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Title: **Cell Selection and Reselection Process**

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1   Introduction

Cell Selection and reselection is an important process in idle mode of any radio access mode. In UMTS, its relations to other processes are described in 3GPP TS RAN 25.304, V1.0.0, "UE Procedures in Idle Mode". This contribution suggests a more detailed description of the process. In particular, a state diagram is presented together with a short description of the states and procedures.

As the UMTS idle mode includes the GSM/GPRS idle mode, as mentioned in 3GPP TS RAN 25.304, V1.0.0, "UE Procedures in Idle Mode", the current description of cell selection and reselection in GSM/GPRS has been used as a foundation. In this contribution, we have considered the description of cell selection and reselection in GSM/GPRS described in the technical specification GSM TS 03.22, Draft V6.1.0, "Functions related to MS in idle mode and group and GSM TS 05.08, V6.3.0, "Radio subsystem link control".

2   Discussion

The purpose of the Cell Selection and Reselection Process is to choose the best cell (according to some criteria). This includes the choice of radio access system (like UMTS and GSM/GPRS), radio access mode (like FDD/TDD) and frequency. Already from the start, UMTS is likely to co-exist with other radio access systems and the market will demand UEs supporting multiple radio access systems.

The added complexity of supporting multiple radio access systems is not explicitly described in the process description in GSM TS 03.22, Draft V6.1.0, "Functions related to MS in idle mode and group receive mode". Therefore, in this contribution, the main concern has been to include support for multiple radio access systems in the cell selection and reselection process described in GSM/GPRS. From a standardisation point of view, it is assumed that UMTS standards will describe how other radio access systems shall be treated by a UE supporting multiple radio access systems. This is necessary, for instance in idle mode and in the control of inter-radio-access-system measurements. Particularly, the idle mode transition (cell selection and reselection) from UMTS to other radio access systems, like GSM/GPRS is described in UMTS standard 3GPP TS RAN 25.304, V1.0.0, "UE Procedures in Idle Mode". This is illustrated in the figure below. Here, we have taken the cell selection and reselection process as an example. Please note that the transition back to UTRA is specified in the standard of the particular radio access system.
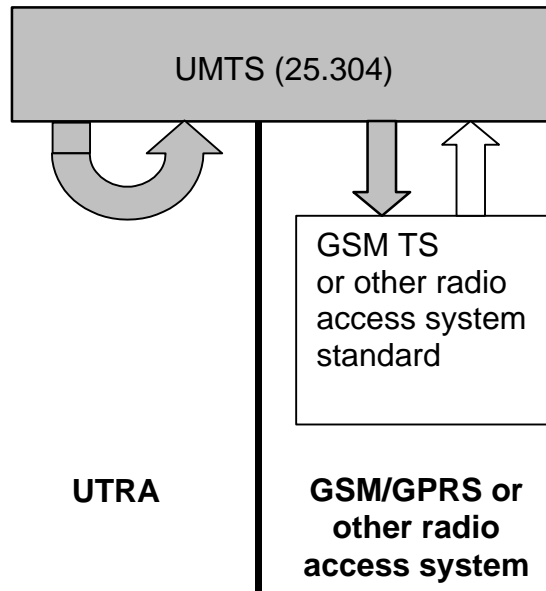
Figure 1 Standardisation of Cell Selection and reselection. It is assumed that UMTS standards will describe how other radio access systems shall be treated by a UE supporting multiple radio access systems. However, the transition back to UTRA is specified in the standard of the particular radio access system.

The cell selection and reselection process described in this contribution is used in idle mode and, in some cases, in connected mode. In the following description, "Common transport channels" denotes all UE RRC states/substates in which the process is used and "Dedicated transport channels" denotes UE RRC states/substates in which other processes for selecting cell(s) apply. Please see Table 1 for details.

Definition	Mode	State	Substate
Common Transport Channels	Idle Mode		
	Connected Mode	Cell Connected	PCH, RACH/FACH
		URA Connected	
Dedicated Transport Channels	Connected Mode	Cell Connected	DCH/DCH

Table 1 The UE RRC states in which the cell selection and reselection process applies is denoted Common Transport Channels. Other processes for selecting cell(s) apply in the UE RRC states denoted Dedicated Common Transport Channels.

3 Cell Selection and Reselection Process

3.1 Assumptions

- The cell selection and reselection process uses a list of radio access systems in priority order. The radio access systems included on the list are those indicated in System Information (Measurement Control information elements) and additional radio access systems that the UE is capable of, if any. This list is passed on to the cell selection and reselection process from another process. A variety of reasons, like user subscription, operator philosophy, current capacity, capability of the UE and user interaction could influence the priorities. However, that is out of the scope for this contribution.

- Here, it is assumed that the PLMN selection and reselection process has higher priority than the cell selection and reselection process so that a cell is chosen within the selected PLMN (normal case). Thus, it is only possible to select one of the radio access systems supported by the specific operator. This way, the UE will stay with an operator rather than a radio access system when loosing coverage. Alternatively, it would be possible to let the selection of radio access system override the selection of PLMN. This way, the UE would stay with a radio access system rather than an operator when loosing coverage.

3.2 Definitions

RAS	Radio access system, for instance UMTS or GSM/GPRS.
Suitable RAS	The radio access system with highest priority supported by the selected/desired PLMN.
Suitable cell	According to 3GPP TS RAN 25.304, V1.0.0, "UE Procedures in Idle Mode": "This is a cell on which the UE may camp. It must satisfy certain conditions. [Note: These certain conditions are FFS.]"
Common transport channels	Common transport channels (either UE RRC idle mode or connected mode states/substates; Cell Connected: PCH, RACH/FACH and URA Connected state).
Dedicated transport channels	Dedicated transport channels (UE RRC connected mode states/substates; Cell Connected: DCH/DCH).

3.3 State Diagram
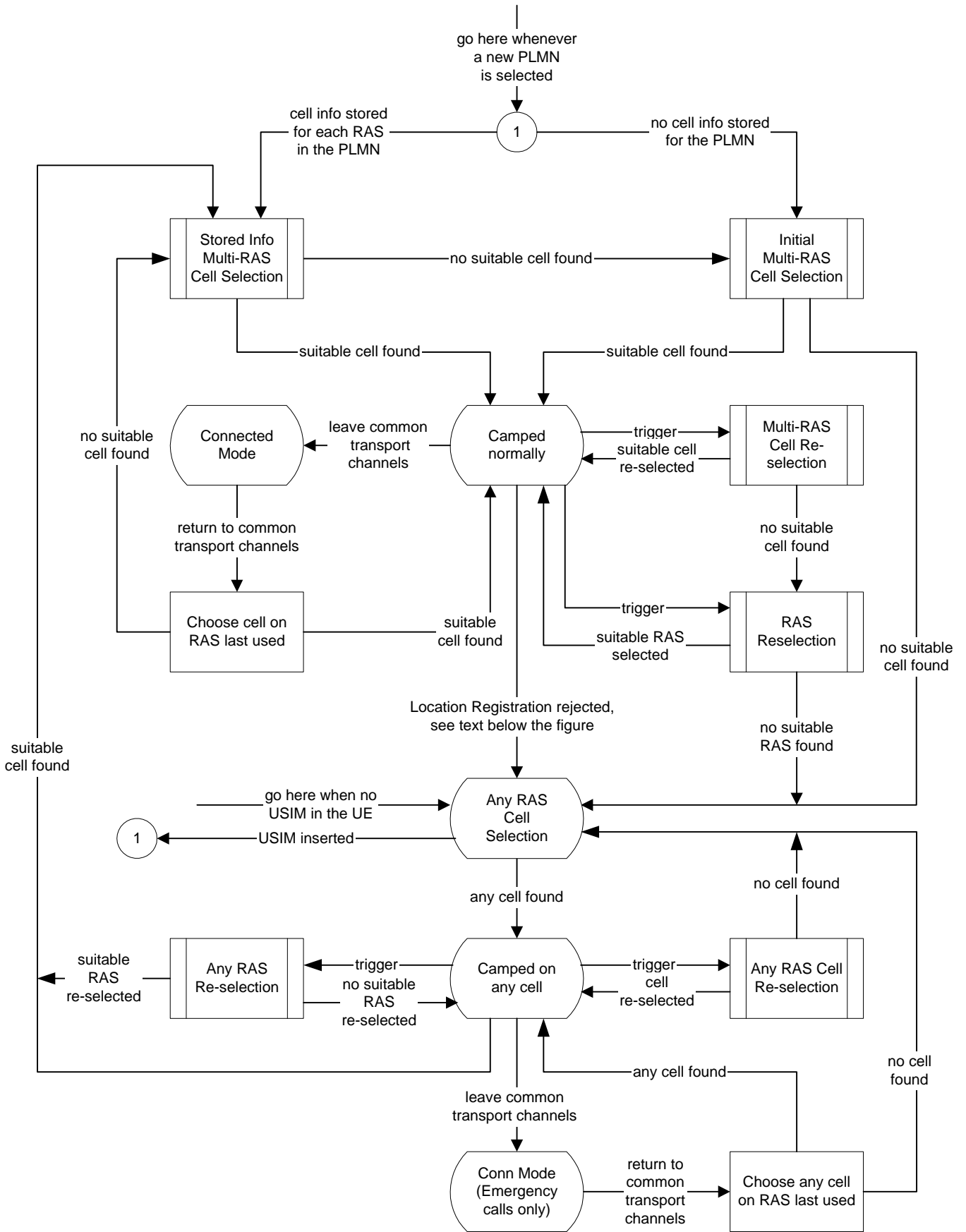
In any state, a new PLMN selection causes an exit to number 1.

The Location Registration has been rejected with one of the following cause values; "IMSI unknown in HLR", "Illegal UE", "PLMN not allowed" and "GPRS not allowed". [Note: This list of cause values is FFS.]

[Note: How transitions from/to other radio access systems may imply a change of state is FFS.]

Figure 2 Cell Selection and Reselection State Diagram.

3.4   List of States and Procedures in the Cell Selection and Reselection process (Figure 2)

Stored Information Multi-RAS Cell Selection
This is the procedure of initial cell selection using System Information (Measurement Control information elements) for the selected PLMN stored in the UE. The stored information can include several different radio access systems.

Initial Multi-RAS Cell Selection
This is the procedure of initial cell selection where the UE is searching all radio access systems supported by the UE, in priority order. The procedure does not require any prior knowledge and may start with radio access systems not previously searched, if any.

Camped Normally
This is the state where the UE is camped on a cell of the selected PLMN and may be able to make and receive calls. (Whether or not the UE can make and receive calls depends on the state within the location registration process). The UE performs measurements according to System Information (Measurement Control information elements), it maintains the current system information and checks whether cell reselection is needed.

Multi-RAS Cell Reselection
This is the procedure where the UE determines that cell reselection is needed and an attempt is made to reselect a new cell. The System Information (Measurement Control information elements) is the base for this decision. Reselecting the new cell may imply a change of radio access system.

Choose Cell on RAS last used
This is when the UE has returned to common transport channels from dedicated transport channels and chooses, on the radio access system last used (in connected mode), a suitable cell to camp on.

RAS Reselection
This is the procedure where the UE attempts to find a radio access system with higher priority than the current radio access system. The list of radio access systems in priority order is the base for this decision. The radio access systems supported by the UE are searched in priority order, unless it already is on the radio access system with highest priority. If a cell is found on a radio access system with higher priority, an attempt is made to reselect that cell. Reselecting the new radio access system may imply a change of PLMN, if that is allowed.

Any RAS Cell Selection
This is the state where the UE is searching a cell to camp on, on any PLMN and on any radio access system, (so that emergency calls can be made), since the UE is unable to camp normally on any cell of the selected PLMN or radio access system, or cannot obtain service because of certain responses to a location registration (LR) attempt. The radio access systems are searched in priority order. The UE will end up in this state if it is out of coverage or no USIM is inserted.

Any RAS Reselection
This is the procedure where the UE attempts to find a radio access system with higher priority than the current radio access system. The list of radio access systems in priority order is the base for this decision. The radio access systems supported by the UE are searched in priority order, unless it already is on the radio access system with highest priority. If a cell is found on a radio access system with higher priority, an attempt is made to reselect that cell. Reselecting the new radio access system may imply a change of PLMN. If the cell belongs to the selected PLMN, this suitable radio access system is reselected and stored information multi-RAS cell selection takes place.

Camped on any Cell
This is the state where the UE is camping on a cell irrespective of its PLMN identity, so that emergency calls can be made.

Any RAS Cell Re-selection
This is the procedure where the UE determines that cell reselection is needed and an attempt is made to reselect a new cell, irrespective of PLMN identity. Reselecting the new cell may imply a change of radio access system.

Choose Any Cell on RAS last used

This is when the UE is returning to common channels after having entered dedicated channels from the "Camped on any Cell" state to make an emergency call. It is attempting to find an acceptable cell to camp on using the radio access system last used in connected mode.

4 Open Issues

- How does the description in 25.304 relate to existing descriptions of idle mode in GSM TS 03.22 and GSM TS 05.08?

5 Proposal

Include section 3.2 in 3.1 of 25.304 and sections 3.3-3.4 in 5.3 of 25.304.

6 References

[1] 3GPP TS RAN 25.304, V1.0.0, "UE Procedures in Idle Mode"
[2] GSM TS 03.22, Draft V6.1.0, "Functions related to MS in idle mode and group receive mode"
[3] GSM TS 05.08, V6.3.0, "Radio subsystem link control"