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Technical Specification

**GEO-Mobile Radio Interface Specifications;
Part 3: Network specifications;
Sub-part 11: Functions Related to
Mobile Earth Station (MES)
in Idle Mode;
GMR-2 03.022**



Reference

DTS/SES-002-03022

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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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IPRs:

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TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US

IPR Owner: Digital Voice Systems Inc
One Van de Graaff Drive Burlington,
MA 01803
USA

Contact: John C. Hardwick
Tel.: +1 781-270-1030
Fax: +1 781-270-0166

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	GB	GB 2 215 567	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 377 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
The Keytech Centre, Ashwood Way
Basingstoke
Hampshire RG23 8BG
United Kingdom

Contact: John Watson
Tel.: +44 1256 864821

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Hughes Network Systems		US	Pending	US

IPR Owner: Hughes Network Systems
11717 Exploration Lane
Germantown, Maryland 20876
USA

Contact: John T. Whelan
Tel: +1 301-428-7172
Fax: +1 301-428-2802

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 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 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 377 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 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-argin Forward Control Signals	US	US 6,072,985	US
TS 101 377 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

IPR Owner: Lockheed Martin Global Telecommunications, Inc.
900 Forge Road
Norrstown, PA. 19403
USA

Contact: R.F. Franciose
Tel.: +1 610.354.2535
Fax: +1 610.354.7244

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:

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- 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 11 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-2 03.001";

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

Sub-part 3: "Numbering, Addressing and Identification; GMR-2 03.003";

Sub-part 4: "Restoration Procedures; GMR-2 03.007";

Sub-part 5: "Organization of Subscriber Data; GMR-2 03.008";

Sub-part 6: "Handover Procedures; GMR-2 03.009";

Sub-part 7: "Technical Realization of Short Message Service (SMES) Point-to-Point; GMR-2 03.040";

Sub-part 8: "Location Registration Procedures; GMR-2 03.012";

Sub-part 9: "Discontinuous Reception (DRX) in the GMR-2 System; GMR-2 03.013";

Sub-part 10: "Security Related Network Functions; GMR-2 03.020";

Sub-part 11: "Functions Related to Mobile Earth Station (MES) in idle Mode; GMR-2 03.022";

Sub-part 12: "Technical Realization of Facsimile Group 3 Transparent; GMR-2 03.045";

Sub-part 13: "Transmission Planning Aspects of the Speech Service in the Public Satellite Mobile Network (PSMN) system; GMR-2 03.050";

Sub-part 14: "Call Waiting (CW) and Call Hold (HOLD) Supplementary Services - Stage 2; GMR-2 03.083";

Sub-part 15: "Multiparty Supplementary Services; GMR-2 03.084";

Sub-part 16: "Technical Realization of Operator Determined Barring; GMR-2 03.015";

Sub-part 17: "Call Barring (CB) Supplementary Services - Stage 2; GMR-2 03.088";

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-n 01.201.

1 Scope

The present document establishes the tasks undertaken by a MES, a Dual-mode GMR-2/Terrestrial User Terminal; e.g., a GMR-2/GSM MES when in idle mode, that is, switched on but not having a dedicated channel allocated. It also describes the corresponding network functions. Service aspects of the dual mode MES are described in the in the GMR-2 02-series and GSM documents listed in clause 2.

The present document outlines how the requirements of such MESs in idle mode of operation shall be implemented. Further details are given in GMR-2 04.008 [24] and GMR-2 05.008 [26].

Clause 5 of the present document gives a general description of the idle mode process. Clause 6 defines the main requirements and technical solutions of those requirements. Clause 7 describes the processes used in idle mode. There is inevitably some overlap between these clauses.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.

- [1] GMR-2 01.004 (ETSI TS 101 377-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and Acronyms".
- [2] GSM 02.01 (ETSI ETS 300 500): "European digital cellular telecommunications system (Phase 2); Principles of telecommunications services supported by a GSM Public Land Mobile Network (PLMN)" (V4.6.0).
- [3] GSM 02.02 (ETSI ETS 300 904): "European digital cellular telecommunications system (Phase 2); Bearer Services (BS) supported by a GSM Public Land Mobile Network (PLMN)" (V4.2.2).
- [4] GMR-2 02.003 (ETSI TS 101 377-2-1): "GEO-Mobile Radio Interface Specifications; Part 2: Service specifications; Sub-part 1: Teleservices supported by a GMR-2 Public Satellite Mobile Network (PSMN)".
- [5] GMR-2 02.004 (ETSI TS 101 377-2-2): "GEO-Mobile Radio Interface Specifications; Part 2: Service specifications; Sub-part 2: General on Supplementary Services".
- [6] GSM 02.06 (ETSI ETS 300 504): "European digital cellular telecommunications system (Phase 2); Types of Mobile Stations (MS)" (V4.5.2).
- [7] GSM 02.07 (V4.8.2) (ETSI ETS 300 505): "European digital cellular telecommunications system (Phase 2); Mobile Station (MS) features".
- [8] GSM 02.08 (ETSI ETR 101): "European digital cellular telecommunications system (Phase 2); Quality of service".
- [9] GMR-2 02.009 (ETSI TS 101 377-2-3): "GEO-Mobile Radio Interface Specifications; Part 2: Service specifications; Sub-part 3: Security Aspects".
- [10] GSM 02.16 (ETSI ETS 300 508): "European digital cellular telecommunications system (Phase 2); International Mobile Station Equipment Identities (IMEI)" (V4.5.0).
- [11] GSM 02.17 (ETSI ETS 300 509): "European digital cellular telecommunications system (Phase 2); Subscriber identity modules functional characteristics" (V4.3.3).

- [12] GSM 02.24 (ETSI ETS 300 510): "European digital cellular telecommunications system (Phase 2); Description of Charge Advice Information (CAI)" (V4.5.0).
- [13] GSM 02.30 (ETSI ETS 300 511): "European digital cellular telecommunications system (Phase 2); Man-Machine Interface (MMI) of the Mobile Station (MS)" (V4.13.0).
- [14] GSM 02.40 (ETSI ETS 300 512): "European digital cellular telecommunications system (Phase 2); Procedures for call progress indications" (V4.5.1).
- [15] GSM 02.41 (ETSI ETS 300 513): "European digital cellular telecommunications system (Phase 2); Operator determined barring" (V4.5.2).
- [16] GSM 02.81 (ETSI ETS 300 514): "European digital cellular telecommunications system (Phase 2); Line identification supplementary services - Stage 1" (V4.6.1).
- [17] GSM 02.82 (ETSI ETS 300 515): "European digital cellular telecommunications system (Phase 2); Call Forwarding (CF) supplementary services - Stage 1" (V4.5.2).
- [18] GMR-2 02.083 (ETSI TS 101 377-2-4): "GEO-Mobile Radio Interface Specifications; Part 2: Service specifications; Sub-part 4: Call Waiting (CW) and Call Hold (HOLD) supplementary services - Stage 1".
- [19] GMR-2 02.084 (ETSI TS 101 377-2-5): "GEO-Mobile Radio Interface Specifications; Part 2: Service specifications; Sub-part 5: Multiparty (MPTY) supplementary services - Stage 1".
- [20] GSM 02.85 (ETSI ETS 300 518): "European digital cellular telecommunications system (Phase 2); Closed User Group (CUG) supplementary services - Stage 1" (V4.2.6).
- [21] GSM 02.86 (ETSI ETS 300 519): "European digital cellular telecommunications system (Phase 2); Advice of Charge (AoC) supplementary services - Stage 1" (V4.1.5).
- [22] GSM 02.88 (ETSI ETS 300 520): "European digital cellular telecommunications system (Phase 2); Call Barring (CB) supplementary services - Stage 1" (V4.4.3).
- [23] GMR-2 03.003: "GEO-Mobile Radio Interface Specifications; Numbering, addressing and identification".
- [24] GMR-2 04.008 (ETSI TS 101 377-4-7): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 7: Mobile radio interface Layer 3 Specifications".
- [25] GMR-2 05.002: (ETSI TS 101 377-5-20): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 20: Multiplexing and Multiple Access on the Radio Path".
- [26] GMR-2 05.008 (ETSI TS 101 377-5-6): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions and apply:

home system: the HPMN system, e.g., the Home satellite system for PSMN based subscribers or the Home terrestrial system for subscribers with a terrestrial HPMN

alternate system: the non-home system for a dual mode phone

selected PMN: PMN that has been selected according to clause 7.4

available PMN: PSMN where the MES has found a spotbeam that satisfies conditions (ii.) and (iv.) of clause 6.2.1. Available terrestrial PLMNs are to be interpreted according to the relevant technical specifications

registered PMN: PMN on which certain LU outcomes have occurred (see table 7.6.4.1)

allowable PMN: PMN which is not in the list of forbidden Public Mobile Networks in the SIM

MES Registration: process of camping on a spotbeam/cell and doing any necessary LUs

camped on a spotbeam/cell: the MES (ME-MES if there is no SIM) has completed the spotbeam/cell selection/reselection process and has chosen a spotbeam/cell from which it plans to receive all available services. Note that the services may be limited, and that the serving network may not be aware of the existence of the MES (ME-MES) within the chosen spotbeam/cell

current serving spotbeam/cell: spotbeam/cell on which the MES is camped

suitable spotbeam/cell: spotbeam/cell on which an MES may camp. It must satisfy criteria (i.) to (iv.) of clause 6.2.1

acceptable spotbeam/cell: spotbeam/cell that the MES may camp on to make emergency calls. It must satisfy criteria (ii.) and (iv.) of clause 6.2.1

operational mode: defines the user-selected order in which the MES attempts to acquire GMR-2 and/or Terrestrial PLMN networks

Operational Modes: Definition of modes:

Satellite Only (SO): MES only attempts to camp on PSMN spotbeams

Satellite Preferred (SP): MES first attempts to camp on PSMN spotbeams, and then if unsuccessful, it will attempt to camp on PLMN cells

Terrestrial Only (TO): MES only attempts to camp on PLMN cells

Terrestrial Preferred (TP): MES first attempts to camp on PLMN cells, and then if unsuccessful, it will attempt to camp on a PSMN spotbeam

3.2 Abbreviations

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

PMN	Public Mobile Network - either a satellite or a terrestrial network.
PSMN	Public Satellite Mobile Network.
PLMN	Public Land Mobile Network
HPMN	Home Public Mobile Network, for a particular subscriber this network carries the subscription records and is the main provider of service.

Additional abbreviations are listed in GMR-2 01.004 [1].

4 Background

The PSMN Network identity is presented in each spotbeam by the system information transmitted on the broadcast channels. The LAI for a given spotbeam is broadcast on the broadcast channels as (SSC + SNC + LAC), where the (SSC + SNC) are associated with the Network Control Centre (NCC) and the LAC is associated with the spotbeam. The SSC identifies the Satellite System Country and allows the terminal to recognize Home or Visited Satellite System. The SNC identifies a particular satellite in a multi-satellite system and may provide regional roaming capabilities between the satellites in such a system. The GMR-2 numbering scheme is discussed in more detail in GMR-2 03.003 [23].

It is noted that the LAI that is stored in the SIM after a GMR-2 Location Update (LU) acknowledgement, will contain the LAC associated with the current serving spotbeam, but will have the (MCC + MNC) associated with the HLR at the gateway where the registration is held. Therefore, the spotbeam broadcast of a given LAI and the stored LAI will have different Country and Network Code values. This is different from GSM and is due to the fact that all gateways have access to all spotbeams and therefore spotbeam broadcasts of LAIs cannot be uniquely mapped to gateways. This unique mapping occurs in the LU acknowledgement.

Dual mode phones may belong to subscribers having either PSMN or a PLMN as their subscription based Home Network. In general, the MCC and MNC portion of a subscriber's IMSI is associated with the Home Gateway where the subscriber has their HLR registration and thus identifies the Home Public Mobile Network (HPMN) which is the Public Mobile Network through which its Home Gateway communicates. In order to implement the GMR-2 system identity mapping as described above, in addition to the IMSI and separate from it, a dual-mode phone must also store the SSC and SNC parameters. When searching for suitable spotbeams in the PSMN, the MES must match the Network Identity of a spotbeam, e.g., the (SSC + SNC) part of the broadcast LAI on the S-BCCH, with those stored in the MES.

5 General description of idle mode

When a user establishes a subscription with a Public Mobile Network, certain information must be programmed into the SIM at subscription. Included in this information there must be HPMN. Whichever system holds the subscription shall be identified as the home system.

When a dual mode MES is switched on, it attempts to make contact with either the Public Satellite Mobile Network (PSMN) or with a Public Land Mobile Network (PLMN). The network selection process is governed by the user selected Operational Mode. The user selects from the following four Operational Modes: Satellite Only (SO), Satellite Preferred (SP), Terrestrial Only (TO), and Terrestrial Preferred (TP). All options are available for the user regardless of home system. For example, if a user with GMR-2-based subscription chooses a (TO) mode, it will be served exclusively by the terrestrial system, until the operational mode is changed again.

If the MES is in the "Satellite Only" (SO) mode when it is switched on, then the MES looks for a suitable spotbeam within the PSMN and chooses a spotbeam to provide available services, and tunes to its control channel carrier. This selection is known as "camping on the spotbeam". The MES will then register its presence in the location area (LA) of the chosen spotbeam, if necessary, by means of a location updating (LU). When camping on a spotbeam, the MES may enter a disadvantaged signalling mode and tune to the High Margin channels in the spotbeam, as described in GMR-2 05.008 [26]. If the MES loses coverage of a spotbeam, it reselects onto the most suitable alternative spotbeam of the PSMN and camps on that spotbeam. If the new spotbeam is in a different location area, a LU request is performed (see clause 6.4 for variations due to GMR-2 PSMN inclined orbit operations). Note that LUs are performed in advantaged signalling mode only. Switching between advantaged and disadvantaged signalling modes is beyond the scope of the present document (discussed in GMR-2 05.008 [26]). If the MES loses coverage of a PSMN and no other PSMN is available then the MES indicates "Network Unavailable" and waits for the PSMN to appear again.

If the MES is in the "Satellite Preferred" (SP) mode when it is switched on, then the MES initially looks for a suitable spotbeam within the PSMN. If the MES is able to camp on a spotbeam as described in the preceding paragraph, then the same procedures apply. If the MES is unable to camp on a spotbeam within the PSMN or if it loses coverage of this PSMN after having camped on a spotbeam, then either a PLMN is selected automatically, or an indication of which PLMNs are available is given to the user, so that a manual selection can be made. Once a PLMN is selected then procedures for camping on a cell proceed as specified in the relevant specifications for the selected PLMN type. If the MES is unable to find a suitable cell in a PLMN then the MES will indicate "Network Unavailable". The MES will then toggle between searching for the Preferred PSMN and searching for a PLMN.

If the MES is in the "Terrestrial Only" (TO) mode when it is switched on, the MES either automatically selects a PLMN or an indication of which PLMNs are available is given to the user, so that a manual selection can be made. The procedures for PLMN selection and for camping on a cell are as specified in the relevant specifications for the selected PLMN type. If the MES is unable to find a suitable cell in a PLMN then the MES will indicate "Network Unavailable".

If the MES is in the "Terrestrial Preferred" (TP) mode when it is switched on, then, after a PLMN is selected, the MES initially looks for a suitable cell within the selected PLMN. If the MES is able to camp on a cell then procedures are as specified in the relevant specifications for the selected PLMN type. If the MES is unable to camp on a cell within a PLMN or if it loses coverage of the available PLMNs, then the MES will attempt to find a spotbeam in the PSMN. If the MES is unable to find a suitable spotbeam then the MES will indicate "Network Unavailable". The MES will then toggle between searching for a PLMN and the PSMN.

The purpose of camping on a PSMN spotbeam in idle mode is threefold:

- a) it enables the MES to receive system information from the PSMN;
- b) if the MES wishes to initiate a call, it can do this by accessing the network on the Satellite Random Access Channel (S-RACH) of the spotbeam on which it is camped (with the exceptions defined in clauses 6.5.3 and 6.5.4);

c) if the PSMN receives a call for the MES it knows (in most cases) the Location Area Identity (LAI) of the spotbeam in which the MES is camped. It can then send a "paging message" for the MES on the Satellite High Penetration Alerting Channel (S-HPACH) of all the spotbeams (up to two for a valid beam pair) in the LAI. The MES will then receive the paging message because it is tuned to the S-HPACH of a spotbeam in that LAI. If the MES receives a Page, it will respond on the S-RACH once it has been moved out of the blockage condition to more acceptable propagation conditions for closure of the return link transmission.

If the MES is unable to find a "suitable" PSMN spotbeam to camp on, or if it receives certain responses to an LU request (e.g., "PSMN not allowed"), it may attempt to camp on a spotbeam anyway, and enter a "limited service" state in which it can only attempt to make emergency calls. (Note that any type of call within the GMR-2 PSMN requires a valid IMSI.)

Idle mode tasks in satellite mode of operations can be subdivided into 2 processes:

- spotbeam selection and reselection;
- location updating.

The relationship between these processes is illustrated in figure 5.1. The states and state transitions within each process are shown in figures 5.2 to 5.4.

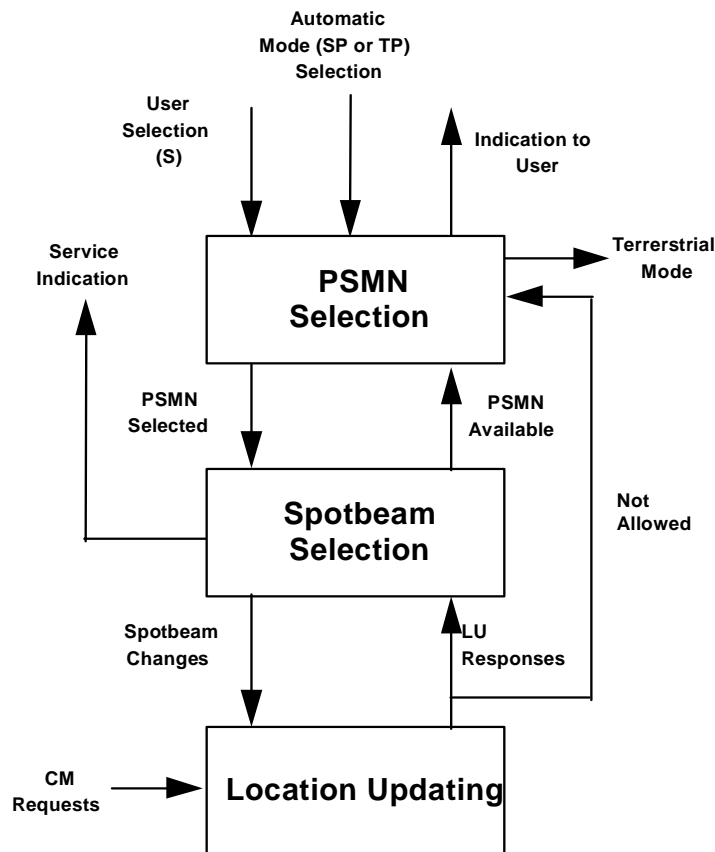


Figure 5.1: Overall idle mode process in satellite mode

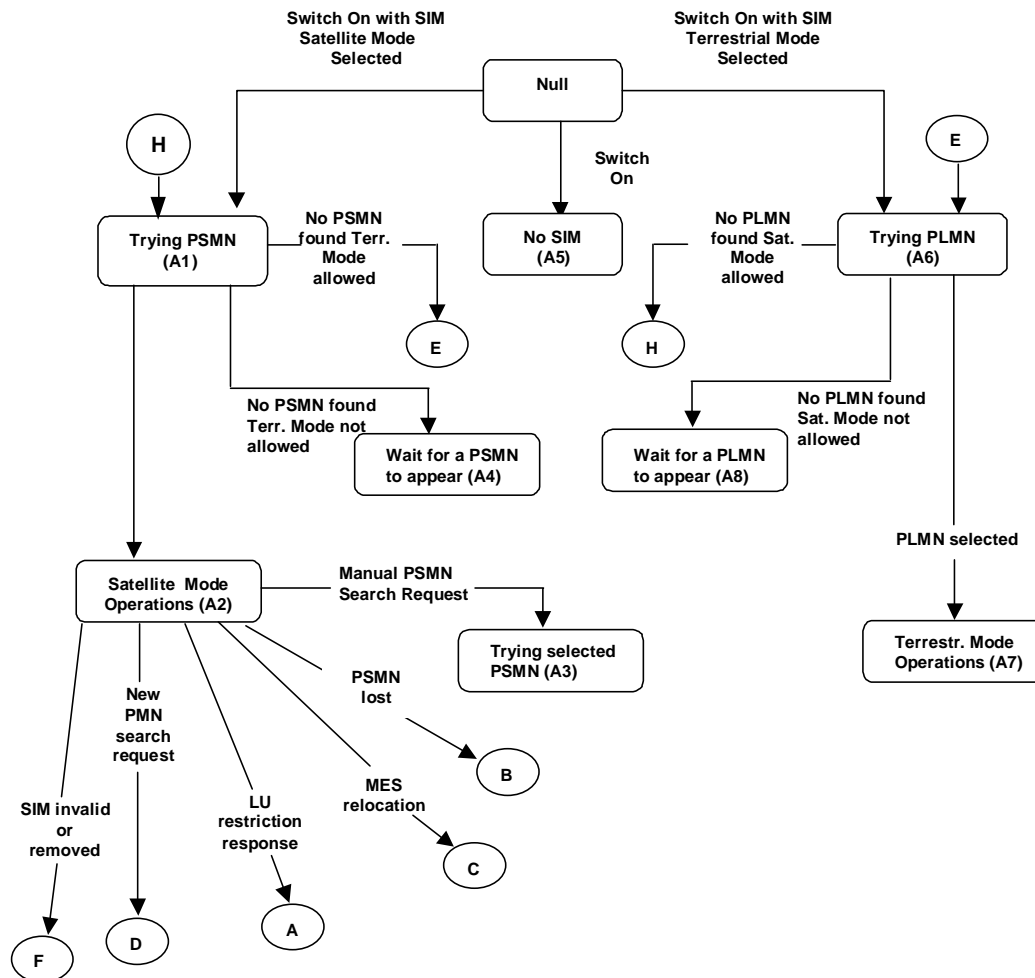
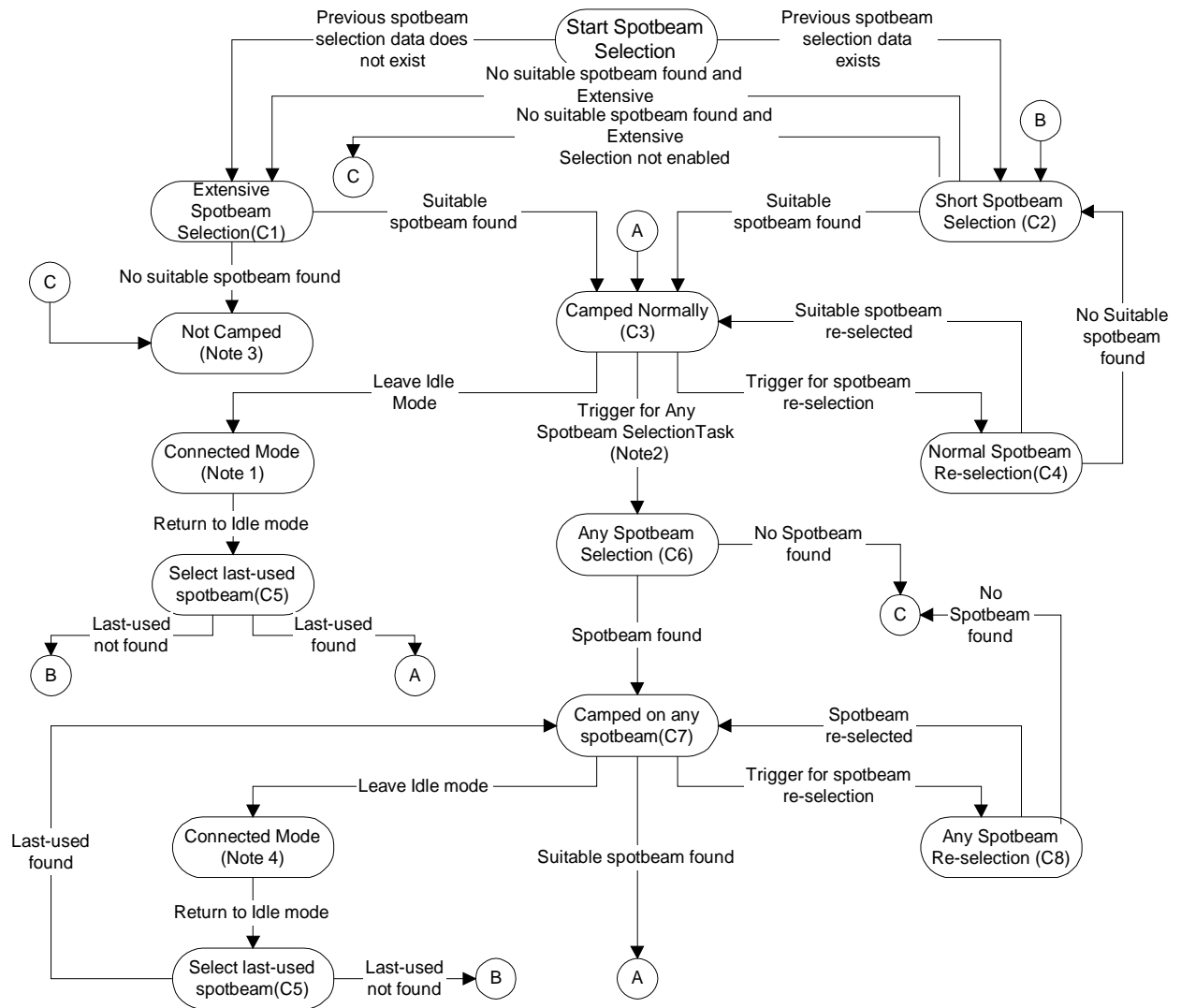


Figure 5.2: Network selection state diagram

- a) For a LU response "PSMN Not Allowed" enter Trying PSMN task; for LU responses "LAI Not Allowed" or "National Roaming Not Allowed" enter Spotbeam Selection task or Any Spotbeam Selection task. See also table 7.6.4.1.
- b) Due to effective loss of radio coverage of selected PSMN (includes attempt to re-select the last used spotbeam). Enter "Trying PSMN". If no PLMN is found and Terrestrial Mode operations are allowed - go to "Trying PLMN"; if Terrestrial Mode operations are not allowed - go to "Wait for a PSMN to appear".
- c) Initiate the LU evaluation process according to clause 6.4.1 - Inclined Orbit Operations.
- d) If a New PSMN Search is requested - go to "Trying PSSMN"; if a New PLMN Search is requested and allowed - go to "Trying PLMN".
- e) A PLMN search is performed in the corresponding search mode. All terrestrial mode operations including PLMN selection are performed according to the relevant technical specifications.
- f) The MES is in "No SIM" state and may enter "Trying PLMN". See clause 7.4.4 - Abnormal cases where the terrestrial mode operations are according to the relevant technical specifications and may cause the MES to enter "Limited Service Mode" where only Emergency Calls are allowed. If the MES does not enter "Trying PLMN", it shall remain in "No SIM" state until switched off or until the SIM is replaced.



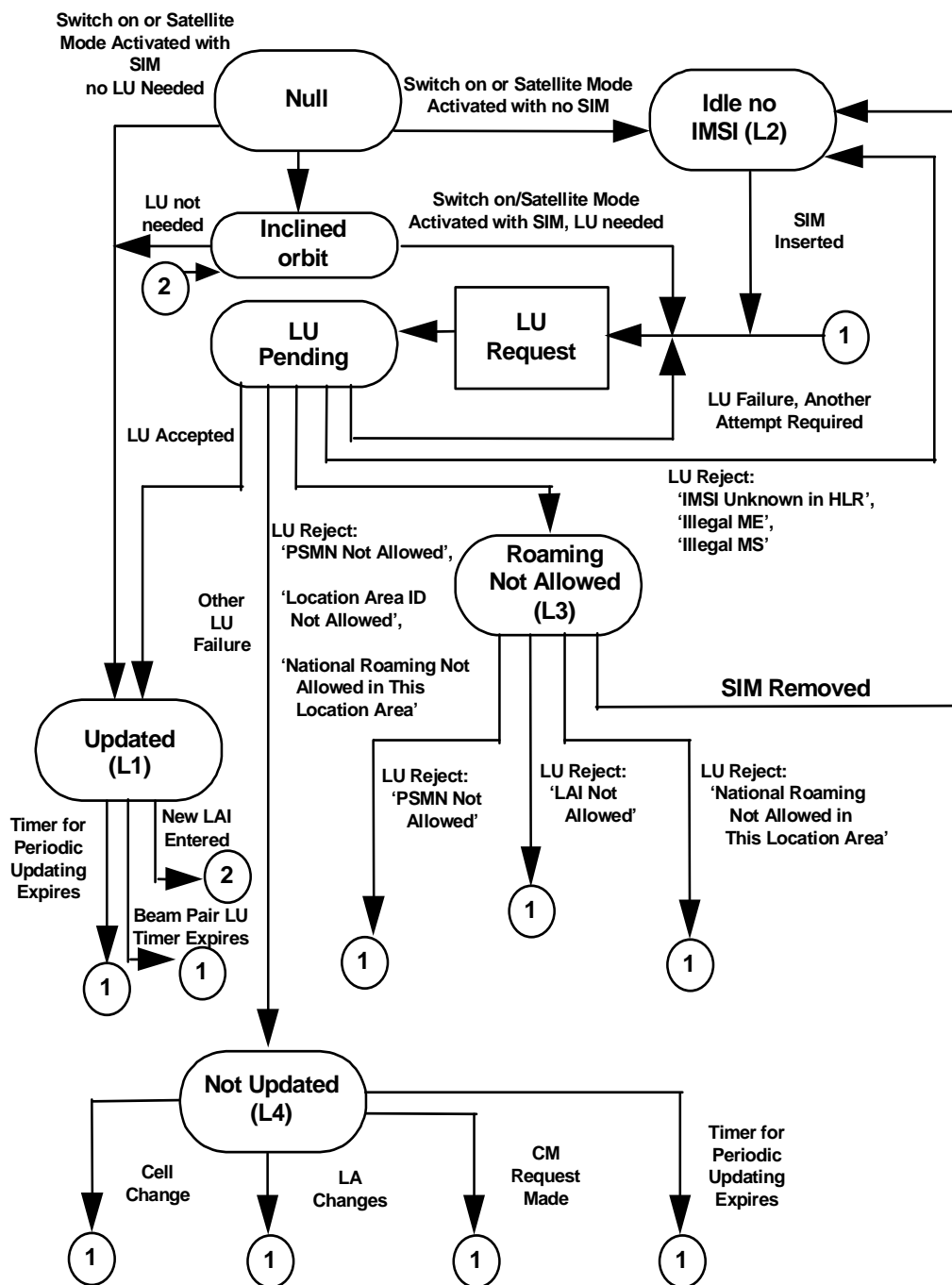
NOTE 1: During system access, e.g. any kind of call.

NOTE 2: The trigger events for any spotbeam selection task are according to table 7.6.4.1.

NOTE 3: MES operations in this state are controlled by the network selection task. If terrestrial mode operations are allowed, the MES shall try to obtain service on a PLMN, if terrestrial mode operations are not allowed, the MES shall wait for a PSMN to appear. User interactions may also be allowed in "Not camped" state.

NOTE 4: During system access, e.g. emergency call (non-emergency calls are not allowed).

Figure 5.3: PSMN spotbeam selection state diagram



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

Figure 5.4: Location updating task state diagram

6 Requirements and technical solutions

The following clauses list the main requirements of idle mode operation when the MES is being served by the satellite system, and give an outline of the technical solution.

6.1 PSMN selection and roaming

When a MES is operating in the satellite network mode there is a single home satellite and home gateway through which all idle mode operations are handled. A MES may roam from one coverage beam to another within the PSMN (within a country or across national borders). However; there may be no need to transfer VLR data between gateways in order to roam; e.g., if all gateways have access to every coverage beam. Therefore, in such a system, instead of moving VLR data between gateways when roaming, the Location Update procedure simply updates the LAI that is stored at the subscriber's home gateway.

6.2 Camping on a spotbeam

6.2.1 Normal camping

For normal service, the MES has to camp on a suitable spotbeam and tune to that spotbeam's control channel carrier so that the MES can:

- a) receive system information from the PSMN on the broadcast channels;
- b) receive paging messages from the PSMN, e.g., when there is an incoming call for the MES;
- c) attempt registration with the PSMN and initiate call set-up for outgoing calls or other actions from the MES (in accordance with clauses 6.5.3 and 6.5.4).

The choice of such a suitable spotbeam for the purpose of receiving normal service is referred to as "normal camping". There are various requirements that a spotbeam must satisfy before an MES can perform normal camping on it:

- i. it should be a spotbeam of the PSMN;
- ii. it should not be "barred" (see clause 6.5.1);
- iii. it should not be in an LAI which is in the list of "forbidden LAIs for roaming", if such list is implemented;
- iv. the MES must be able to successfully decode at least the high margin power bursts on the control channel carrier. For different radio environments and the corresponding MES service states, see GMR-2 05.008 [26].

Initially the MES looks for a spotbeam which satisfies these 4 constraints ("suitable spotbeam") by checking spotbeams in descending order of received signal strength. If a suitable spotbeam is found, the MES camps on it and performs any LU registration necessary.

- In order to speed up these processes, a list of the RF channels containing control channel carriers of the PSMN is broadcast on the S-BCCH and S-HBCCH, see clause 7.8. Also, the MES does not need to search all possible RF channels to find a suitable spotbeam. If after searching the RF channels with strongest received signal level, a control channel carrier has been found but no "suitable spotbeam" has been found, the MES can stop the attempt to find a suitable spotbeam of the PSMN.
- In order to further speed the spotbeam selection process, the MES may maintain a list of the RF channels pertaining to a spotbeam cluster - the spotbeam where the MES camped recently and the surrounding beams. If such list is present, the MES may initially try to select the recently camped on spotbeam.

6.2.2 Camp on any spotbeam

If the MES cannot find a suitable spotbeam and enters "limited service state", then the MES actions shall be as defined in clause 6.7.

6.3 Regional provision of service

A MES may have a "regionally restricted service" where it can only obtain service on certain LAIs. If such a MES attempts to camp on a spotbeam of an LAI for which it does not have service entitlement, when it does an LU request, it will receive an "LAI not allowed" message. In this case:

- the MES stores the forbidden Location Area Identity (LAI) in a list of "forbidden LAIs for regional provision of service", to prevent repeated access attempts on a spotbeam of the forbidden LAI. This list is deleted when the MES is switched off or the SIM is removed;
- the MES shall attempt to find an acceptable spotbeam in satellite mode and enter a limited service state as defined in clause 6.7. See also clause 6.5.4.

6.4 Borders between location areas

6.4.1 Inclined orbit operations

There are some coverage locations where an inclined orbit of the satellite will cause an MES to have coverage from one spotbeam, transition to coverage from a different spotbeam, and then transition back to the original spotbeam coverage over the course of one day. In order to prevent this scenario from resulting in cyclic location updating by all MESs in such locations, the GMR-2 system utilizes a concept called "Valid Beam Pairs". In this concept, each of the spotbeams in a pair would be considered unique and separate Location Areas, but there is an additional Location Area, which is defined as the "beam pair". For each coverage beam there are up to 6 possible spotbeams with which it can form a valid beam pair. The Network broadcasts each spotbeam's unique LAI and list of valid beam pair LAIs on the broadcast channels of each spotbeam.

6.4.1.1 MES storage of LAIs and periodic update timer value

When an MES is camped on a spotbeam and appropriately registered with the network, the MES shall store the following:

- 1) the LAI for which it is currently registered (either a spotbeam LAI or a beam pair LAI, see GMR-2 04.008 [24]);
- 2) the list of valid beam pair LACs and the unique Single Spotbeam LAC which are broadcast on the broadcast channels of the current spotbeam (see GMR-2 04.008 [24]);

The storage of the Single Spotbeam LAC of the serving spotbeam shall be in addition to the storage of the registered LAI. The MES shall update the stored Single Spotbeam LAC whenever the serving spotbeam changes even if no LU has been performed.

At switch on, or when the MES camps on a new spotbeam, the MES shall use the stored information in a LU evaluation process as described in 6.4.1.2.

6.4.1.2 MES registration requirements

6.4.1.2.1 Initial MES registration

When a MES camps on a spotbeam and has never registered with the PSMN, then the MES shall perform a LU to register in the current spotbeam LAI.

6.4.1.2.2 Normal MES registration

When PSMN selection is complete and a MES camps on a spotbeam; e.g., after a switch on, or after subsequent change of a serving spotbeam, the MES shall:

- a) compare the previously registered lai with the current spotbeam lai:
 - 1) if there is a match then no LU necessary;
 - 2) if the operator identities in the LAIs, i.e., SSC and SNC do not match, then perform a LU to register in the current spotbeam LAI; otherwise, go to "b" below.
- b) compare the previously registered LAC with the LACs in the current spotbeam's valid beam pair list:
 - 1) if there is a match, then the MES shall initiate the Beam Pair LU Timer with the value broadcast on the current spotbeam and proceed as follows:
 - i.) if the previously stored Single Spotbeam LAC matches the serving spotbeam LAC; i.e., the MES has not changed spotbeam, then no LU is necessary;
 - ii.) otherwise, no LU is necessary, but the MES shall store the list of valid beam pair LACs and the Single Spotbeam LAC which are broadcast on the S-BCCH of the current spotbeam; this may occur when the MES is registered with a spotbeam pair and has changed spotbeams within this pair.
 - 2) if there is no match then go to "c" below.
- c) compare the previously valid beam pair list with current spotbeam's valid beam pair list:
 - 1) if there is a match, then perform a LU to register in the matched valid beam pair LAI and initiate the Beam Pair LU Timer with the value broadcast on the current spotbeam;
 - 2) if there is no match, then perform a LU to register in the current single spotbeam LAI and clear the current value of the Beam Pair LU Timer, if it is running.

6.4.1.2.3 Timer initiated MES registration

6.4.1.2.3.1 MES beam pair LU timer handling

When a MES is camped on a spotbeam and no LU with the network is required, the MES shall initiate its Beam Pair LU Timer, with the value broadcast on the current spotbeam, whenever the registered LAC does not match the spotbeam unique LAC (see Single Spotbeam LAC in GMR-2 04.008 [24]) broadcast on the current spotbeam.

The MES shall stop the Beam Pair LU Timer, if it is running, and reset its value to zero in the following cases:

- at switch off;
- before re-initialization of the timer with the value for a new spotbeam;
- if the broadcast system parameter that governs over the duration of the timer becomes equal to zero (see GMR-2 04.008 [24]);
- after a LU procedure is performed with a Single Spotbeam LAC.

6.4.1.2.3.2 MES LU upon beam pair LU timer expiration

When the timer expires, the MES shall perform a LU to register in the (unique) LAI, i.e., with the Single Spotbeam LAC, for the current serving spotbeam.

6.4.1.2.3.3 Interaction between the beam pair LU timer and the T3212 periodic LU timer

- If both Beam Pair LU Timer and T3212 Timer LU procedures are pending (see GMR-2 04.008 [24]), then only the Beam Pair LU procedure shall be performed, and the T3212 LU procedure shall be ignored.
- After completion of a Beam Pair LU procedure, the T3212 Timer shall be reset and restarted according to the T3212 time-out value, broadcast in the current spotbeam (see GMR-2 04.008 [24]).

- If the T3212 Timer expires and a Periodic LU procedure is performed, the last registered LAC value shall be used - either a Beam Pair LAC or a Single Spotbeam LAC. The Beam Pair LU Timer shall not be impacted, if it is running.

6.4.1.2.4 MES registration at return to satellite mode of operations

If the MES leaves satellite mode of operations, e.g., for operation in terrestrial mode, then, if the MES returns to satellite mode of operations, and after the MES camps on a spotbeam, the MES shall compare the previously registered spotbeam LAI with the current spotbeam LAI:

- a) if the operator identities in the LAIs, i.e. SSC and SNC, do not match, then perform a LU to register in the current spotbeam LAI; otherwise, go to step "b" below;
- b) compare previously registered spotbeam LAC with the LACs in the current spotbeam's valid beam pair list:
 - 1) if there is a match, then perform a LU to register in the matched valid beam pair LAI and initiate the Beam Pair LU Timer with the value broadcast on the current spotbeam;
 - 2) if there is no match, then perform a LU to register in the current single spotbeam LAI.

6.4.2 Normal operations

If the MES is moving in a border area between LAIs or if the MES encounters a satellite antenna side lobe level that allows it to receive a S-BCCH from a spot beam with a different LAI, it might repeatedly change between spotbeams of different LAIs. Each change of LAI would require a LU, which would cause a heavy signalling load. To prevent this, a CELL_RESELECT_HYSTERESIS (CRH) parameter is used. A spotbeam in a different LAI is only selected if it is "better" in terms of the path loss criterion (see clause 6.6) than all the spotbeams in the current LAI by at least the value of CRH. The network broadcasts the CRH parameter on the S-BCCH. As the value of CRH broadcast may be different on different spotbeams, the CRH parameter to be used is that broadcast on the current serving spotbeam. There is also a lower limit on the time interval between reselection of spotbeams on different LAIs.

6.5 Barred spotbeams and access control

6.5.1 Barred spotbeams

The PSMN operator may decide not to allow MESs to camp on certain spotbeams. Barred spotbeam information is broadcast on the S-BCCH to instruct MESs not to camp on these spotbeams. The barred spotbeam status may in fact change dynamically; hence the MES needs to regularly check the S-BCCH system information for this parameter.

The barred status of a spotbeam depends both on CELL_BAR_ACCESS and on the spotbeam's priority indicated by CELL_BAR_QUALIFY. The effect of these two parameters is further described in GMR-2 05.008 [26].

If a spotbeam is barred, this applies both for spotbeam selection and reselection.

6.5.2 Prioritizing spotbeams

In general, spotbeam prioritization is a means of encouraging MESs to select some suitable spotbeams in preference to others. Since the priority comparison is only between suitable spotbeams, prioritization does not affect coverage. Operators may prefer a certain type of spotbeam not to be selected unless it is the only suitable type.

6.5.2.1 Spotbeam selection

During spotbeam selection (see clause 6.2.1), a spotbeam with low priority indication will only be selected if a suitable spotbeam of normal priority cannot be found.

6.5.2.2 Spotbeam reselection

Spotbeam prioritization can also be achieved during spotbeam reselection by the use of the reselection parameters optionally broadcast. Spotbeams are reselected on the basis of a parameter called C2, and the C2 value for each spotbeam is given a positive or negative offset to encourage or discourage MESs to reselect that spotbeam.

6.5.3 Access control

Due to problems in certain areas, Network Operators may decide to restrict access from some MESs (e.g., in case of congestion on the S-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 broadcast channels (together with a bit indicating whether emergency calls may be made).

This information is modified dynamically and therefore the MES has to check the broadcast channels before each attempt to access. The GMR-2 system can selectively bar channel requests (S-RACH) for the purpose of location updates or for the purpose of requesting a S-DCCH for other procedures.

The MES ignores the Access Control information when selecting a spotbeam to camp on, i.e.; it shall not reject a spotbeam for camping on because access on that spotbeam is not allowed.

6.5.4 Forbidden LAI for regional provision of service

When the MES is camped on a spotbeam, the LAI of which belongs to the list of forbidden LAIs for regional provision of service, the MES is not allowed to initiate establishment of a CM connection except for an emergency call. The MES may respond to paging.

If the MES has received the cause "LAI not allowed", it shall ignore this fact when selecting any spotbeam to camp on in "limited service state" (see clause 6.3).

6.6 Radio constraints

The MES uses a radio constraint condition in order to determine whether a spotbeam is suitable to camp on. The condition is that a control channel carrier can be found and can provide sufficient frequency and timing information so that signals received on, at least, the high margin channels of that carrier can be decoded successfully.

A MES service state when both high power and nominal power channels are decodable (Advantaged mode of operations) is distinguished by the MES from a serviced state with only high power channels decodable (Disadvantaged mode of operation) by means of the "path loss criterion" parameter C1 (see GMR-2 05.08). C1 depends on 4 parameters:

- a) the received signal level (averaged as specified in GMR-2 05.08);
- b) the parameter RXLEV_ACCESS_MIN which is broadcast on the S-BCCH, and is the minimum received signal level at the MES require for access to the system;
- c) the parameter MS_TXPWR_MAX_CCH, which is also broadcast on the S-BCCH and is the maximum power that a MES may use when initially accessing the network;
- d) the maximum RF output power of the MES.

The formula for determining C1 is given in GMR-2 05.008 [26].

For the service states mentioned above, use of the parameter C1 enables the MES to determine whether two-way communications is possible with the network in the absence of interference. However, because of the possibility of interference degrading the communications, an additional safeguard is used for both Advantaged and Disadvantaged modes. This is to monitor the success rate of the MES decoding signalling blocks on the S-BCCH channel in Advantaged mode, and on the S-HBCCCH channel in Disadvantaged mode. If there is a forward link signalling failure, i.e., the success rate drops too low, this indicates probable interference on the forward link. The service state of the MES within the current spotbeam is degraded from Advantaged mode to Disadvantaged mode, or, if already in Disadvantaged mode, a spotbeam reselection is triggered. Forward Link signalling failure monitoring is specified in GMR-2 05.008 [26].

In order to optimize spotbeam reselection, spotbeam reselection parameters can be broadcast on the broadcast channels of each spotbeam. The spotbeam reselection process employs a parameter C2 that depends on these parameters.

The parameters used to calculate C2 are as follows:

- i. CELL_RESELECT_OFFSET (see clause 6.5.2.2);
- ii. PENALTY_TIME

When the MES places the spotbeam on the list of the strongest carriers as specified in GMR-2 05.0 8 [26], it starts a timer which expires after the PENALTY_TIME. This timer will be reset when the spotbeam is taken off the list. For the duration of this timer, C2 is given a negative offset.

- iii. TEMPORARY_OFFSET

This is the amount of the negative offset described in ii.) above. An infinite value can be applied, but a number of finite values are also possible.

The permitted values of these parameters and the way in which they are combined to calculate C2 are defined in GMR-2 05.008 [26].

6.7 Limited service state

There are a number of situations in which the MES is unable to obtain normal camping and service (see clause 6.2.1) from the PSMN. These include:

- a) failure to find a suitable spotbeam;
- b) certain outcomes of LU procedures - for LU events that may trigger the MES to enter the Limited Service State, See table 7.6.4.1.

Under any of these conditions, and depending upon present MES operational mode and valid SIM, and possible user interaction, the MES may attempt to obtain service on the Terrestrial system or may attempt to camp on any acceptable PSMN spotbeam, so that emergency calls can be made if necessary. When in the "limited service" state with a valid SIM, any searching for available and allowable PSMN spotbeams shall be performed according to GMR-2 05.008 [26]. To minimize the time taken to find new available PSMN spotbeams while maintaining battery life, discontinuous search schemes may be used. No LU requests are made until a valid SIM is present and either a suitable spotbeam is found or a manual network reselection is performed. In the limited service state within GMR-2, the presence of the MES need not be known to the PSMN network. Spotbeam reselection takes place as normal, except that a zero dB value of CRH will be used.

7 Overall process structure

7.1 Process goal

The aim of the idle mode processes within satellite mode is to achieve the following conditions ("normal service state"):

- a) the MES is camped on a suitable spotbeam of the LAI on which the last successful LU was performed, and that spotbeam has the highest value of C2 for any unbarred spotbeam in that LAI;
- b) the value of C2 for the MES is not lower than the value of C2 for any suitable spotbeam in another LA of the selected PSMN by more than the hysteresis value CRH.

There may be temporary conditions under which not all these are fully satisfied, e.g., during spotbeam selection or while in the process of reselecting another spotbeam. However, if the above cannot be satisfied for a certain period of time, the MES will normally enter a "limited service state" in which it will try to camp on an acceptable spotbeam. In this state, only emergency calls are possible.

7.2 States description

Each of the processes of Public Mobile Network selection - either a satellite or a terrestrial, of spotbeam/cell selection and of location updating can be described by a set of states. The overall state of the MES is thus a composite of the states of the three processes. In some cases, an event, which causes a change of state in one process, may trigger a change of state in another process; e.g., camping on a spotbeam in a new LAI triggers a LU request. The relationship between the processes is illustrated in figure 5.1.

The states, in which the MES may reside, for each of the processes, are described below and illustrated in figures 5.2 to 5.4.

In the event of any conflict between the diagrams and the text in the present document, the text takes precedence.

7.3 List of states

7.3.1 List of states for the PSMN selection process (figure 5.2)

- | | |
|----|---|
| A1 | Trying PMN - The MES is trying to perform a Location Update on the registered PSMN. |
| A2 | Satellite mode operations / On PSMN - The MES has successfully registered on a PSMN. |
| A3 | Satellite mode operations / Trying PSMN - The MES is trying to register on a PSMN manually selected by the user. A manual PSMN search is performed in a single attempt to lock on the selected PSMN according to clause 7.4.2 - Automatic and manual PMN selection. |
| A4 | Wait for PMN to Appear - PMN is not available at present and the MES is waiting for it to appear. |
| A5 | No SIM - There is no valid SIM in the MES, or certain LU responses have been received. |
| A6 | Trying PLMN - The MES is trying to perform a location update on a PLMN. |
| A7 | Terrestrial mode operations / On PLMN - The MES has successfully registered on a PLMN. |
| A8 | Wait for PLMN to appear - PLMN is not available at present and the MES is waiting for it to appear. |

7.3.2 List of states for the spotbeam selection process (figure 5.3)

- | | |
|----|---|
| C1 | Extensive spotbeam selection - This is the process of initial spotbeam selection, searching all GMR-2 PSMN control channel carrier frequencies. |
| C2 | Short stored list spotbeam Selection - This is the process of initial spotbeam selection where MES stored spotbeam information is used. |
| C3 | Camped Normally - This is where the MES is camped on a spotbeam and may be able to make and receive calls. (Whether or not the MES can make and receive calls depends on the state within the location updating process). The MES monitors received signal level and system broadcast data and checks whether spotbeam reselection is needed. |

- C4 Normal spotbeam reselection - This is where the MES has determined that spotbeam reselection is needed and an attempt is being made to reselect a spotbeam. If the spotbeam reselection is triggered by loss of radio coverage, see clause 7.5.2, then the spotbeam reselection task shall include an attempt to select the last used spotbeam.
- C5 Select last used spotbeam - This is where the MES has returned to idle mode from connected mode and is trying to select the spotbeam it was camping on before entering connected mode. If connected mode was entered from Camped Normally state, the MES is trying to camp on the last used suitable spotbeam; if connected mode was entered from Camped On Any Spotbeam state, The MES is trying to camp on the last used acceptable spotbeam.
- C6 Any Spotbeam Selection - This is where the MES is unable to camp normally on any spotbeam of the PSMN, or cannot obtain service because of certain responses to a location updating (LU) attempt. It is searching for a spotbeam to camp on.
- C7 Camped on any Spotbeam - This is where the MES has camped on an acceptable spotbeam (bMES not "camped normally"). This a "limited service" state in which only emergency calls can be made.
- C8 Any Spotbeam Reselection - This is where the MES is attempting to reselect any acceptable spotbeam.

7.3.3 List of states for location updating (figure 5.4)

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:

- 1) IMSI unknown in HLR;
- 2) Illegal ME-MES;
- 3) 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;

- 1) PSMN not allowed;
- 2) Location area not allowed;
- 3) National 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 7.6.4.2.

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".

7.4 PMN selection process

7.4.1 Introduction

There are two modes for choosing the PMN, automatic and manual. These are described in the following clauses and are illustrated in figure 5.2. In a single satellite GMR-2 network and without other available PSMNSs, a SO or SP MES may only select the GMR-2 PSMN.

7.4.2 Automatic and manual PMN selection

7.4.2.1 Automatic PMN selection procedure

At switch on, the MES follows the following procedure depending on its operational mode

The MES selects and attempts registration on PMNs, if available and allowable, in the following order depending on current operational mode:

- Satellite Only (SO): PSMNs in a priority order as described below;
- Terrestrial Only (TO): PLMNs in a priority order as described below;
- Satellite Preferred (SP): First PSMNs and then PLMNs in a priority order as described below;
- Terrestrial Preferred (TP): First PLMNs and then PSMNs in a priority order as described below;
- the PLMN selection priority in terrestrial mode is according to the relevant technical specifications.

IN satellite mode, the MES shall try to select the last registered PSMN first, but is allowed to select the PSMN that provides the spotbeam which satisfies conditions (ii) and (iii) and has the highest possible signal level (lowest radio path loss) according to condition (iv) of clause 6.2.1.

7.4.2.2 Manual PMN selection process

In terrestrial mode of operations, manual PLMN selection and reselection procedures are performed according to the relevant technical specifications.

In satellite mode of operations, the MES shall provide user interface means for indication and selection of PSMNs in intra-system, e.g. multi satellite system, as well as an inter-satellite system environment.

7.4.2.2.1 Manual PSMN selection

In satellite mode of operations, a manual PSMN selection procedure shall allow the user to choose a PSMN from the PSMN selector list, followed by a single MES attempt to find and register on the chosen PSMN. For such attempt the MES shall ignore the contents of the forbidden LAI and PSMN lists.

Automatic PSMN selection mode is the default in satellite mode of operations, i.e. the manual PSMN selection mode is temporary and the MES shall resume the automatic mode automatically after completion of the MES attempt to find and register to the user specified PSMN.

7.4.2.2.2 Manual PSMN reselection

At any time the user may request the MES to initiate reselection and registration onto a different PSMN whereas the corresponding selection procedure depends on the current operational mode and shall be according to clause 7.4.2.

7.4.3 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 ME-MES" or "illegal MES" response to an LU request, then effectively there is no selected Mobile Network ("No IMSI" state). In these cases the states of the spotbeam selection process are such that no selection information is used. No further attempts at registration on any network are made until the MES is switched off and on again, or a SIM is inserted.

If the MES is currently served by a PSMN which does not support any service at all for MESs in the "No IMSI" state, and if terrestrial operations are allowed, the MES may try to obtain service on a terrestrial network. Switching to terrestrial mode may be co-ordinated with the user, i.e. may be subject to user approval. If the MES does not transfer to terrestrial mode of operations, it shall remain in the "No IMSI" state until switched off, or until the SIM is inserted/replaced.

When in Automatic Network Selection mode and the MES is in the "not updated" state with one or more suitable spotbeams to camp on, then after 3 minutes or 6 unsuccessful LU requests, the MES may continue (or start if it is not running) the user reselection procedure of clause 7.4.2.

7.4.4 National roaming not allowed in this LAI

While in Automatic PSMN selection mode a LU response "National Roaming Not Allowed in this LAI received from the PSMN, shall cause the MES to initiate the PSMN selection procedure according to clause 7.4.2.

7.4.5 Visited PMN (optional)

While being served by a visited PMN, the MES may periodically attempt to obtain service by its HPMN. For this purpose, a value T minutes may be stored in the SIM, where T is either in the range 6 minutes to 6 hours in 6-minute steps or indicates that no periodic attempts shall be made. If no value is stored in the SIM, a default value may be used.

If needed, the attempt may cause switching between the satellite and the terrestrial systems.

If performed at all, the attempts to access the home network shall be as specified below:

- a) the periodic attempts shall only be performed in automatic mode;
- b) after a predefined minimum time period and/or at most T minutes shall elapse before the first attempt is made;
- c) the MES shall make an attempt if the MES is on a visited PMN at time T after the last attempt;
- d) periodic attempts shall only be performed by the MES while in idle mode.
- e) if the HPMN is not found, the MES shall remain on the visited PMN.
- f) no attempts shall be made if the current operational mode indicates preferred or exclusive use of a system which is not the home system, e.g. for subscribers with HPMN in PSMN no attempts shall be made if the user has chosen (TO) or (TP) operational modes. Similarly, no attempts to access a HPMN in a terrestrial system shall be done in (SO) or (SP) operational modes.

7.5 Spotbeam selection and reselection process

7.5.1 Selection

Selection of a cell in a terrestrial network shall be done according to the corresponding technical specifications. Whenever the GMR-2 PSMN is selected, the MES attempts to find a suitable spotbeam to camp on. At least two methods of searching for a suitable spotbeam are possible:

- a) extensive spotbeam selection - this selection process utilizes all control channel carrier frequencies for the selected PSMN. It does not require any user interaction. The time duration for this process is up to 12 minutes. The activation of this method within the MES may be a subject of user control;
- b) short spotbeam selection process - stored camping information or user interaction are used to speed up the selection. The time duration for this process shall be up to 2 minutes. This method is always enabled within the MES.

If no suitable spotbeam is found using method b), method a) may then be tried.

7.5.2 Reselection

While camped on a spotbeam of PSMN ("camped normally"), the MES may need to select a different spotbeam ("normal spotbeam reselection" state). The following events trigger a spotbeam reselection:

- a) the path loss criterion parameter C1 (see clause 6.6) indicates that the path loss to the spotbeam has become too high;
- b) there is a downlink signalling failure (clause 6.6);

- c) the spotbeam camped on (current serving spotbeam) has become barred;
- d) there is a better spotbeam (in terms of the path loss criterion C2) in the same LAI (in the case of a valid beam pair), or a much better spotbeam in another LAI (using the CRH parameter clause 7.4);
- e) a random access attempt is still unsuccessful after "Max retrans" repetitions; "Max retrans" being a parameter broadcast on S-BCCH.

The MES will then reselect a new spotbeam in order to fulfill the process goal (see clause 7.1).

Before camping on the spotbeam after re-selection, the MES shall attempt to decode the full set of data of the S-BCCH. The MES shall check that the parameters affecting spotbeam re-selection are unchanged. If a change is detected, the MES shall check if the spotbeam re-selection criterion is still valid using the changed parameters. If the spotbeam selection criteria are still valid, the MES shall camp on the spotbeam. If they are not still valid, the MES shall repeat this process for the spotbeam with the next highest value of C2.

Once the MES has re-tuned to the chosen spotbeam, it shall monitor its paging subgroup (if known) for that spotbeam. If the MES receives a page before having decoded the full S-BCCH data for the new spotbeam, the MES may store the page and respond, if permitted. once the full S-BCCH data has been decoded. If not permitted, no page response shall be made.

7.5.3 Return to idle mode

When the MES leaves idle mode and enters "connected mode" (e.g., to make a call), on return to idle mode at the end of the call, a spotbeam must be chosen ("choose spotbeam" state) as soon as possible e.g., to allow a new call to be made as soon as possible. The chosen spotbeam will not necessarily be the same cell as the MES was camped on when the call started e.g., if the MES moved a significant distance while the call was in progress.

However the MES shall always try to reselect the last used spotbeam first.

The MES may use the short or the extensive spotbeam selection procedure.

7.5.4 Any spotbeam selection

During the spotbeam selection or reselection procedures if no suitable spotbeam is found, the MES attempts to find an "acceptable spotbeam" on which it may camp so that emergency calls may be made ("any spotbeam selection" task). In the "any spotbeam selection" task The MES ignores the PSMN information when selecting an acceptable spotbeam, and no attempt at location updating is made. This task may also be entered if a PSMN LU reject is received with one of the following cause values (for general MES actions as a result of LU responses, see table 7.6.5.1):

- a) "LAI no allowed"; "illegal MES";
- b) "National roaming not allowed";
- c) "PSMN not allowed.

If an acceptable spotbeam is found, the MES camps on it ("Camped on any spotbeam" state). If a suitable spotbeam is found, the MES camps on it ("Camped Normally" state).

If one of the spotbeam reselection trigger events a) to c) above occurs, the MES attempts to find a new acceptable spotbeam to camp on ("any spotbeam reselection" state) by using a zero dB value of CRH. If no acceptable spotbeam can be found, the "any spotbeam selection" task is re-entered.

If while camped on an acceptable spotbeam, an emergency call origination is made, the MES enters a connected mode end at the end of the call, chooses the last used acceptable spotbeam so that it is ready for the next emergency call origination.

7.6 Location updating process

The terrestrial LU procedures are described in the corresponding technical specifications.

7.6.1 General

When the MES is switched on in satellite mode of operations, the action taken by the location updating process is as follows:

- a) SIM present and no LU needed (because of the status of the stored LAI): The MES is in the update state UPDATED;
- b) SIM present and LU needed: A LU request is made;
- c) no SIM present: The MES enters the update state Idle, NO IMSI. See also clause 7.4.5.

In case b) 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 7.3.3 above.

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

7.6.2 Initiation of location updating

A LU request indicating Normal Location Updating is made in GMR-2 when, in idle mode:

- the MES changes spotbeam while being in the update state NOT UPDATED;
- the MES detects that it has entered a new location area,(i.e., when the received LAI differs from the one stored in the MES and the stored LAI is not on the received list of valid beam pairs), and the LAI or GMR-2 is not contained in a list of forbidden LAIs or PSMN identities respectively, while being in one of the following update states:
 - UPDATED;
 - NOT UPDATED;
 - ROAMING NOT ALLOWED.
- the Periodic Location Updating Timer expires while being in the update state NOT UPDATED;
- a manual network reselection has been performed, an acceptable GMR-2 spotbeam is present, and the MES is not in the UPDATED state on ACeS;
- after the MES has switched from a terrestrial to the satellite network and in order to make the MES known to the satellite system;
- the Beam Pair LU Timer expires while being in the update state UPDATED or NOT UPDATED.

All types of registration attempts may be disabled in GMR-2 by the means of broadcasted system data.

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.

Table 7.6.4.2 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 7.6.4.1.

See also clause 6.4.1.2.

7.6.3 Periodic location updating

A timer with the following characteristics shall be implemented in the MES (for interaction with the Beam Pair LU Timer, see clause 6.4.1):

- a) upon switch on of the MES or when the broadcast channel 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 time-out value and started;
- b) the time-out value shall be within the range of 1 deci-hour to 255 deci-hours with a granularity of 1 deci-hour;
- c) when the timer reaches its expiration value, it shall be initiated with respect to the broadcast time-out value, and the MES shall initiate Periodic Location Updating;
- d) 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 time-out value, then started. Thereafter, the procedure in c) shall be followed;
- e) when a change in the broadcast time-out value occurs (at a change of serving spotbeam or a change in the broadcast time-out value), the timer shall be reloaded so that the new time to expiration will be: "old time to expiration" modulo "new broadcast time-out value".

7.6.4 LU - related MES operations in satellite mode

The effects of different LU outcomes are described in table 7.6.4.1. Table 7.6.4.2 summarizes allowed MES actions and events in each state that trigger a new LU request.

Table 7.6.4.1: The effect of LU outcomes on GMR-2 registration

Location Updating Task State	Registration Status	GMR-2 Registration is
Updated	Successful	Indicated in the stored LAI
Idle, No IMSI	Unsuccessful	No registration in GMR-2
-IMSI unknown in HLR		
-Illegal MES		
-Illegal ME		
Roaming not allowed	Unsuccessful	No registration in GMR-2
-PSMN not allowed	Intermediate	No registration in GMR-2
-LAI not allowed	Intermediate	No registration in GMR-2
-National Roaming not allowed in this LAI		
Not updated	Unsuccessful	No registration in GMR-2

If a LU is rejected with one of the clauses a) to c) above, the MES shall consider any present SIM invalid until replaced or switched off. If operations in terrestrial mode are not allowed, the MES may try to obtain limited service in terrestrial mode in order to be able to make emergency calls, see clause 7.4.5.

If a LU is rejected with one of the causes d) to f) above, the MES shall attempt to find a different PSMN, for events d) and f), or a new suitable spotbeam for event e) to camp on. If no PSMN or no suitable spotbeam can be found, the MES shall enter the "Any Spotbeam Selection" task as described in clause 7.4.5.

Table 7.6.4.2: Satellite mode - LU process states and allowed actions

Location Updating Task State	New LU Request when			Normal Calls Supported (note 1)	Paging Responded to
	Changing LAI	Changing PSMN	Other		
Null (note 4)	Yes	Yes	No	No	No
Updated	Yes	Yes	(notes 2 and 6)	Yes (note 1)	Yes
Idle, No IMSI	No	No	No	No	No
a) IMSI unknown in HLR					
b) Illegal MES					
c) Illegal ME					
Roaming not allowed					
a) Idle PSMN not allowed	No	Yes	No	No (note 1)	Optional if with IMSI
b) Idle LAI not allowed	Yes	Yes	No	No (note 1)	Optional if with IMSI
c) Idle, National roaming not allowed in LAI	Yes	Yes	No	No (note 1)	Optional if with IMSI
Not updated	Yes	Yes	(notes 2, 3 and 6)	(notes 3 and 1)	Yes if with IMSI
NOTE 1: Emergency calls may always be made, subject to valid SIM and 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 spotbeam and either made an LU attempt or decided that no LU attempt is needed.					
NOTE 5: Not Used.					
NOTE 6: A LU is made when the Beam Pair LU timer expires.					

7.7 Service indication

This is an indication to the user that GMR-2 service is available. The service indication should be set if the following conditions is satisfied:

- Camped On a suitable spotbeam and in updated state, or in connected mode having been camped on a suitable Spotbeam.

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

7.8 S-BCCH allocation broadcasting and storage

The S-BCCH allocation is the list of S-BCCH carriers in use by GMR-2 in a given geographical area. (It indicates the RF channels that the MES is required to monitor while camped on a GMR-2 spotbeam.) It is broadcast in the system information messages on the broadcast channels, and is referred to as the neighbour spotbeam frequency list.

When the MES is switched on in GMR-2, and has no knowledge of which RF channels are the local control channel carriers, it has to search the strongest RF channels in order to find which are control carriers. Once it has found a GMR-2 control channel, it can read the neighbour spotbeam frequency list. It then knows which RF channels to monitor for spotbeam selection and reselection purposes.

While switched on in GMR-2, the MES can gain knowledge of the preferable carriers to use in subsequent spotbeam selections in GMR-2. This knowledge may come from previously transmitted system data information.

When the MES switches off, it has the option of storing the last known spotbeam frequency information in a non-volatile memory so that on a subsequent switch on it can use the information to camp on a spotbeam more quickly. If the spotbeam frequency information is stored in a SIM GSM directory, it shall be stored in the format specified in GSM 11.11. Any other information used by the MES during spotbeam selection shall be stored in a non-volatile memory on the ME-MES.

The neighbour spotbeam frequency list) may or may not be the total list of S-BCCH carriers in use throughout the GMR-2 coverage area. For example there may be variations in different geographical areas.

Stored spotbeam frequency data is not necessarily valid when the MES is switched on again e.g., if the system operator has made a change or if the MES is switched on in a different geographical area. In these cases, the MES may not find a suitable spotbeam for camping on using the stored data. However, the MES may use other stored information to find a suitable spotbeam before searching all the strongest RF channels to find a suitable PSMN spotbeam.

7.9 Page-ability 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, see (GMR-2 05.002 [25]), when the following conditions are all satisfied:

- a SIM is inserted;
- the MES is camped on a spotbeam;
- the MES is not in state "Idle, No IMSI".

NOTE: The MES will not necessarily be pageable in the following circumstances:

- during spotbeam reselection there is a certain period when the MES is no longer camped on the old spotbeam but must decode the full set of broadcast messages before camping on the new spotbeam;
- after switching systems, e.g., at inter-system roaming, if not and until properly registered in the new PMN;
- in the cases described in GMR-2 05.008 [26] clauses 6.2.4 and 6.4.4.1.

7.9.1 GMR-2 alerting modes

GMR-2 provides two types of alerting to the MES for notification of incoming calls. Normal alerting via the Satellite Paging Channel (S-PCH) for fixed terminals and a high margin alerting via the Satellite High Penetration Alerting Channel (S-HPACH) for mobile terminals. Fixed terminals shall always listen to the S-PCH and mobile terminals shall always listen to the S-HPACH.

In order to receive alerting messages of any kind in a GMR-2 spotbeam, the MES must:

- a) be registered in the PSMN; and
- b) have performed a LU for the LAI of the spotbeam (or valid beam pair) in which the page is to be sent.

If a) and b) above have been satisfied, then the MES may be switched off, and then back on in the same spotbeam, and receive either type of page (as required) without having to re-register.

7.9.1.1 HPA operations between HPA message receipt and MES access attempt

The MES shall receive HPA messages by listening to the appropriate HPA sub-group as determined by a function (defined in GMR-2 05.02 [25]) of the SB_HPA_EXT_RES parameter and the subscriber IMSI stored on the SIM card.

Upon decoding a HPA message containing the subscriber's IMSI, the MES shall initiate a HPA operations countdown timer with initial value set to the parameter HPA_TIMER broadcast on the S-BCCH and:

- a) the MES shall set on an alarm which is uniquely identifiable as notification of receipt of a HPA message;
- b) the MES may provide a means of allowing the subscriber to acknowledge an HPA alarm notification;
- c) if the HPA alarm is acknowledged within the HPA operations countdown, then the MES may withhold automatic transmission of the S-RACH message, in response to the HPA receipt and alarm acknowledgement, until advantaged signalling conditions are achieved. The transmission of the HPA response shall be indicated to the user;

- d) if the HPA operations countdown timer expires prior to a HPA acknowledgement or without any transmission of a random access message, then:
- 1) the MES shall set off the HPA alarm, if still on, and notify the user that the HPA operations are terminated;
 - 2) the MES shall automatically return to idle mode "Camped Normally" state.

8 Dual-mode GMR-2/AMPS special operations for single number routing

GMR-2/AMPS dual mode phone single number routing is accomplished in the GMR-2 network by manual use of "call forward" supplementary services. No automatic action is required to take place by the MES, the GMR-2 network or the AMPS Network.

8.1 Void

8.2 Void

8.3 Void

History

Document history		
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