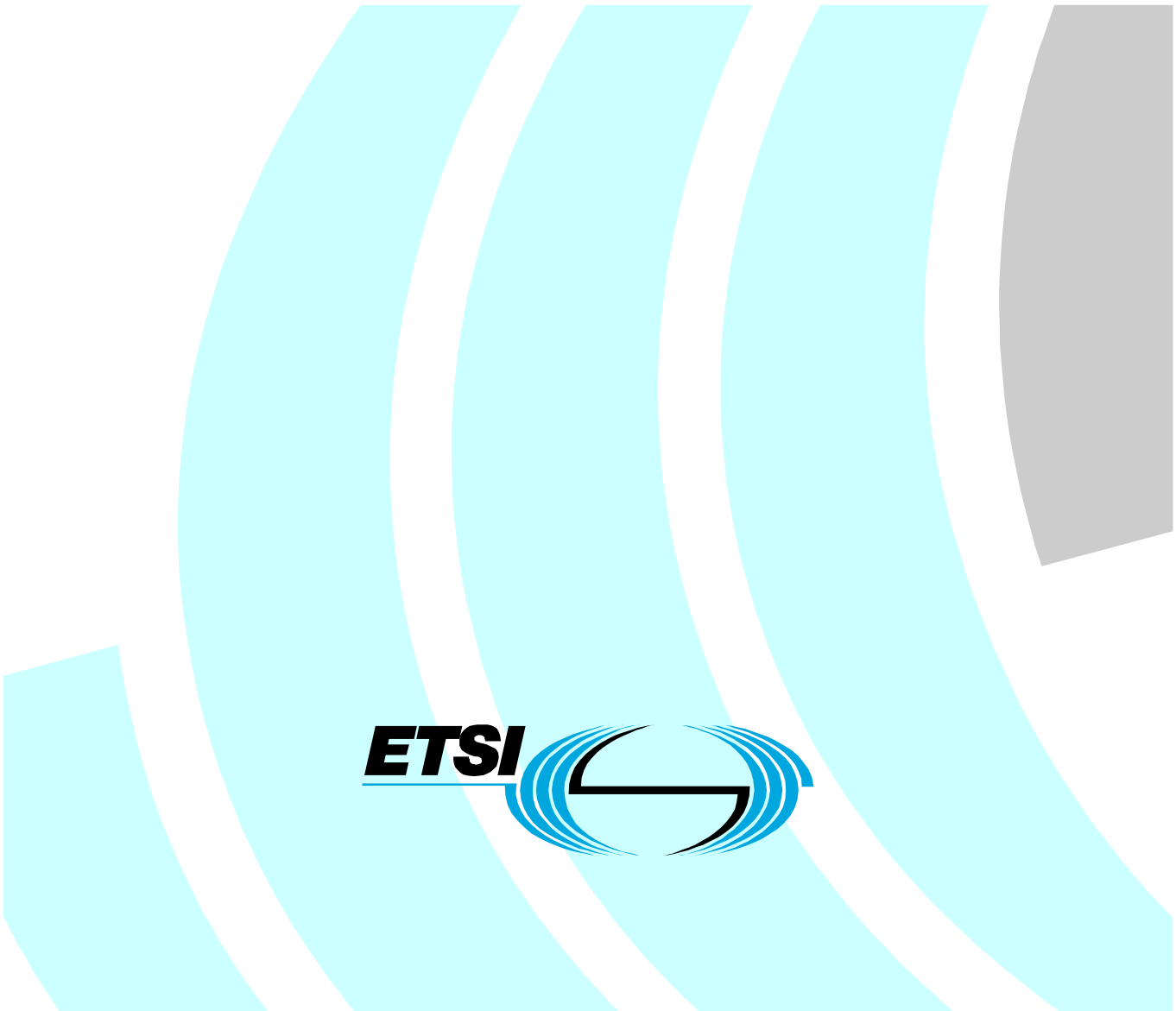
ETSI TS 101 376-3-10 V1.2.1 (2002-04)

Technical Specification

GEO-Mobile Radio Interface Specifications;
Part 3: Network specifications;
Sub-part 10: Functions related to
Mobile Earth Station (MES) in idle mode;
GMR-1 03.022



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Contents

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IPRs:

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TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US

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TS 101 376 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalizers	GB	GB 2 215 567	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Transmitter Power Control for Radio Telephone System	GB	GB 2 233 517	GB

IPR Owner: Ericsson Mobile Communications (UK) Limited
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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Hughes Network Systems		US	Pending	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	2.4-to-3 KBPS Rate Adaptation Apparatus for Use in Narrowband Data and Facsimile Communication Systems	US	US 6,108,348	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic ThroughputCellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Enhanced Access Burst for Random Access Channels in TDMA Mobile Satellite System	US	US 5,875,182	
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-margin Forward Control Signals	US	US 6,072,985	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Spot Beam Pairing for Reduced Updates	US	US 6,118,998	US

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The contents of the present document are subject to continuing work within TC-SES and may change following formal TC-SES approval. Should TC-SES modify the contents of the present document it will then be republished by ETSI with an identifying change of release date and an increase in version number as follows:

Version 1.m.n

where:

- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 3, sub-part 10 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications, as identified below:

Part 1: "General specifications";

Part 2: "Service specifications";

Part 3: "Network specifications";

Sub-part 1: "Network Functions; GMR-1 03.001";

Sub-part 2: "Network Architecture; GMR-1 03.002";

Sub-part 3: "Numbering, Addressing and identification; GMR-1 03.003";

Sub-part 4: "Organization of Subscriber Data; GMR-1 03.008";

Sub-part 5: "Technical realization of Supplementary Services; GMR-1 03.011";

Sub-part 6: "Location Registration and Position Identification Procedures; GMR-1 03.012";

Sub-part 7: "Discontinuous Reception (DRX); GMR-1 03.013";

Sub-part 8: "Support of Dual-Tone Multifrequency Signalling (DTMF); GMR-1 03.014";

Sub-part 9: "Security related Network Functions; GMR-1 03.020";

Sub-part 10: "Functions related to Mobile Earth Station (MES) in idle mode; GMR-1 03.022";

Sub-part 11: "Technical realization of the Short Message Service (SMS) Point-to-Point (PP); GMR-1 03.040";

Sub-part 12: "Technical realization of the Short Message Service Cell Broadcast (SMSCB); GMR-1 03.041";

Sub-part 13: "Technical realization of group 3 facsimile using transparent mode of transmission; GMR-1 03.045";

Sub-part 14: Transmission Planning Aspects of the Speech Service in the GMR-1 system; GMR-1 03.050";

Sub-part 15: "Line Identification supplementary service - Stage 2; GMR-1 03.081";

Sub-part 16: "Call Barring (CB) supplementary services - Stage 2; GMR-1 03.088";

Sub-part 17: "Unstructured Supplementary Service Data (USSD) - Stage 2; GMR-1 03.290";

Sub-part 18: "Terminal-to-Terminal Call (TtT); GMR-1 03.296";

Sub-part 19: "Optimal Routing technical realization; GMR-1 03.297";

Sub-part 20: "Technical realization of High-Penetration Alerting; GMR-1 03.298";

Sub-part 21: "Position Reporting services; Stage 2 Service description; GMR-1 03.299";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications";

Part 6: "Speech coding specifications";

Part 7: "Terminal adaptor specifications".

Introduction

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for mobile satellite services (MSS) utilizing geostationary satellite(s). GMR is derived from the terrestrial digital cellular standard GSM and supports access to GSM core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM standard are necessary. Some GSM specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM specifications do not apply, while some GMR specifications have no corresponding GSM specification.

Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. The GMR numbers have been designed to correspond to the GSM numbering system. All GMR specifications are allocated a unique GMR number as follows:

GMR-n xx.zyy

where:

- xx.0yy (z = 0) is used for GMR specifications that have a corresponding GSM specification. In this case, the numbers xx and yy correspond to the GSM numbering scheme.
- xx.2yy (z = 2) is used for GMR specifications that do not correspond to a GSM specification. In this case, only the number xx corresponds to the GSM numbering scheme and the number yy is allocated by GMR.
- n denotes the first (n = 1) or second (n = 2) family of GMR specifications.

A GMR system is defined by the combination of a family of GMR specifications and GSM specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM specification (if any). This precedence rule applies to any references in the corresponding GSM specifications.

NOTE: Any references to GSM specifications within the GMR specifications are not subject to this precedence rule. For example, a GMR specification may contain specific references to the corresponding GSM specification.

- If a GMR specification does not exist, the corresponding GSM specification may or may not apply. The applicability of the GSM specifications is defined in GMR-1 01.201 [2].

1 Scope

The present document gives an overview of the tasks undertaken by a GMR-1 Mobile Earth Station (MES) when in idle mode, that is, switched on but not having a dedicated channel allocated, e.g., not making or receiving a call.

The present document outlines how the idle mode operation shall be implemented. Further details are given in GMR-1 04.008 [4] and GMR-1 05.008 [7].

Clause 4 of the present document gives a general description of the idle mode process. Clause 5 outlines the main requirements and technical solutions of those requirements. Clause 6 describes the processes used in idle mode.

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] GMR-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and acronyms; GMR-1 01.004".

[2] GMR-1 01.201 (ETSI TS 101 376-1-2): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 2: Introduction to the GMR-1 Family; GMR-1 01.201".

[3] GMR-1 03.299 (ETSI TS 101 376-3-21): "GEO-Mobile Radio Interface Specifications; Part 3: Network specifications; Sub-part 21: Position Reporting services; Stage 2 Service description; GMR-1 03.299".

[4] GMR-1 04.008 (ETSI TS 101 376-4-8): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 8: Mobile Radio Interface Layer 3 Specifications; GMR-1 04.008".

[5] GMR-1 05.002 (ETSI TS 101 376-5-2): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access; Stage 2 Service Description; GMR-1 05.002".

[6] GMR-1 05.005 (ETSI TS 101 376-5-5): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception; GMR-1 05.005".

[7] GMR-1 05.008 (ETSI TS 101 376-5-6): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control; GMR-1 05.008".

[8] GMR-1 05.010 (ETSI TS 101 376-5-7): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronisation; GMR-1 05.010".

[9] GSM 03.22 (ETSI ETS 300 535): "Digital cellular telecommunications system (Phase 2) (GSM); Functions related to Mobile Station (MS) in idle mode (GSM 03.22 V4.11.0)".

3 Abbreviations

For the purposes of the present document, the abbreviations given in GMR-1 01.004 [1] and the following apply:

MES	Mobile earth station
GMR-1	GEO-Mobile Radio interface - family 1
GSS	Gateway station system
GSC	Gateway station controller
GTS	Gateway transceiver station

4 General description

4.1 Comparison of GMR-1 and GSM systems

A GMR-1 satellite system differs from a terrestrial cellular system in several important respects.

In GSM, a cell is always wholly contained within a single LA. In a GMR-1 satellite system, a spot beam may contain several LAIs. Furthermore, these LAIs may be associated with different PLMNs.

In a cellular system, a cell always provides access to only one BS and only one MSC. In GMR-1, a spot beam may provide access to more than one GS and to more than one MSC. The gateways may have the same or different PLMN.

In GSM, PLMN selection has priority over cell selection, and any suitable cell of a selected PLMN can be selected even if there are other stronger cells belonging to other PLMNs. In GMR-1, only the strongest or next to the strongest spot beam from a particular satellite should be camped on, and the PLMN should be selected from the BCCHs of these spot beams.

Having coverage from more than one satellite is also a distinct attribute of a GMR-1 system, with no comparable situation in GSM.

In GSM, the position of the MS is indicated only by the accuracy of the cell selection and, at present, there is no need for further explanation. In a GMR-1 system, the MES is required to perform GPS position determination and report its position to the PLMN network.

In GSM, any detectable signal is a candidate for camp-on. Due to link margins for the FCCH and BCCH and the beamforming properties of the satellite antenna, it is possible to receive a signal that is not from the spot beam associated with the MES's location. The MES scan procedure shall avoid camping on these spurious signals.

In GSM, registration is permitted on any network for which a minimally acceptable signal can be detected. In a GMR-1 system, and assuming that the spurious signals described above have been rejected, registration is not always allowed on detectable networks. Registration is position based, as will be described later. In this regard, the GS participates in the PLMN and LAI selection process, which is never the case in a cellular system. However, a GMR-1 system may or may not require MES position reporting.

The GMR-1 system has different service levels: Normal Service, Alerting Service, Limited Service, and No Service.

4.2 Idle mode

The GMR-1 idle mode can be subdivided into four processes:

- Spot beam selection and reselection.
- PLMN selection.
- GPS position determination.
- Location updating.

The next chapter introduces the issues to be accommodated by idle mode, and describes at a general level how the idle mode processes shall specifically solve them.

The functional aspects of the idle mode process are described in the next chapter. The relationship between these processes is illustrated in figure 6.1. The internal states and state transitions within each process are shown in figures 6.2 to 6.5.

5 Requirements and technical solutions

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

5.1 Service capabilities

The MES shall provide five levels of service: Normal Service, Alerting Service, Limited Service, Position-Restricted Service, and No Service. The service levels are shown schematically in figure 5.1.

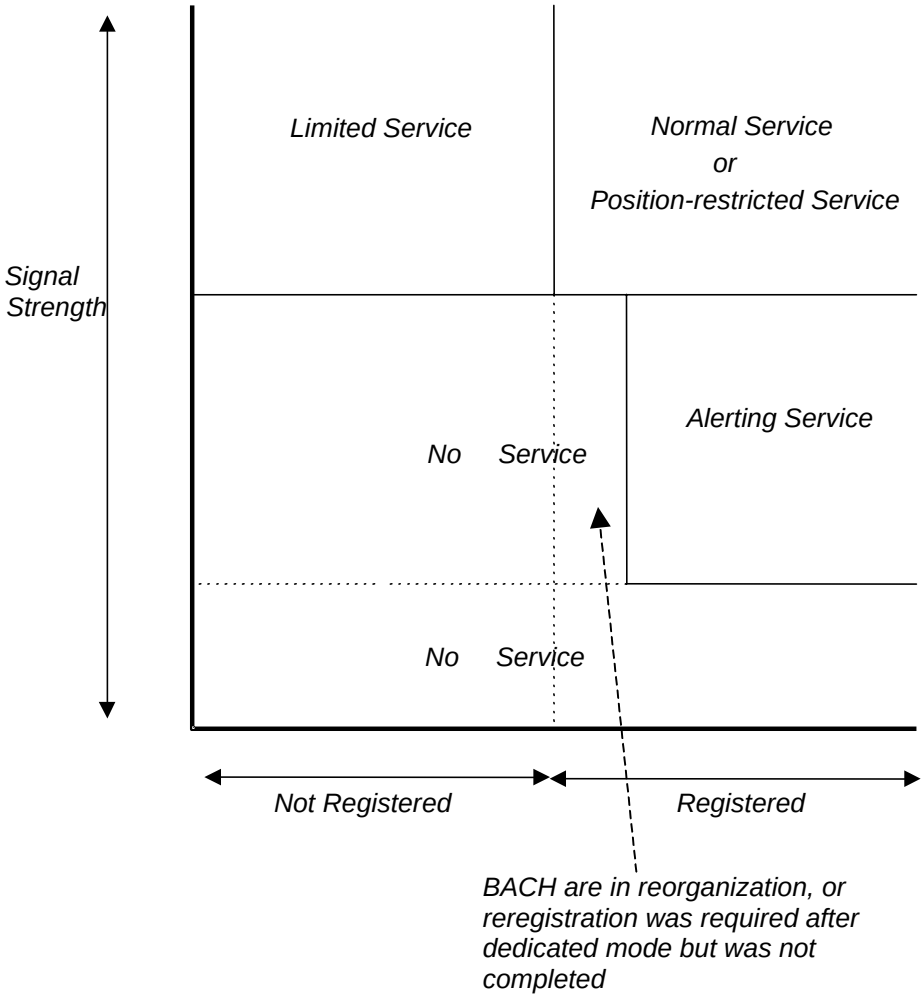


Figure 5.1: Service states

5.1.1 Normal service

Normal Service is the capability wherein the MES has full service access to the GMR-1 system and sufficient signal quality for two-way communication. In order to be in Normal Service, the MES shall be registered. For Normal Service, the MES shall select a suitable spot beam, tune to that spot beam's BCCH + CCCH associated with the selected PLMN, and register within the PLMN. If it registers successfully, it has Normal Service.

5.1.2 Limited service

There are a number of situations in which the MES is not allowed to register with any PLMN or the PLMN denies registration, but the signal strength is acceptable for Normal Service. The inability to obtain Normal Service is due to one or more of the following factors:

- No SIM in the MES.
- A "PLMN not allowed" or "LA not allowed "response to an LU.
- An "illegal MES", "illegal MES-ME", or "IMSI unknown in HLR" response to a LU (any SIM in the MES-ME is then considered "invalid").
- The SIM status is "Updated" but the MES shall reregister before it can obtain Normal Service. (It is camped in a different LAI from the one on which it is registered. See clause 5.1.3 and clause 5.5).

Under any of these conditions, the MES is considered to be "not registered". It attempts to camp on an acceptable spot beam so that emergency calls can be made if necessary. When in the limited service state with a valid SIM, the MES shall initiate LUs in the manner described in clause 6.5.3. No LU requests are made until a valid SIM is present. In the limited service state, the presence of the MES need not be known to the PLMN on whose spot beam it has camped. Spot beam reselection takes place as normal.

There are also other conditions under which only emergency calls may be made. These are shown in table 6.2.

5.1.3 Position-Restricted Service

There are a number of situations in which the registration status of the MES cannot be determined, and access to the system is blocked in any case. The inability to obtain Normal Service is due to the following:

- An "Invalid Position" or "Invalid Position for the MES's Service Provider" response to a Channel Request.

Under these conditions, the MES's registration status in indeterminate, and the MES provides only Position-Restricted Service. Position-Restricted Service differs from Limited Service in that the MES will not attempt non-emergency calls for the latter. In Position-Restricted Service, and the user attempts a call, the MES will attempt an LU and then follow with the CM Service Request if it is successful. Other aspects of the Position-Restricted and Limited Services, such as non-responsiveness to pages and high-penetration alerts, are the same.

5.1.4 Alerting service

The GMR-1 system implements an Alerting Service. The purpose of this service is to notify registered users when they have an incoming call, under highly attenuated signal conditions. The Alerting Service has the following features.

- The signal level is too low for normal operation. Therefore, a special high-penetration alerting channel with modulation suitable for very low signal to noise ratios, called the BACH, is used. This channel sacrifices information carrying capacity in order to deliver alerts. Therefore, the MES has limited knowledge about the incoming call at the point of reception of the alert.
- The MES might not be able to monitor broadcast information in signal conditions where the Alerting Service is functioning.
- The high-penetration alerting channel is one-way. The user shall move the MES into a position in which it can obtain Normal Service in order to respond to the high-penetration alert.
- There are several necessary conditions for the MES to provide the Alerting Service.

- The MES shall be registered. In addition, upon a transition from Dedicated Mode to Idle Mode and if reregistration is required, the MES shall reregister before entry into Normal Service. (The LAI in which the MES is registered is not the one upon which it is camped). If the signal level drops before the MES is able to reregister, it shall enter No Service. See also clause 5.6.

  1) The signal level received by the MES, although lower than for Normal Service, is sufficient to receive the BACH.

  2) The MES shall be camped on the proper BACH. While the MES is in the Alerting Service, it shall monitor the BACH organization state from the BACH. If the BACH organization changes, the MES shall transition to No Service and remain in this service state until it updates its BACH channel configuration from the BCCH.

5.1.5 No service

If the MES cannot obtain any better level of service, it is in No Service. The MES may be in the process of acquiring the system but not camped on any system channel; or the signal may have dropped into the high penetration alerting range, but it is not registered or it may not be camped on the proper BACH; or the signal may be insufficient for high penetration alerting.

5.2 Spot beam selection

Spot beam selection consists of the process of locating a suitable BCCH from a suitable spot beam and camping on it. After initial spot beam selection, multiple BCCHs might be available to camp on. The BCCH selection process involves the PLMN selection process, selection of an LAI if there are more than one available with the same PLMN ID, and also involves the interpretation of information that is returned to the MES in response to Channel Request messages.

5.2.1 Multiple satellites

A GMR-1 system may employ resources from more than one satellite. For a given satellite, all channels on all carriers are time-synchronized. In principle, it would be desirable to treat resources from different satellites in an identical way. However, this is not entirely possible due to the fact that the timing of different satellites is not synchronized with respect to one another. This lack of synchronization requires that an MES shall resynchronize when switching from one satellite to another.

Each satellite radiates its own spot beams. The spot beams of two satellites might not physically overlap on the earth. Therefore a particular spot beam from one satellite could partially overlap the coverage of several spot beams of a different satellite.

5.2.2 Initial spot beam selection

Initial spot beam selection is the process in which the MES uses signal acquisition and measurement to discover and evaluate BCCH carriers. Initial spot beam selection occurs most often at power-on. However, this process may also be necessary to reacquire the satellite signal if, for example, an MES has lost the satellite signal for a significant period

The GMR-1 system provides signalling channels that are broadcast in spot beams, including the BCCH. The MES searches for BCCHs that are available in various spot beams, measures them, and classifies them by signal strength. The MES selects one or more BCCH carriers. Spot beam or beams that contain these BCCHs are called "suitable" spot beams.

In the neighbourhoods of the spot beam intersections, the BCCHs of neighbouring spot beams have signal levels that are approximately equal. Typically, the MES will identify a single suitable spot beam, but it may identify multiple suitable spot beams in this case.

Multiple Gateways may each provide their own BCCH carrier in a given spot beam. Initial spot beam selection selects spot beams using a single BCCH carrier from each spot beam. Once a spot beam has been selected, all of the BCCH carriers in a spot beam are equally suitable candidates for PLMN and LAI selection.

5.2.3 Spot beam restriction by system response

The MES can report its GPS position to the Gateway Station in Channel Request messages. Based upon the reported GPS position or other information, the Gateway Station may determine various position-based access errors or enforce position-based access restrictions by responding with reject causes in Immediate Assignment Reject messages.

These reject causes terminate the interaction between the MES and the Gateway but provide information regarding spot beam and/or LAI selection. They may restrict the selection of a spot beam or require a reselection and may also restrict the selection of the BCCH within the spot beam.

The MES could choose an incorrect spot beam due to measurement error. The Gateway Station may detect this from the reported GPS position and shall indicate this to the MES with the reject cause "Invalid Position for the Selected Spot Beam". Upon reception of this reject cause, the MES shall select another spot beam.

The Gateway Station may also force the MES to camp on a BCCH from a different satellite with this reject cause and appropriate supporting parameters.

The handling for these reject causes is also described in clause 6.2 and in GMR-1 04.008 [4].

5.2.4 System information

The Gateway shall provide the following information in System Information in its BCCH:

1) BCCH_NEIGHBOR_LIST. This list shall contain the BCCH carrier frequency and timing information for one BCCH carrier in each of the spot beams that are nearest neighbour to the beam that contains the BCCH. A BCCH carrier and the neighbour BCCH carriers of this list shall always be on the same satellite.

2) BCCH_FULL_LIST. This list shall contain a BCCH carrier frequency for every spot beam in a GMR-1 system. (If a GMR-1 system uses a BCCH carrier in multiple spot beams, it only occurs once in the BCCH_FULL_LIST).

3) CONCURRENT_BCCH_INFORMATION. The BCCH shall identify other BCCH carriers that might be suitable for the MES. These carriers might be in the same spot beam as the BCCH, or they might be in spot beams from different satellites that at least partially overlap the spot beam containing the BCCH.

4) The BCCH shall contain the SB_RESELECT_HYSTERESIS parameter to control spot beam reselection. One value shall disable spot beam reselection. During certain satellite orbit manoeuvres, the Gateway may temporarily modify the value of SB_RESELECT_HYSTERESIS to prevent spot beam reselections.

5.3 PLMN selection and roaming

5.3.1 Selection of PLMN

The MES shall select an available PLMN with which to register.

Each BCCH identifies the PLMN ID of its Gateway Station in system information. CONCURRENT_BCCH_INFORMATION in system information also identifies all other PLMNs that provide service via other Gateway Stations. Therefore, a BCCH identifies all PLMNs that are served anywhere in the spot beam. All of these PLMNs are equally eligible for PLMN selection.

The MES camps on a BCCH of a PLMN associated with its current location, which is often its home PLMN. However, a visited PLMN may be selected, e.g., if the MES visits a geographic region where the HPLMN is not available in any suitable spot beam at the current location, or if the HPLMN is a GSM PLMN and is not available in any spot beam of the GMR-1 system.

There are two modes for PLMN selection:

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

2) Manual mode. The MES indicates to the user which PLMNs are available. After the user makes a manual selection, the MES tries to obtain service on the selected PLMN.

If a "Roaming not allowed in this location area" reject cause is received in a LU Reject message, the LA is added to a list of "forbidden LAs for roaming". If a "LA not allowed" reject cause is received in a LU Reject message, the LA is added to a list of "forbidden LAs for regional provision of service". These lists are stored in the MES and are deleted when the MES is switched off or when the SIM is removed.

If the MES receives either of these reject causes, it should attempt to select a different LA or PLMN.

If a "PLMN not allowed" reject cause is received by an MES in an LU Reject message from a Visited PLMN, that the VPLMN is added to a list of "forbidden PLMNs" in the SIM; thereafter, that VPLMN will not be accessed by the MES when in automatic mode. A PLMN is removed from the "forbidden" list if, after a subsequent manual selection of that PLMN, there is a successful LU. This list is retained when the MES is switched off or the SIM is removed.

5.3.2 Geographic restrictions on service delivery

Multiple Gateway Stations may provide service within a spot beam. However, the coverage of a spot beam is large, and the Gateway Stations may only be allowed to provide coverage in a portion of the beam. Also, different Gateway Stations might provide service into different geographic regions within a spot beam. Gateway Stations inform MESs about position based service limitation via reject causes in response to Channel Request messages.

If the MES is at a location from which service might be obtained but not from the LAI that was selected by the MES, a Channel Request message can be rejected with the reject cause "Invalid position for the Selected LAI". The selected LAI is no longer available. The MES shall select any other LAI that is still available. If the MES receives this cause upon access of the final "Available" LAI, it shall treat this case in the same manner as for "Invalid Position".

If the MES is at a location from which service is not available from any Gateway Station, the Channel Request message shall be rejected with the reject cause "Invalid Position" or "Invalid Position for the MES's Service Provider". The MES shall consider all LAIs for this GMR-1 system to be not available and cease PLMN and LAI selection for the GMR-1 system. The MES may remain in the Service Level (Normal Service or Limited Service) that was in effect prior to the Channel Request message.

These reject codes are discussed further in clause 6.2.5.4 and in GMR-1 04.008 [4].

NOTE: All further discussions in the present document concerning the error cause "Invalid Position" shall equivalently apply to the error cause "Invalid Position for the MES's Service Provider".

5.3.3 Multiple GMR-1 systems

There may be more than one GMR-1 system in operation throughout the world at one time. Each system may consist of one or more satellites. The footprints of the different systems may or may not overlap.

The user selection for service shall be by PLMN selection. Since the discovery of serving PLMNs is governed by the procedures for spot beam detection and selection, the spot beam selection rules determine the procedures by which PLMNs from different GMR-1 systems are made available for selection.

5.4 Position determination

The GMR-1 system utilizes two types of position information.

1) The MES computes a position relative to spot beam centers, and adjusts the timing of system access via the RACH accordingly. See GMR-1 05.008 [7] and GMR-1 05.010 [8] for specific requirements.

2) The GMR-1 system uses position information, which is reported by the MES. See GMR-1 03.299 [3] for a description of services based upon GPS position.

5.4.1 Position reporting

MESs may be required to report their geographic position in a GMR-1 system. If required, the MES shall report GPS position information in two circumstances.

1) The Channel Request and Extended Channel Request messages.

2) Vehicular Terminals shall periodically report position during a call, if commanded to do so in the Immediate Assignment or Extended Immediate Assignment message.

The MES shall periodically execute a Position Determination process to provide the position.

5.4.2 GPS receiver system support

The MES should have a GPS receiver. See GMR-1 03.299 [3] and GMR-1 05.005 [6]. The Gateway may provide broadcast information that a GPS receiver can use to accelerate the time it takes to obtain a position.

The Gateway shall provide a GBCH, provided the GBCH_PRESENT flag is set. The MES should read the GPS broadcast channel (GBCH). This channel will contain system information messages that provide GPS information to the MESs.

The Gateway shall provide GPS almanac information on the PCH, provided the ALMANAC_PRESENT flag is set. The MES should read GPS almanac information from the paging channel (PCH).

See GMR-1 03.299 [3] for a description of the almanac and GBCH information.

5.4.3 Position verification system access

In addition to Location Updates and CM Service Requests, the Gateway supports system accesses that only report the position to the Gateway. These accesses have two functions.

1) Obtain a response that either implicitly accepts the position or specifically rejects the access due to a positionbased restriction.

2) Update the displayed country and/or region.

This system access is done with a Channel Request message with an establishment cause of Position Verification. See GMR-1 04.008 [4].

5.5 Dedicated mode to idle mode transition

The MES may temporarily register, while in Dedicated Mode, in an LA that is different from the one in which it was registered in Idle Mode. Dedicated Mode operation may involve a change of satellite, which also entails a change of LA.

Upon return from Dedicated Mode to Idle Mode, if the MES has registered to a different LA from the one to which it was registered in Idle Mode, the MES shall camp on the BCCH last camped-on in Idle Mode and reregister in the same LAI last registered in Idle Mode. Failing this reregistration, the MES shall enter Limited Service.

5.6 Barred LAs and access control

System access by MESs is limited by two types of control: LA barring and access control classes.

An MES shall not select in idle mode any BCCH that is restricted by the CELL_BAR_ACCESS parameter.

An MES may be operated as a test MES for the purpose of accessing a test cell. Test MESs should disregard the CELL_BAR_ACCESS parameter but shall instead consider the Test GS parameter. Test MESs shall only access BCCHs belonging to test cells.

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

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

The MES shall ignore the access control information when selecting a spot beam to camp on, i.e. it shall not reject a spot beam for camping on because access on that spot beam is not allowed.

5.7 Radio constraints

The MES uses the "signal quality" criterion C1 to determine whether the link quality of a BCCH carrier is sufficient for camp-on. The C1 criterion is based upon the RXLEV_SELECT_MIN parameter that is broadcast in System Information. The MES shall select BCCH carriers only if they exceed the C1 signal quality criterion. The computation of C1 is defined in GMR-1 05.008 [7].

The MES can operate in several different ways, depending upon signal level. First, the signal level may be sufficient for two-way communication and the MES is capable of camping on the paging channel (PCH). A state in which the MES is camped on the PCH is called a "Paging" state.

Second, the signal level may drop below the threshold for two-way communication capability but the MES can monitor the high-penetration alerting channel. A state in which the MES is camped on the BACH is called a "High penetration" state.

Third, the signal level may be too low for high-penetration alerting. The MES may enter a state that allows it an opportunity to recover from signal fades in excess of the alerting link margin and retain the high-penetration alerting function if the signal level improves. This state is called a "Frequency Search" state.

These signal-quality-dependent activities are captured in states of the Spot Beam Selection Process and are described in clause 6.2. The state change conditions are subject to the MES performance requirements defined in GMR-1 05.005 [6].

5.8 Transition in/out GMR-1 idle mode

This clause lists the requirements for mode interactions of multi-mode MESs, where the modes are GMR-1 and any other mode. This description uses GSM for the alternate mode of operation. However, the MES shall apply these requirements to any alternate mode of operation.

A SIM card shall only have one IMSI and therefore only one Home PLMN. At no time shall the MES be registered to more than one PLMN, i.e., there shall be only one Registered PLMN at a time stored in the MES. There shall only be one IMSI associated with an MES.

5.8.1 Modes of operation

A dual mode MES may have the operational modes listed in table 5.1. If the MES has more than one mode of table 5.1, it shall be contained in a mode selection setting. The mode selection setting shall be stored in non-volatile memory. The mode selection is set by the user and is not a subscription-based parameter.

An MES may implement other modes in addition to the modes listed in table 5.1. The rest of this clause applies only to the modes listed in table 5.1.

Table 5.1: Dual mode MES mode selections

Mode Selection	Mode Selection Definition
GSM only	The MES only accesses GSM.
GMR-1 only	The MES only accesses GMR-1.

The Home PLMN of the MES shall have no effect on mode selection or mode interactions. The mode-selection and mode-interaction rules take priority over Home PLMN. The Home PLMN only has priority during network selection within a mode.

The specifications of GSM 03.22 [9] apply for GSM Only mode.

The specifications contained in the rest of the present document apply for GMR-1 Only Mode.

5.8.2 Dual mode hold timer

If an MES implements any mode of operation in which it automatically switches modes, then the Dual Mode Hold Timer shall apply.

The Gateway shall broadcast the Dual Mode Hold Timer parameter in GMR-1 system information, with a value that ranges from 15 min to 120 min, in increments of 15 min.

The MES shall not autonomously change mode from any other mode to GMR-1 more often than once per Dual Mode Hold Timer.

The limitation imposed by the Dual Mode Hold Timer shall only apply for Automatic Mode.

The Dual Mode Hold Timer restrictions shall be restarted upon any mode change.

6 Overall process structure

6.1 Process goal

The aim of the idle mode processes is to achieve the normal service state:

- The MES is camped on a suitable spot beam.
- The MES is registered in an LA consistent with its position. (The SIM status may be "Not Updated", but it is registered in the network and camped on the same network).
- The registered PLMN is the selected PLMN.

There may be temporary conditions under which not all of these are fully satisfied, e.g., during spot beam selection, while in the process of reselecting another spot beam, or after movement out of an LA but before a registration with the new LA has been completed. However, if the above are not satisfied at the completion of operations that normally correct these transitory conditions, the MES will normally enter a "limited service state" in which it will try to camp on an acceptable spot beam. In this state, only emergency calls are possible.

Each of the processes of spot beam selection, PLMN selection, GPS position determination, and location updating can be described by a set of states. The overall state of the mobile is thus a composite of the states of the four processes. In some cases, an event that causes a change of state in one process may trigger a change of state in another process, e.g., a response to an LU request may cause a spot beam reselection, followed by another LU request. The relationship among the processes is illustrated in figure 6.1.

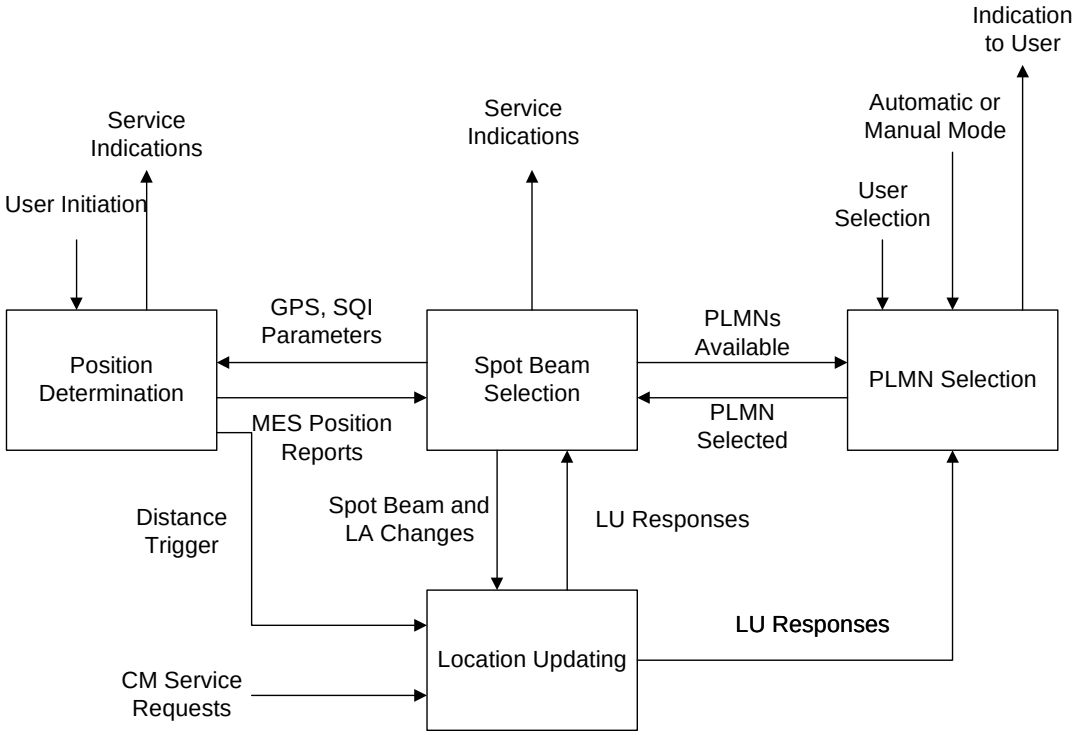


Figure 6.1: Four processes of idle mode

The states in which the MES may be for each of the processes are described below and illustrated in figure 6.2 to figure 6.5. For many of the states, a fuller description can be found in other GMR-1 technical specifications, and a reference to the GMR-1 Technical Specification and the relevant clause within it are given after the state description.

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

6.2 Spot beam selection process

The Spot Beam Selection Process includes the procedures that perform spot beam selection and the procedures for LA identification and LA selection**.** Selection of the LA is equivalent to selection of a BCCH to camp on.

6.2.1 List of states for the spot beam selection process

Refer to figure 6.1.

1) **Primary spot beam selection:** this is the state in which the MES creates a list of suitable spot beams, with no current camp-on history. This state is entered at power-on, at entry into GMR-1 mode, when the user restarts PLMN selection, and when there is no suitable spot beam (including when all suitable spot beams are rejected by the Gateway Station).

2) **Select a spot beam:** this is the state in which the MES selects and camps on a particular spot beam. PLMN selection occurs while in this state. This occurrence implies in turn that the MES selects and camps on a selected BCCH from a particular LA in this state. The MES moves to state B4 either upon the success of a registration or to state B8 if it determines that no registration can be successful (possibly requiring one or more LAI and or PLMN reselections). If the MES selects the same LAI as the one to which it was registered before the last power-down, the transition through this state is automatic without a new LU attempt. During the course of registration attempts, there may be changes of LAI selection to camp on due to Gateway Station responses to system accesses. This state may also be entered due to spot beam reselection or due to the error causes that cause an LAI reselection: "Invalid Position for the Selected Spot Beam" or "Invalid Position for the Selected LAI".

3) **RF Carrier synchronization:** the MES enters this state if it is necessary to synchronize to a carrier from another satellite or to locate a carrier of the same satellite whose timing is unknown to the MES. This occurrence may be due to an autonomous Idle Mode procedure or it may be indicated to the MES supporting information along with an "Invalid Position for this Spot Beam" error cause. The MES performs a complete BCCH carrier acquisition and synchronization in this state. (These steps may not be necessary for carrier switching among carriers on the same satellite). The MES moves to state B2 upon synchronization to the FCCH and BCCH.

4) **Camped normally paging:** the MES is camped on a spot beam and is able to make and receive calls. The MES is in Normal Service in this state. The MES executes the spot beam reselection process in this state.

5) **Normal service dedicated mode**: the MES is not in idle mode but is connected to the GMR-1 network for a call.

6) **Camped normally high penetration:** the MES is at least capable of receiving the BACH and synchronizing with the FCCH in this state. The MES is in Alerting Service provided it satisfies the requirements of clause 5.1.3. Otherwise, the MES is in No Service in this state.

7) **Normal service frequency search:** the MES is not capable of receiving the BACH. It may be tracking the FCCH or may attempt to reacquire the FCCH if it has lost synchronization. The MES is in No Service in this state. If the MES cannot reacquire synchronization, it will go to state B1. The specific criteria for the transition from B7 to B1 are implementation-dependent.

8) **Camped limited service - paging:** this is the state in which the MES has selected a spot beam but cannot obtain service because the MES is not registered in the selected LAI. The MES is in Limited Service in this state. The MES camps on the BCCH carrier so that emergency calls can be made. The MES monitors received level and BCCH data and checks periodically whether spot beam reselection is needed. The MES executes the spot beam reselection process in this state.

   The MES may also enter this state upon completion of a call and where reregistration in the camped-on LAI is required but not completed. This state is then transitory until the MES either reregisters or the signal drops and the MES shall go to state B10.

9) **Limited service dedicated mode:** the MES is not in idle mode but is connected to the GMR-1 network to make an emergency call.

10) **Camped no service high penetration:** the MES is camped on a spot beam. The signal level is not sufficient for making emergency calls. The MES is synchronized to the FCCH. The MES is not registered and therefore is in No Service in this state. The MES does not monitor the BACH.

11) **No service frequency search:** the MES may be tracking the FCCH or may attempt to reacquire the FCCH if it has lost synchronization. The MES is in No Service in this state. If the MES cannot reacquire synchronization, it shall go to state B1. The specific criteria for the transition from B11 to B1 are implementation-dependent.

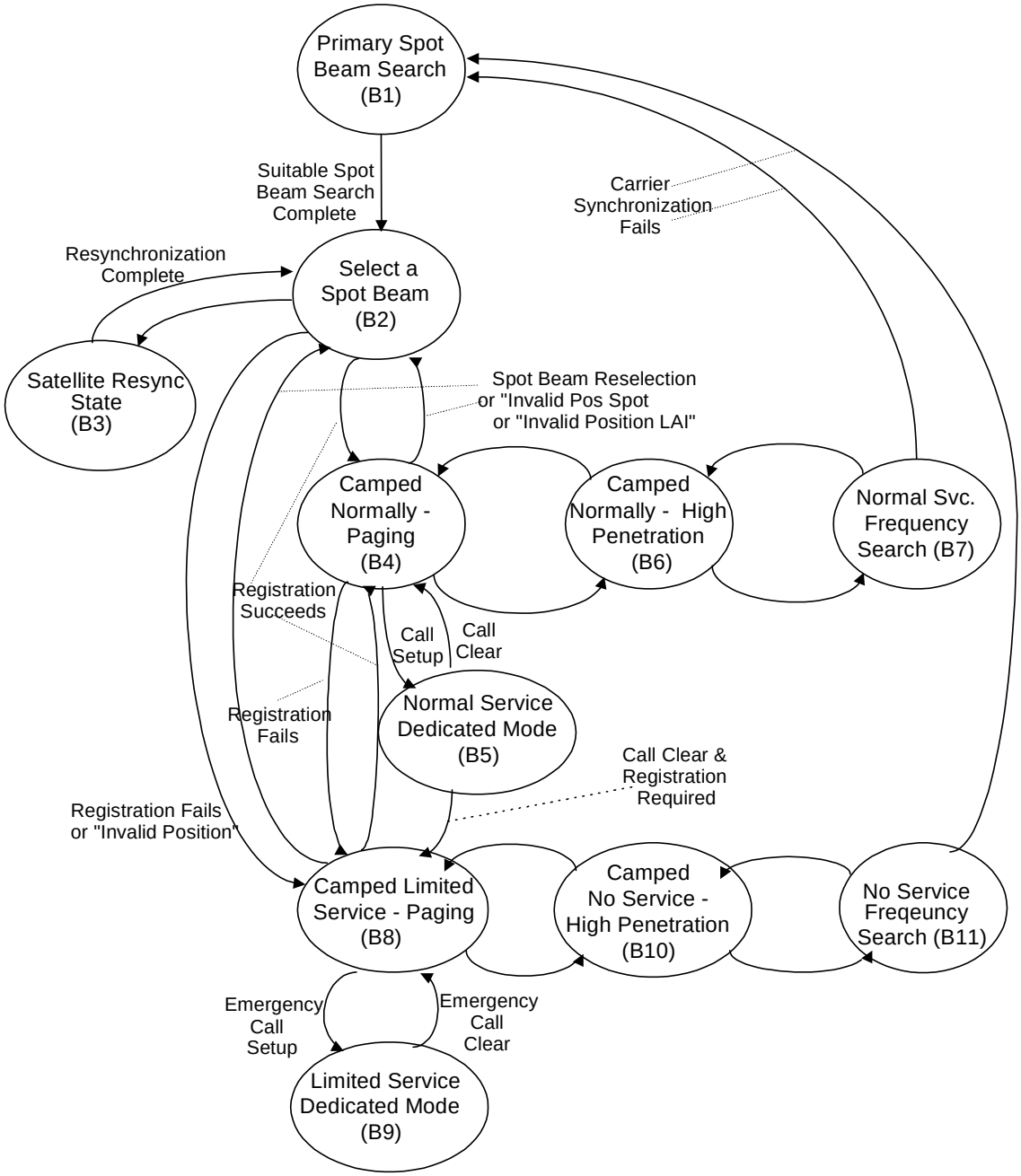


Figure 6.2: Spot beam selection process

6.2.2 Initial spot beam selection

The initial spot beam selection includes the signal scan and acquisition procedures and signal strength measurement and comparison procedures that the MES uses to locate suitable BCCHs. It is executed whenever the MES searches for a spot beam in states B1, B7, and B11 of the spot beam selection process.

The MES shall conduct initial spot beam selection in a manner that is consistent with the requirements of PLMN selection. Therefore, if a suitable BCCH of a PLMN is detected, then BCCHs that are also suitable that are from any PLMN with higher priority (from the Home PLMN or PLMN of the Preferred List) shall also be detected.

The MES shall use the C1 criterion (refer to GMR-1 05.008 [7]) for minimum signal strength for spot beam selection.

The MES is not required to search the full LMSS band for BCCH carriers when in Automatic PLMN selection mode.

The MES may segment frequency searches subsequent to the first one in a discontinuous manner to conserve battery power.

GMR-1 05.008 [7] contains other spot beam selection requirements.

6.2.3 Spot beam reselection

If an MES that is satisfactorily camped on a BCCH moves far enough, it may move out of the region of coverage of the initial spot beam and into another spot beam. The MES should preferentially obtain service in the new, stronger spot beam when this happens. It is therefore necessary for the MES to periodically monitor signals contained in spot beams that are geographically adjacent to the initial spot beam and to camp on a BCCH from the new, stronger spot beam when one is detected. This process is called spot beam reselection.

The MES shall periodically monitor the camped-on BCCH of the selected spot beam and the BCCHs from each of its immediate neighbour spot beams as listed in the BCCH_NEIGHBOR_LIST to determine if it will select a new spot beam.

The MES shall execute the spot beam reselection procedure upon expiration of the SB_RESELECTION_TIMER while in states B4 or B8. If the timer expires while in states B5, B6, B7, B9, B10, or B11, the MES shall execute spot beam reselection as soon as possible upon reentry into states B4 or B8. The MES shall reset the timer upon exit from state B1.

The MES shall limit reselection of different spot beams by application of the SB_RESELECT_HYSTERESIS (SRH) parameter.

The MES shall obtain the SB_RESELECT_HYSTERESIS parameter from System Information before performing reselection, at all decision points that normally trigger reselection.

The method of measurement is defined in GMR-1 05.008 [7].

6.2.4 Gateway response to channel requests

Spot beam selection is influenced by the "Invalid Positon for the Selected Spot Beam" error cause in the Immediate Assignment Reject message.

If the MES receives "Invalid Position for the Selected Spot Beam" and the SI bit is not set, no BCCH from this spot beam (on the same satellite) shall be allowed for camp-on. If the MES receives "Invalid Position for the Selected Spot Beam" and the SI bit is set, no BCCH from this satellite shall be allowed for camp-on.

This error cause shall always have a BCCH Carrier associated with it. The MES shall synchronize to the associated BCCH carrier. If the RI bit is not set, the MES shall evaluate the spot beam for suitability for camping on. If the RI bit is set, the MES shall conduct a spot beam selection between this BCCH and the BCCHs of its BCCH_NEIGHBOR_LIST and identify suitable spot beams (see also GMR-1 05.008 [7]). After identifying new suitable spot beams, if any, the MES shall identify new suitable BCCHs, if any.

During a spot beam selection procedure that is executed in compliance with this clause, the MES might not identify any new suitable BCCH that it is not also on the Forbidden BCCH List (see later clauses). In this circumstance, the MES may identify a spot beam as suitable even if it is more than SB_SELECTION_POWER dB weaker than the strongest spot beam, provided that it is the strongest spot beam not already disallowed for camp-on and that it exceeds C1.

6.2.5 BCCH selection

After the MES has selected suitable BCCH(s), it shall select and camp on the BCCH of a proper Gateway. This clause describes detailed requirements regarding BCCH selection. These activities occur in states B2 and B3. In some cases, the MES may be required to repeat initial spot beam selection.

This description uses three lists called the Primary BCCH List, the Secondary BCCH List, and the Forbidden BCCH List. The lists are informative only, but the functions that are to be performed by the MES and that are illustrated by application of the lists are normative. The PLMNs for which there is a BCCH on the Primary BCCH List and not restricted by the Forbidden BCCH List are the Available PLMNs.

PLMN selection shall select only from Available PLMNs. PLMN selection has precedence over BCCH selection, but multiple BCCHs may be available with the same PLMN.

6.2.5.1 Primary BCCH list

The MES shall construct a Primary BCCH List. This list shall contain an entry for every suitable BCCH. The Primary BCCH List shall contain entries for the following BCCHs:

- each BCCH that was identified as "suitable" by initial spot beam selection or by spot beam reselection. Spot beam selection may have identified more than one "suitable" BCCH;
- all BCCHs that are identified as concurrent BCCHs by CONCURRENT_BCCH_INFORMATION on each of the suitable BCCHs.

The list identifies, at minimum, the PLMN, the BCCH carrier number, the SYSTEM_ID and the SATELLITE_ID but can also include any other useful information.

The MES shall construct a new Primary BCCH List at the following times:

1) when the MES conducts an initial spot beam selection;
2) when the MES conducts a spot beam reselection.

6.2.5.2 Selection procedure for BCCHs

The Primary BCCH List may have multiple entries. Assuming that a BCCH is allowed by higher-priority considerations (is from the selected PLMN, is not barred by the forbidden PLMN or forbidden LAI lists), does not appear on the Forbidden BCCH List, and is not barred by CELL_BAR_ACCESS, the MES shall prioritize the selection among multiple BCCHs from this list in the following order.

1) The BCCH whose matching LAI is stored in the SIM (last registered LAI).
2) A BCCH that does not require a change of satellite.
3) A BCCH from the strongest spot beam. (BCCHs in the same spot beam shall be considered to have the same signal strength. It is not necessary to measure the BCCH signal strength of different BCCHs in a spot beam. If it is required to change satellite, the signal strength might not be known for BCCH carriers from the new satellite).
4) Select the BCCH in random order.
5) If a BCCH is chosen on a different satellite, Spot Beam Verification shall be performed, subject to the limitations in the next clause.

6.2.5.3 Spot beam verification

Spot Beam Verification is a procedure which validates the entries of the Primary BCCH List for an alternate satellite before the BCCH on the alternate satellite is actually selected.

Spot Beam Verification involves the following steps.

a) Select the BCCH. If the BCCH is from a different satellite, acquire and synchronize to the BCCH on the selected BCCH carrier.
b) Verify the BCCH is not prohibited by CELL_BAR_ACCESS, if not already done.
c) Obtain the BCCH_NEIGHBOR_LIST and the SATELLITE_ID.
d) Perform a BCCH_NEIGHBOR_LIST search (see GMR-1 05.008 [7]).
e) Construct a Secondary BCCH List. This list is similar to the Primary BCCH List except that the Secondary List is limited to entries where the SATELLITE_ID matches the SATELLITE_ID of step 2. (i.e., all BCCHs are on the second satellite).
f) Eliminate those BCCHs from the Primary BCCH List that have the same SATELLITE_ID as the second satellite but do not appear in the Secondary BCCH List. (All BCCHs whose SATELLITE_ID does not match are not affected. No BCCHs are added to the Primary BCCH List).

g) If the BCCH that was selected in step 1 is still available in the Primary BCCH List, remain camped on the BCCH and proceed with Idle or Dedicated mode procedures. If the BCCH that was selected in step 1 is no longer in the Primary BCCH List, repeat the PLMN or BCCH selection process with the modified Primary BCCH List.

Spot Beam Verification shall be executed in all cases when the MES selects a BCCH that requires a change of satellite, and the selection was caused by an autonomous selection of BCCH by the MES (either PLMN or BCCH selection). Spot Beam Verification shall not be executed if the MES is commanded to a BCCH carrier by use of the "Invalid Position for the Selected Spot Beam" reject cause and with the SI bit set. Spot Beam Verification is not required until the MES selects the BCCH and synchronizes to it.

6.2.5.4 Availability expansion and restriction by system responses

After processing the "Invalid Position for the Selected Spot Beam" error cause, the MES shall augment the Primary BCCH List with new suitable BCCHs and with BCCHs from CONCURRENT_BCCH_INFORMATION of the new suitable BCCHs.

The MES shall also construct a temporary list called the Forbidden BCCH List. The entries may have the same form as those of the Primary BCCH List in order to make matches between the lists. The MES shall add BCCHs to the Forbidden BCCH List, or create a list if one does not exist, in the following circumstances:

1) The MES receives "Invalid Position for the Selected Spot Beam", and the SI bit is not set. The MES shall enter all BCCHs onto the Forbidden BCCH List as follows:

   a) The current BCCH.

   b) All BCCHs from CONCURRENT_BCCH_INFORMATION that are in this spot beam (from the same satellite).

   c) All BCCHs from CONCURRENT_BCCH_INFORMATION that are from other satellites and for which this BCCH is the only remaining link. (If a BCCH on a second satellite is identified as available in CONCURRENT_BCCH_INFORMATION from more than one spot beam of a first satellite, the BCCH is not added to the Forbidden BCCH List until all BCCHs that link to it are on the Forbidden BCCH List).

2) The MES receives "Invalid Position for the Selected Spot Beam", and the SI bit is set. The MES shall enter BCCHs onto the Forbidden BCCH List as follows:

   a) The current BCCH.

   b) All other BCCHs from all spot beams from the same satellite as the current BCCH. (This shall include spot beams from this satellite that are subsequently added to the Primary BCCH List, up to the point that the Forbidden BCCH List is deleted).

- If the MES receives "Invalid Position for the Selected LAI", it shall add the BCCH to the Forbidden BCCH List. (There is a 1:1 correspondence between the BCCH carrier and LAI in the GMR-1 system).

- If the MES receives "Invalid Position", it shall add the BCCH and all other BCCHs that share the same SYSTEM_ID to the Forbidden BCCH List.

NOTE: The Forbidden BCCH List is different from the Forbidden LAI Lists. The Forbidden BCCH List is used to force an MES to camp on a Gateway Station that provides service in the geographic region in which the MES is located, if any. The Forbidden BCCH List is constructed according to responses to Channel Request messages. The Forbidden LAI Lists identify LAIs whose selection is prohibited, based upon responses to Location Updating Request messages.

The MES shall delete the Forbidden BCCH List whenever it deletes the Primary BCCH List, or assumes a state in which it ceases to attempt to register with the network (see GMR-1 04.008 [4]). In the latter case, the MES might be either registered or unregistered, and will allow the MES to retry a registration in a rejected LAI if by chance it moves in location during the intervening interval.

6.2.6 Dedicated mode to idle mode transition

This clause describes the use of a BCCH Carrier Register. This description is informative only, but the functions that are to be performed by the MES and are illustrated by application of the BCCH Carrier Register are normative.

Immediately before entry into Dedicated Mode, the MES shall save the frequency number of the BCCH carrier upon which the MES is camped in a memory location called the BCCH carrier register. During Dedicated Mode, the MES be required to synchronize to a BCCH carrier from a different satellite and may be required to register to a different LAI than registered to in Idle Mode.

Upon return from Dedicated Mode to Idle Mode, the MES shall take the following actions:

- the MES shall synchronize to the BCCH identified in the BCCH Carrier Register and camp on it;
- if the LAI from the BCCH does not match the LAI stored in the SIM, the MES shall attempt to register with the LAI of the BCCH. The MES shall perform this registration before a new CM Service Request is attempted;
- the MES should determine the BACH reorganization state immediately before entry into any high penetration state.

6.2.7 Limited service

If the MES is unable to register or if there is no SIM in the MES, the MES selects an LAI on which it shall camp so that emergency calls can be made. The MES shall give the following priority to LAIs for camp-on:

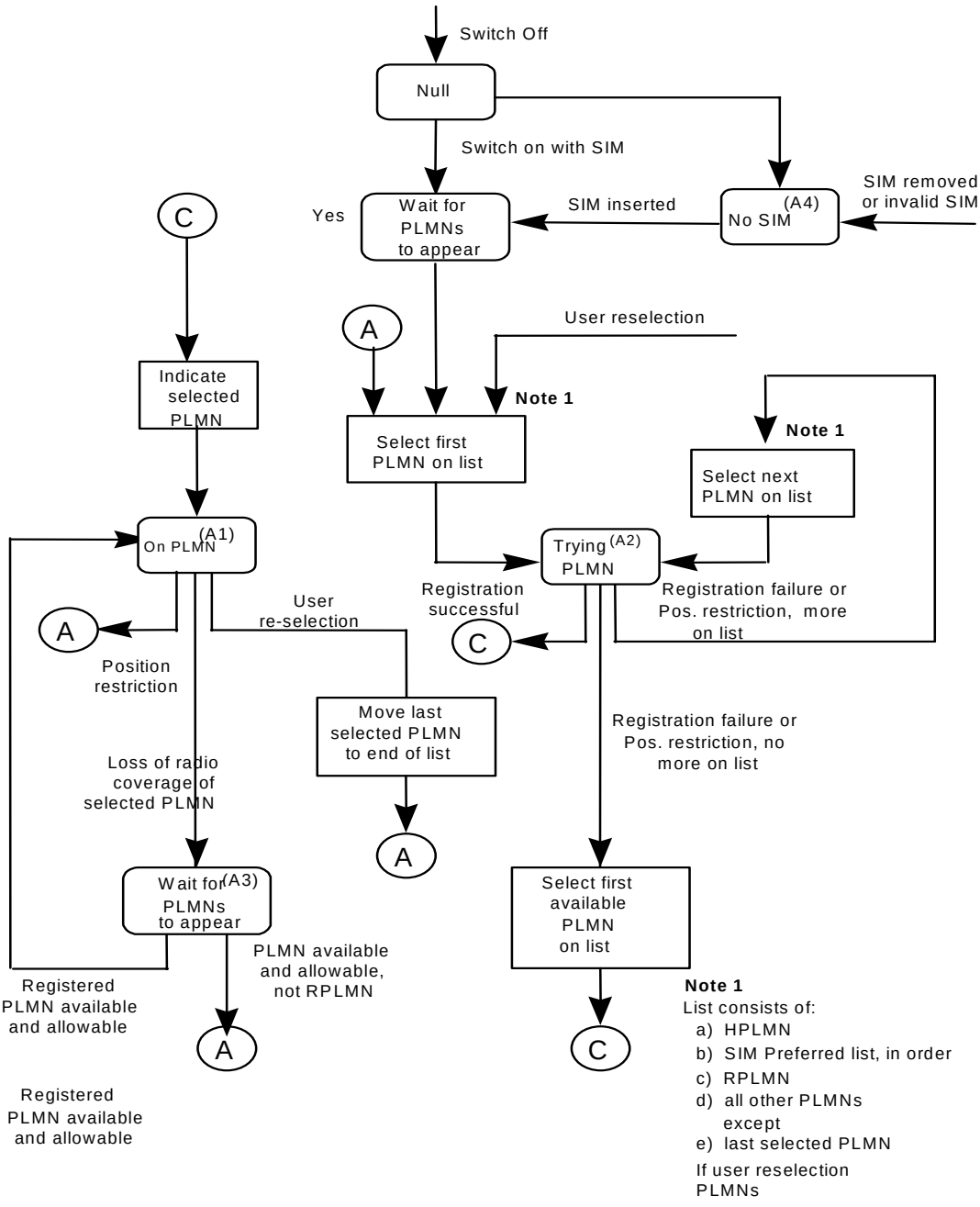
- shall be an LAI of a suitable spot beam (therefore, spot beam selection has been completed);
- LAI to which most recently registered;
- LAIs that are not allowable (therefore, GPS position has been accepted by the Gateway Station);
- LAIs that are not available.

6.3 PLMN selection process

6.3.1 List of states for the PLMN selection process

There are two modes for Satellite Network selection, automatic and manual. These are illustrated in figures 6.3 and 6.4.

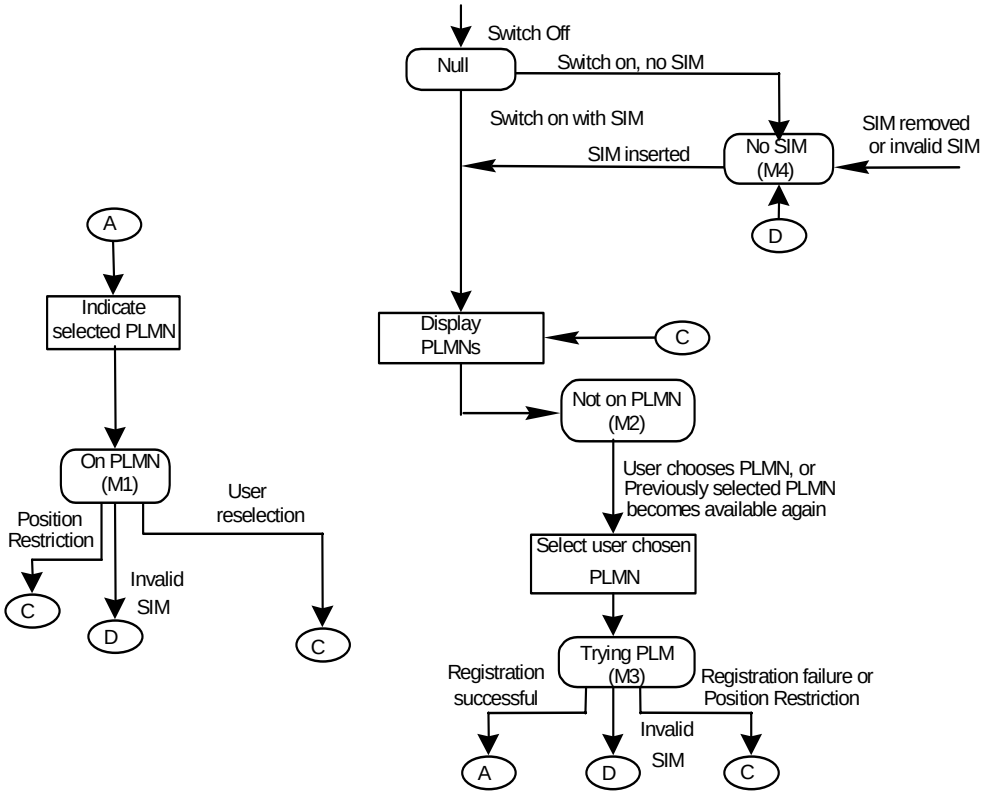
6.3.1.1 List of states for automatic mode



A1: On PLMN. The MES has successfully registered on a PLMN.
A2: Trying PLMN. The MES is trying to register on a PLMN in the ordered list of PLMN.
A3: Wait for PLMN to appear. There are no allowable and available PLMNs at present and the MES is waiting for one to appear.
A4: No SIM. There is no SIM in the MES, or certain LU responses have been received.

Figure 6.3: PLMN Selection State Diagram (Automatic Mode)

6.3.1.2 List of states for manual mode



M1: On PLMN. The MES has successfully registered on a PLMN.
M2: Not on PLMN. The MES has failed to register on the selected PLMN.
M3: Trying PLMN The MES is trying to register on a user selected PLMN.
M4: No SIM. There is no SIM in the MES, or certain LU responses have been received.

Figure 6.4: PLMN Selection State Diagram (Manual Mode)

6.3.2 Registration on a PLMN

In both automatic and manual modes, the concept of registration on a PLMN is used. An MES successfully registers on a PLMN if:

a) the MES has found a suitable BCCH of the PLMN to camp on; and

b) a LU request from the MES has been accepted on which the MES is camped (see table 6.1).

Table 6.1: Effect of LU Outcomes on PLMN Registration

Location Updating Task State	Registration Status	Registered PLMNIs
Updated	Successful	Indicated in the stored LAI
Idle, No IMSI	Unsuccessful	No registered PLMN
Roaming not allowed:		
a) PLMN not allowed	Unsuccessful	No registered PLMN
b) LA not allowed	Indeterminate	No registered PLMN
c) Roaming not allowed in this LA	Indeterminate	No registered PLMN
Not updated	Unsuccessful	No registered PLMN
NOTE: The registered PLMN is determined by looking at the stored LAI and stored location updating status.		

In automatic mode, the MES may conduct spot beam selection in a manner such that preferred PLMNs are discovered in the order of preference, assuming the MES is in coverage of them. The search may be terminated as soon as the MES can determine that it has found the highest priority PLMN (i.e., the MES is not required to perform a complete search in all cases).

In manual mode, the MES may display PLMNs as they are discovered, reordering the display by priority if necessary.

6.3.3 PLMN selection

6.3.3.1 MES switch-on or recovery from lack of coverage

At switch on in manual mode, the MES selects and attempts to perform a Location Update on the registered PLMN, if it exists. If there is no registered PLMN at switch on in manual mode, and at switch on in automatic mode, the MES follows one of the following two procedures depending on its operating mode.

On recovery from lack of coverage in both manual and automatic mode, the MES selects the registered PLMN (if it is available) and, if necessary (see clause 6.5.3), attempts to perform a Location Update.

If successful registration is achieved, the MES indicates the selected PLMN. If registration is not possible due to the PLMN being unavailable or registration failure, the MES follows one of the following two procedures depending on its operating mode.

1) Automatic Network Selection Mode Procedure

The MES selects and attempts registration on PLMNs, if available and allowable, in the following order:

a) Home PLMN (if not previously selected).

b) Each PLMN in the "PLMN Selector" data field in the SIM (in priority order).

c) The registered PLMN.

d) All other PLMNs.

If successful registration is achieved, the MES indicates the selected PLMN.

If there are no suitable spot beams, the MES indicates "no service" to the user.

If registration cannot be achieved the MES indicates "limited service" to the user. If there is a PLMN available but no PLMN is allowable, it indicates "limited service" to the user and enters the limited service state.

2) Manual Network Selection Mode Procedure

The MES shall camp on the most appropriate BCCH available and shall enter the limited service state.

6.3.3.2 User reselection

At any time the user may request the MES to initiate reselection and registration onto an available PLMN according to the following procedures, dependent upon the operating mode.

1) Automatic Network Selection Mode

The MES selects and attempts registration on PLMNs, if available and allowable in accordance with the following order:

a) Home PLMN.

b) PLMNs contained in the "PLMN Selector" data field in the SIM (in priority order).

c) All other PLMNs excluding the previously selected PLMN.

d) The previously selected PLMN.

The previously selected PLMN is the PLMN that the MES has selected prior to the start of the user reselection procedure.

If successful registration is achieved, the MES indicates the selected PLMN.

If there are no suitable spot beams, the MES indicates "no service" to the user.

If registration cannot be achieved the MES indicates "limited service" to the user. If there is a PLMN available but no PLMN is allowable, it indicates "limited service" to the user and enters the limited service state.

2) Manual Network Selection Mode

The MES indicates whether there are any PLMNs available, in all suitable spot beams (see clause 5.6), which may be available including "Forbidden PLMNs". Any PLMN shall only be presented once.

The MES should present PLMN as they are discovered by spot beam selection. If displayed, PLMNs are presented in the following order:

a) Home PLMN.

b) PLMNs contained in the "PLMN Selector" data field in the SIM (in priority order).

c) All other PLMNs.

The user may select a desired PLMNs and the MES then initiates registration on this PLMN. The user selection may take place at any time during the presentation of PLMNs. For such a registration, the MES shall ignore the contents of the forbidden LAI and PLMN lists.

In manual mode, if the user does not select a PLMN, the MES shall camp on the last selected PLMN, if available. If it is unavailable, the MES shall camp on the most appropriate BCCH available and shall enter the limited service state.

6.3.4 Abnormal cases

If there is no SIM in the MES, if there is an authentication failure, or if the MES receives an "IMSI unknown in HLR", "illegal MES-ME" or "illegal MES" response to an LU request, then effectively there is no selected PLMN ("No SIM" state). In these cases, the states of the spot beam selection process are such that no PLMN selection information is used. No further attempts at registration on any PLMNs are made until the MES is switched off and on again or a SIM is inserted.

Some terminal types, such as fixed terminals, may restrict PLMN selection to the Home PLMN or to the Home PLMN and the SIM Preferred List.

When in automatic network selection mode and the MES are in the "not updated" state with one or more suitable BCCHs to camp on, then after four unsuccessful LU requests, the MES may continue (or start if it is not running) the user reselection procedure of clause 6.3.3.2.

6.3.5 Roaming not allowed in this LA

If in either PLMN selection mode the LU response "Roaming not allowed in this LA" is received, the PLMN automatic or manual mode selection procedure of clause 6.3.3.1 is followed.

6.4 Position determination process

6.4.1 Idle mode parameters

The Position Determination process shall maintain parameters that determine when the MES shall attempt to obtain a position and what the MES shall do after it has obtained a position. The MES shall maintain separate parameters for Idle Mode and Dedicated Mode. The rest of the description of the Position Determination Process is for Idle Mode. The Idle Mode parameters are the parameters: GPS_UPDATE_TIMER and GPS_UPDATE_DISTANCE.

See GMR-1 03.299 [3] and GMR-1 04.008 [4] for definition of parameters for Dedicated Mode, and or other requirements and restrictions on position reporting.

6.4.2 Receiver operation

A MES may run a position determination receiver, such as a GPS receiver, discontinuously. The MES may obtain position more frequently than is minimally required.

The MES shall run the obtain a position in Idle Mode in the following circumstances:

- upon expiration of an Idle Mode timer of duration GPS_UPDATE_TIMER;
- before a system access for a LU or CM Service request or in response to a page or an alert, and a newer position is required than any that is already stored in the MES;
- before all system accesses for Position Verification. (The Position Verification shall only be executed with a new position, without regard to the stored "current position").

In addition, the MES should obtain a position at other times that improve the likelihood that it will have a "current" position when needed.

6.4.3 Configuration of position determination

The Gateway Station shall broadcast a default GPS_UPDATE_TIMER value and a default GPS_UPDATE_DISTANCE parameter value on the BCCH. The MES shall revert to the default parameter values each time it selects a new BCCH.

The Gateway Station may update the GPS_UPDATE_TIMER and GPS_UPDATE_DISTANCE on a MES-by-MES basis, to a MES-specific value. The MES shall store MES-specific parameter values in non-volatile memory for use at power-on. The Gateway Station may update these parameters by any of the following messages:

1) Position Verification Notify.
2) Immediate Assignment Reject.
3) Immediate Assignment Reject with Position.

When a change in the GPS_UPDATE_TIMER value occurs and the timer is running, the timer shall be reloaded so that the new time to expiration will be "old time to expiration" modulo "new GPS_UPDATE_TIMER value".

6.4.4 "Current" position storage

Each time the MES determines a position, it shall store the position as the "current" position and a timestamp of when it was obtained. The position and timestamp shall be stored in non-volatile memory.

The "current" position and timestamp shall be updated any time a position is determined.

6.4.5 "Reported" position storage

The MES shall store the "reported" position and its timestamp. The "reported" position is the last MES position for which either of the following conditions are true.

- The MES has sent a Channel Request message and has received an Immediate Assignment, an Immediate Assignment Reject (or IAR with Position), or a Position Verification Notify, but has not been requested to send an Extended Channel Request. If the response was an IAR, the reject cause was not "Lack of resources", "Position too old", or "Invalid Position for the Selected Spot Beam".
- The MES has sent an Extended Channel Request message and has received an Extended Immediate Assignment or an Extended Immediate Assignment Reject. If the response was an EIAR, the reject cause was not "Lack of resources", "Position too old", or "Invalid Position for the Selected Spot Beam".

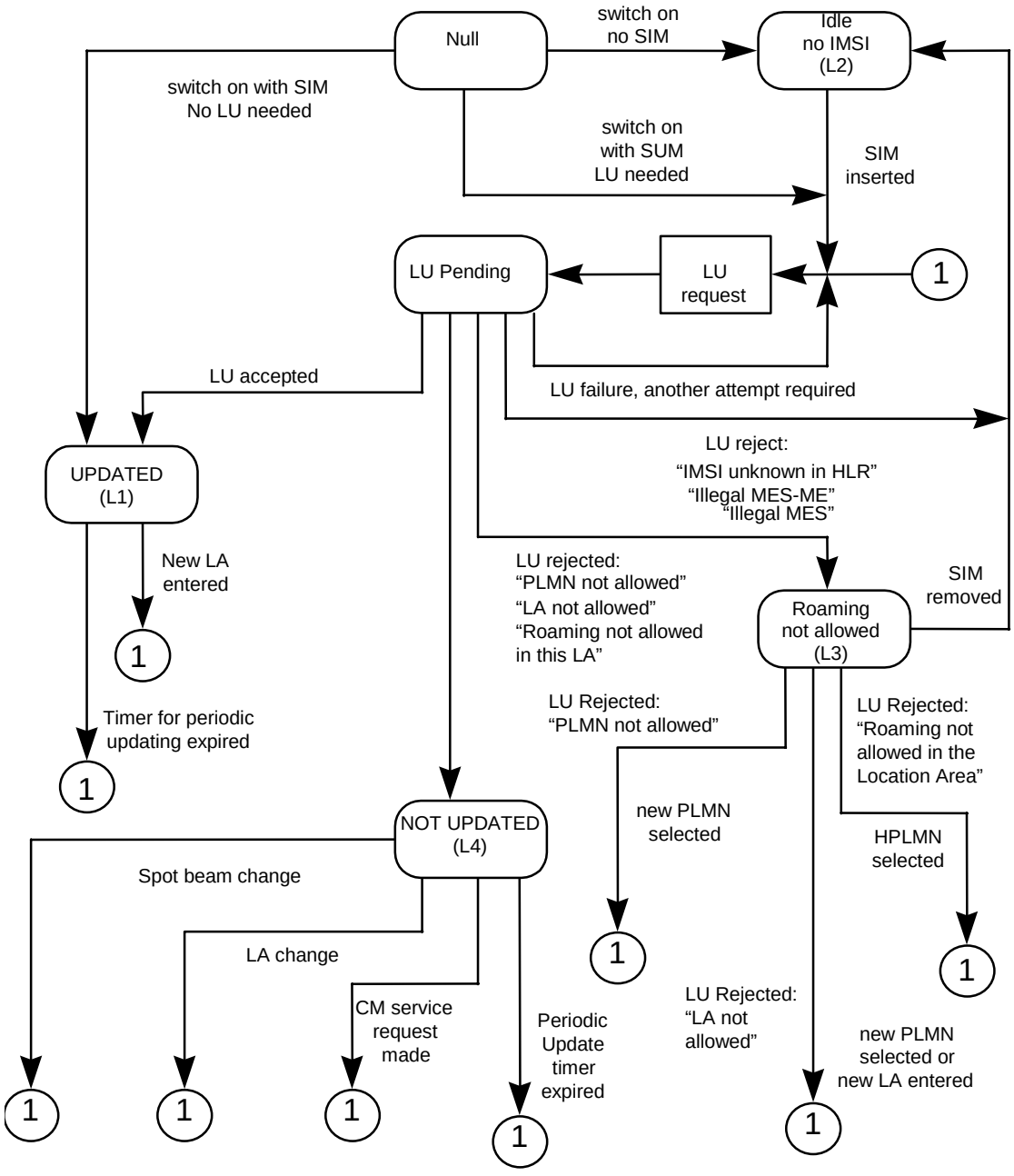
6.4.6 Distance check

A computation of distance moved since the position was last reported to the Gateway Station shall be implemented in the Position Determination Process in Idle Mode.

Each time the MES determines its position for the first reason identified in clause 6.4.2 or at other times while in Idle Mode, it shall execute a check of the distance moved. The distance moved is the calculated distance between the new position and the "reported" position. If this distance exceeds GPS_UPDATE_DISTANCE, and GPS_UPDATE_DISTANCE is not equal to zero, the MES shall initiate a Position Verification.

6.5 Location updating process

6.5.1 List of states for location updating



NOTE: Whenever the MES goes to connected mode and then returns to Idle mode again, the MES selects he appropriate state.

Figure 6.5: Location Updating Task State Diagram

The states are entered depending on responses to location update (LU) requests.

L1: **Updated**. The MES enters this state if an LU request is accepted. The update status on the SIM is set to "updated".

L2: **Idle, No IMSI**. The MES enters this state if an LU request is rejected with cause:

a) IMSI unknown in HLR.

b) Illegal MES-ME.

c) Illegal MES.

Or if there is no SIM.

If a SIM is present, the update status of the SIM is set to "Roaming not allowed".

L3: **Roaming not allowed**. The MES enters this state if it receives an LU reject message with the cause:

a) PLMN not allowed.

b) Location area not allowed.

c) Roaming not allowed in this location area.

The update status on the SIM is set to "Roaming not allowed".

The behaviour of the MES in the "roaming not allowed" state is dependent on the LU reject cause as shown in table 6.2. Additionally:

- In automatic mode, "PLMN not allowed" and "roaming not allowed in this location area" cause the automatic network selection procedure of clause 6.3.3.1 to be started.
- In manual mode, "PLMN not allowed" and "roaming not allowed" cause the manual network selection procedure of clause 6.3.3.1 to be started.

L4: Not updated. The MES enters this state if any LU failure not specified for states L2 or L3 occurs, in which cases the MES is not certain whether or not the network has received and accepted the LU attempt. The update status on the SIM is set to "not updated".

6.5.2 General

When the MES is switched on, the action taken by the location updating process is as follows:

1) SIM present and no LU needed (because of the status of the stored LAI and "attach" flag): the MES is in the update state UPDATED.

2) SIM present and LU needed: A LU request is made.

3) No SIM present: The MES enters the update state Idle, NO IMSI.

In case 2 above, and subsequently whenever a LU request is made, the MES enters a state depending on the outcome of the LU request, as listed in clause 6.5.1.

Whenever the MES goes to connected mode and then returns to idle mode again, the MES selects the appropriate state.

6.5.3 Initiation of location updating

An LU request indicating normal location updating is made when, in idle mode,

- The received LAI differs from the one stored in the MES, and the LAI or the PLMN identity is not contained in a list of forbidden LAIs or PLMN identities respectively, while being in one of the following update states:
  - updated;
  - not updated;
  - roaming not allowed.
- The periodic location updating timer expires while in the update state NOT UPDATED (clause 6.5.4).
- A manual network reselection has been performed, and the LAI or the PLMN identity is not contained in a list of forbidden LAIs or PLMN identities respectively, and the MES is not in the UPDATED state for the LAI of the selected PLMN.
- The following conditions both apply:
  - in response to a Position Verification message, the MES receives either a Position Verification Notify or Immediate Assignment Reject with error cause "Reported Position Acceptable";
  - the MES is in the NOT UPDATED state.

An LU request indicating periodic location updating is made when, in idle mode, the periodic location updating timer expires while being in the update state UPDATED.

An LU request indicating IMSI attach is made when the MES is activated in the same location area in which it was deactivated while being in the update state UPDATED, and the BCCH indicates that IMSI attach/detach shall be used.

Furthermore, an LU request indicating Normal Location Updating is also made when the response to an outgoing request shows that the MES is unknown in the VLR.

Table 6.2 summarizes the events in each state that trigger a new LU request. The actions that may be taken while being in the various states are also outlined in table 6.2.

Table 6.2: LU Process States and Allowed Actions

Location Updating	New LU Request When			Normal Calls	Paging
Task State	**Changing LA (Notes 6 and 7)**	**Changing PLMN**	**Other**	**Supported (Note 1)**	**Responded to**
Null (see note 4)	Yes	Yes	No	No	No
Updated (see note 5)	Yes	Yes	(see note 2)	Yes	Yes
Idle, No IMSI	No	No	No	No	No
Roaming not allowed:					
a) Idle, PLMN not allowed	No	Yes	No	No	Optional if with IMSI
b) Idle, LA not allowed	Yes	Yes	No	No	Optional if with IMSI
c) Idle, Roaming not allowed in this LA	Yes	Yes	No	No	Optional if with IMSI
					Yes if with IMSI
Not updated		Yes	(Notes 2, 3 and 8)	(Note 3)	

NOTE 1: Emergency calls may always be made, subject to access control permitting it.
NOTE 2: A new LU is made when the periodic registration timer expires.
NOTE 3: If a normal call request is made, an LU request is made. If successful, the updated state is entered and the call may be made.
NOTE 4: The MES is in the null state from switch-on until it has camped on a spot beam and either made an LU attempt or decided that no LU attempt is needed.
NOTE 5: In this state, IMSI detach is performed if the MES is deactivated and the BCCH indicates that IMSI attach/detach shall be used. An LU request indicating IMSI attach is performed if the MES is activated in the same location area in which it was deactivated while being in this state.
NOTE 6: Change of spot beam always means a change of LA.
NOTE 7: A change of registered LA may happen as a result of optimal routing. It is necessary to reregister.
NOTE 8: Response to a Position Verify message indicates the position is acceptable.

6.5.4 Periodic location updating

A timer with the following characteristics shall be implemented in the MES:

1) Upon switch-on of the MES or when the BCCH indicates that periodic location updating shall be applied and the timer is not running, the timer shall be loaded with a random value between 0 and the broadcast timeout value and started.

2) The timeout value shall be within the range of 1 deci-hour to 255 deci-hours with a granularity of 1 deci-hour.

3) When the timer reaches its expiration value, it shall be reinitiated to the broadcast timeout value, and the MES shall initiate periodic location updating.

4) The timer shall be prevented from triggering periodic location updating during connected mode. When the MES returns to idle mode, the timer shall be initiated with respect to the broadcast timeout value, then started. Thereafter, the procedure in item 3 shall be followed.

5) When a change in the broadcast timeout value occurs (at a change of serving spot beam or a change in the broadcast timeout value), the timer shall be reloaded so that the new time to expiration will be: "old time to expiration" modulo "new broadcast timeout value".

6) When the periodic timer has expired, and the MES has information that it is not able to complete a LU because a system access may not be completed, the MES should queue the condition that a Periodic LU is required pending a change in the condition limiting the system access. These conditions may include insufficient link quality to access the system or a previous "Invalid Position" error cause in response to a system access.

6.5.5 IMSI attach/detach operation

The BCCH will contain an indicator indicating whether or not IMSI attach/detach operation is mandatory to use in the spot beam. The MES shall operate in accordance with the received value of the indicator.

When IMSI attach/detach operation applies, an MES shall send the IMSI detach message to the network when the MES is powered down or the SIM is removed while being in the update state UPDATED. The IMSI detach message will not be acknowledged by the network.

When the MES returns to the active state, the MES shall perform an LU request indicating IMSI attach, provided that the MES still is in the same location area. If the location area has changed, an LU request indicating Normal Location Updating according to clause 6.5.3 shall be performed.

6.6 User indications

6.6.1 Service indication

The MES shall indicate to the user whether the MES is in the GMR-1 or GSM mode of operation.

6.6.2 GMR-1 service indication

The MES shall indicate to the user the appropriate level of service:

- Normal service.
- Alerting service.
- Limited service.
- No service.

Due to the fact that there may be some transitory changes of state, the service indications are permitted to continue to be set for up to 10 seconds after the applicable conditions cease to be met. The service indication is permitted to take up to 1 second to be set after the applicable conditions are met.

6.6.3 GPS indication

The MES shall indicate to the user whether a GPS position is currently held by the MES. The indicator shall be set if the current GPS position stored in the MES is newer than the GPS_POSITION_AGE parameter (has not expired); otherwise the indicator shall be not set.

The MES shall indicate the GPS position to the user. This display may be made subject to mode or menu selection by the user.

6.7 Non-volatile storage requirements

The MES shall store the following information in non-volatile memory:

- BCCH_FULL_LISTs. The MES shall provide storage for at least three BCCH_FULL_LISTs.
- Current GPS position and timestamp, reported GPS position and timestamp, MES-specific GPS_UPDATE_TIMER and GPS_UPDATE_DISTANCE parameters, and flag indicating whether MES-specific values are in use.

6.8 BCCH Broadcasting and Storage

System information contains a BCCH carrier list, called the BCCH_FULL_LIST, that the MES uses to scan for BCCHs, rather than scanning the full LMSS band. A BCCH_FULL_LIST consists of a set of RF carriers that are used by a GMR system as BCCH carriers, such that there is at least one BCCH carrier in the list for all geographic areas of coverage of a GMR system. Each GMR system has its own BCCH_FULL_LIST.

When an MES is first switched on in a PLMN, it first of all has no knowledge of which RF channels are BCCH carriers (of that PLMN or any other PLMN), and has to search the strongest RF carriers in order to find which are BCCH carriers. Second, the MES is limited in its consideration of BCCH carriers to those that are approximately the strongest BCCH carriers, in order to obtain service via resources that are associated with its location under the satellite coverage; it shall select the spot beam. Finally it has to determine which BCCH carriers belong to the selected PLMN.

The process of scanning for BCCH carriers is a relatively slow process. Consequently the MES is only required to scan the full band in manual PLMN selection mode. In automatic mode, the MES is only required to scan BCCH_FULL_LISTs. Scanning a BCCH_FULL_LIST fulfils the need to locate BCCH carriers and, in cooperation with the spot beam selection procedure, the need that the BCCH carrier is from a proper spot beam. However, a scan of a BCCH_FULL_LIST followed by spot beam selection only satisfies these considerations for a single GMR system.

A BCCH_FULL_LIST may have BCCH carriers of one or more PLMNs. It does not necessarily contain all the BCCH carriers of any PLMN and does not necessarily contain a BCCH carrier of every PLMN that is available in the GMR system. A BCCH_FULL_LIST may have BCCH carriers from more than one satellite, but it does not necessarily contain a BCCH carrier of every satellite of a GMR system at every location within system coverage. Therefore, after spot beam selection on a GMR system, the MES reads CONCURRENT_BCCH_INFORMATION from system information to discover the range of PLMNs and BCCH carriers that are available for selection at the MES's current location. All concurrent BCCHs on BCCH carriers of a spot beam from a satellite are transmitted at the same time.

The system information contains a second BCCH carrier list, called the BCCH_NEIGHBOR_LIST, that the MES uses for spot beam reselection. The BCCH_NEIGHBOR LIST and BCCH_FULL_LIST do not necessarily contain the same RF channels.

The MES may store other information in non-volatile memory to accelerate the processes of spot beam selection and PLMN selection.

6.9 Pageability of the mobile subscriber

An MES is required to listen to all paging messages that could address it (as defined by its paging sub channel and the page mode, see GMR-1 05.002 [5]), when the following conditions are all satisfied:

- a SIM is inserted;
- the MES is camped on a spot beam;
- the MES is not in state "Idle, No IMSI";
- the MES is not performing the task to search for available PLMNs. (Whenever possible during this task, the MES should listen for paging).

NOTE 1: During spot beam reselection there is a period when the MES is no longer camped on the old spot beam but shall decode the BCCH and perform other processing before camping on the new spot beam. During this period, the MES will not be pageable.

NOTE 2: It is permissible for an MES to miss pages to scan for service on a non-GMR-1 system.

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