD cells and Srxlev for TDD and GSM cells as Sx in the following rules.

1. If Sx > $S_{intrasearch}$, UE need not perform intra-frequency measurements.
   If Sx <= $S_{intrasearch,}$ UE shall perform intra-frequency measurements.
   If $S_{intrasearch,}$ is not sent for serving cell, UE shall perform intra-frequency measurements.
2. If Sx > $S_{intersearch}$, UE need not perform inter-frequency measurements
   If Sx <= $S_{intersearch}$, UE shall perform inter-frequency measurements.
   If $S_{intersearch}$, is not sent for serving cell, UE shall perform intra-frequency measurements.
3. If Sx > $Ssearch_{RAT\ n}$, UE need not perform measurements on cells of RAT n
   If Sx <= $Ssearch_{RAT\ n}$, UE shall perform measurements on cells of RAT n.
   If $Ssearch_{RAT\ m}$, is not sent for serving cell, UE shall perform measurements on cells of RAT m.

#### 5.2.6.1.2 Measurements for cell re-selection when HCS is used

When serving cell belongs to a hierarchical cell structure, the UE shall follow these rules for intra- and inter-frequency measurements:

1. Intra- and inter-frequency threshold-based measurement rules

   The UE shall use Squal for FDD cells and Srxlev for TDD cells as Sx in the following rules.

   IF ($Srxlev_s$ <= $Ssearch_{HCS}$) or ($S_x$ <= $S_{intersearch}$ (FDD only)) THEN

   <UE shall measure on all intra- and inter-frequency cells>

   ELSE

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

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

ELSE

<UE shall measure on all intra- 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

2. Intra- 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- and inter-frequency neighbouring cells, which have equal or lower HCS priority than serving cell. Furthermore, UE shall prioritise re-selection of intra- 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 $T_{CrmaxHyst}$. Then, UE shall revert to measure 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

   The UE shall use Squal for FDD cells and Srxlev for TDD cells as Sx in the following rules.

   IF ($Srxlev_s$ <= $S_{HCS,RATm}$) or ($S_{qual}$ <= $S_{SearchRATm}$ (FDD only)) THEN

   <UE shall measure on all inter-RATm cells>

   ELSE

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

   < UE need not measure inter-RATm neighbouring cells >

   ELSE

   <UE shall measure on all inter-RATm cells, which have equal or higher HCS priority level than the serving cell unless measurement rules for fast-moving UEs are triggered >

   ENDIF

   ENDIF

2. Inter-RAT 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 RATm neighbouring cells, which have an equal or lower HCS priority than the serving cell. Furthermore, UE shall prioritise re-selection of RATm neighbouring cells on lower HCS priority level before RATm neighbouring cells on same HCS priority level.

     When the number of cell reselections during time interval $T_{CRmax}$ no longer exceeds $N_{CR}$, UE shall continue these measurements during time period $T_{CrmaxHyst}$. Then, UE shall revert to measure according to the threshold-based measurement rules.

#### 5.2.6.1.3 Non-suitable cells (Squal > 0 or Srxlev > 0)

If the best cell according to cell reselection criteria specified in subclause 5.2.6.1.4, does not fulfil all requirements for a suitable cell, that cell, together with all cells on that frequency shall be removed as candidate for cell re-selection (see also subclause 5.2.6).

#### 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:

$$H_s = Q_{meas\_LEV,s} - Qhcs_s$$

$$H_n = Q_{meas\_LEV,n} - Qhcs_n - TO_n * L_n$$

The cell-ranking criterion R is defined by:

$$R_s = Q_{map,s} + Qhyst_s$$

$$R_n = Q_{map,n} - Qoffset_{s,n} - TO_n * (1 - L_n)$$

where:

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

$L_n = 0$ if $HCS\_PRIO_n = HCS\_PRIO_s$
$L_n = 1$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

$W(x) = 0$ for $x < 0$
$W(x) = 1$ for $x >= 0$

$T_n$ is a timer implemented for each neighbouring cell. $T_n$ shall be started from zero when one of the following conditions becomes true:

$Q_{meas\_LEV,n} > Qhcs_n$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

or

For TDD cells, GSM cells and FDD cells if the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH RSCP:

$Q_{map,n} > Q_{map,s} + Qoffset1_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

or

For FDD cells if the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH Ec/No:

$Q_{meas\_LEV,n} > Q_{meas\_LEV,s} + Qoffset2_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

$T_n$ shall be stopped as soon as these conditions are no longer fulfilled.

At cell-reselection, a timer $T_n$ is stopped only if the corresponding cell is not a neighbour cell of the new serving cell, or if the criterion given above for starting timer $T_n$ for the corresponding cell is no longer fulfilled with the parameters of the new serving cell.

TEMP_OFFSET$_n$ applies an offset to H and R criteria for the duration of PENALTY_TIME$_n$ after the timer $T_n$ has started for that cell.

| | |
|---|---|
| $S_n$ | Cell Selection value of the neighbouring cell, (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive quality measures $Q_{map,n}$ and $Q_{map,s}$, (read in system information). |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells, from P-CCPCH RSCP for TDD cells and from RXLEV for GSM cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH RSCP for TDD cells. 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. |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH_Ec/No or CPICH_RSCP_LEV for FDD cells as set by the Cell_selection_and_reselection_quality_measure information element, P-CCPCH_RSCP_LEV for TDD cells and RXLEV for GSM cells. |
| $Qoffset1_{s,n}$ | Offset value 1between the two cells considered in the evaluation (read in system information). |
| $Qoffset2_{s,n,}$ | Offset value 2 between the two cells considered in the evaluation (read in system information). |
| $Qhyst1_s$ | Hysteresis value of the serving cell. |
| $Qhyst2_s$ | Hysteresis value of the serving cell. |
| $HCS\_PRIO_s$, $HCS\_PRIO_n$ | HCS priority level (0-7) for serving cell and neighbouring cells |
| PENALTY_TIME$_n$ | Duration for applying TEMP_OFFSET$_n$ to H and R criteria (s) |
| $Qhcs_s$, $Qhcs_n$ | Quality threshold level for applying prioritised hierarchical cell re-selection |
| TEMP_OFFSET1$_n$ | Offset to H and R criteria for the duration of PENALTY_TIME$_n$ |
| TEMP_OFFSET2$_n$ | Offset to H and R criteria for the duration of PENALTY_TIME$_n$ |
| $T_{Crmax}$ | Duration for evaluating allowed amount of cell reselections (s). |
| $N_{CR}$ | Maximum number of cell reselections |
| $T_{CrmaxHyst}$ | Additional time period before UE reverts to low-mobility measurements (s) |
| $Treselection_s$ | Time-to-trigger for cell reselection, (s) |

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

The UE shall perform ranking of all cells that fulfil the S criterion (see subclause 5.2.~~6.1.4~~3.1.2) among

- all cells that have the highest HCS_PRIO among those cells that fulfil the criterion H >= 0**.** Note that this rule is not valid when UE high-mobility is detected (see subclause 5.2.6~~,1,4~~.1.2).
- all cells, not considering HCS priority levels, if no cell fulfil the criterion H >= 0. This case is also valid when HCS is not applied, 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, using CPICH RSCP, P-CCPCH RSCP and RXLEV for deriving $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD, TDD and GSM cells, respectively. The offset $Qoffset1_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst1_s$ is used to calculate $R_s$ and TEMP_OFFSET1$_n$ is used to calculate $TO_{n.}$ 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 a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH RSCP, the UE shall perform cell re-selection to that FDD cell.

If a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH Ec/No, 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 as given in cell_selection_and_reselection-quality_measure for deriving the $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD cells. In this case, default mapping function $Q_{map} = Q_{meas\_LEV}$ is used

and the offset $Qoffset2_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst2_s$ is used to calculate $R_s$ and $TEMP\_OFFSET2_n$ is used to calculate $TO_n$. Then the UE shall perform cell re-selection to the best ranked FDD cell.

The UE shall reselect the new cell, if the cell reselection criteria are fulfilled during a time interval Treselection.

#### 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 as follows:

**$Qoffset1_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qoffset2_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$Qhyst1_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qhyst2_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$HCS\_PRIO_s$, $HCS\_PRIO_n$**

HCS priority level (0-7) for serving cell and neighbouring cells are read in system information of serving cell.

**$Qhcs_s$, $Qhcs_n$**

Quality threshold levels for applying prioritised hierarchical cell re-selection are read in system information of serving cell.

**Qqualmin**

Minimum required quality level in the cell, (dB). Not applicable for TDD cells or GSM cells.

**Qrxlevmin**

Minimum required RX level in the cell. (dBm)

**$PENALTY\_TIME_n$**

Time duration for which the $TEMPORARY\_OFFSET_n$ is applied for a neighbouring cell is read in system information of serving cell.

**$TEMPORARY\_OFFSET1_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$TEMPORARY\_OFFSET2_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$T_{CRmax}$**

Duration for evaluating allowed amount of cell reselection(s) is read in system information of serving cell.

**$N_{CR}$**

Maximum number of cell reselections is read in system information of serving cell.

**$T_{CRmaxHyst}$**

Additional time period before UE reverts to low-mobility measurements is read in system information of serving cell.

**$Treselection_s$**

The cell reselection timer value is read in system information of the serving cell.

**$Ssearch_{HCS}$**

Below this limit in the serving cell, the UE shall initiate measurements of all neighbouring cells of the serving cell. The value is read in system information of the serving cell.

**$Ssearch_{RAT\ 1}$ - $Ssearch_{RAT\ k}$**

This RAT specific threshold in the serving cell is used in the inter-RAT measurement rules. The values are read in system information of the serving cell.

**$S_{HCS,RATm}$**

This RAT specific threshold in the serving cell is used in the inter-RAT measurement rules. The values are read in system information of the serving cell.

**$S_{intrasearch}$**

Threshold for intra frequency measurements (dB ~~for FDD, dBm for TDD~~) and for the HCS measurement rules.

**$S_{intersearch}$**

Threshold for intra frequency measurements (dB ~~for FDD, dBm for TDD~~)and for the HCS measurement rules.

**$S_{limit,SearchRATm}$**

Above this RAT specific threshold in the serving UTRA cell, the UE need not perform any inter-RATm measurements (dB ~~for FDD, dBm for TDD~~)

**Mapping Info**

Mapping Info contains all the information that is necessary to define the mapping function that is used for mapping a certain range of measurement values to a representing quality value (0..99, step size 1).

#### 5.2.6.2 GSM

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

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 se*lection.

#### 5.2.7.2 GSM

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

## 5.2.8 Any Cell Selection state

### 5.2.8.1 UTRA

In this state, the UE shall attempt to find an acceptable cell to camp on, trying all radio access technologies that are supported by the UE.

If no acceptable cell is found, the UE shall continue to search for an acceptable cell in this state.

### 5.2.8.2 GSM

The *any cell selection* state in GSM is specified in [1].

## 5.2.9 Camped on Any Cell State

### 5.2.9.1 UTRA

If an acceptable cell is found, the UE shall camp on this cell and obtain limited service, state Camped on any cell.

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

- 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 trying all radio access technologies that are supported by the UE. If a suitable cell is found, this causes an exit to number 1 in Figure 2.

### 5.2.9.2 GSM

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

# 5.4 Cell Reselection Processes in RRC Connected Mode

## 5.4.1 Initial Cell Reselection Process

Triggers for the Initial cell re-selection process are specified in [4].

The UE shall attempt to find a suitable cell belonging to the selected PLMN according to the following steps:

1) The UE shall scan all RF channels of the UTRA band to find a suitable cell. 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.

2) After the UE has found one suitable cell for the selected PLMN, the UE shall create a candidate list consisting of this cell and its neighbouring UTRA cells, as received in measurement control information via the selected cell.

3) Rank the cells according to the cell reselection criteria (see 5.2.6.1.4), without considering the parameters Qhyst and Treselection.

4) Check if the highest ranked cell fulfils all requirements for a suitable cell. If so, select this cell. If this cell does not fulfil all requirements for a suitable cell, this cell and all cells on the same frequency shall be removed as candidates for cell selection (see also 5.~~2.~~3.1~~3~~), and step ~~4~~ 3 shall be repeated for the remaining cells.

~~If different radio access modes are involved in the procedure, then~~The use of mapping functions ~~shall be applied~~is indicated in system information. For each radio access mode and radio access technology, such a mapping function is defined and its parameters are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value $Q_{map}$ that can have values between 0 and 99 (step size 1). These quality values $Q_{map}$ ~~can then be compared with each other and the cell with the highest $Q_{map}$ value is chosen (among those cells with S criterion is fulfilled).~~are then used to evaluate the cell reselection criteria in section 5.2.6.1.4.

If the UE is unable to find any suitable cell, the UE shall release the RRC connection and enter idle mode.

### 5.4.1.1 Criteria

The criteria for initial cell reselection is specified in subclause 5.2.2.1.2.

# 6 Broadcast information receiving

## 6.1 Reception of System Information

~~Requirements are specified in [4].~~ Requirements are specified in [4].

## 6.2 Cell Broadcast in Idle Mode

A UE supporting Cell Broadcast Service (CBS) shall be capable to receive BMC messages in the Idle mode. 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.

# 7 Measurements for cell selection / reselection

## 7.1 Use of Mapping Functions

Different types of measurements are used in different radio access technologies and modes for the cell selection and reselection (CPICH Ec/N0 or CPICH RSCP in UTRA FDD, P-CCPCH RSCP in UTRA TDD, RXLEV in GSM). ~~Whenever a direct comparison of these measurements is required, mapping functions shall be applied.~~The use of mapping functions is indicated in system information.

Mapping functions are used for mapping a certain range of measurement values $Q_{meas\_LEV}$ (CPICH_EC/N0, CPICH_RSCP_LEV, P-CCPCH_RSCP_LEV, RXLEV) to a representing quality value $Q_{map}$ (0..99, step size 1).

For each radio access technology and mode, one mapping function is defined. It may be defined over one or several consecutive intervals of the measurement values $Q_{meas\_LEV}$.

The size of the consecutive intervals is sufficiently defined by their upper limit (given by parameter Upper_limit). In case of only one interval specified, the parameter Upper_limit is not needed and the interval is equivalent to the measurement range defined for that radio access technology. In case of more than one interval specified, the upper limit of the last interval defined is equivalent to the upper limit of the defined measurement range. The lower limit of an interval is equivalent to the upper limit of the interval before that interval. For the first interval, the lower limit is equivalent to the lower limit of the defined measurement range.

Within each interval, one function type (given by parameter Function_type) is defined by two parameters Map_parameter_1 and Map_parameter_2. For release 99, only linear functions are specified: $Q_{map} = a * Q_{meas\_LEV} + b$, if $Q_{meas\_LEV}$ is the measured value and $Q_{map}$ is the representing quality value.

Map_parameter_1 and Map_parameter_2 for an interval define the $Q_{map}$ values that the $Q_{meas\_LEV}$ values at the upper and the lower limit of this interval are mapped to, respectively. In other words, the linear function within one interval is defined by two tuples ($Q_{meas\_LEV}$, $Q_{map}$) at the interval limits, so that the parameters a and b can be derived from this.

Accordingly, if the mapping function is steady between two consecutive intervals, Map_parameter_2 for the first interval has the same value as Map_parameter_1 for the following interval. This is illustrated in the following Figure 3:

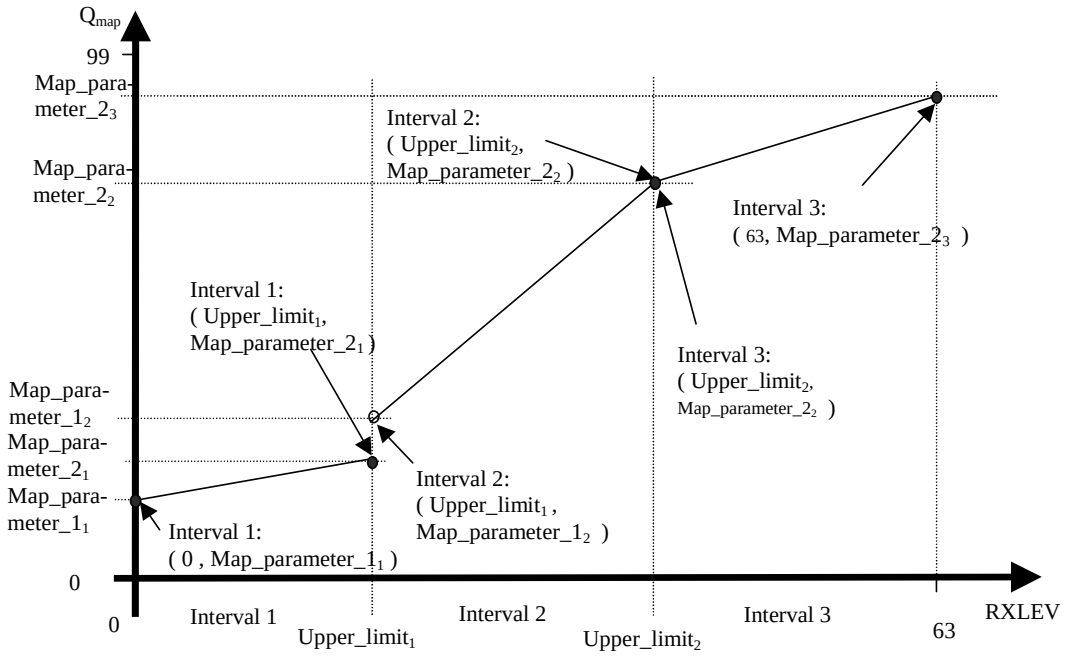



**Figure 3: Illustration of mapping of RXLEV using multiple linear models**

If no mapping functionality is needed (e.g. in FDD- or TDD-only networks), an implicit mapping is used: $Q_{map}= Q_{meas\_LEV}$. This is specified as default case.

The parameters defined for each interval (Function_type, Map_parameter_1, Map_parameter_2 and Upper_limit)are broadcast in system information.

# 8 Paging and SCCPCH selection in Idle mode

## 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 is 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:

  Index of selected SCCPCH = (IMSI div (("DRX cycle length" div PBP)*Np*$N_{PICH}$)) mod 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.

"Index of selected SCCPCH" identifies the selected SCCPCH with the PCH and the uniquely associated PICH to be used by the UE. "DRX cycle length", PBP, Np and $N_{PICH}$ shall be determined as specified Section 8.3.

**3GPP TSG-RAN WG 2 Meeting #17**
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***Tdoc r2-002412***

*CR-Form-v3*

# CHANGE REQUEST

⌘ **25.304 CR 052** ⌘ rev **r1** ⌘ Current version: **3.4.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE ☒ Radio Access Network ☒ Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Clarifications to cell selection and reselection procedures |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | ***Date:*** ⌘ 15/11/2000 |
| ***Category:*** | ⌘ | **F** ***Release:*** ⌘ R99 |

*Use one of the following categories:*
***F*** *(essential correction)*
***A*** *(corresponds to a correction in an earlier release)*
***B*** *(Addition of feature),*
***C*** *(Functional modification of feature)*
***D*** *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

*Use one of the following releases:*
*2 (GSM Phase 2)*
*R96 (Release 1996)*
*R97 (Release 1997)*
*R98 (Release 1998)*
*R99 (Release 1999)*
*REL-4 (Release 4)*
*REL-5 (Release 5)*

***Reason for change:*** ⌘ The cell selection and re-selection procedure contain many ambiguities that need to be clarified.

***Summary of change:*** ⌘

Section 5.2.3.1.1 - The action taken when the selected cell is not suitable has been clarified. When cells on the same frequency are removed from the candidate list it is clarified that this also applies to the initial suitable cell if that is on the same frequency.

Section 5.2.3.1.1 - The meaning of the 'highest ranked acceptable cell' has been clarified.

Section 5.2.4.1.1 - References corrected

Section 5.2.4.1.2 - Clarified that Qoffset used in the criteria should be Qoffset1 or Qoffset2 according to cells being compared and the cell-selection-and-reselection-quality-measure.

Section 5.2.6.1.1 - Reference to GSM removed as section does not apply to GSM

Section 5.2.6.1.4 - It is clarified whether references to TDD, GSM and FDD cells is referring to the neighbour cell or the serving cell.

Section 5.2.6.1.4 - Confusing reference to the 'default' mapping function is removed, as there is no possibility to use any other mapping function for making a comparison between FDD cells and other FDD cells.

| | | |
|---|---|---|
| ***Consequences if not approved:*** | ⌘ | The cell selection and re-selection procedures will be ambiguous and different UE implementations will not have consistent behaviour. |

| | | | | |
|---|---|---|---|---|
| ***Clauses affected:*** | ⌘ | 5.2.3.1.1, 5.2.4.1.1, 5.2.4.1.2, 5.2.6.1.1, 5.2.6.1.4 | | |
| ***Other specs affected:*** | ⌘ | ☐ Other core specifications<br>☐ Test specifications<br>☐ O&M Specifications | ⌘ | |
| ***Other comments:*** | ⌘ | | | |

**How to create CRs using this form:**
Comprehensive information and tips about how to create CRs can be found at: http://www.3gpp.org/3G_Specs/CRs.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.
2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://www.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2000-09 contains the specifications resulting from the September 2000 TSG meetings.
3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

## 5.2.3 Cell Selection Process

### 5.2.3.1 UTRA

#### 5.2.3.1.1 Description

Whenever a PLMN is selected [5], the UE shall attempt to find a suitable cell of that PLMN to camp on according to the following steps.

1) Create a candidate list of potential cells to camp on by using one of the 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 band to find a suitable cell. On each carrier, the UE searches first for the strongest cell and reads its system information, in order to find out which PLMN the cell belongs to. If the selected PLMN is found, the search of the rest of carriers may be stopped. Once the UE has found a suitable cell for the selected PLMN, the UE shall create a candidate list consisting of this cell and its neighbouring cells, as received in measurement control information via the selected cell.

   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. After the UE has found one suitable cell for a selected PLMN the UE shall create the candidate list consisting of this cell and its neighbouring cells, using information from the selected cells' measurement control information.

2) For each cell on the candidate list calculate the cell selection value Srxlev and Squal (Squal is used for FDD cells only), defined in subclause 5.2.3.1.2. Cells which do not fulfil the criteria S are removed from the candidate list.

3) Evaluate the cells as follows;

   - For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section 5.2.4.1.2 by the Cell_selection_and_reselection_quality measure in system information.

   - If mapping information is provided in system information, the specified mapping function is used in the UE following the formula in clause 5.2.4.1.2 for cell ranking.

   - If mapping information is not provided in system information, the UE shall use the default mapping function Qmap = $Q_{meas\_LEV}$ in the formula in clause 5.2.4.1.2 and apply it for cell ranking.

4) Select the cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criterion in 5.2.4.1.2 best. If no cell fulfils the criteria, the UE should select the initial suitable cell. Check if the selected cell fulfils all requirements for a suitable cell. If so, choose this cell to camp on. If this cell does not fulfil all requirements for a suitable cell, and the cell does not allow intra-frequency cell selection and re-selection, then this cell and all cells on the same frequency, including the initial suitable cell if that is on the same frequency, shall be removed as candidates for cell selection. in case the barred cell does not accept intra-frequency cell selection and re-selection. If the cell does not fulfil all the requirements for a suitable cell and the cell does allow intra-frequency cell selection, then On the other hand, in case the selected cell accepts intra-frequency cell selection and re-selection, only the barred cell shall be removed as candidate for cell selection (see also subclause 5.2.3)., and sStep 3 shall be repeated for the remaining cells.

NOTE: $Q_{map,s}$ and $Qoffset_{s,n}$ in this case apply to the cell from which system information was read.

5) Move to state *camped normally*

If different radio access modes are involved in the procedure, specific mapping functions shall be applied. For each radio access mode, such a mapping function is defined and its parameters are broadcast in system information. The mapping function maps a certain range of measurement values $Q_{meas\_LEV}$ to a representative quality value $Q_{map}$ that ranges between 0 and 99 with a granularity of 1. These quality values $Q_{map}$ can then be compared with each other and the cell with the highest $Q_{map}$ value is chosen (among those cells fulfilling 5.2.3.1.2).

If no suitable cell of selected PLMN is found and the stored information cell selection procedure was used in step 1, the Initial cell selection procedure shall be started and the steps are repeated. If the UE is unable to find any suitable cell of selected PLMN using the Initial cell selection procedure, it shall attempt to find an acceptable cell, create a candidate list consisting of this cell and its neighbouring cells, as received in measurement control information, and then repeat steps 2 to 4 to find the ~~camp on~~ highest ranked acceptable cell. It shall then ~~and~~ enter the Camped on any cell state, where it can only obtain limited service. In PLMN selection, automatic mode, this would normally result in a new PLMN selection [5].

#### 5.2.3.1.2 Criteria

The cell selection criteria S are defined as follows.

$$Squal = Q_{qualmeas} - Qqualmin$$

$$Srxlev = Q_{rxlevmeas} - Qrxlevmin - Pcompensation$$

| | |
|---|---|
| Squal | Cell Selection quality value, (dB)<br>Not applicable for TDD cells or GSM cells. |
| Srxlev | Cell Selection RX level value (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) to use as quality measure $Q_{meas\_LEV}$ (read in system information) |
| $Q_{qualmeas}$ | Measured cell quality value. The quality of the received signal expressed in CPICH $E_c/N_0$ (dB) for FDD cells. Not applicable for TDD cells or GSM 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 RXLEV for GSM cells (dBm). |
| ~~$Q_{meas\_LEV}$~~ | ~~Quality value. The quality value of the received signal expressed in CPICH $E_c/N_0$ or CPICH_RSCP_LEV for FDD cells, P-CCPCH RSCP_LEV for TDD cells and RXLEV for GSM cells (dBm).~~ |
| Qqualmin | Minimum required quality level in the cell (dB). Not applicable for TDD cells or GSM cells. |
| Qrxlevmin | Minimum required RX level in the cell. (dBm) |
| Pcompensation | 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 cell selection criterion S is fulfilled when:

$$Squal > 0$$

$$Srxlev > 0$$

Squal has to be evaluated for FDD cells only.

### 5.2.3.2 GSM

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

## 5.2.4 Immediate Cell Evaluation Process

### 5.2.4.1 UTRA

#### 5.2.4.1.1 Description

The Immediate Cell Evaluation procedure is used by the UE to perform a quick evaluation of the quality of the intra-frequency cells. Based on this information, the UE shall select the best cell among the cells on the same frequency, according to the criteria defined in the next subclause.

The following steps shall be carried out when an immediate cell evaluation has been triggered.

1) The candidate list of potential cells to camp on consists of the cells in the current registration area listed for intra-frequency measurements in system information of the serving cell.

2) For each cell on the candidate list calculate the cell selection values, Srxlev and Squal (for FDD cells only), defined in subclause 5.2.3.1.2. Cells, which do not fulfil criteria S, are removed from the candidate list.

3) Evaluate the cells as follows;

   - For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section ~~5.2.6.1.4~~5.2.4.1.2 based on Cell_selection_and_reselection_quality_ measure in system information.

   - If mapping information is provided in system information, the specified mapping function is used in the UE and the formula in section 5.2.4.1.2 ~~5.2.6.1.4~~ for cell ranking is applied.

   - If mapping information is not provided in system information, UE shall use default mapping function Qmap = $Q_{meas\_LEV}$ in the formula in section 5.2.4.1.2 ~~5.2.6.1.4~~ and use it for cell ranking.

4) Select the neighbouring cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criteria in 5.2.4.1.2 ~~5.2.6.1.4~~ best. If the best cell does not fulfil all other requirements for a suitable cell, UE shall trigger cell re-selection Otherwise select the serving cell if $Q_{map,s} > Q_{map,n} - Qoffset_{s,n}$.

NOTE: Whether the calculation of the $Q_{map}$ value should require the immediate decoding (e.g. in case the UL load value is used for the calculation) of a set of neighbouring cell BCHs is FFS.

#### 5.2.4.1.2 Criteria

The UE shall select a new cell if the following criteria are fulfilled.

$$Squal_n > 0$$

$$Srxlev_n > 0$$

$$Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$$

$Squal_n$ has to be evaluated for FDD cells only.

| | |
|---|---|
| $Squal_n$ | Cell Selection quality value of the neighbouring cell, (dB)<br>Not applicable for TDD cells or GSM cells. |
| $Srxlev_n$ | Cell Selection RX level value of the neighbouring cell, (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive $Q_{map,n}$ and $Q_{map,s}$, (read in system information). |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH $E_C/N_0$ or CPICH_RSCP_LEV for FDD cells and P-CCPCH*RSCP*LEV for TDD cells. |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH RSCP for TDD cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied. 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. |
| $Qoffset_{s,n}$ | Offset between the two cells considered in the evaluation (read in system information). For comparison between FDD cells when the cell_selection_and_reselection_quality_measure is CPICH Ec/No then $Qoffset2_{s,n}$. For all other cases $Qoffset1_{s,n}$ shall be used. |

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

If more than one neighbouring cell fulfils the criteria, the UE shall choose the cell where the difference between $Q_{map,n}$ and ($Q_{map,s}$ + Qoffset) is highest. If no neighbouring cell fulfils the criteria, the UE shall keep the serving cell.

#### 5.2.4.2 GSM

Immediate Cell Evaluation procedure is not applicable for GSM.

### 5.2.5 Camped Normally State

#### 5.2.5.1 UTRA

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

The Camped Normally State is specified in [1].

### 5.2.6 Cell Reselection Evaluation Process

#### 5.2.6.1 UTRA

The cell reselection process is described by the following sub-clauses:

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

When serving cell does not belong to a hierarchical cell structure, UE shall follow these rules for intra- and inter-frequency measurements and inter-RAT measurements:

The UE shall use Squal for FDD cells and Srxlev for TDD ~~and GSM cells~~ as Sx in the following rules.

1. If Sx > $S_{intrasearch}$, UE need not perform intra-frequency measurements.
   If Sx <= $S_{intrasearch,}$ UE shall perform intra-frequency measurements.
   If $S_{intrasearch,}$ is not sent for serving cell, UE shall perform intra-frequency measurements.

2. If Sx > $S_{intersearch}$, UE need not perform inter-frequency measurements
   If Sx <= $S_{intersearch}$, UE shall perform inter-frequency measurements.
   If $S_{intersearch}$, is not sent for serving cell, UE shall perform ~~intra~~inter-frequency measurements.

3. If Sx > $Ssearch_{RAT\ n}$, UE need not perform measurements on cells of RAT n
   If Sx <= $Ssearch_{RAT\ n}$, UE shall perform measurements on cells of RAT n.
   If $Ssearch_{RAT\ m}$, is not sent for serving cell, UE shall perform measurements on cells of RAT m.

#### 5.2.6.1.2 Measurements for cell re-selection when HCS is used

When serving cell belongs to a hierarchical cell structure, the UE shall follow these rules for intra- and inter-frequency measurements:

1. Intra- and inter-frequency threshold-based measurement rules

   The UE shall use Squal for FDD cells and Srxlev for TDD cells as Sx in the following rules.

   IF ($Srxlev_s$ <= $Ssearch_{HCS}$) or ($S_x$ <= $S_{intersearch}$ (FDD only)) THEN

      <UE shall measure on all intra- and inter-frequency cells>

   ELSE

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

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

      ELSE

         <UE shall measure on all intra- 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

2. Intra- 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- and inter-frequency neighbouring cells, which have equal or lower HCS priority than serving cell. Furthermore, UE shall prioritise re-selection of intra- 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 $T_{CrmaxHyst}$. Then, UE shall revert to measure 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

   The UE shall use Squal for FDD cells and Srxlev for TDD cells as Sx in the following rules.

   IF ($Srxlev_s$ <= $S_{HCS,RATm}$) or ($S_{qual}$ <= $S_{SearchRATm}$ (FDD only)) THEN

<UE shall measure on all inter-RATm cells>

ELSE

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

< UE need not measure inter-RATm neighbouring cells >

ELSE

<UE shall measure on all inter-RATm cells, which have equal or higher HCS priority level than the serving cell unless measurement rules for fast-moving UEs are triggered >

ENDIF

ENDIF

2. Inter-RAT 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 RATm neighbouring cells, which have an equal or lower HCS priority than the serving cell. Furthermore, UE shall prioritise re-selection of RATm neighbouring cells on lower HCS priority level before RATm neighbouring cells on same HCS priority level.

  When the number of cell reselections during time interval $T_{CRmax}$ no longer exceeds $N_{CR}$, UE shall continue these measurements during time period $T_{CrmaxHyst}$. Then, UE shall revert to measure according to the threshold-based measurement rules.

#### 5.2.6.1.3 Non-suitable cells (Squal > 0 or Srxlev > 0)

If the best cell according to cell reselection criteria specified in subclause 5.2.6.1.4, does not fulfil all requirements for a suitable cell, that cell, together with all cells on that frequency shall be removed as candidate for cell re-selection (see also subclause 5.2.6).

#### 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:

$$H_s = Q_{meas\_LEV,s} - Qhcs_s$$

$$H_n = Q_{meas\_LEV,n} - Qhcs_n - TO_n * L_n$$

The cell-ranking criterion R is defined by:

$$R_s = Q_{map,s} + Qhyst_s$$

$$R_n = Q_{map,n} - Qoffset_{s,n} - TO_n * (1 - L_n)$$

where:

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

$L_n = 0$ if $HCS\_PRIO_n = HCS\_PRIO_s$

$L_n = 1$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

$W(x) = 0$ for $x < 0$
$W(x) = 1$ for $x >= 0$

$T_n$ is a timer implemented for each neighbouring cell. $T_n$ shall be started from zero when one of the following conditions becomes true:

$Q_{meas\_LEV,n} > Qhcs_n$ if $HCS\_PRIO_n <> HCS\_PRIO_s$

or

For serving and neighbour cells that are of different radio access modes or technologies, and for serving and neighbour FDD cells when ~~TDD cells, GSM cells and FDD cells if~~ the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH RSCP:

$Q_{map,n} > Q_{map,s} + Qoffset1_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

or

For serving and neighbour FDD cells when ~~if~~ the cell_selection_and_reselection-quality_measure IE sets the quality value to be CPICH Ec/No:

$Q_{meas\_LEV,n} > Q_{meas\_LEV,s} + Qoffset2_{s,n}$ if $HCS\_PRIO_n = HCS\_PRIO_s$

$T_n$ shall be stopped as soon as these conditions are no longer fulfilled.

At cell-reselection, a timer $T_n$ is stopped only if the corresponding cell is not a neighbour cell of the new serving cell, or if the criterion given above for starting timer $T_n$ for the corresponding cell is no longer fulfilled with the parameters of the new serving cell.

$TEMP\_OFFSET_n$ applies an offset to H and R criteria for the duration of $PENALTY\_TIME_n$ after the timer $T_n$ has started for that cell.

| | |
|---|---|
| $S_n$ | Cell Selection value of the neighbouring cell, (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive quality measures $Q_{map,n}$ and $Q_{map,s}$, (read in system information). |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells, from P-CCPCH for TDD cells and from RXLEV for GSM cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH for TDD cells. 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. |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH_Ec/No or CPICH_RSCP_LEV for FDD cells as set by the Cell_selection_and_reselection_quality_measure information element, P-CCPCH_RSCP_LEV for TDD cells and RXLEV for GSM cells. |
| $Qoffset1_{s,n}$ | Offset value 1between the two cells considered in the evaluation (read in system information). |
| $Qoffset2_{s,n,}$ | Offset value 2 between the two cells considered in the evaluation (read in system information). |
| $Qhyst1_s$ | Hysteresis value of the serving cell. |
| $Qhyst2_s$ | Hysteresis value of the serving cell. |
| $HCS\_PRIO_s$, $HCS\_PRIO_n$ | HCS priority level (0-7) for serving cell and neighbouring cells |
| $PENALTY\_TIME_n$ | Duration for applying $TEMP\_OFFSET_n$ to H and R criteria (s) |
| $Qhcs_s$, $Qhcs_n$ | Quality threshold level for applying prioritised hierarchical cell re-selection |
| $TEMP\_OFFSET1_n$ | Offset to H and R criteria for the duration of $PENALTY\_TIME_n$ |
| $TEMP\_OFFSET2_n$ | Offset to H and R criteria for the duration of $PENALTY\_TIME_n$ |
| $T_{Crmax}$ | Duration for evaluating allowed amount of cell reselections (s). |
| $N_{CR}$ | Maximum number of cell reselections |
| $T_{CrmaxHyst}$ | Additional time period before UE reverts to low-mobility measurements (s) |
| $Treselection_s$ | Time-to-trigger for cell reselection, (s) |

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

The UE shall perform ranking of all cells that fulfil the S criterion (see subclause 5.2.6.1.4) among

- all cells that have the highest HCS_PRIO among those cells that fulfil the criterion H >= 0**.** Note that this rule is not valid when UE high-mobility is detected (see subclause 5.2.6,1,4).

- all cells, not considering HCS priority levels, if no cell fulfil the criterion H >= 0. This case is also valid when HCS is not applied, 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, using CPICH RSCP, P-CCPCH RSCP and RXLEV for deriving $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD, TDD and GSM cells, respectively. The offset $Qoffset1_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst1_s$ is used to calculate $R_s$ and $TEMP\_OFFSET1_n$ is used to calculate $TO_{n.}$ 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 a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH RSCP, the UE shall perform cell re-selection to that FDD cell.

If a FDD cell is ranked as the best cell and IE cell_selection_and_reselection-quality_measure is set to CPICH Ec/No, 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 as given in cell_selection_and_reselection-quality_measure for deriving the $Q_{map,n}$ and $Q_{map,s}$ and calculating the R values of the FDD cells. In this case, ~~default~~ the mapping function $Q_{map} = Q_{meas\_LEV}$ is used and the offset $Qoffset2_{s,n}$ is used to calculate $R_n$, the hysteresis $Qhyst2_s$ is used to calculate $R_s$ and $TEMP\_OFFSET2_n$ is used to calculate $TO_n$. Then the UE shall perform cell re-selection to the best ranked FDD cell.

The UE shall reselect the new cell, if the cell reselection criteria are fulfilled during a time interval Treselection.

#### 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 as follows:

**$Qoffset1_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qoffset2_{s,n}$**

The offset between the two cells is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$Qhyst1_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$Qhyst2_s$**

The hysteresis value (Qhyst) is read in system information of the serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$HCS\_PRIO_s$, $HCS\_PRIO_n$**

HCS priority level (0-7) for serving cell and neighbouring cells are read in system information of serving cell.

**$Qhcs_s$, $Qhcs_n$**

Quality threshold levels for applying prioritised hierarchical cell re-selection are read in system information of serving cell.

**Qqualmin**

Minimum required quality level in the cell, (dB). Not applicable for TDD cells or GSM cells.

**Qrxlevmin**

Minimum required RX level in the cell. (dBm)

**$PENALTY\_TIME_n$**

Time duration for which the $TEMPORARY\_OFFSET_n$ is applied for a neighbouring cell is read in system information of serving cell.

**$TEMPORARY\_OFFSET1_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for TDD and GSM cells and for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH RSCP.

**$TEMPORARY\_OFFSET2_n$**

Applies an offset to the H and R criteria for a neighbouring cell for the duration of $PENALTY\_TIME_n$. The parameter is read in system information of serving cell. It is used for FDD cells in case IE cell_selection_and_re-selection_quality_measure is set to CPICH Ec/No.

**$T_{CRmax}$**

Duration for evaluating allowed amount of cell reselection(s) is read in system information of serving cell.

**$N_{CR}$**

Maximum number of cell reselections is read in system information of serving cell.

**$T_{CRmaxHyst}$**

Additional time period before UE reverts to low-mobility measurements is read in system information of serving cell.

**$Treselection_s$**

The cell reselection timer value is read in system information of the serving cell.

**$Ssearch_{HCS}$**

Below this limit in the serving cell, the UE shall initiate measurements of all neighbouring cells of the serving cell. The value is read in system information of the serving cell.

**$Ssearch_{RAT\ 1}$ - $Ssearch_{RAT\ k}$**

This RAT specific threshold in the serving cell is used in the inter-RAT measurement rules. The values are read in system information of the serving cell.

**$S_{HCS,RATm}$**

This RAT specific threshold in the serving cell is used in the inter-RAT measurement rules. The values are read in system information of the serving cell.

**$S_{intrasearch}$**

Threshold for intra frequency measurements (dB for FDD, dBm for TDD) and for the HCS measurement rules.

**$S_{intersearch}$**

Threshold for intra frequency measurements (dB for FDD, dBm for TDD)and for the HCS measurement rules.

**$S_{limit,SearchRATm}$**

Above this RAT specific threshold in the serving UTRA cell, the UE need not perform any inter-RATm measurements (dB for FDD, dBm for TDD)

**Mapping Info**

Mapping Info contains all the information that is necessary to define the mapping function that is used for mapping a certain range of measurement values to a representing quality value (0..99, step size 1).

### 5.2.6.2 GSM

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

**3GPP TSG-RAN Meeting #17** ***Tdoc R2-002350***
**Sophia Antipolis, France, 13th – 17th November 2000**

*CR-Form-v3*

# CHANGE REQUEST

⌘ **25.304 CR 053** ⌘ rev **-** ⌘ Current version: **3.4.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

***Proposed change affects:*** ⌘ (U)SIM ☐ ME/UE ☒ Radio Access Network ☒ Core Network ☐

| | | |
|---|---|---|
| ***Title:*** | ⌘ | Removal of Immediate Cell Evaluation Process |
| ***Source:*** | ⌘ | TSG-RAN WG2 |
| ***Work item code:*** | ⌘ | ***Date:*** ⌘ 14. Nov 2000 |
| ***Category:*** | ⌘ | **F** ***Release:*** ⌘ R99 |

| *Use one of the following categories:* | *Use one of the following releases:* | |
|---|---|---|
| ***F*** *(essential correction)* | *2* | *(GSM Phase 2)* |
| ***A*** *(corresponds to a correction in an earlier release)* | *R96* | *(Release 1996)* |
| ***B*** *(Addition of feature),* | *R97* | *(Release 1997)* |
| ***C*** *(Functional modification of feature)* | *R98* | *(Release 1998)* |
| ***D*** *(Editorial modification)* | *R99* | *(Release 1999)* |
| Detailed explanations of the above categories can be found in 3GPP TR 21.900. | *REL-4* | *(Release 4)* |
| | *REL-5* | *(Release 5)* |

| | | |
|---|---|---|
| ***Reason for change:*** | ⌘ | Decision of R2/R4 AdHoc to remove the immediate cell evaluation process from R99 specifications |
| ***Summary of change:*** | ⌘ | • The immediate cell evaluation states in figure 2 and the descriptive text in section 5.2.2 related to immediate cell evaluation is removed. When leaving idle mode the UE attempts to access the current serving cell. If the access attempt fails the UE shall uses the cell reselection procedure to find a suitable cell.<br>• The definition of the $Q_{map,n}$, $Q_{map,s}$ and $Qoffset_{S,N}$ are moved from section 5.2.4 to section 5.2.3.1.2 since they are still needed for the cell selection procedure. Corresponding references in 5.2.3.1.1 are changed accordingly.<br>• Section 5.2.4 (idle mode) and 5.4.2 (connected mode) are removeds |
| ***Consequences if not approved:*** | ⌘ | |

| | | |
|---|---|---|
| ***Clauses affected:*** | ⌘ | 5.2.2; 5.2.3.1.1; 5.2.3.1.2; 5.2.4; 5.2.4.1; 5.2.4.1.1; 5.2.4.1.2; 5.2.4.2; 5.3.1.1; 5.4.2 |
| ***Other specs affected:*** | ⌘ | ☐ Other core specifications ⌘<br>☐ Test specifications<br>☐ O&M Specifications |
| ***Other comments:*** | ⌘ | |

**How to create CRs using this form:**
Comprehensive information and tips about how to create CRs can be found at: http://www.3gpp.org/3G_Specs/CRs.htm. Below is a brief summary:

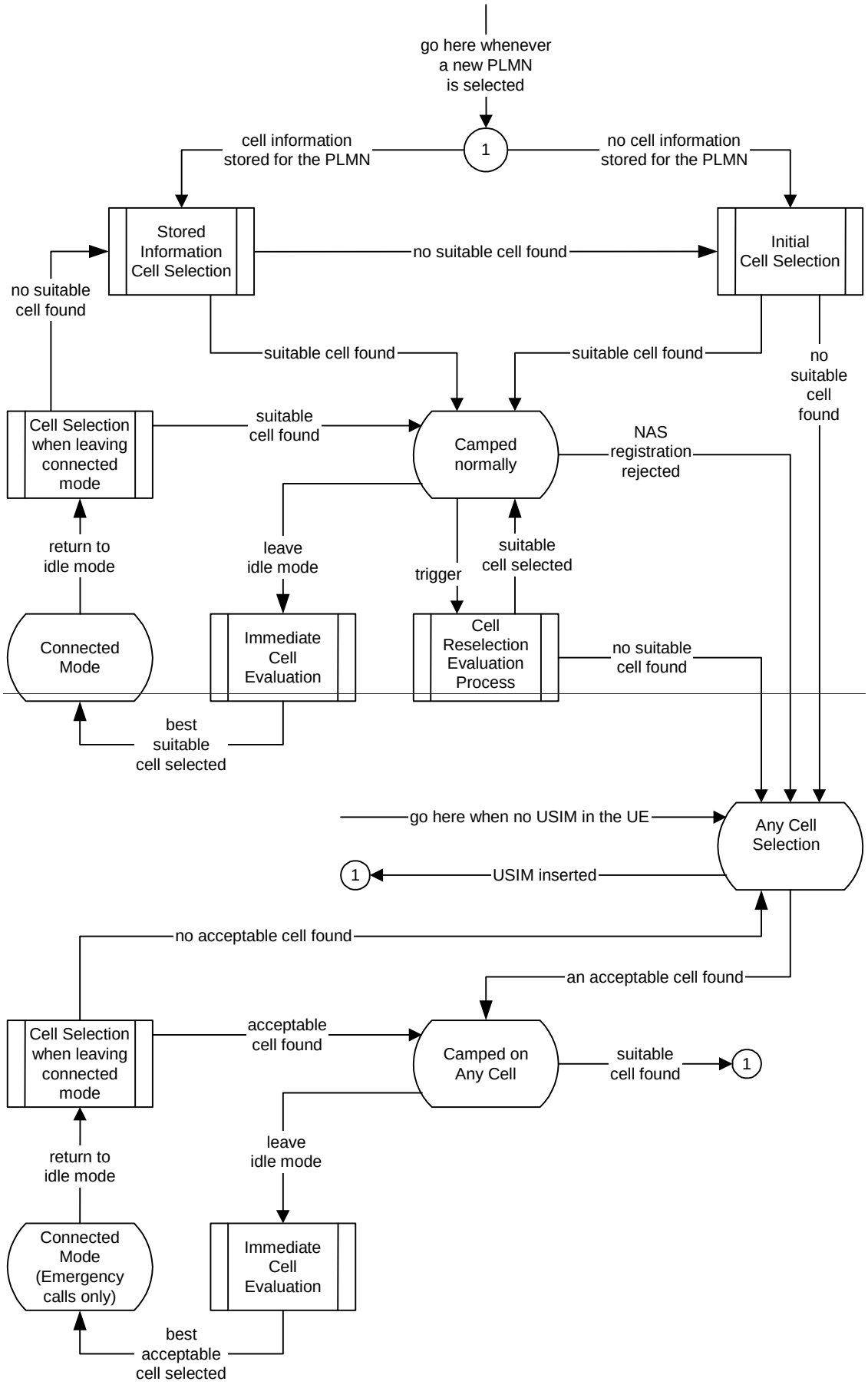
1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://www.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2000-09 contains the specifications resulting from the September 2000 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

## 5.2.2 States and state transitions in Idle Mode

Figure 2 shows the states and procedures in Idle Mode.


go here whenever a new PLMN is selected
1
cell information stored for the PLMN
no cell information stored for the PLMN
Stored Information Cell Selection
Initial Cell Selection
no suitable cell found
no suitable cell found
suitable cell found
suitable cell found
no suitable cell found
Cell Selection when leaving connected mode
suitable cell found
Camped normally
NAS registration rejected
return to idle mode
leave idle mode
trigger
suitable cell selected
Connected Mode
Immediate Cell Evaluation
Cell Reselection Evaluation Process
no suitable cell found
best suitable cell selected
go here when no USIM in the UE
Any Cell Selection
1
USIM inserted
no acceptable cell found
an acceptable cell found
Cell Selection when leaving connected mode
acceptable cell found
Camped on Any Cell
suitable cell found
1
return to idle mode
leave idle mode
Connected Mode (Emergency calls only)
Immediate Cell Evaluation
best acceptable cell selected

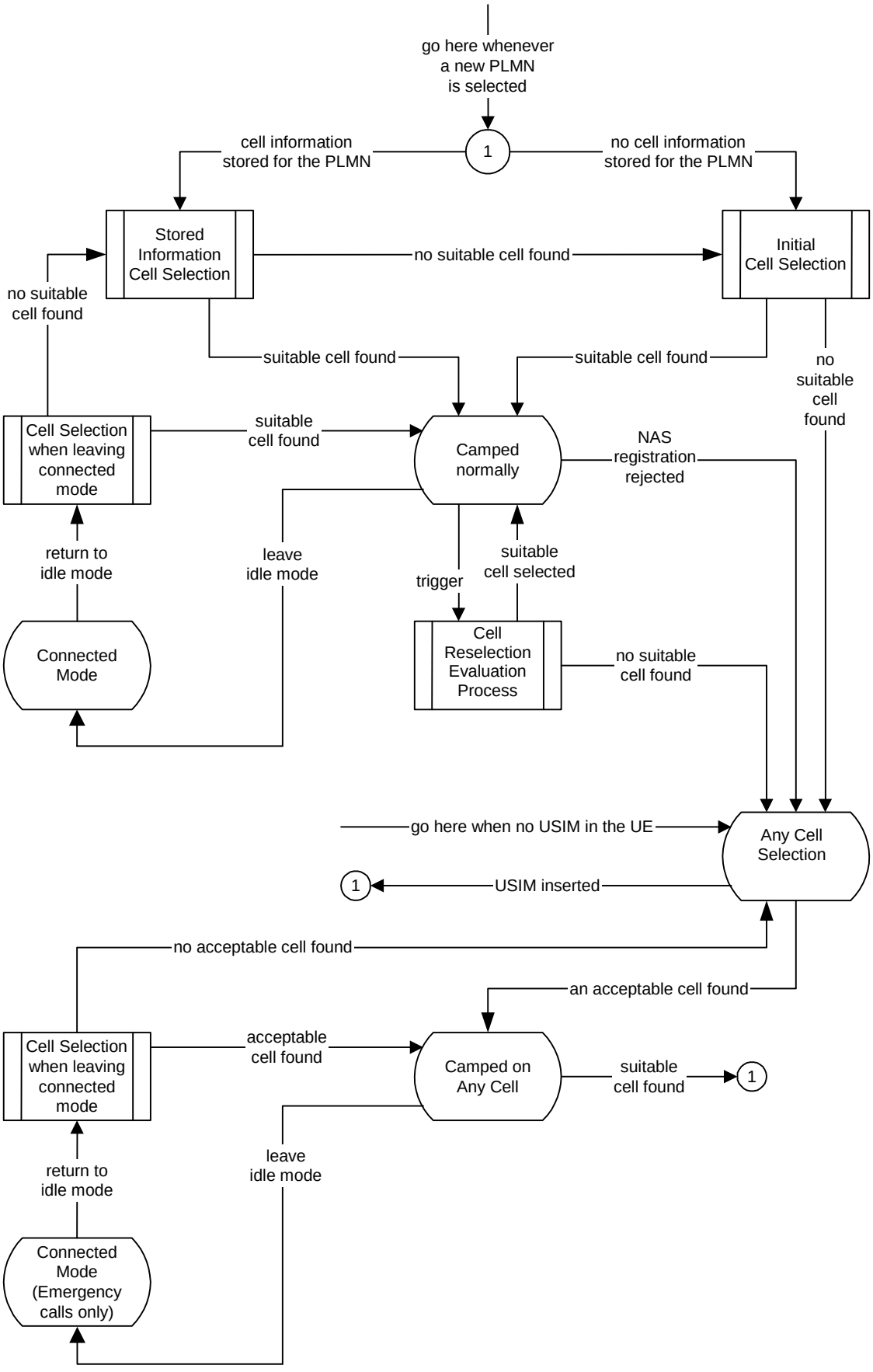



**Figure 2: Idle Mode Cell Selection and Reselection**
**In any state, a new PLMN selection causes an exit to number 1**

Whenever a PLMN has been selected, the UE shall attempt to find a suitable cell to camp on using one of the two procedures, *Initial cell selection* or *Stored information cell selection*. The *Initial cell selection* procedure requires no knowledge about the selected PLMN, but the *Stored information cell selection* procedure requires information to have been stored about the selected PLMN during a previous selection of that PLMN. This stored information makes the search for a suitable cell faster. The information may contain information about several radio access technologies. The non-access stratum may control the cell selection by:

- providing information on radio access technology(ies);
- association with the selected PLMN;
- maintaining lists of forbidden registration areas;
- a list of NAS defined service areas in priority order.

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

When a suitable cell has been found, the UE shall perform necessary NAS registration procedures. When the UE has registered successfully, the UE shall camp on the cell, state *Camped normally*. In this state, the UE shall monitor paging information, monitor system information and perform radio measurements. The measurements shall be used in evaluation of the cell selection~~, immediate cell evaluation (UTRA only)~~ and reselection criteria. The network controls what the UE shall measure by sending measurement control information in the system information. The measurement control information may contain intra-frequency, inter-frequency and inter-radio-access- technology measurements.

The UE shall evaluate the cell reselection criteria based on radio measurements, and if a better cell is found that cell is selected, procedure *Cell reselection*. The change of cell may imply a change of radio access technology.

When UE leaves idle mode, state *Camped normally*, in order to enter connected mode, state *Connected mode*, the UE shall attempt to access the current serving cell. ~~use the *Immediate cell evaluation* procedure (UTRA only) in order to select the best cell on the current frequency for the access attempt. This procedure allows the UE to reduce power consumption spent on radio measurements, still enabling the UE to select the best cell for access, thus minimising the interference in the system. If no suitable cell is found~~If the access attempt to the serving cell fails, the UE shall use the *Cell reselection* procedure. 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, state *Camped normally*. If no suitable cell is found, the *Stored information cell selection* procedure shall be used.

If no suitable cell is found, the UE shall attempt to find an acceptable cell of any PLMN, state *Any cell search*. This state is also entered if a non-access stratum registration procedure is rejected, see [5], or if there is no USIM in the UE. If an acceptable cell is found, the UE shall camp on this cell and obtain limited service, state *Camped on any cell*. In this state, the UE shall behave as specified for state *Camped normally*, but typically with a different PLMN. Additionally, the UE shall regularly attempt to find a suitable cell using stored information, trying all radio access technologies that are supported by the UE. If a suitable cell is found, the PLMN is reselected which causes an exit to number 1.

When a cell reselection is triggered, the UE shall evaluate the cell reselection criteria based on radio measurements, and if a better cell is found that cell is selected, procedure *Any cell search*. The change of cell may imply a change of radio access technology.

If no acceptable cell is found, the UE shall continue to search for an acceptable cell of any PLMN in state *Any cell selection* trying all radio access technologies that are supported by the UE.

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

#### 5.2.3.1.1 Description

Whenever a PLMN is selected [5], the UE shall attempt to find a suitable cell of that PLMN to camp on according to the following steps.

1) Create a candidate list of potential cells to camp on by using one of the 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 band to find a suitable cell. On each carrier, the UE searches first for the strongest cell and reads its system information, in order to find out which PLMN the cell belongs to. If the selected PLMN is found, the search of the rest of carriers may be stopped. Once the UE has found a suitable cell for the selected PLMN, the UE shall create a candidate list consisting of this cell and its neighbouring cells, as received in measurement control information via the selected cell.

   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. After the UE has found one suitable cell for a selected PLMN the UE shall create the candidate list consisting of this cell and its neighbouring cells, using information from the selected cells' measurement control information.

2) For each cell on the candidate list calculate the cell selection value Srxlev and Squal (Squal is used for FDD cells only), defined in subclause 5.2.3.1.2. Cells which do not fulfil the criteria S are removed from the candidate list.

3) Evaluate the cells as follows;

   - For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section ~~5.2.4.1.2~~5.2.3.1.2 by the Cell_selection_and_reselection_quality measure in system information.

   - If mapping information is provided in system information, the specified mapping function is used in the UE following the formula in clause ~~5.2.4.1.2~~5.2.3.1.2 for cell ranking.

   - If mapping information is not provided in system information, the UE shall use the default mapping function Qmap = $Q_{meas\_LEV}$ in the formula in clause ~~5.2.4.1.2~~5.2.3.1.2 and apply it for cell ranking.

4) Select the cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criterion in ~~5.2.4.1.2~~5.2.3.1.2 best. If no cell fulfils the criteria, the UE should select the initial suitable cell. Check if the selected cell fulfils all requirements for a suitable cell. If so, choose this cell to camp on. If this cell does not fulfil all requirements for a suitable cell, this cell and all cells on the same frequency shall be removed as candidates for cell selection in case the barred cell does not accept intra-frequency cell selection and re-selection. On the other hand, in case the selected cell accepts intra-frequency cell selection and re-selection, only the barred cell shall be removed as candidate for cell selection (see also subclause 5.2.3), and step 3 shall be repeated for the remaining cells.

NOTE: $Q_{map,s}$ and $Qoffset_{s,n}$ in this case apply to the cell from which system information was read.

5) Move to state *camped normally*

If different radio access modes are involved in the procedure, specific mapping functions shall be applied. For each radio access mode, such a mapping function is defined and its parameters are broadcast in system information. The mapping function maps a certain range of measurement values $Q_{meas\_LEV}$ to a representative quality value $Q_{map}$ that ranges between 0 and 99 with a granularity of 1. These quality values $Q_{map}$ can then be compared with each other and the cell with the highest $Q_{map}$ value is chosen (among those cells fulfilling 5.2.3.1.2).

If no suitable cell of selected PLMN is found and the stored information cell selection procedure was used in step 1, the Initial cell selection procedure shall be started and the steps are repeated. If the UE is unable to find any suitable cell of selected PLMN using the Initial cell selection procedure, it shall attempt to camp on highest ranked acceptable cell and enter the Camped on any cell state, where it can only obtain limited service. In PLMN selection, automatic mode, this would normally result in a new PLMN selection [5].

### 5.2.3.1.2 Criteria

The cell selection criteria S are defined as follows.

$$Squal = Q_{qualmeas} - Qqualmin$$

$$Srxlev = Q_{rxlevmeas} - Qrxlevmin - Pcompensation$$

The cell selection criterion S is fulfilled when:

$$Squal > 0$$

$$Srxlev > 0$$

Squal has to be evaluated for FDD cells only.

$$Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$$

where the index *N* indicates neighbouring cells and the index *S* indicates the serving cell.

The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).

If more than one neighbouring cell fulfils the criteria, the UE shall choose the cell where the difference between $Q_{map,n}$ and ($Q_{map,s}$ + Qoffset) is highest.

| | |
|---|---|
| Squal | Cell Selection quality value, (dB)<br>Not applicable for TDD cells or GSM cells. |
| Srxlev | Cell Selection RX level value (dB) |
| Cell_selection_and_reselection_quality_measure (FDD only) | Choice of measurement (CPICH Ec/N0 or CPICH RSCP) to use as quality measure $Q_{meas\_LEV}$ (read in system information) |
| $Q_{qualmeas}$ | Measured cell quality value. The quality of the received signal expressed in CPICH $E_C/N_0$ (dB) for FDD cells. Not applicable for TDD cells or GSM 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 RXLEV for GSM cells (dBm). |
| $Q_{meas\_LEV}$ | Quality value. The quality value of the received signal expressed in CPICH $E_C/N_0$ or CPICH_RSCP_LEV for FDD cells, P-CCPCH RSCP_LEV for TDD cells and RXLEV for GSM cells (dBm). |
| Qqualmin | Minimum required quality level in the cell (dB). Not applicable for TDD cells or GSM cells. |
| Qrxlevmin | Minimum required RX level in the cell. (dBm) |
| Pcompensation | 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) |
| $Q_{map,n}$ | Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_C/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH RSCP for TDD cells. 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. |
| $Q_{map,s}$ | Quality of the serving cell, after mapping function is applied. 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. |
| $Qoffset_{s,n}$ | Offset between the two cells considered in the evaluation (read in system information). |

~~The cell selection criterion S is fulfilled when:~~

| |
|---|
| Squal > 0 |
| Srxlev > 0 |

~~Squal has to be evaluated for FDD cells only.~~

### 5.2.3.2 GSM

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

## 5.2.4 Immediate Cell Evaluation Process

Void.

### ~~5.2.4.1 UTRA~~

#### ~~5.2.4.1.1 Description~~

~~The Immediate Cell Evaluation procedure is used by the UE to perform a quick evaluation of the quality of the intra-frequency cells. Based on this information, the UE shall select the best cell among the cells on the same frequency, according to the criteria defined in the next subclause.~~

~~The following steps shall be carried out when an immediate cell evaluation has been triggered.~~

~~1) The candidate list of potential cells to camp on consists of the cells in the current registration area listed for intra-frequency measurements in system information of the serving cell.~~

~~2) For each cell on the candidate list calculate the cell selection values, Srxlev and Squal (for FDD cells only), defined in subclause 5.2.3.1.2. Cells, which do not fulfil criteria S, are removed from the candidate list.~~

~~3) Evaluate the cells as follows;~~

~~- For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section 5.2.6.1.4 based on Cell_selection_and_reselection_quality_ measure in system information.~~

~~- If mapping information is provided in system information, the specified mapping function is used in the UE and the formula in section 5.2.6.1.4 for cell ranking is applied.~~

~~- If mapping information is not provided in system information, UE shall use default mapping function Qmap = $Q_{meas\_LEV}$ in the formula in section 5.2.6.1.4 and use it for cell ranking.~~

~~4) Select the neighbouring cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criteria in 5.2.6.1.4 best.~~
~~If the best cell does not fulfil all other requirements for a suitable cell, UE shall trigger cell re-selection~~
~~Otherwise select the serving cell if $Q_{map,s} > Q_{map,n} - Qoffset_{s,n}$.~~

~~NOTE: Whether the calculation of the $Q_{map}$ value should require the immediate decoding (e.g. in case the UL load value is used for the calculation) of a set of neighbouring cell BCHs is FFS.~~

#### ~~5.2.4.1.2 Criteria~~

~~The UE shall select a new cell if the following criteria are fulfilled.~~

| |
|---|
| $Squal_n > 0$ |
| ~~$Srxlev_n > 0$~~ |
| $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ |

~~$Squal_n$ has to be evaluated for FDD cells only.~~

| | |
|---|---|
| ~~$Squal_n$~~ | ~~Cell Selection quality value of the neighbouring cell, (dB)~~<br>~~Not applicable for TDD cells or GSM cells.~~ |
| ~~$Srxlev_n$~~ | ~~Cell Selection RX level value of the neighbouring cell, (dB)~~ |
| ~~Cell_selection_and_reselection_quality_measure (FDD only)~~ | ~~Choice of measurement (CPICH Ec/N0 or CPICH RSCP) that is used to derive $Q_{map,n}$ and $Q_{map,s}$ (read in system information).~~ |
| ~~$Q_{meas\_LEV}$~~ | ~~Quality value. The quality value of the received signal expressed in CPICH $E_c/N_0$ or CPICH_RSCP_LEV for FDD cells and P-CCPCH*RSCP*LEV for TDD cells.~~ |
| ~~$Q_{map,n}$~~ | ~~Quality of the neighbouring cell, after mapping function is applied, derived from CPICH $E_c/N_0$ or CPICH RSCP for FDD cells and from P-CCPCH RSCP for TDD cells. 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.~~ |
| ~~$Q_{map,s}$~~ | ~~Quality of the serving cell, after mapping function is applied. 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.~~ |
| ~~$Qoffset_{s,n}$~~ | ~~Offset between the two cells considered in the evaluation (read in system information).~~ |

~~The quality values $Q_{map,n}$ and $Q_{map,s}$ are determined by mapping functions. The parameters for these mapping functions are broadcast in system information. The mapping function maps a certain range of measurement values to a representing quality value. $Q_{map,n}$ and $Q_{map,s}$ can have values between 0 and 99 (step size 1).~~

~~If more than one neighbouring cell fulfils the criteria, the UE shall choose the cell where the difference between $Q_{map,n}$ and ($Q_{map,s}$ + Qoffset) is highest. If no neighbouring cell fulfils the criteria, the UE shall keep the serving cell.~~

#### ~~5.2.4.2 GSM~~

~~Immediate Cell Evaluation procedure is not applicable for GSM.~~

Next modified section

# 5.3 Cell Access Restrictions

## 5.3.1 UTRA cells

There are two mechanisms which allow an operator to impose cell 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 SoLSA exclusive use (IE type: "reserved" or "not reserved").

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

- the UE may select/re-select this cell during the cell selection~~, immediate cell evaluation~~ 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 SoLSA,

- UEs not supporting SoLSA (i.e. all UEs for Release '99) shall behave as if cell status "barred" is indicated (see below).

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

- UEs assigned to an Access Class in the range 11 to 15 may select/re-select this cell if in the home PLMN.
- UEs assigned to an Access Class in the range 0 to 9 shall behave as if cell status "barred" is indicated (see below).

When cell status "barred" is indicated,

- the UE is not permitted to select/re-select this cell, except for emergency call, when no other acceptable cell can be found, and the cell is not barred for emergency call by means of the "Access Class 10 bit", see clause 5.3.1.3.
- The UE shall ignore the "Cell Reserved for SoLSA exclusive 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 $T_{barred}$. The time interval $T_{barred}$ 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 $T_{barred}$ 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 $T_{barred}$ again check whether the status of the barred cell has changed.

Next modified section

### 5.4.1.1 Criteria

The criteria for initial cell reselection is specified in subclause 5.2.2.1.2.

## 5.4.2 Immediate Cell Evaluation Process

Void.

~~The immediate cell evaluation procedure is the same as used for idle mode, described in subclause 5.2.4, with the following differences:~~

~~1) The potential cells for selection at immediate cell evaluation in Connected Mode consists of the cells for intra-frequency measurements in system information of the serving cell. However, if UE dedicated measurements control information has been assigned to the UE in the serving cell, the candidate list consists of the cells for intra- frequency measurements included in this UE dedicated measurement control information.~~

**3GPP TSG RAN WG2 Meeting #17**
**Sophia Antipolis, France, Nov. 13-17th 2000**

***Document* R2-002367**
*e.g. for 3GPP use the format TP-99xxx*
*or for SMG, use the format P-99-xxx*

# CHANGE REQUEST

*Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.*

**25.304 CR 054** Current Version: 3.4.0

*GSM (AA.BB) or 3G (AA.BBB) specification number ↑* *↑ CR number as allocated by MCC support team*

For submission to: TSG-RAN #10 *list expected approval meeting # here ↑* for approval [X] / for information [ ]

strategic [ ] / non-strategic [ ] *(for SMG use only)*

*Form: CR cover sheet, version 2 for 3GPP and SMG* *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

**Proposed change affects:** *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [X] Core Network [ ]

**Source:** TSG-RAN WG2 **Date:** 16-11-2000

**Subject:** One step cell selection

**Work item:**

**Category:** *(only one category shall be marked with an X)*

| | | |
|---|---|---|
| F | Correction | X |
| A | Corresponds to a correction in an earlier release | |
| B | Addition of feature | |
| C | Functional modification of feature | |
| D | Editorial modification | |

**Release:**

| | |
|---|---|
| Phase 2 | |
| Release 96 | |
| Release 97 | |
| Release 98 | |
| Release 99 | X |
| Release 00 | |

**Reason for change:**

Alignment with conclusion found on "Workshop on Handover and Cell Selection 9th and 10th of June 1999", Sophia Antipolis.

In cell selection process, the UE directly select the first suitable cell of the selected PLMN involved in the process.

**Clauses affected:** 5.2.3.1.1, 5.2.3.1.2

**Other specs affected:**

| | | |
|---|---|---|
| Other 3G core specifications | [ ] | → List of CRs: |
| Other GSM core specifications | [ ] | → List of CRs: |
| MS test specifications | [ ] | → List of CRs: |
| BSS test specifications | [ ] | → List of CRs: |
| O&M specifications | [ ] | → List of CRs: |

**Other comments:**

help.doc

<--------- double-click here for help and instructions on how to create a CR.

### 5.2.3.1.1 Description

Whenever a PLMN is selected [5], the UE shall attempt to find a suitable cell of that PLMN to camp on according to the following steps.

1) The UE shall use one of the following two search procedures: ~~Create a candidate list of potential cells to camp on by using one of the 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 band to find a suitable cell. On each carrier, the UE searches first for the strongest cell and reads its system information, in order to find out which PLMN the cell belongs to. If the selected PLMN is found, the search of the rest of carriers may be stopped. Once the UE has found a suitable cell for the selected PLMN~~,~~ the UE shall select it. ~~create a candidate list consisting of this cell and its neighbouring cells, as received in measurement control information via the selected cell.~~

   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 ~~After~~ the UE has found ~~one~~ a suitable cell for ~~a~~ the selected PLMN the UE shall select it.~~create the candidate list consisting of this cell and its neighbouring cells, using information from the selected cells' measurement control information.~~

2) ~~For each cell on the candidate list calculate the cell selection value Srxlev and Squal (Squal is used for FDD cells only), defined in subclause 5.2.3.1.2. Cells which do not fulfil the criteria S are removed from the candidate list.~~

~~3) Evaluate the cells as follows;~~

- ~~For FDD cells, select CPICH Ec/N0 or RSCP used for evaluation of $Q_{meas\_LEV}$ defined in section 5.2.4.1.2 by the Cell_selection_and_reselection_quality measure in system information.~~
- ~~If mapping information is provided in system information, the specified mapping function is used in the UE following the formula in clause 5.2.4.1.2 for cell ranking.~~
- ~~If mapping information is not provided in system information, the UE shall use the default mapping function $Qmap = Q_{meas\_LEV}$ in the formula in clause 5.2.4.1.2 and apply it for cell ranking.~~

~~4) Select the cell that fulfils the $Q_{map,n} > Q_{map,s} + Qoffset_{s,n}$ criterion in 5.2.4.1.2 best. If no cell fulfils the criteria, the UE should select the initial suitable cell. Check if the selected cell fulfils all requirements for a suitable cell. If so, choose this cell to camp on. If this cell does not fulfil all requirements for a suitable cell, this cell and all cells on the same frequency shall be removed as candidates for cell selection in case the barred cell does not accept intra-frequency cell selection and re-selection. On the other hand, in case the selected cell accepts intra-frequency cell selection and re-selection, only the barred cell shall be removed as candidate for cell selection (see also subclause 5.2.3), and step 3 shall be repeated for the remaining cells.~~

~~NOTE: $Q_{map,s}$ and $Qoffset_{s,n}$ in this case apply to the cell from which system information was read.~~

3~~2~~5) Move to state *camped normally*

~~If different radio access modes are involved in the procedure, specific mapping functions shall be applied. For each radio access mode, such a mapping function is defined and its parameters are broadcast in system information. The mapping function maps a certain range of measurement values $Q_{meas\_LEV}$ to a representative quality value $Q_{map}$ that ranges between 0 and 99 with a granularity of 1. These quality values $Q_{map}$ can then be compared with each other and the cell with the highest $Q_{map}$ value is chosen (among those cells fulfilling 5.2.3.1.2).~~

If no suitable cell of selected PLMN is found and the stored information cell selection procedure was used in step 1, the Initial cell selection procedure shall be started ~~and the steps are repeated~~. If the UE is unable to find any suitable cell of selected PLMN using the Initial cell selection procedure, it shall attempt to camp on ~~highest ranked~~the strongest acceptable cell and enter the Camped on any cell state, where it can only obtain limited service. In PLMN selection, automatic mode, this would normally result in a new PLMN selection [5].

#### 5.2.3.1.2 Criteria

The cell selection criteria S are defined as follows.

$$Squal = Q_{qualmeas} - Qqualmin$$

$$Srxlev = Q_{rxlevmeas} - Qrxlevmin - Pcompensation$$

| | |
|---|---|
| Squal | Cell Selection quality value, (dB)<br>Not applicable for TDD cells or GSM cells. |
| Srxlev | Cell Selection RX level value (dB) |
| ~~Cell_selection_and_reselection_quality_measure (FDD only)~~ | ~~Choice of measurement (CPICH Ec/N0 or CPICH RSCP) to use as quality measure $Q_{meas\_LEV}$ (read in system information)~~ |
| $Q_{qualmeas}$ | Measured cell quality value. The quality of the received signal expressed in CPICH $E_c/N_0$ (dB) for FDD cells. Not applicable for TDD cells or GSM 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 RXLEV for GSM cells (dBm). |
| ~~$Q_{meas\_LEV}$~~ | ~~Quality value. The quality value of the received signal expressed in CPICH $E_c/N_0$ or CPICH_RSCP_LEV for FDD cells, P-CCPCH RSCP_LEV for TDD cells and RXLEV for GSM cells (dBm).~~ |
| Qqualmin | Minimum required quality level in the cell (dB). Not applicable for TDD cells or GSM cells. |
| Qrxlevmin | Minimum required RX level in the cell. (dBm) |
| Pcompensation | 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 cell selection criterion S is fulfilled when:

$$Squal > 0$$

$$Srxlev > 0$$

Squal has to be evaluated for FDD cells only.

### 5.2.3.2 GSM

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