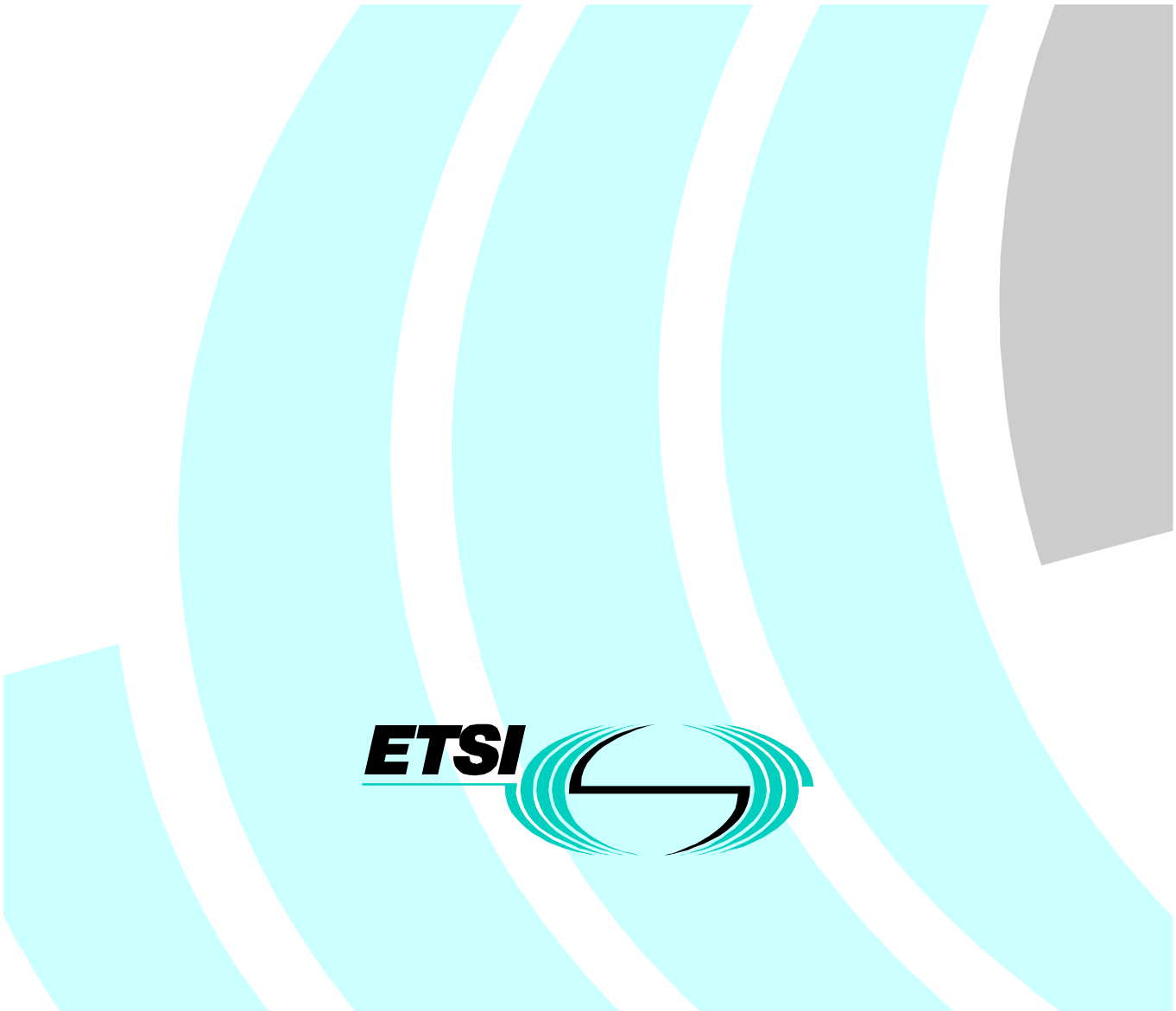
ETSI TS 101 376-3-19 V1.1.1 (2001-03)

Technical Specification

GEO-Mobile Radio Interface Specifications;
Part 3: Network specifications;
Sub-part 19: Optimal Routing technical realization;
GMR-1 03.297



Reference
DTS/SES-001-03297

Keywords
GMR, GSM, GSO, interface, MES, mobile, MSS,
radio, satellite, S-PCN

ETSI

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
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

The information pertaining to essential IPRs is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://www.etsi.org/ipr).

The attention of ETSI has been drawn to the Intellectual Property Rights (IPRs) listed below which are, or may be, or may become, Essential to the present document. The IPR owner has undertaken to grant irrevocable licences, on fair, reasonable and non-discriminatory terms and conditions under these IPRs pursuant to the ETSI IPR Policy. Further details pertaining to these IPRs can be obtained directly from the IPR owner.

The present IPR information has been submitted to ETSI and pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

IPRs:

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
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

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 101 376 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	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
The Keytech Centre, Ashwood Way
Basingstoke
Hampshire RG23 8BG
United Kingdom

Contact: John Watson
Tel.: +44 1256 864 821

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 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 101 376 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-argin 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

IPR Owner: Lockheed Martin Global Telecommunications, Inc.
900 Forge Road
Norristown, 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:

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 19 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 contains the technical realization of the Optimal Routing (OR) function within the GMR-1 Mobile Satellite System. The present document specifies:

- The operational requirements for the mobile satellite OR functionality
- The functional requirements on a network nodal basis
- The functional requirements for the MES

The purpose of mobile satellite OR is to reduce the number of PLMN and PSTN call legs required to complete a call using the mobile satellite system.

The OR function for mobile satellite systems consists of the following:

- Mobile Origination Gateway Selection. This gateway feature enables the selection of a gateway station and subsequent reregistration within that gateway station to minimize the PSTN/PLMN terrestrial network usage or facilitate MES-MES single-hop calls.
- Mobile Termination OR. This network feature enables calls to be routed directly to the mobile subscriber's actual location or to his/her forwarded-to destination while minimizing the use of network trunks.

The present document addresses the system approach for mobile-originated gateway selection. Mobile termination OR is addressed in detail in GSM 02.79 [7] and GSM 03.79 [8] (not addressed in the present document).

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 03.022 (ETSI TS 101 376-3-10): "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".

[4] GMR-1 03.296 (ETSI TS 101 376-3-18): "GEO-Mobile Radio Interface Specifications; Part 3: Network specifications; Sub-part 18: Terminal-to-Terminal Call (TtT); GMR-1 03.296".

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

[6] 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".

[7] GSM 02.79: "Digital Cellular Telecommunications System (Phase 2+); Support of Optimal Routing (SOR); Service Definition, Stage 1 (GSM 02.79 V5.1.0)".

[8] GSM 03.79 (ETSI TS 101 045): "Digital cellular telecommunications system (Phase 2+); Support of Optimal Routeing (SOR); Technical realization (GSM 03.79 version 5.2.0)".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in GMR-1 01.004 [1] and the following apply. The following definitions are expressed within the context of optimal routing.

Authorized Roamer: subscriber whose PLMN is present in roaming agreements at the GS to which the subscriber is attempting to reregister. Similarly, an Unauthorized Roamer is a subscriber who is denied service at the requested GS due to the absence of a roaming agreement between the subscriber's home PLMN and the GS to which the subscriber is trying to reregister.

Cooperating PLMN: PLMN to which an HLR query (SRI/ATI/SRI-SMS) may be composed from the GS for the purpose of OR. Similarly, a Non-Cooperating PLMN is a PLMN to which an HLR query by the GS is prohibited.

BCCH Carrier: RF carrier that carries the FCCH and BCCH. The BCCH carriers may be reused within the system as long as the spot beams in which they are reused are neither overlapping nor immediately adjacent to one another.

Broadcast Control Channel (BCCH): carries control information specific to a particular Gateway Station, plus synchronization information by which an MES can locate other BCCHs within the system. There is a unique BCCH for every Gateway in every spot beam.

Gateway Operator: administrative entity that manages a GS and its resources

GS (Gateway Station): network entity connected to the terrestrial network that allows network access to and from a user terminal

Local Gateway Station: GS to which the MES registers when not governed by optimal routing concerns. The selection of the local GS is done as described in GMR-1 03.022 [3].

Optimal Gateway Station: GS that will reduce the number of PLMN and PSTN call legs required to complete a call using the mobile satellite system

PRN (Provide Roaming Number): MAP procedure used to obtain a routing identifier from a VLR. This procedure is initiated by the HLR to complete the SRI procedure.

RA (Roaming Agreements): defined relationship between PLMNs and GMR-1 networks allowing subscribers in one network to register and use resources within another network

Radio Resource Sharing Agreement: established relationship between gateway operators such that the radio spectrum allocated to a specific GS may be negotiated and used by another GS on a call-by-call basis

Roaming Agreement: agreement between Gateway Providers permitting the subscriber to receive service in an area outside of his or her Gateway Provider's service area

SRI (Send Routing Information): MAP procedure used to determine the current registration location of a mobile subscriber and used in mobile terminated calls

3.2 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	GeoMobile Radio interface
NPI	Numbering Plan Identifier

NSS	Network Switching Subsystem
OR	Optimal Routing
TON	Type of Number
VMSC	Visited Mobile Switching Center

4 Feature description

4.1 Overview

Mobile-originated OR enables the MES to gain access to a gateway station closest to the terminator's current location in an MES-PSTN, MES-PLMN or MES-MES call. This access results in minimizing the network interconnections required to complete the call. The terminator's home network is considered optimal in the absence of subscriber location information. Additionally, mobile origination gateway selection OR provides supporting logic for the MES-MES single-hop call model described in GMR-1 03.296 [4].

For OR, the home network of the PSTN subscriber is the network designated by the country code (CC) and network destination code (NDC) of the called party number. The home network of a PLMN user is considered to be the network identified by the CC and NDC of the terminator's MSISDN number.

4.2 Sequence summary

A high-level summary of the signalling sequence of optimal routing is given in figure 4.1. The figure illustrates the sequence of initial access, gateway selection, mobile origination and reregistration back to the local GS. Note that a routing query to the terminator's HLR is not used in the PSTN termination case.

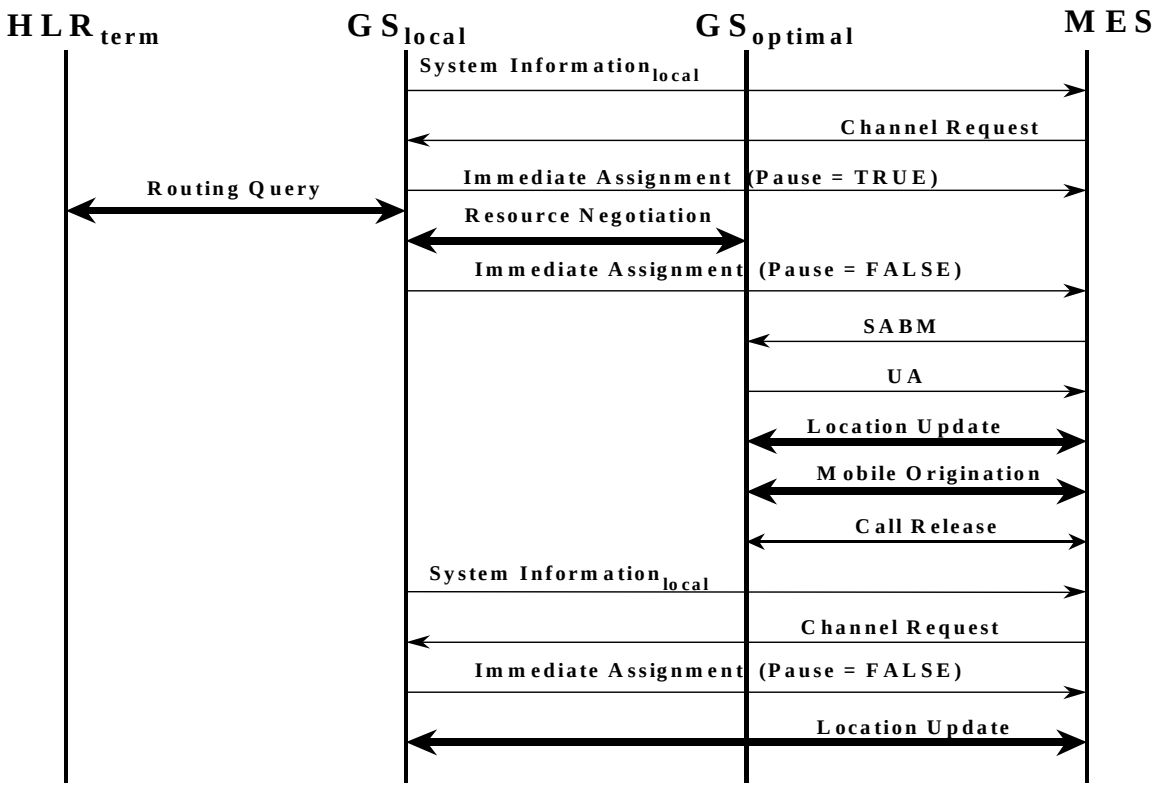


Figure 4.1: Optimal routing sequence

The following sequence provides a description of the steps used in OR. The numbering denotes a sequence and should not be used in a one-to-one correlation with the preceding figure.

1) Mobile origination is initiated by the user within the MES. When a called party address is formed and an MM-session is initiated, the RR sublayer within the MES shall compose and send the Channel Request (CR) message on a RACH. This channel is determined by the BCCH upon which the MES is camped, subject to forbidden spot beam considerations (see GMR-1 03.022 [3]). The Channel Request message shall contain the information necessary to perform the gateway selection procedure. This information includes the calling subscriber's service provider ID (encoded as MCC and MNC), the NPI, the TON, the calling subscriber's GPS position, and the called party digits of the terminating address.

   The Extended Immediate Assignment procedure is required if all of the information needed for OR is not received correctly in the first Channel Request.

2) The GS shall evaluate whether the OR is to be applied according to the results of the dialled digit analysis and permission checking upon receipt of the Channel Request message.

   If the OR is to be applied and there will be a considerable delay involved in the procedure, an Immediate Assignment message will be returned to the MES indicating (Pause Indicator IE = TRUE) that network delays may exceed the timer T3126. If the MES receives an Immediate Assignment message with the Pause Indicator IE set to TRUE, then the timer T3126 is stopped and the MES timer T3115 (pause timer) is started. A second Immediate Assignment message is then expected prior to expiration of T3115. If the GS cannot complete the GS selection procedure within the allotted time, then the local GS should be selected as the optimal GS and the GS should proceed with the call.

   The network may send a single Immediate Assignment message with the Pause Indicator IE set to FALSE to the MES after the GS selection procedure if the OR is to be applied and there will be only minimal delay in the procedure.

   The gateway selection algorithm selects the local GS when the OR is not to be applied. A single Immediate Assignment message with the Pause Indicator IE set to FALSE is sent and the call proceeds at the local GS.

3) If the OR is to be applied, then the HLR interrogation may be required to determine the MSC where the terminating MES is currently registered. The optimal GS is selected based on the result of the HLR query and the operator-configured data (or operator-configured data alone). Permission shall be checked for each optimal GS selected. The permissions shall include position-based access permission, roaming permission, and radio resource sharing permission.

4) A second Immediate Assignment message (Pause Indicator IE = FALSE) is sent to the MES from the local GS upon completion of the GS selection procedure. This message indicates that a reregistration of the subscriber to the optimal GS is to be performed using a location update procedure with a follow-on CM session.

5) The MES establishes the Layer 2 link with the optimal GS. The SABM frame does not contain a complete Layer 3 message. The data field of the SABM frame will contain the mobile identifier for contention resolution. The Unnumbered Acknowledgment frame from the GS establishes the link.

6) The Location Update Request message is then sent in by the MES. This message starts the Location Update procedure at the optimal GS and causes the subscriber's registration information to move from the local VLR to the optimal GS VLR. The registration of the subscriber in the local GS is assumed because the SIM card insertion lets the GMR-1 network know about the subscriber's presence within the GMR-1 network.

7) The mobile-originated call proceeds at the optimal GS.

8) The MES may initiate reregistration back to the local GS upon the conclusion of the mobile-originated call. The local GS is chosen via MES idle-mode procedures (outlined in GMR-1 03.022 [3]). The Immediate Assignment procedure is used to gain access to the system to accommodate the new dedicated connection.

Additional details of the procedures used by the GS and MES are given in clauses 4.2.1 and 4.2.2 respectively.

4.2.1 Optimal route gateway selection

The gateway selection procedure selects an optimal GS that provides the shortest terrestrial route based on the configuration provided by an operator. The procedure includes the following activities:

- Dialled digit analysis;
- Selecting the optimal GS; and
- Checking permission.

The information provided in the Channel Request, the NPI, the TON, and the called party digits shall be used to determine the type of called party, PSTN user, PLMN user or GMR-1 user before an optimal GS can be selected. The type of procedure to be performed for gateway selection is dependent upon the type of call.

- For an MES to cooperating PLMN call: an optimal GS is selected by interrogating the HLR in the PLMN to determine the MSC where the terminating MES is currently registered.
- For an MES to GMR-1 MES call: an optimal GS is selected by interrogating the GMR-1 HLR.
- For an MES to PSTN call or an MES to noncooperating PLMN call: an optimal GS is selected based on operator-configured data.

The HLR address is determined using the SCCP MSISDN Global Title analysis on the MSISDN of the called party for HLR interrogation. This information is contained in the Channel Request.

The CC + NDC is mapped to a GS that will provide a minimal routing path from the GMR-1 network to the terminating exchange for an MES-PSTN call or an MES to noncooperating PLMN call.

The ATI/SRI-SMS capability of the terminating subscriber's HLR is assessed and the appropriate MAP procedure is initiated for a cooperating PLMN or GMR-1 exchange. If the ATI procedure is supported at the initiating GS and at the subscriber's HLR, then its use is preferred for better performance.

The ATI or SRI-SMS response is checked to determine whether the terminating subscriber is registered at a GS within the GMR-1 system. If the subscriber is registered, then the call is TtT (see GMR-1 03.296 [4]) and the optimal GS is the GS where the terminating subscriber is registered. If the terminating subscriber is not registered within the GMR-1 system, then the optimal GS is determined by digit analysis, performed in the same manner as for PSTN and noncooperating PLMN calls.

The following permissions shall be checked for every optimal GS selected:

- access permission to the optimal GS against the calling MES's position;
- the Calling MES's roaming permission at the optimal GS; and
- radio resource sharing permission between two GSs involved in the optimal routing. A radio resource sharing agreement between two GSs allows the use of the radio resource allocated to one GS by the other and vice versa.

If any one of the three permissions is violated, another GS candidate shall be chosen. After an optimal GS is selected that passes all permission checking, dedicated resources are allocated from the local GS resource pool and transferred to the optimal GS and the Immediate Assignment procedure proceeds as mentioned in previous clause.

The GS selection algorithm may select the terminator's home network as the optimal gateway if the HLR query results in a VMSC address unsupported in roaming agreements.

The algorithm will default to the local GS if a suitable optimal GS cannot be found or if an error occurs in optimal gateway selection.

4.2.2 RR connection and MM session behaviour at the MES

Because the characteristic behaviour of optimal routing introduces requirements regarding the behaviour of the MM Session in the MES, a description of the MES internal functionality is provided by the present document. The sublayer interaction within the MES is described in figure 4.2.

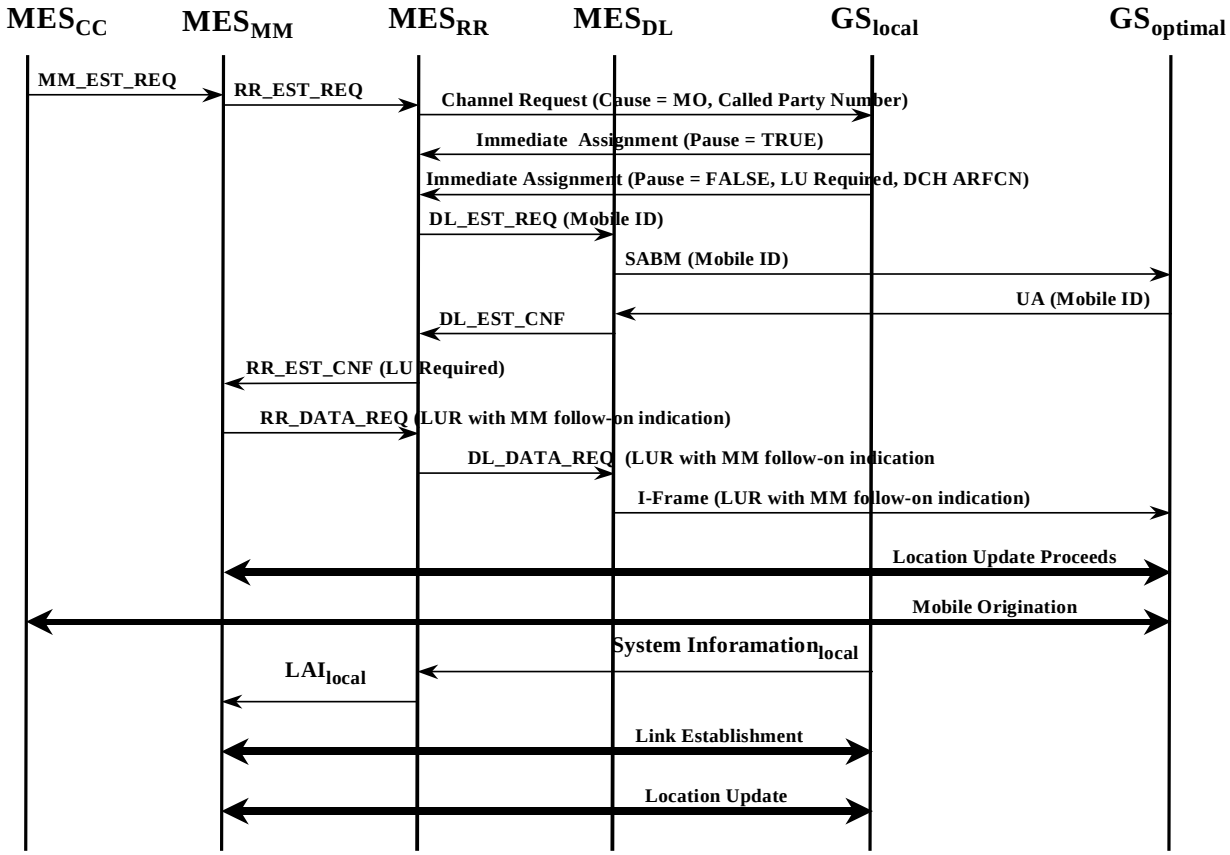


Figure 4.2: MES Internal primitives for reregistration

1) The MM sublayer initiates an MM session by composing a CM Service Request and invoking the RR_EST_REQ primitive to RR.

2) The RR sublayer builds and sends the Channel Request message on the RACH dictated by the spot beam/LAI upon which the MES is currently camped.

3) The local GS returns an Immediate Assignment message indicating that the pause timer is to be used.

4) The local GS sends an Immediate Assignment message when the optimal GS has been calculated. This message indicates that the location update with a follow-on MM session is to be performed by the MES along with the dedicated radio channel specification. The Immediate Assignment message indicates that the spot beam selection and current LAI are to be stored for use in subsequent reregistration through the value of the "MES requires reregistration" flag.

5) The RR sublayer within the MES invokes the DL_EST_IND primitive to the data layer. The mobile identifier is passed as a parameter.

6) The SABM frame from the MES to the optimal GS includes the mobile identifier for contention resolution.

7) The Unnumbered Acknowledgment frame from the GS establishes the dedicated link.

8) The data link sublayer in the MES reports a successful data link establishment to the RR.

9) The RR sublayer in the MES then notifies the MM sublayer that a Location Update is required. The LAI of the optimal GS is not known at the MES.

10) The MM sublayer in the MES initiates a follow-on Location Update procedure at the optimal GS via the RR_DATA_REQ primitive.

11) The RR sublayer in the MES passes on the Layer 3 payload via the DL_DATA_REQ primitive.

12) The DL sublayer in the MES passes on the Layer 3 payload via the I-frame.

13) The follow-on Location Update procedure executes to completion.

14) The indicated LAI of the optimal GS is placed in the SIM upon successful reregistration of the MES subscriber at the optimal GS. If a Location Update Reject is returned, then the MES shall not store a value in the "forbidden LAI" or "forbidden PLMN" list and the MES Idle-mode procedure attempts reregistration at the local GS.

15) The mobile origination uses the existing RR connection in a manner consistent with the GSM follow-on MM session procedures.

16) The MES returns to its idle-mode procedure upon call completion. It detects that the LAI value stored in its SIM is not equivalent to that broadcast on the BCCH and so it initiates the PLMN selection procedures as outlined in GMR-1 03.022 [3].

17) The MES may initiate a Location Update to the local GS without going through the PLMN selection algorithm.

18) Additionally, the "MES requires reregistration" flag value in the Immediate Assignment message may be used to initiate the reregistration procedure. It is assumed that the MES can store the current LAI when the flag is read.

4.2.3 Reregistration with local GS after call completion

The MES is notified that reregistration is required via the "PLMN_reregistration_required" flag in the Immediate Assignment message during the initial access. Upon receipt of the "PLMN_reregistration_required" flag, the MES may store the flag value, the current BCCH ARFCN and the current LAI within the MES. If, upon call completion, the value indicates that reregistration is necessary, then the stored BCCH will be retuned and a Location Update shall be performed. The MES will perform a location update at the next available opportunity when a break in communication is encountered. If a SIM card is removed, then the stored value of the "PLMN_reregistration_required" flag within the MES is purged.

The MES may use the stored BCCH and LAI values or it may perform its idle-mode procedure to evaluate the spot beam upon which to perform the Location Update procedure upon completion of the optimally routed call.

Optionally, the LAI (upon which the MES is camped at the initiation of the OR call) may be retained by the MES for later reregistration at the OR call completion. If this option is implemented, then position-based service considerations that were established through a previously unsuccessful registration attempt will be retained by the MES. Only the BCCH carrier, the flag value and the LAI are stored. The CCCH organization shall be reread from the BCCH before the Location Update procedure may be attempted.

If the location update cannot complete due to SIM-card removal or MES power-off, then the location of the subscriber (stored by the HLR) remains set to the optimally routed GS until the SIM successfully reregisters. If the MES loses communication with the network, then the subscriber's registration remains at the optimally routed location. When a SIM card has been removed while in camp on-paging mode, the SIM is considered detached by the network and all termination attempts will be reflected as such by the HLR.

4.3 Legal interception

Legal interception is administered by the network switching system. Because optimal routing can move a subscriber's registered location, the distribution of the intercepted data in the network shall accommodate the possibility of roaming.

4.4 Multiple satellite operation

The GS may optimally route a call to a GS located on a different satellite within the same GMR-1 system. To redirect a call to the new satellite, the GS shall send an Immediate Assignment Reject (IAR) with Reject Cause = "Redirect to new satellite". This IAR shall include the new BCCH carrier to be used for RACH access and the MSC ID for the optimal GS. Note that the optimal GS need not be the GS operating the new BCCH.

When the MES receives IAR, it shall not go into idle mode to perform spot beam selection or PLMN selection. The MES shall acquire the new BCCH from the new satellite and repeat the Channel Request on the RACH channel with the R-bit set to 1. The Channel Request shall include the MSC ID provided by the local GS to the MES in the IAR or Extended IAR. The GS may use the MSC ID to determine the optimal routing for the call. The GS shall not redirect the MES to another new satellite when the R-bit is set to 1. Call routing and processing on the new satellite shall otherwise proceed as with a single satellite except that the MES shall always register on the new GS, even if no further optimal routing is performed.

The MES shall attempt to retune to the original BCCH on the original satellite upon call completion.

If the redirect to the new satellite ends in failure anytime before the MES receives an Immediate Assignment message or Immediate Assignment Reject message from the new satellite, the MES shall return to the original BCCH on the original satellite and shall repeat its RACH attempt with the R-bit set to 1 and the O-bit set to 1.

If the MES is unable to register at the optimal GS, clause 4.6.3 applies. The MES may return to the original satellite and reaccess the RACH, in which case it shall set the O-bit to 1 and set the R-bit to 0.

Figure 4.3 shows a sequence of events in an optimal routing procedure for two satellite cases with three GSs involved.

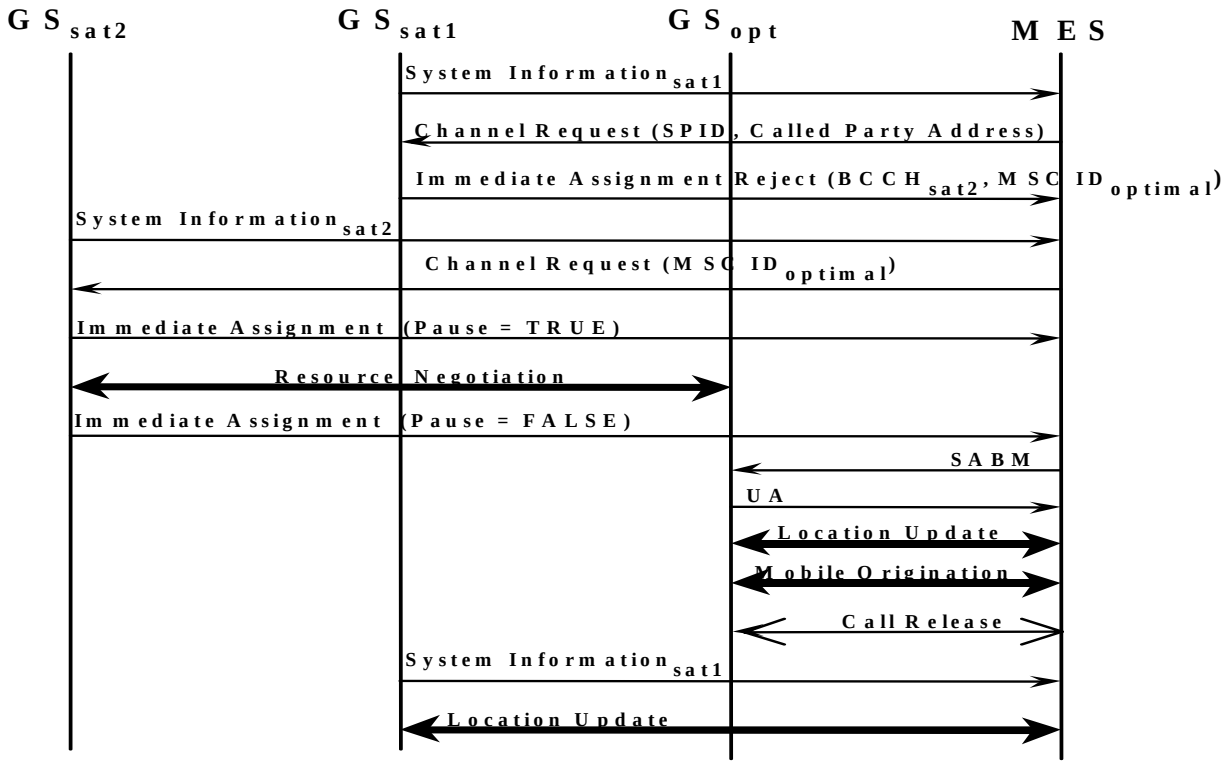


Figure 4.3: OR Procedure with two satellites and three GSs involved

4.5 Resource negotiation procedures

Although resource negotiation procedures are not directly addressed by the present document, some notice of the relevant points in call should be made. Three procedures have been identified which require communication between the GSs to support radio resource negotiation for an optimally routed call's operation. They are:

- Initial Assignment;
- Dedicated Channel Change;
- Connection Release.

The local GS shall provide a radio frequency specification allocated from its resource pool to the optimal GS during Initial Assignment. Permissible delays on the GS to GS communication shall be such that the Extended Immediate Assignment procedure can execute without failure due to excessive delay.

New resources shall be obtained from the resource pool of the local GS during a Dedicated Channel Change. The request for a new resource may be initiated by the optimal GS or by the local GS. The radio frequency specification is provided by the local GS within a suitable time frame so that the air interface assignment may proceed. Figure 4.4 illustrates this procedure.

Examples of a Dedicated Channel Change requiring radio resource negotiation include the assignment initiated from the A interface, the handover initiated by the local GS and the handover initiated by the optimal GS. The local GS may initiate handover due to frequency allocation schedule changes or due to interference conditions.

The local GS shall be notified that the resource previously in use by the optimal GS is now free for use by another connection during Connection Release.

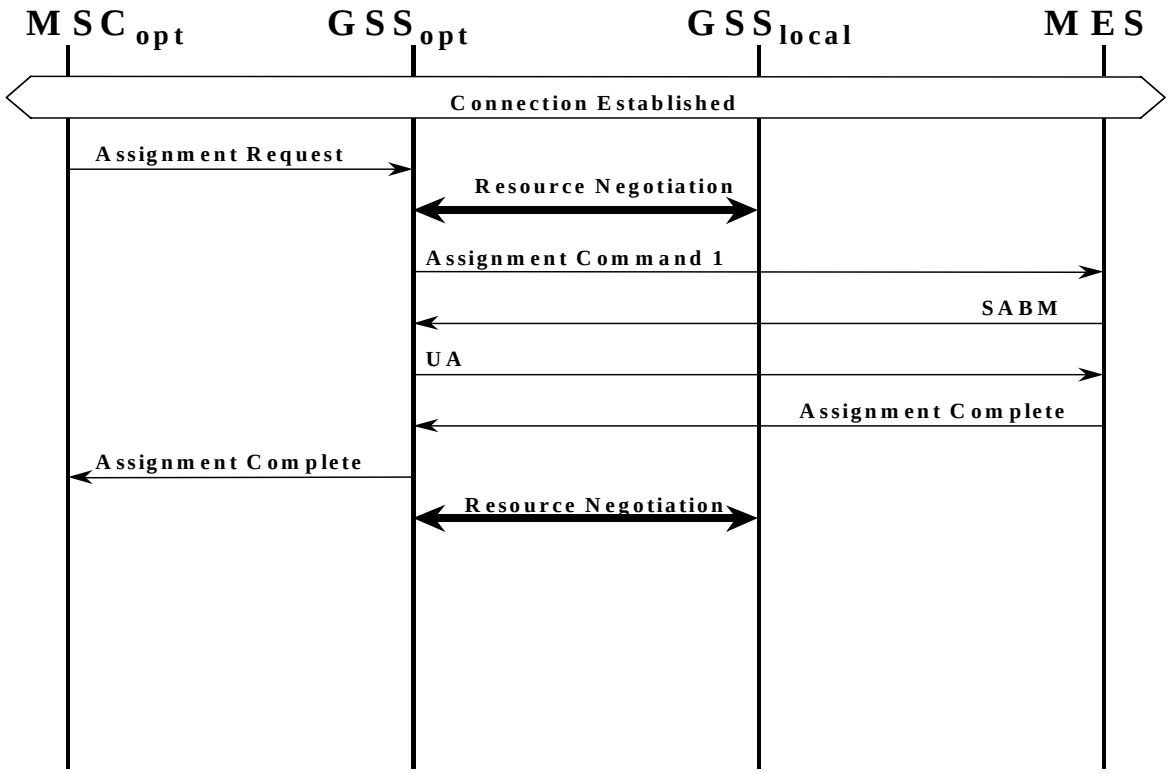


Figure 4.4: Resource negotiation as the result of assignment

4.6 Exceptional conditions

4.6.1 Routing response indicates call handling procedures

The GS may process the SRI, ATI or SRI-SMS response to provide functionality beyond the results obtained from a single routing query. The GS is not required to do so, thereby allowing call handling to be performed by the terminating VMSC. The gateway selection implementation may select to resolve upon the local MSC when the routing dialogue results in call handling procedures.

The GS may process the routing response to evaluate the "No Roaming Number Allocated" condition. When this occurs, the gateway selection routes the call to the local MSC.

4.6.2 Glare conditions

When the MES is trying to originate a call and the Paging message is received, then the Paging is ignored (see Reference GMR-1 04.008 [6]) In GMR-1 when a call is attempting to terminate on the MES due to routing information received earlier, then that call will not terminate on the MES. This situation can occur when a PSTN call routes to a particular GS/MSC due to an SRI response. The MES then initiates an OR call onto another gateway (VMSC-B). The terminating call will proceed on VMSC-A as though no response to paging was received.

This case illustrates that a window of time exists during which mobile-terminating calls can be routed to the incorrect VMSC. This condition can arise in a traditional GSM, but does so rarely.

4.6.3 Location update rejected at optimal gateway station

Roaming considerations make it possible for the VMSC or HLR to trigger the return of a Location Update Reject in response to the MES's attempt to Location Update at the optimal GS.

The optimal GS may deny permission to the subscriber's request to roam into its network at the point of MAP_UPDATE_LOCATION message composition to the originating subscriber's HLR in certain network operational conditions. Additionally, the originating subscriber's HLR may deny the subscriber the ability to roam into the selected VMSC during the MAP_UPDATE_LOCATION message processing.

A call may be established at the local GS or terminated when the registration for optimal routing is denied at the optimal GS. The MES shall resend the Channel Request to the local GS by setting the "O" bit in the RACH request to "1" to indicate to the network that the OR attempt for the same service request previously failed. The network should use this information on the next attempt to set up the connection. This process is illustrated in figure 4.5.

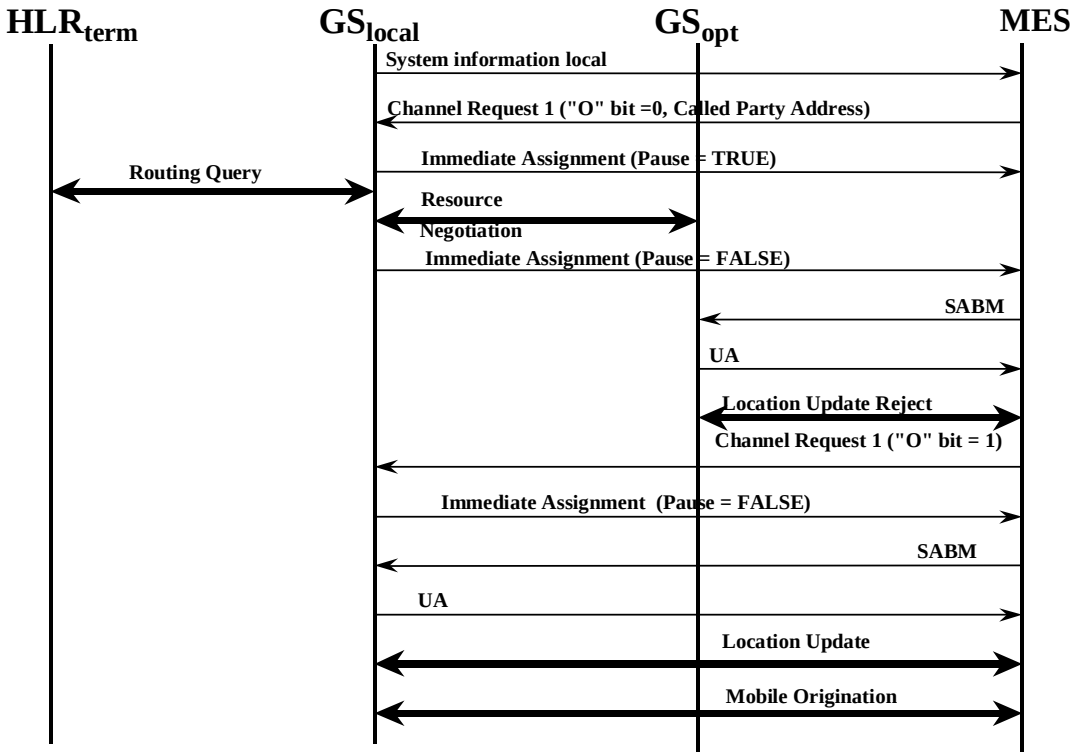


Figure 4.5: Location update rejected at optimal GS

Because the MES is unaware of the LAI of the optimal GS at the initiation of the dedicated link, cause codes returned in the Location Update Reject message should not be acted upon as described in Reference GMR-1 04.008 [6].

The possible returned cause codes are defined by Reference GMR-1 04.008 [6]. The MES will try to originate the attempted call at the local GS for all cause codes returned. Because the LAI of the optimal GS is not known at the MES, the cause values of #11 (PLMN not allowed), #12 (Location Area not allowed) and #13 (national roaming not allowed in this location area) will not modify the "forbidden PLMN" list, the "forbidden list for regional provision of service" nor the "forbidden location areas for national roaming" list.

4.7 Interactions of optimal routing with supplementary services

4.7.1 Call forwarding

The GS may provide analysis of the SRI response to preclude selection of a GS which will result in a CFU or CFNRea (detached) invocation. The GS is not required, however, to do provide this analysis.

No additional constraints are placed upon the CFB, the CFNRep and the CFNRea (paging) due to optimal routing.

4.7.2 Barring of Outgoing International Calls

Barring of Outgoing International Calls (BOIC) may be administered on a national basis at the (GS). National-level barring can be enforced at the GS by performing a comparison between the provisioned CC (at the serving GS) and the dialled CC. This refers to the optimal GS and not to the subscriber's GS as is often used in the scenarios in GSM 02.79 [7]. When an MES-A originates a call to MES-B at VMSC-B, the GS digit translation detects that this call would go to a country code that is barred at a national level.

Subscriber-level barring shall be enforced at the HLR (not the GS), as is normally supported by GSM. This means the NSS shall take the call through called-party analysis before barring can be applied. It is not possible for the GS to perform this digit analysis because the gateway does not have the subscriber's identity.

5 Functional requirements

5.1 Functional behaviour of NSS elements

5.1.1 Functional behaviour of VMSC-A

The functionality of VMSC-A is identical to that discussed in GSM Phase 2 with the exception of the following requirements:

- VMSC-A shall contain STP functionality to transfer the GS originated HLR query.
- VMSC-A shall maintain the interception list for the entire PLMN-A authorized interceptions.

5.1.2 Functional behaviour of VLR-A

The functionality of VLR-A is identical to that discussed in GSM Phase 2.

5.1.3 Functional behaviour of GMSC

The functionality of GMSC is identical to that discussed in GSM Phase 2.

5.1.4 Functional behaviour of HLR

The functionality of HLR is identical to that discussed in GSM Phase 2 with the exception of the following requirement:

- HLR shall provide a means for the GS operator to assess whether the ATI message is supported. (This allows configuration of the GS on an HLR-specific basis.)

5.1.5 Functional behaviour of VMSC-B

The functionality of VMSC-B is identical to that discussed in GSM Phase 2 with the exception of the following requirement:

- The MSC in the terminating GS shall be capable of allocating an MSRN to be used for routing purposes without requiring its subsequent use as an address within its routing system to support the GS initiated SRI query.

5.2 Functional behaviour of GS elements

5.2.1 GS digit translation

The functionality of the GS Digit Translation is identical to that discussed in GSM Phase 2.

- The GS shall be capable of evaluating whether a mobile-originated call has dialled PSTN or MSISDN digits.
- The GS shall be capable of evaluating whether ATI or SRI MAP procedures are applicable in the event of MSISDN dialled digits.
- The GS shall be capable of analyzing the PSTN dial plan to evaluate the CC for which the PSTN-terminated calls will be optimally routed.
- The GS shall be capable of analyzing the MSISDN formats for all CC+NDC combinations for which mobile-terminated calls will be optimally routed.
- The GS shall be capable of analyzing a minimum of one SRI response or one ATI response. The SRI and ATI procedures may be repeated if the result returned is that the CFU or CFNrea (detached) is active.

5.2.2 Roaming agreements

Partial dialling plans for each country handled shall be uniquely discernible in the case of the PSTN. Sample roaming agreement tables are shown in table 5.1 and table 5.2.

Table 5.1: Sample GMR-1/PLMN/PSTN roaming agreements table

Index	Originator's Gateway Provider	Gateway Providers operating within the GS closest to terminator's VMSC/PSTN exchange	Comments
1	MCC_a + MNC_a	MCC_b + MNC_b	A subscriber administered by GP_A can roam into a service areas supported by GP_B
2	MCC_a + MNC_a	MCC_c + MNC_c	A subscriber administered by GP_A can roam into a service areas supported by GP_C
3	MCC_b + MNC_b	MCC_a + MNC_a	A subscriber administered by GP_B can roam into a service areas supported by GP_A

Table 5.2: Sample radio resource sharing agreements table

Index	Spot beam GS	Roaming GS	Comments
1	GS_a	GS_b	GS_a allows GS_b to use its allocated spectrum
2	GS_a	GS_c	GS_a allows GS_c to use its allocated spectrum

The tables presented here are for the purposes of illustration only and are not intended to convey preference to a particular implementation.

The GS shall be capable of provisioned control of the routing information.

5.2.3 HLR query

SRI shall be used when the destination HLR is not supporting ATI. The ATI response is a single VLR number, from which the GS can be determined. The SRI response is a full routing information structure containing MSRN which will produce a unique MCC and MNC upon analysis.

- The GS shall be capable of discerning whether the SRI/PRN, SRI-SMS, ATI, or no query procedure is supported by the terminating subscriber's HLR.

5.3 Functional behaviour of MES

The MES shall initiate a subsequent location update procedure to the local GS at the conclusion of the optimally routed call.

The MES shall be capable of initiating a Location Update procedure to an OR GS without knowing the LAI of the GS to which it is attempting to register.

The MES shall be capable of initiating a data link layer connection without carrying Layer 3 payload.

The MES shall be capable of interpreting the pause indicator in the Immediate Assignment message such that timers T3126 (refer to clause 4.2) and T3115 (refer to clause 4.2) are supported.

The MES shall support position-based services as described in Reference GMR-1 03.299 [5].

History

Document history		
V1.1.1	March 2001	Publication