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UE Procedures in Idle Mode

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Contents

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[Editor's note: This section needs to be reviewed. It is assumed here than a 3GPP IPR report will be available in the near future.]

Foreword

This Technical Specification has been produced by the 3GPP.
The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 Indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the specification;

1. Scope

The present document shall describe the overall idle mode process for the UE and the functional division between the non-access stratum and access stratum in the UE. The UE is in idle mode when the connection of the UE is closed on all layers, e.g. there is neither an MM connection nor an RRC connection.

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

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.
- A non-specific reference to an TS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETSI 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: “UE Functions and Inter-Layer Procedures in Connected Mode”

[4] 3GPP TS 25.331: “RRC Protocol Specification”

3. Definitions, abbreviations and symbols

3.1 Definitions

Acceptable Cell — This is a cell that the UE may camp on to make emergency calls. It must satisfy certain conditions.

Allowable PLMN — This is a PLMN which is not in the list of forbidden PLMNs in the UE.

Available PLMN — This is a PLMN where the UE has found a cell that satisfies certain conditions.

Camped on a cell — The 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. Note that the services may be limited, and that the PLMN may not be aware of the existence of the UE within the chosen cell.

DRX — Discontinuous Reception.

DRX cycle — The individual time interval between monitoring Paging Occasion ~~reading initial paging information~~ for a specific UE.

Home PLMN — This is 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.

~~**Initial paging information**~~ — ~~This information indicates if the UE need to continue to read more paging information and eventually receive a page message.~~

~~**Initial paging occasion**~~ — ~~The paging occasion the UE use as starting point for its DRX cycle.~~

Location Registration (LR) — The 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 a non-contiguous radio coverage.

LSA exclusive access cell — A 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 — A LSA preferential access cell is a cell which is part of the LSA. UEs of users that have subscribed to a LSA of a LSA-preferential-access cell have higher priority to resources than non-LSA users in the same cell. The availability of LSA preferential access cells impact the following procedure(s):

- radio resource allocation (controlled by UTRAN-Access Stratum). This function is out of the scope of the standards.

Maximum DRX cycle — The time interval for the longest possible DRX cycle in a cell.

Paging Block Periodicity (PBP) — The period of the occurrence of Paging Blocks. (For FDD, PBP = 1).

Paging Message Receiving Occasion The frame where the UE receives actual paging message.

Paging occasions ~~The time instances where it is possible to receive initial paging information~~The frame where the UE monitors in FDD or the paging block, which consists of several frames, for TDD. For Paging Blocks, the value of Paging Occasion is equal to the first frame of the Paging Block.

PICH Monitoring Occasion The time instance where the UE monitors PICH within Paging Occasion.

Radio Access Mode Mode of the cell, FDD or TDD

Radio Access System UMTS, GSM etc.

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

Registration Area A (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 This is a cell on which an UE may camp. It must satisfy certain conditions.
[Note: These certain conditions are FFS.]

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

3.2 Abbreviations

AS	Access Stratum
BCCH	Broadcast Control Channel
CN	Core Network
DSCH	Downlink Shared Channel
FDD	Frequency Division Duplex
GC	General Control (SAP)
GPRS	General Packet Radio System
GSM	Global System for Mobile
IMSI	International Mobile Subscriber Identity
MCC	Mobile Country Code
MM	Mobility Management
MNC	Mobile Network Code
NAS	Non-Access Stratum
ODMA	Opportunity Driven Multiple Access
ORACH	ODMA Random Access Channel
PCH	Paging Channel
PLMN	Public Land Mobile Network
RRC	Radio Resource Control
SAP	Service Access Point
TDD	Time Division Duplex
UE	User Equipment
UE_R	User Equipment with ODMA relay operation enabled
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network

3.3 Symbols

4. General description of Idle mode

[NOTE: The Idle mode in UMTS also includes the Idle mode of GSM. Further details are invited.]

4.1 Overview

When a multi-mode UE is switched on, it attempts to make contact with a public land mobile network (PLMN) using a certain radio access system.

The particular PLMN to be contacted may be selected either automatically or manually.

The UE looks 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 in the registration area of the chosen cell if necessary, by means of a location registration procedure.

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

If necessary, the UE will look for more suitable cells on other PLMNs at regular time intervals, which is referred to as PLMN-reselection. Particularly, in the home country of the UE, the UE will try to get back to its Home PLMN.

If the UE loses coverage of a 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 UE's 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 initiate a call, 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 messages

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 the Figure 1.

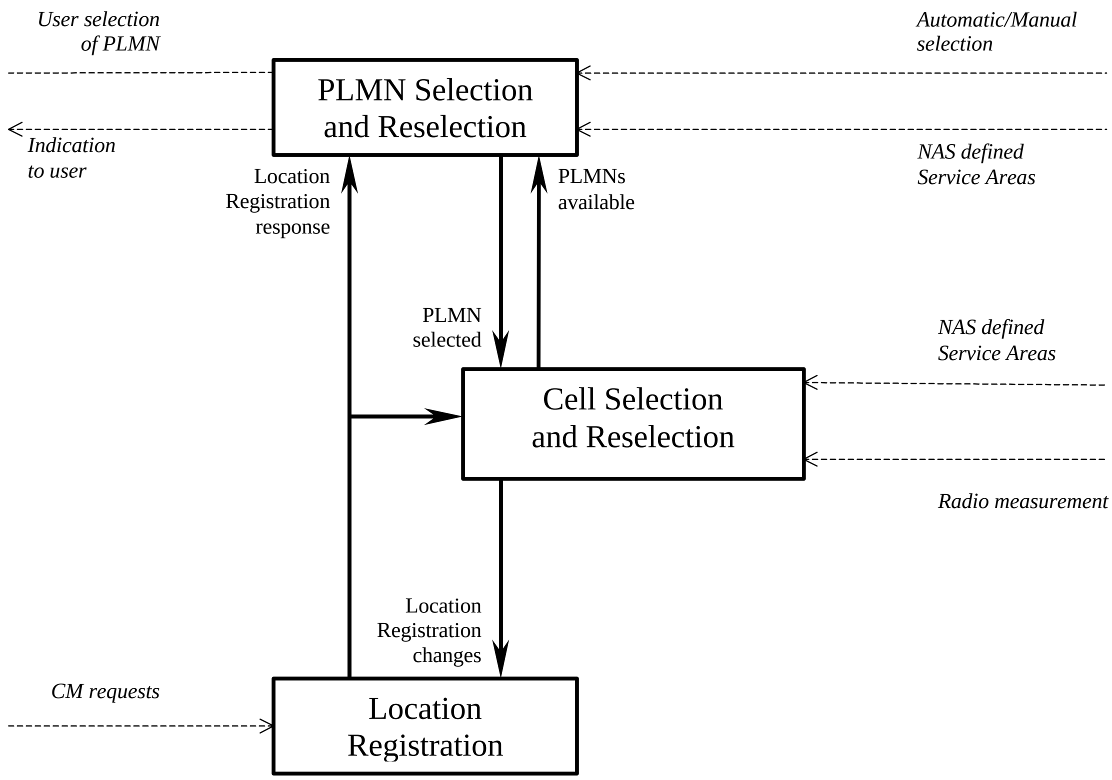

Figure 1~~1~~. Overall Idle Mode process.

[Note: The prioritization of radio access systems and 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 primary purpose of this functional division is to serve as a basis for the work division between 3GPP TSG RAN WG2 and other groups. Examples of different idle mode procedures are presented in chapter 10.

Idle Mode Process	UE Non-Access Stratum	UE Access Stratum
PLMN Selection and Reselection	Maintain a list of PLMNs in priority order. Request AS to select a cell either belonging to the PLMN having the highest priority (in automatic mode) or belonging to the manually selected PLMN. In automatic mode, if a PLMN with higher priority is found, request AS to select a cell belonging to that PLMN.	Report available PLMNs to NAS on request from NAS or autonomously.
Cell Selection	Control cell selection 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 selection. Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS. Search for a suitable cell belonging to the PLMN requested by NAS. The cells are identified with PLMN identity in the system information. Respond to NAS whether such cell is found or not. 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. Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS. Change cell if a more suitable cell is found. Perform ODMA probing in an ODMA Relay Node.
Location registration	Register the UE as active after power on. Register the UE’s presence in a registration area, for instance regularly or when entering a new registration area. Deregister UE when shutting down.	Report registration area information to NAS.

Table 11~~1~~. Functional division between AS and NAS in idle mode.

4.3 Service type in Idle mode

This chapter provides some definitions regarding the level of service that may be provided by the UTRAN to an UE in Idle mode.

The action of camping on a cell is generally presented as mandatory to receive some service from the cell. This notion of service should be distinguished in 3 categories, so that the network may eventually not provide all kind of services in every cells for UE in idle mode:

- Emergency calls
- Normal services (for public use)
- Operator related services

Furthermore, the cells can be categorised according to services they can offer:

<u>acceptable cell:</u>

An "acceptable cell" is a cell on which the UE may camp on to originate emergency calls. Such a cell fulfills the following requirements, which is the minimum set of requirements to initiate an emergency call in a UTRAN network:

- the cell may or may not belong to the allowable PLMN list stored on the USIM
- the path loss between the UE and the radio site is below a threshold which is set by the operator
- the cell is not reserved for operator use only

<u>high priority suitable cell:</u>

A "high priority suitable cell" is a cell on which the UE may camp on. Such a cell fulfill the following requirements:

- the cell belongs to the selected PLMN
- the path loss between the UE and the radio site is below a threshold which is set by the operator
- the cell is not barred or reserved for operator use only
- the cell priority is provided by the network on the BCCH.

<u>low priority suitable cell:</u>

An UE may only camp on this cell if no other high priority suitable cells are available. This may be used as an example for the support of multilayered networks

<u>barred cell:</u>

An UE cannot camp on this kind of cell for standard services, but may eventually initiate an emergency call from this cell if no other suitable cell is available, either low or high priority.

This type of cell may be used by operators for traffic load balancing, as an example.

Whether or not the cell is barred, is provided by the network on the BCCH.

<u>"operator only" cell:</u>

The aim of this type of cells is to allow the operator using and test newly deployed cells without being disturbed by normal traffic. UE cannot camp on this cell, or initiate an emergency call from this cell, except for some classes of UE. The clearance for accessing to initiate a call within such a cell is part of the information stored on the USIM.

Whether or not the cell is reserved for operator use only, is provided by the network on the BCCH.

Table 2~~Table 2~~Table 2 quickly summarizes all the different cases above as well as the level of service provided by UTRAN, as seen from the UE in Idle mode.

	acceptable cell	high priority suitable cell	low priority suitable cell	barred cell	operator only cell
Emergency	Y	Y	Y	Y	N
Standard	N	Y	Y (backup)	N	N
Operator	N	Y	Y	N	Y

Table 2~~2~~2. Summary of service provided by UTRAN.

5. Process descriptions

5.1 PLMN selection and reselection

The non-access stratum selects a suitable PLMN. Normally, the UE operates on its Home PLMN (HPLMN). However, a visited PLMN (VPLMN) may be selected, e.g., if the UE loses coverage with its HPLMN. There are two modes for PLMN selection:

i) Automatic mode - This mode utilizes a list of PLMNs in priority order. The highest priority PLMN that is available and allowable is selected.

ii) Manual mode - Here the UE indicates which PLMNs are available to the user. Only when the user makes a manual selection does the UE try to obtain normal service on the VPLMN.

In the automatic mode, the UE will look for more suitable PLMNs regularly, if necessary. This is referred to as PLMN-reselection. Particularly, in the home country of the UE, the UE will try to get back to its Home PLMN.

Selection of the radio access system may be part of the PLMN selection and reselection process or it may be a separate process inside NAS *[FFS]*.

[Note: Details of the possible NAS process of the radio access system selection are out of the scope of TSG-RAN WG2.]

5.2 Cell selection and reselection

The UE selects the most suitable cell and the radio access mode based on idle mode measurements and cell selection criteria. The non-access stratum can control the cell selection, for instance in terms of a list of forbidden registration area(s) and a list of NAS defined service area(s) in priority order. In addition, NAS may also influence to the radio access system into which the cell should belong. For instance, NAS may create a list of radio access systems in priority order. *[FFS]*

When camped on a cell, the UE regularly searches a better cell according to the cell reselection criteria. If a more suitable 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
  - 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.

5.2.1 Cell Selection Procedure~~Process~~

5.2.1.1 Description

The purpose of the cell selection procedure is to find the most suitable cell for the UE to camp on. A suitable cell must fulfil all the following requirements.

1. The cell is part of the selected PLMN.
2. The cell is not barred [details are FFS].

3. The cell is not part of a forbidden registration area [details are FFS].
4. The cell selection criteria are fulfilled (see below).
5. The SoLSA criteria are fulfilled [FFS].

Whenever a PLMN is selected, the UE shall attempt to find the most suitable cell of that PLMN according to the following steps.

1. Create a candidate list of potential cells to camp on. Two procedures are possible for searching the most suitable cell.

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 scrambling code of the strongest cell, in order to find out which PLMNs are available. If the PLMN that NAS requested to search for is found, the search of the rest of carriers shall be stopped. After the UE has found one suitable cell for the selected PLMN, the UE shall create a candidate list, based on the measurement control information, containing the scrambling codes found.

b) Stored Information Cell Selection

This procedure requires stored carrier frequencies and potentially also scrambling codes information from previously received measurement control information elements. The scrambling code information should not, however, be requirement to camp on the selected PLMN. After the UE has found one suitable cell for a selected PLMN the UE shall create the candidate list based on the neighbour cell measurements, based on the measurement control information, containing the scrambling codes found.

[Note: Setting the priorities of PLMN search and selection are FFS]

2. Read the following information from the system information of each cell of the candidate list.

- Cell Barred [details are FFS]
- Registration area
- Cell selection parameters

3. For each cell on the candidate list not barred or forbidden, calculate the cell selection value, S, and the quality value, Q, defined below.

4. Among the cells with S > 0 choose the cell with the highest Q value to camp on.

If no suitable cells are found and the stored information cell selection procedure was used in step 1, the Initial cell selection procedure is started and the steps are repeated. If the UE is unable to find any suitable cell using the Initial cell selection procedure, it attempts to camp on any acceptable cell and enters "limited service state".

[Note: In PLMN selection, automatic mode, this would normally result in a new PLMN selection.]

5.2.1.2 Criteria

The cell selection value, S, is defined as follows.

$$\boxed{S = Q - Qmin - Pcompensation}$$

S	Cell Selection value, (dB)
Q	Quality value. The quality of the received signal, (dB or dBm) *[Note: Exact unit is FFS]*
Qmin	Minimum required quality level in the cell (read in system information and dependent on the quantity to measure), (dB or dBm).
Pcompensation	max(MS_TXPWR_MAX – P_MAX, 0), (dB)

MS_TXPWR_MAX Maximum TX power level an UE may use when accessing the cell (read in system information), (dBm)

P_MAX Maximum RF output power of the UE, (dBm)

The selection of values for network controlled parameters can be optimised by means of different methods. Examples of methods are described in 25.922.

The cell selection criterion is fulfilled if:

$$S > 0$$

5.2.2 Immediate Cell Evaluation Procedure

[Note: Conditions on the use of the immediate cell evaluation procedure are FFS]

5.2.2.1 Description

The purpose of the immediate cell evaluation is to quickly find the best cell.

Triggers of immediate cell evaluation are:

1) Prior to RACH transmission

2) $S \leq 0$

3) Downlink signalling failure [details are FFS]

4) Cell has become barred or forbidden [details are FFS]

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

1. The candidate list of potential cells to camp on consists of the cells for intra- and inter-frequency measurements in system information of the serving cell.
2. Calculate the Q value for each cell on the candidate list.
3. Calculate the S value for the best cell.
4. Select the neighbouring cell if the criteria defined below are fulfilled.
5. If the criteria are not fulfilled, check the S value for the next best cell until the criteria defined below are fulfilled.

[Note: Whether the calculation of the Q 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.]

5.2.2.2 Criteria

The UE shall perform cell reselection if the following criteria are fulfilled.

$$S_n > 0$$

$$Q_n > Q_s + Qoffset_{s,n}$$

S_n Cell Selection value of the neighbouring cell, (dB)

Q_n Quality of the neighbouring cell, (dB or ~~/~~dBm) *[Note: Exact unit is FFS]*

Q_s Quality of the serving cell, (dB or ~~/~~dBm)

$Qoffset_{s,n}$ Offset between the two cells considered in the evaluation (read in system information), (dB).

The selection of values for network controlled parameters can be optimised by means of different methods. Examples of methods are described in 25.922.

If more than one neighbouring cell fulfils the criteria, the UE shall choose the cell where the difference between Q_n and (Q_s + Qoffset) is highest. If no neighbouring cell fulfils the criteria, the UE shall keep the serving cell if the immediate cell evaluation was triggered prior to a RACH transmission otherwise a new cell selection shall take place.

~~5.2.2~~5.2.3 Cell Reselection Procedure~~Process~~

5.2.3.1 Description

The purpose of the cell reselection is to regularly look for the best cell for the UE to camp on (according to some criteria). The serving cell is changed when a better cell is found. The criterion for a better cell is different for intra/inter-frequency and inter-RAS reselections (see below).

The following steps are carried out when evaluating cells for cell reselection.

1. The candidate list of potential cells to camp on consists of the cells for intra- and inter-frequency measurements and intra-radio access system measurements in system information of the serving cell.
2. Calculate the Q value and the S value for each cell in the candidate list.
3. Depending on which type of cells are on the candidate list (intra-frequency, inter-frequency and inter radio access system), select the cell that fulfils the corresponding criteria best.

Better cells are prioritised in the following order when several cells fulfil their corresponding criteria:

1) Intra-frequency neighbouring cells
2) Inter-frequency neighbouring cells
3) Inter-radio access system neighbouring cells

5.2.3.2 Intra-Frequency Cell Reselection Criteria

The criteria for a better intra-frequency cell are:

$$S_n > 0$$

$$Q_n > Q_s + Qoffset_{s,n} + Qhyst$$

S_n Cell Selection value of the neighbouring cell, (dB)

Q_n Quality of the neighbouring cell, (dB or ~~/~~dBm) *[Note: Exact unit is FFS]*

Q_s Quality of the serving cell, (dB or ~~/~~dBm)

$Qoffset_{s,n}$ Offset between the two cells considered in the evaluation (read in system information), (dB)

Qhyst Hysteresis value, (dB)

The timer Treselection puts a time-to-trigger criteria for cell reselection. The timer shall be started when the cell reselection criteria is fulfilled. At timer expiry, the UE shall reselect the new cell, if the cell reselection criteria are still fulfilled. The timer is reset if the cell reselection criteria are no longer fulfilled. The value of the Treselection is presented in system information.

5.2.3.3 Inter-Frequency Cell Reselection Criteria

The inter-frequency cell reselection evaluation uses the same criteria as intra-frequency cell reselections.

5.2.3.4 Inter Radio Access System Cell Reselection Criteria

Measurements on another radio access system (RAS) are not carried out unless the quality in the current radio access system is lower than a threshold, Qsearch. The quality of the target cell in the other radio access system has to exceed a threshold, Qaccept, before a reselection takes place. The following quantities are defined for inter-RAS cell reselection evaluations:

Qaccept Minimum quality required for a cell in the new system.

Qsearch Below this limit in the serving cell, the UE shall take measurements of inter-RAS cells if such entries exist in the measurement control information elements.

The UE shall consider inter-RAS cells with a quality Q > Qaccept, for reselection. The UE shall select the cell with the highest quality Q. Qaccept and Qsearch are included in the system information of the serving cell.

If the present quality is below Qsearch but no cells of the other systems reach the Qaccept quality, the cell reselection should not be performed. However, the measurements shall still continue.

If several RASs fulfils Qaccept the UE shall choose the RAS with the highest priority [FFS].

5.2.3.5 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 25.922. Cell reselection parameters are broadcast in system information as follows:

$Qoffset_{s,n}$

The offset between the two cells considered in the evaluation ($Qoffset_{s,n}$ (dB)) can be conveyed in two different ways:

1. Offsets can be included for each neighbouring cell in the intra-frequency neighbouring cell list, which is decoded from system information broadcasts in the serving cell.

2. The offset can be broadcast in each cell, and the UE decodes it from system information broadcasts in the neighbouring cell. In the case, this offset is applied for all cell relations towards that neighbouring cell (i.e. for each value on the subscript s). Decoding is done only when the cell measurement exceeds the neighbour cell decoding range. The offset is broadcast is together with an offset expiration timer, which indicates how long the offset value is valid.

[Note: Whether both 1 and 2 could be used or if only one of these alternatives is used is FFS]

Qhyst

The hysteresis value (Qhyst (dB)) is decoded from system information broadcasts in the serving cell.

Treselection

The cell reselection timer value is decoded from system information broadcasts in the serving cell.

Decoding range

The decoding range is decoded from system information broadcasts in the serving cell.

OffsetExp

The offset expiration timer decoded from system information broadcasts in the neighbouring cell.

~~5.2.2.1~~5.2.4 ODMA probing sub-process

In addition to UE cell selection process the UE_R will initiate or continue to evaluate the relay link via probing. The ODMA probing process state machine controls the rate of ODMA relay node probing. The ODMA probing state machines and mechanisms for controlling the rate of ODMA probing are discussed in the following section.

~~5.2.2.1.1~~5.2.4.1.1 ODMA probing state machines

Probing is a mechanism used by the ODMA relay node to build a neighbour list which should contain at least a predefined minimum number of neighbours. The probing activity levels of an ODMA relay node may also be influenced by a number of key system parameters such as

- Number of neighbours
- Gradient information
- Path loss to neighbours
- Speed of the terminal
- Battery power level

The probing state machines are characterised by the level of probing opportunities. The objective of the probing state machines is to optimise ORACH activity to provide reduced interference and regulate power consumption. The difference between these state machines can generally be characterised by the number of ORACH channels which may be used for probing. Thus the probing opportunities within one N multiframe may vary depending upon the active state machine. Additionally, the ratio of probe transmission to reception is controlled by a probing activity parameter *K*. The state machines are full probing, duty maintained probing, and relay prohibited. The function of each of these state machines is described below:

Full probing
Full probing is the case where probing is allowed on every ORACH timeslot within a *N* multiframe. The UE_R will probe on the ORACH at a rate defined by the probing activity parameter *K*.

Duty Maintained probing
The duty maintained probing is the case where probing is allowed on *M* slots of an *N* multiframe. The UE_R will probe on the *M* ORACH slots in an *N* multiframe at a rate defined by the probing activity parameter *K*.

Relay Prohibited
In this mode the UE_R would cease all of its ODMA probing activities and will fall into standard TDD or FDD operation.

The probing activity levels for given state machines are illustrated in Figure 2 for a system with an ORACH for M slots per N × 16 multiframe.

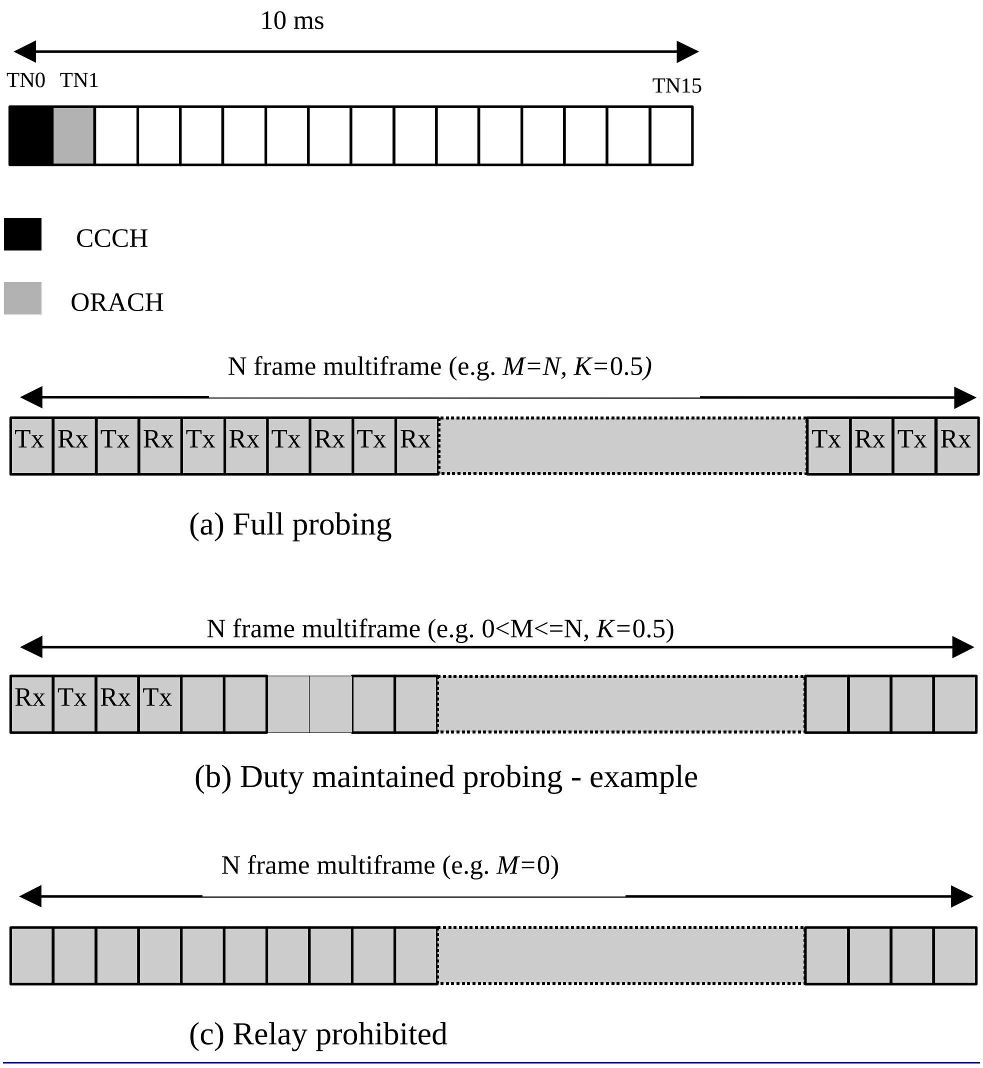

Figure 22~~2~~. Probing state machines and mechanism.

Note that the distribution of probing opportunities within a multiframe may not necessarily be consecutive and located at the beginning of a multiframe.

A practical illustration of these probing state machines within the ODMA system is shown in Figure 3.

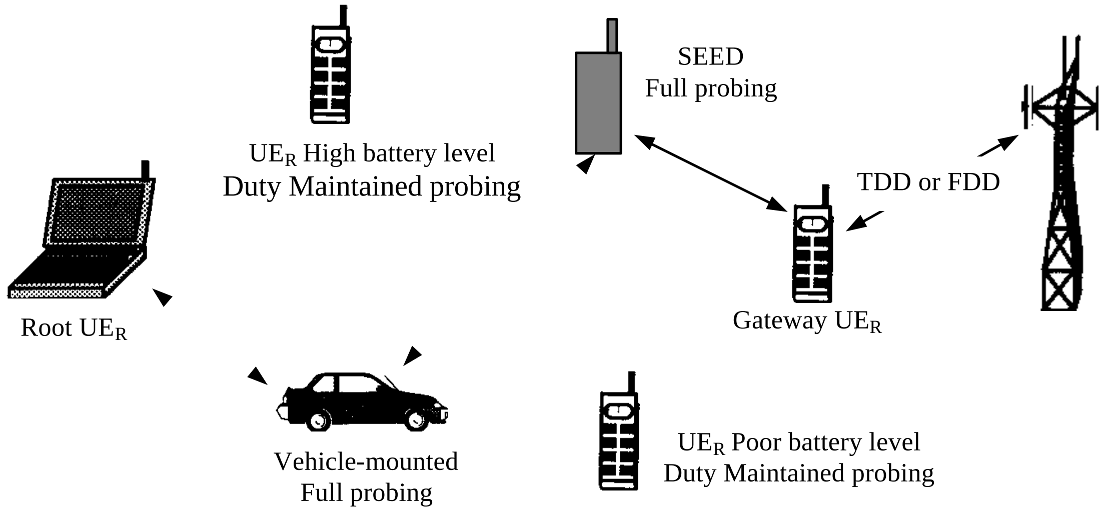

Figure 3~~3~~. Illustration of probing process assignment.

~~5.2.3~~5.2.5 Barred Cells and Access Control

FFS

~~5.2.4~~5.2.6 Regional Provision of Service

FFS

5.3 Location Registration

When first camped on a suitable cell after power on, the non-access stratum will register the UE as active and present in the registration area of the chosen cell, if necessary.

The non-access stratum will register the UE's presence in a registration area, for instance regularly and when entering a new registration area.

The access stratum will inform the non-access stratum in which NAS defined service area(s) the UE is located, for instance regularly and when entering a new NAS defined service area.

Prior to power off, the non-access stratum will deregister the UE, if necessary.

6. Broadcast information receiving

6.1 Reception of System Information

The UE shall read the BCCH to acquire valid system information. For each acquisition, the UE will need different combinations of system information blocks broadcast on BCCH. Thus, the scheduling of the broadcast channel is done in such way that the UE knows exactly when the needed information can be found.

When any of the system information blocks are modified, the corresponding scheduling information is updated to reflect the changes in system information transmitted on BCCH. Further, a message is sent to all UEs on PCCH to indicate that a new master information block is available in the cell. Then the UE shall read the updated master information block on BCCH and if the changes are applicable for the UE, the modified system information block(s) are read as well.

6.2 Cell Broadcast

7. Idle mode measurements

8. Discontinuous Reception

The UE may use Discontinuous Reception (DRX) in idle mode in order to save power consumption. When DRX is used the UE needs only to monitor at one PICH Monitoring Occasion in the P~~p~~aging O~~o~~ccasion 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.

The UE may be attached to different CN domains with different DRX cycle lengths. In this case, the UE shall use the shortest of those DRX cycle lengths. The DRX cycle lengths for each CN domain are broadcast in UTRAN cells. An UE may also be assigned an individual DRX cycle length by a CN.

The UE shall use the IMSI, the Cell System Frame Number, Np (number of PICH paging occasions within a frame), Frame offset (For FDD, Frame offset = 0), PBP and the DRX cycle length to determine the Paging Occasions.

The Paging Occasions ~~occur at~~ is the frame number~~s~~:

Cell SFN = {(IMSI mod M) 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.

~~where~~ M is a constant used to simplify the calculations (FFS). M will depend on the coding used for IMSI. M must be significantly greater than the maximum possible DRX cycle length*Np. ~~n is a integer counter that is incremented every Paging Occasions.~~

The actual Paging Indicator within ~~the frame~~ Paging Occasion that the UE shall read is similarly determined based on IMSI. ~~The same applies for the PICH in case more than one exists.~~

The PICH Monitoring Occasion is calculated by using the following formula:

PICH Monitoring Occasion = DRX Index mod Np

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

The value of Np can be calculated by PICH repetition cycle(1,2,4,8) in FDD mode (Np = 144/PICH repetition cycle). In TDD mode, Np is calculated by PICH repetition cycle and Burst Type(long or short midamble).

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 (For FDD, $N_{PICH} = 0$). 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 (for FDD, $N_{PCH} = 1$).

9. Multicast services

9.1 State diagram between the multicast service and DSCH

[NOTE: The use of DSCH for multicast services is FFS.]

The multicast service relative to the DSCH consists of the following states:

- MT_Null State
- MT_Monitor State
- MT_Saving State
- MT_Active State

Figure 5 shows the multicast state diagram relative to the DSCH. The MT_Monitor State is a state for decoding the DSCH in order to monitor its multicast control data and the MT_Saving State is a state in which the UE savings for the supporting power saving feature.

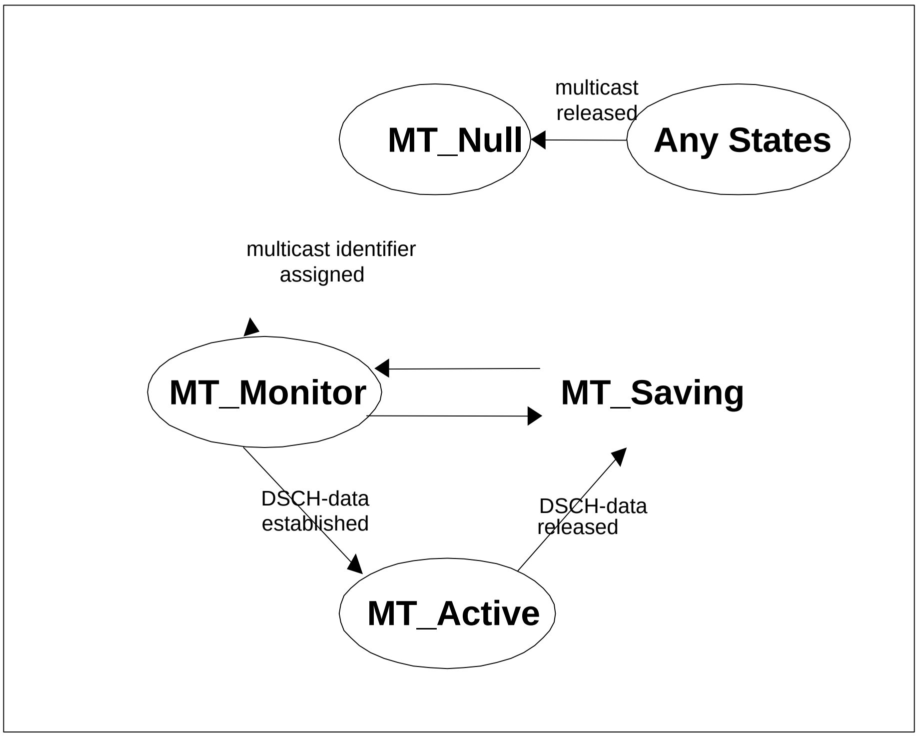

Figure 5. Multicast State Diagram relative to the DSCH, MT=MulTicast service.

9.1.1 MT_Null State

a) Attributes
- Multicast service has not been activated.
- DSCH is not established.

b) Behavior
- Waits for activation of multicast service.

9.1.2 MT_Monitor State

a) Attributes

- DSCH is monitored in order to decode the multicast control data that contains the assigned multicast identifier.

b) Behavior

- Receives the DSCH control data on DSCH and confirms the assigned multicast identifier.

9.1.3 MT_Saving State

a) Attributes

- DSCH is not monitored for the control nor the user data.

b) Behavior

FFS

9.1.4 MT_Active State

a) Attributes

- DSCH is not monitored for the control data.
- DSCH is monitored for the user data.

b) Behavior

- Receives the multicast user data on the established DSCH.

10. Examples of Procedures

10.1 NAS initiated change of system information

The sequence in Figure 6 shows the change of broadcast system information initiated from the non-access stratum (NAS).

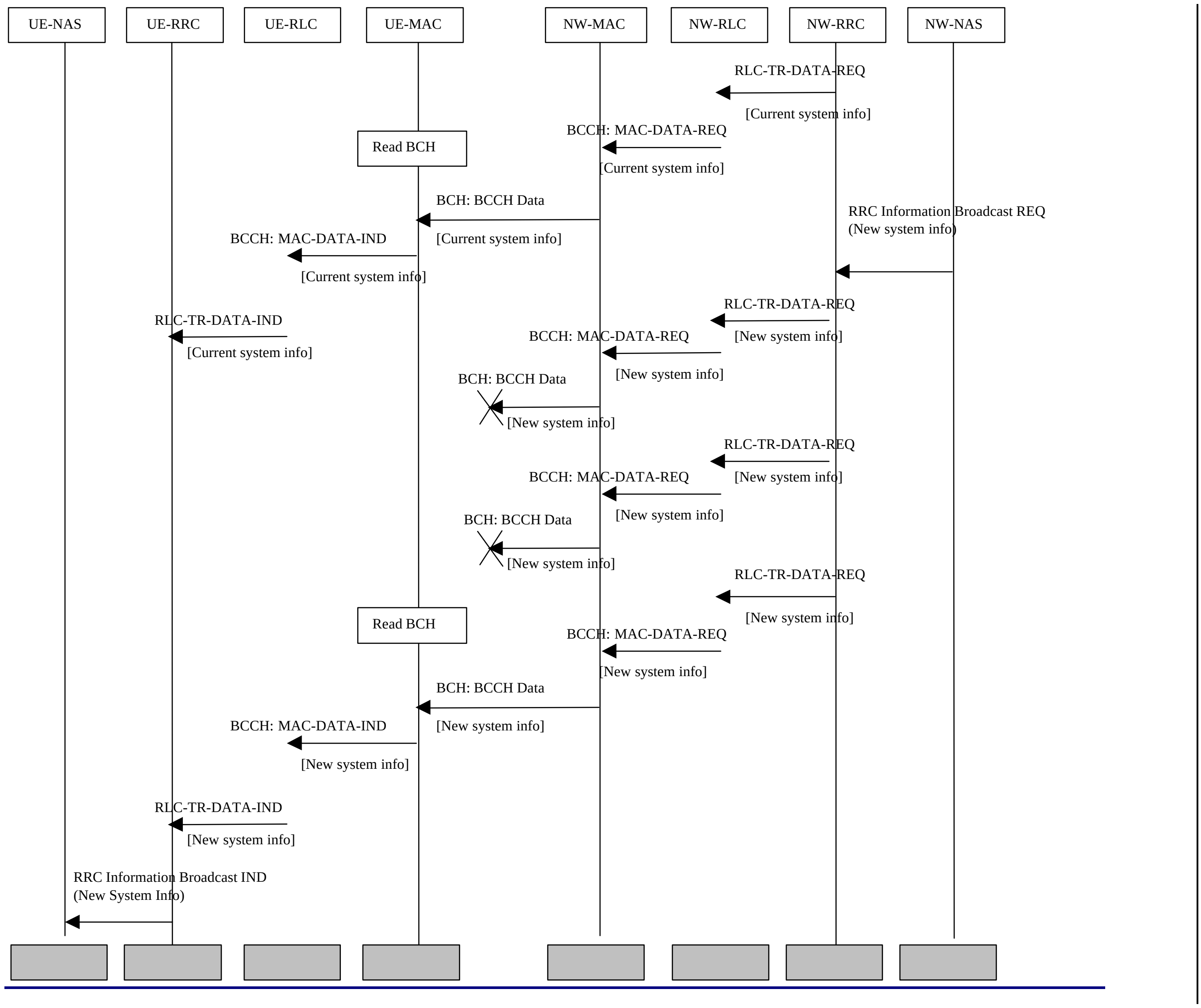

Figure 6. Example sequence, non-access stratum initiated change of broadcast system info.

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

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

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

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

10.2 System Information Update to NAS

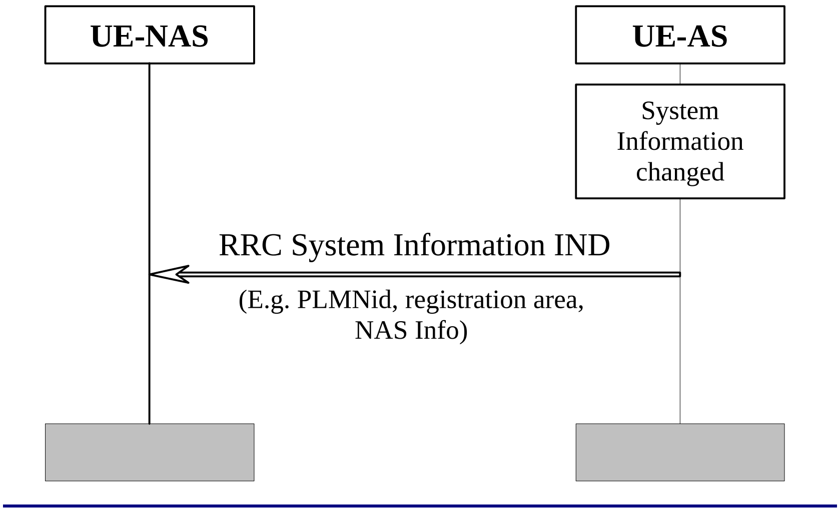

Figure 7. System Information Update to NAS.

AS sends system information to NAS when a change of system information is detected in the cell currently camped on. This happens for instance when a new cell is selected due to cell reselection. The information sent can include PLMN identity, registration area and NAS information. The NAS information includes the identity of the NAS defined service area.

10.3 CN originated paging in idle mode

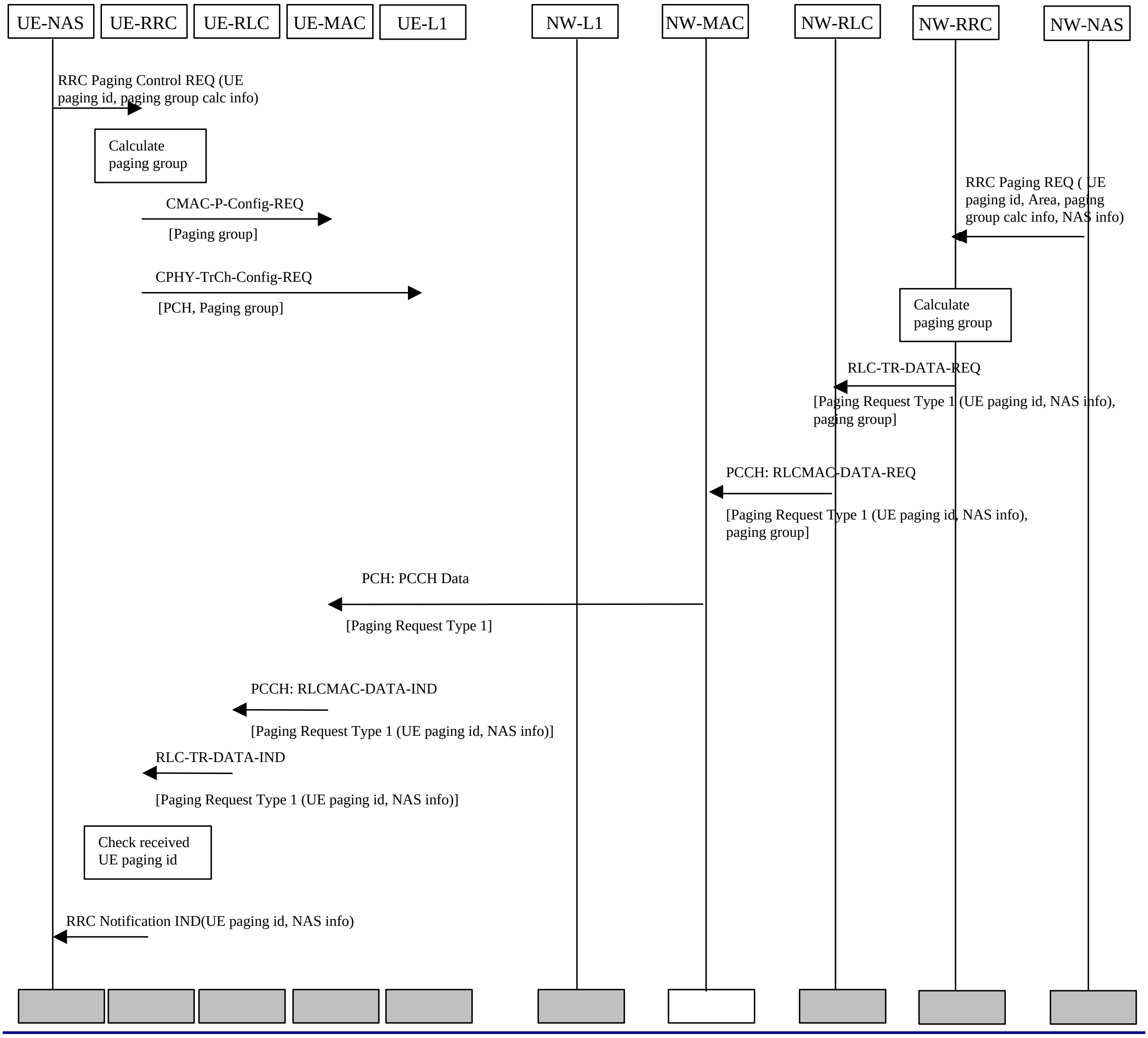

Figure 8. Example sequence of CN initiated paging request in idle mode.

Figure 8 illustrates a CN originated paging request when the UE is in idle mode.

In the UE, a NAS entity issues the primitive RRC Paging Control REQ, which tells RRC to listen to paging and notifications addressed to a given UE paging identity and on a paging group which can be calculated using information given from NAS. *[Note: The paging group calculation info can e.g. be the IMSI of the UE.]*

A NAS entity on the network side requests paging of an UE using the RRC Paging REQ primitive over the Nt-SAP. The primitive contains a UE paging identity, an area where the page request is to be broadcast, information for calculation of the paging group and NAS information to be transparently transmitted to the UE by the paging request.
The RRC layer calculates the paging group, and formats a Paging Request Type 1 message containing the UE paging identity and the NAS information The RRC layer then requests MAC to transmit the message on the PCH on the selected paging group.

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

10.4 PLMN Selection, automatic mode, normal case

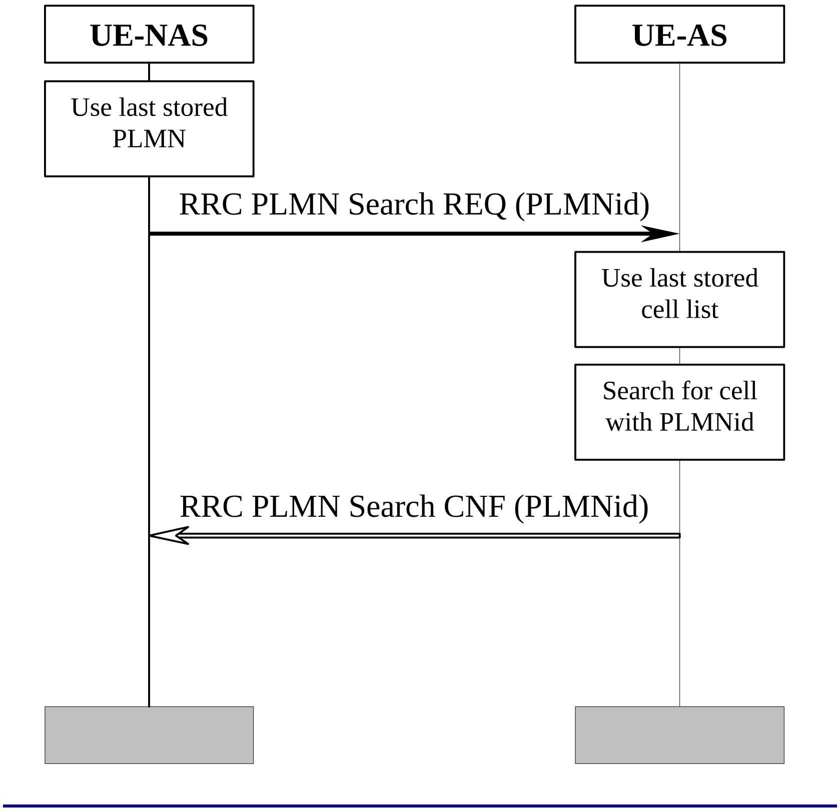

Figure 9. PLMN Selection, automatic mode, normal case.

At power-on, the non-access stratum (NAS) selects the PLMN with highest priority, possibly the last PLMN stored prior to previous power off. The access stratum (AS) is requested to find a cell belonging to that PLMN. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information stored prior to previous power-off. When a cell belonging to the requested PLMN is found, that cell is selected and NAS is notified that the PLMN was found.

10.5 PLMN Reselection, automatic mode

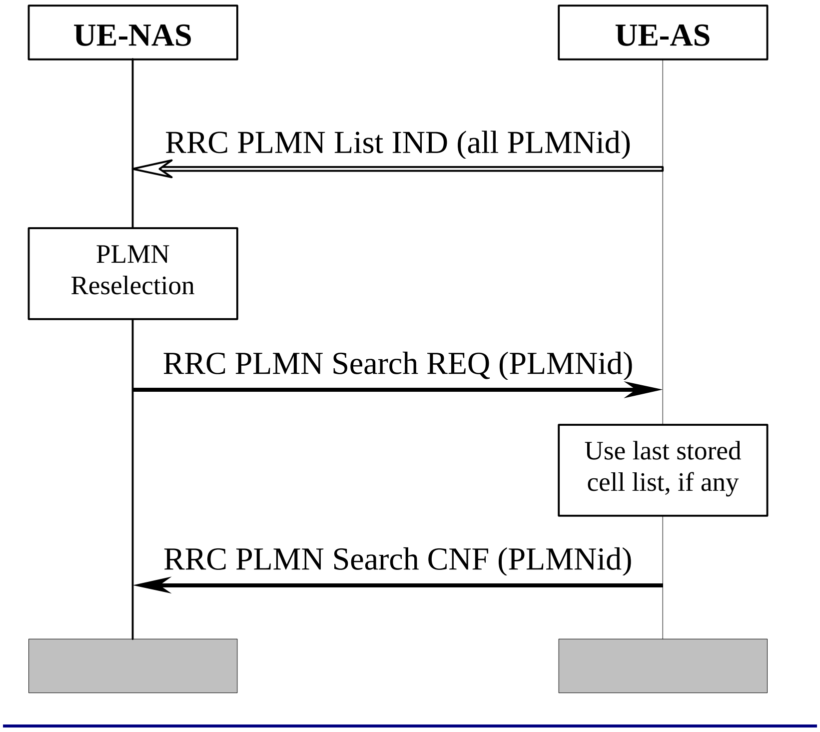

Figure 10. PLMN Reselection, automatic mode.

Triggered by, for instance, a timer, AS sends a list to NAS with all PLMNs currently available. The list includes the identities of available PLMNs and possibly information about their NAS defined service area(s). Assuming that a PLMN with higher priority is found, NAS requests AS to select a cell belonging to the PLMN with highest priority. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information previously stored, if any. When a cell belonging to the requested PLMN is found, that cell is selected and NAS is notified that the PLMN was found.

10.6 PLMN Reselection, manual mode

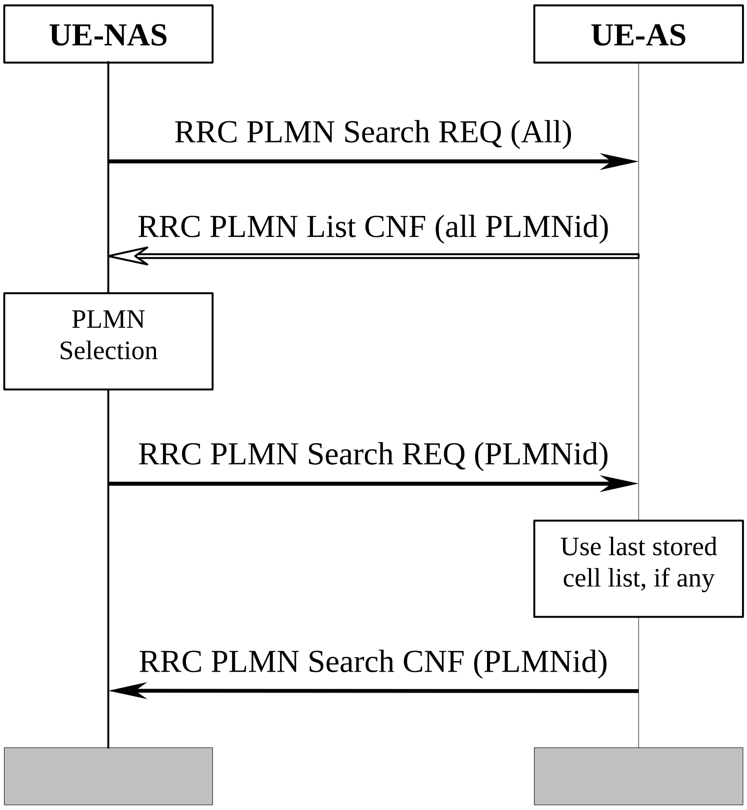

Figure 11. PLMN Reselection, manual mode.

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

10.7 PLMN Selection, automatic mode, selected PLMN not found

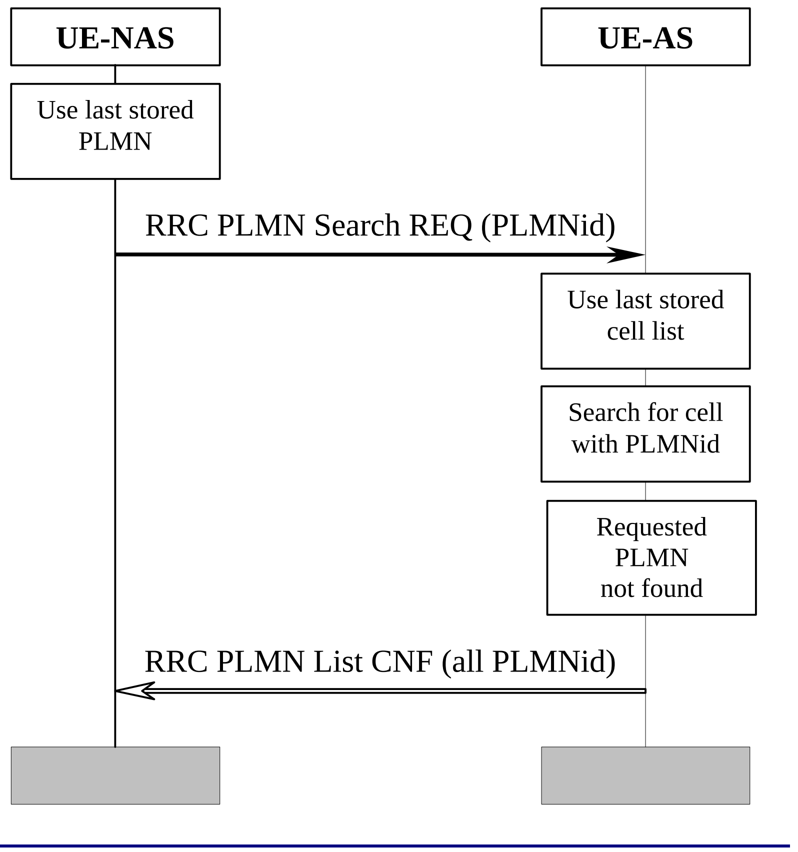

Figure 12. PLMN Selection, automatic mode, selected PLMN not found.

At power-on, the non-access stratum selects the PLMN with highest priority, possibly from the list of PLMNs stored prior to previous power off. The access stratum is requested to find a cell belonging to that PLMN. When searching for the requested PLMN and in order to speed up the search, AS may use a list of cell information stored prior to previous power-off. If no cell is found belonging to the requested PLMN, a list of available PLMNs is sent to NAS, indicating which PLMN has been temporarily chosen by AS.

10.8 NAS Controlled Cell Selection

10.8.1 Execution in Access Stratum

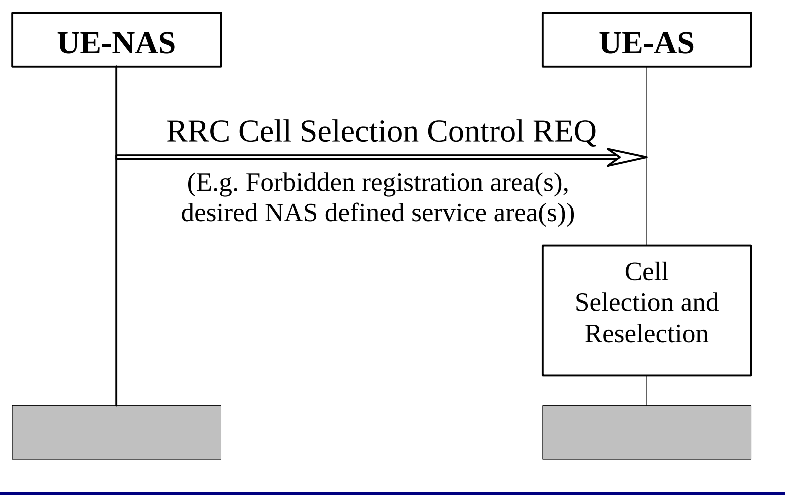

Figure 13. NAS Controlled Cell Selection, execution in AS.

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

- Cells belonging to a forbidden registration area will only be selected if no better cell is found. At this point, the services provided the UE might be limited.
- Cells belonging to a NAS defined service area with higher priority than current service area will be considered better than the cell currently camped on. Depending on radio access mode, the most suitable cell in idle mode may not be the most suitable cell in connected mode.

10.8.2 Execution in Non-Access Stratum

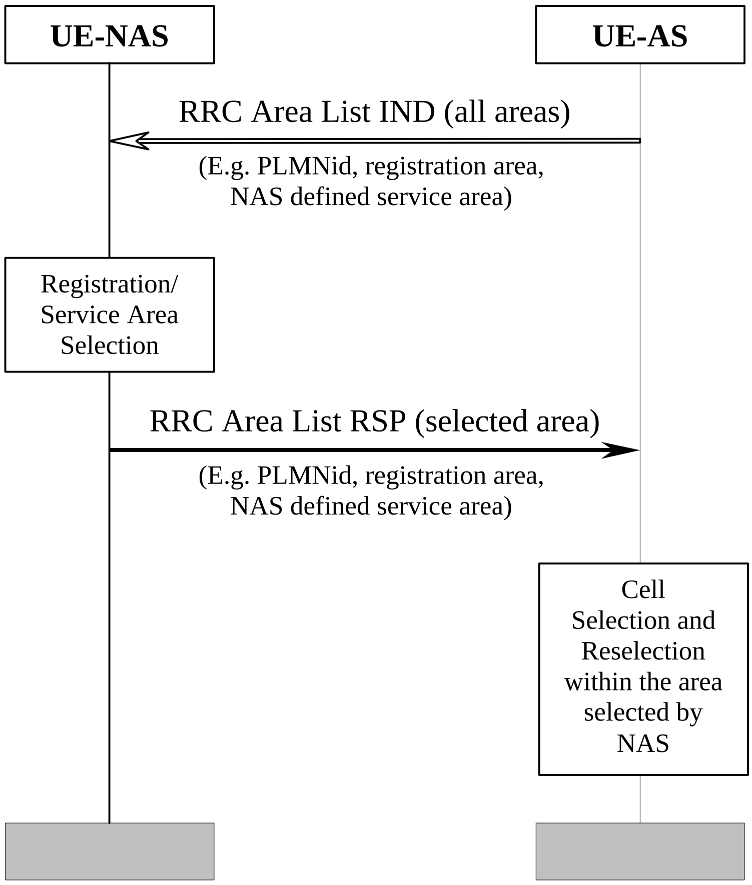

Figure 14. NAS Controlled Cell Selection, execution in NAS.

As an alternative to the example in section 11.8.1, AS sends cell selection information to NAS. This information can include PLMN identity, registration area and NAS defined service area. The information contains the full set of available registration areas and NAS defined service areas. The information is typically sent when there is a change of available areas, for instance when a neighbour cell belonging to a new registration area/NAS defined service area is found. Correspondingly, a new list of available areas is sent from AS to NAS when for instance coverage is lost from the cell currently camped on and that is the only cell belonging to the current NAS defined service area.

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

11. History

Document history		
Date	**Version**	**Comment**
January 1999	0.0.0	Based on the input document of ETSI SMG2 UMTS L23 Expert Group, TDoc RAN WG2 014/99, "UMTS YY.04, Description of Procedures in Idle mode, V0.3.0 1999-01" and changes agreed in the first TSG RAN WG2 meeting.
March 1999	0.0.1	Revisions of V0.0.0 accepted. Document layout updated according to 3GPP template. "Intellectual Property Rights" adopted from S2.01 V0.0.2.
March 1999	0.1.0	Revisions of V0.0.1 accepted. Document approved in the second TSG RAN WG2 meeting.
April 1999	0.1.1	Examples of procedures updated.
April 1999	0.2.0	Approval of version 0.1.1 in the TSG RAN WG2 meeting #3 in Yokohama.
April 1999	TS 25.304 V1.0.0	Endorsed by TSG-RAN as TS 25.304 V1.0.0
May 1999	1.0.1	References and rapporteur information updated.
June 1999	1.1.1	Changes from R2-99393 incorporated with modifications agreed in the TSG RAN WG2 meeting #4 in Berlin. Overall structure of system information added (based on R2-99414).
June 1999	1.1.2	Added definitions from R2-99413 and a new chapter for DRX.
June 1999	1.2.0	Document approved on the 3GPP_TSG_RAN_WG2 mailing list.
August 1999	1.3.1	Changes from R2-99585 and R2-99590 incorporated with modifications agreed in the TSG RAN WG2 meeting #5.
August 1999	1.3.2	Overall structure of system information removed.
August 1999	1.4.0	Approval of version 1.3.2 in the TSG RAN WG2 meeting #6 in Sophia Antipolis.
September 1999	1.4.1	Updated according to proposals from R2-99951 and R2-99952 and agreements made in the TSG RAN WG2 meeting #6.
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