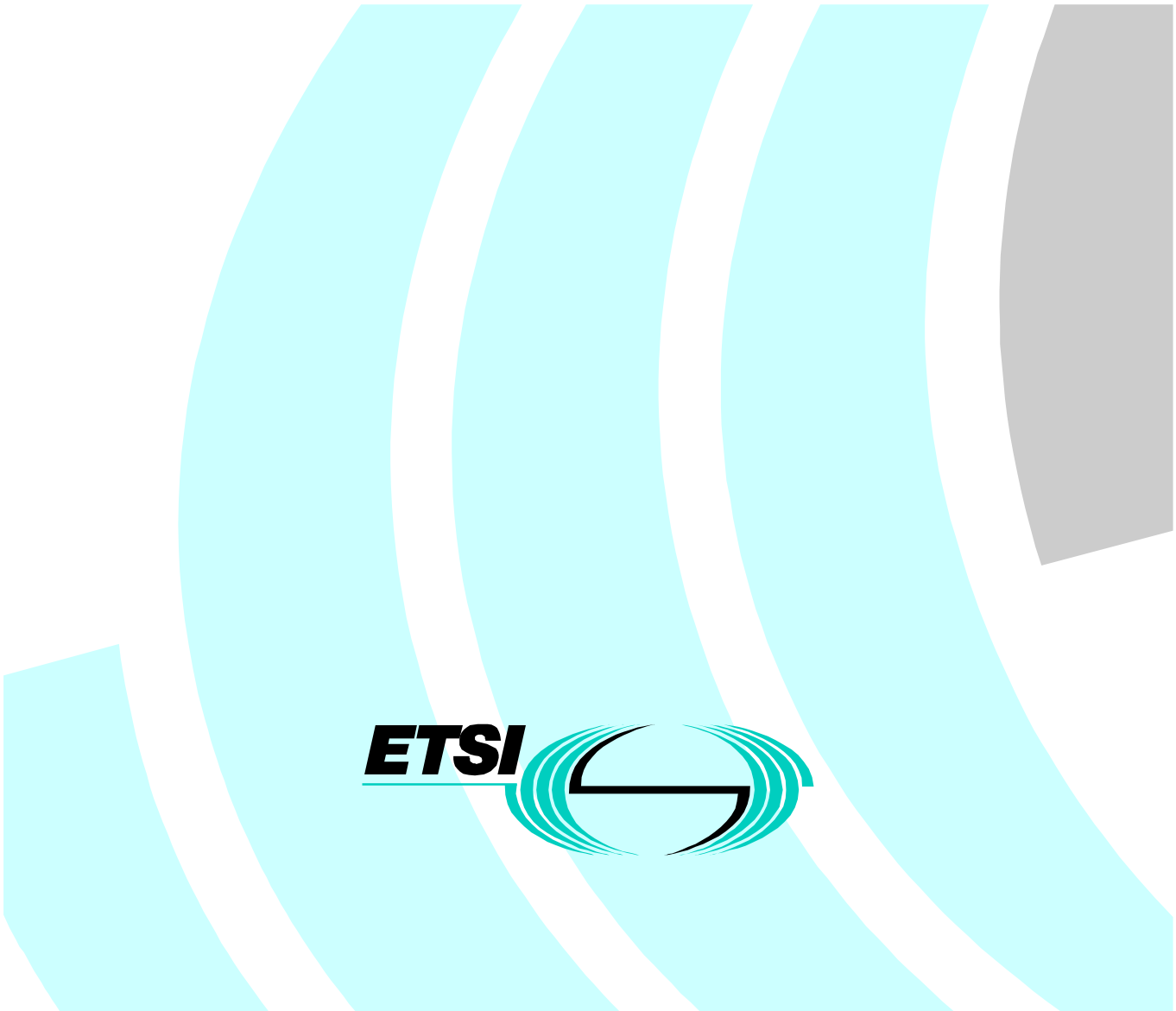
ETSI TS 101 377-1-3 V1.1.1 (2001-03)

Technical Specification

GEO-Mobile Radio Interface Specifications;
Part 1: General specifications;
Sub-part 3: GMR-2 General System Requirements;
GMR-2 01.202



Reference
DTS/SES-002-01202

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

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

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IPRs:

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
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
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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
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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
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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 ThroughputCellular 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

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Foreword

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

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

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- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
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The present document is part 1, sub-part 3 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications, as identified below:

Part 1: "General specifications";

Sub-part 1: "Abbreviations and Acronyms; GMR-2 01.004";

Sub-part 2: "Introduction to the GMR-2 family of specifications; GMR-2 01.201";

Sub-part 3: "GMR-2 General System Requirements; GMR-2 01.202";

Part 2: "Service specifications";

Part 3: "Network specifications";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications";

Part 6: "Speech coding 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 specifies the general system requirements to be used in the GMR-2 system

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-2 01.004 (ETSI TS 101 377-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and Acronyms; GMR-2 01.004".

3 Abbreviations

For the purposes of the present document, the abbreviations given in GMR-2 01.004 [1] apply.

4 General introduction to the GMR-2 system

4.1 Overview and system elements

The GMR-2 system provides voice, data, fax, and supplemental communication services between mobile and fixed/mobile users and worldwide connectivity through public and private switched telecommunications networks. Mobile communication services are provided in a large regional coverage area, defined by the orbital location of the geosynchronous satellite and satellite payload performance. The connectivity is provided by the satellite and fixed ground equipment, whose main elements are gateways and network control centre. Examples are now given for the typical mobile coverage area, the system elements, and subscriber connectivity.

The mobile coverage area defines where mobile services are provided. Subscribers located anywhere in this area have full use of system services. Figure 4.1.1 shows an example coverage area that includes a portion of the Middle East, India, China, and Southeast Asia. The area is covered by a single C-band feeder-link beam for communication between the satellite and the ground equipment. The same area is covered by a large (140 in this example) number of L-band user-link spotbeams for communication between the satellite and the user terminals of the subscribers. As shown in the figure, the feeder-link and user-links also carry signalling information in addition to traffic communication.

The spotbeams are highly focussed beams, providing signal concentration and making possible communication with a small handheld user terminal. Additionally, the spotbeams play the role of cells in a GSM system, allowing frequency reuse, while limiting interference between spotbeams using the same frequencies.

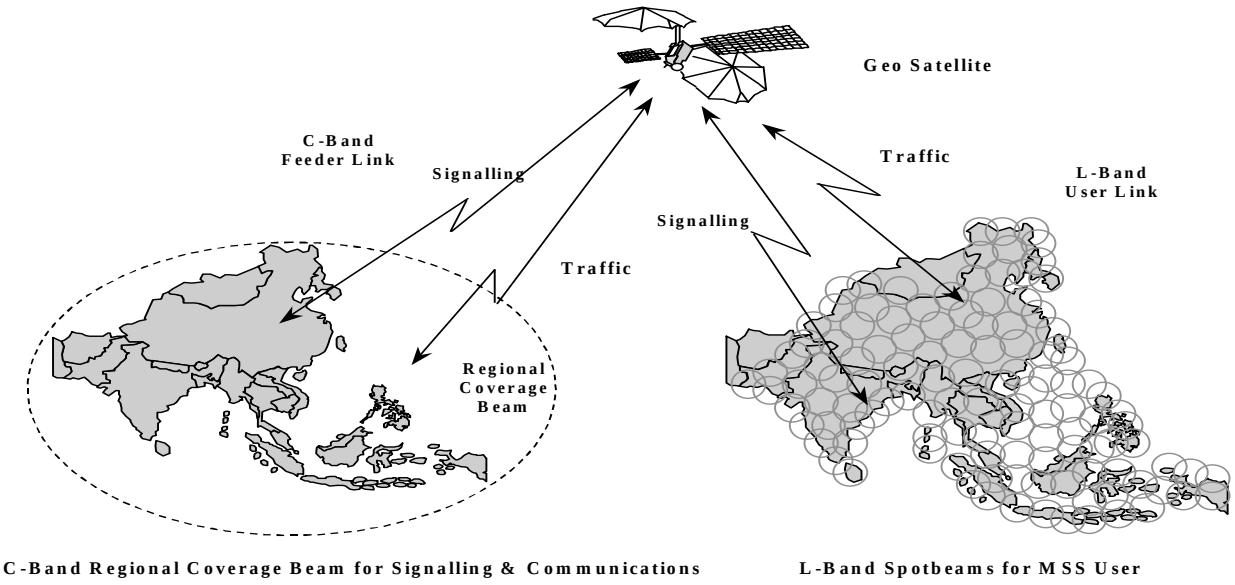

Figure 4.1.1: Mobile Coverage region of an example system

Figure 4.1.2 shows the various system elements, including a geostationary satellite, a Network Control Centre (NCC), a Satellite Control Facility (SCF), a Customer Management Information Centre (CMIS), a number of Gateways, and a large number of user terminals, referred to as Mobile Earth Stations (MES) in the GMR-2 specifications. The user terminals (MES) include handsets, vehicle-mounted terminals, and fixed terminals. The Gateways have external interfaces to existing fixed telecommunications infrastructure, namely PSTN, PN and PLMN.

From a functional point of view, the Gateways implement the radio modem functions of the terrestrial BTS, the radio resource management functions of BSC and switching functions of MSC, along with databases for subscriber data. These are shown in figure 4.1.3.

An example of traffic and signalling channels connectivity is shown in figure 4.1.4. Two-way connectivity (of traffic and associated signalling) between a user terminal and fixed network subscriber uses L-band and C-band links to the satellite. Access to fixed telecommunications networks takes place through the Gateway. Fixed network connectivity includes the Public Switched Telephone Network (PSTN), Public Land Mobile Networks (PLMNs), and private networks (PN). Broadcast and Common control signalling channels are provided by the NCC and are used during initial call set up.

A single hop user-to-user traffic link through the satellite uses L-band links. Call control for user-to-user circuits are performed by the NCC, Gateways, and by switching on the satellite, to achieve single-hop connectivity.

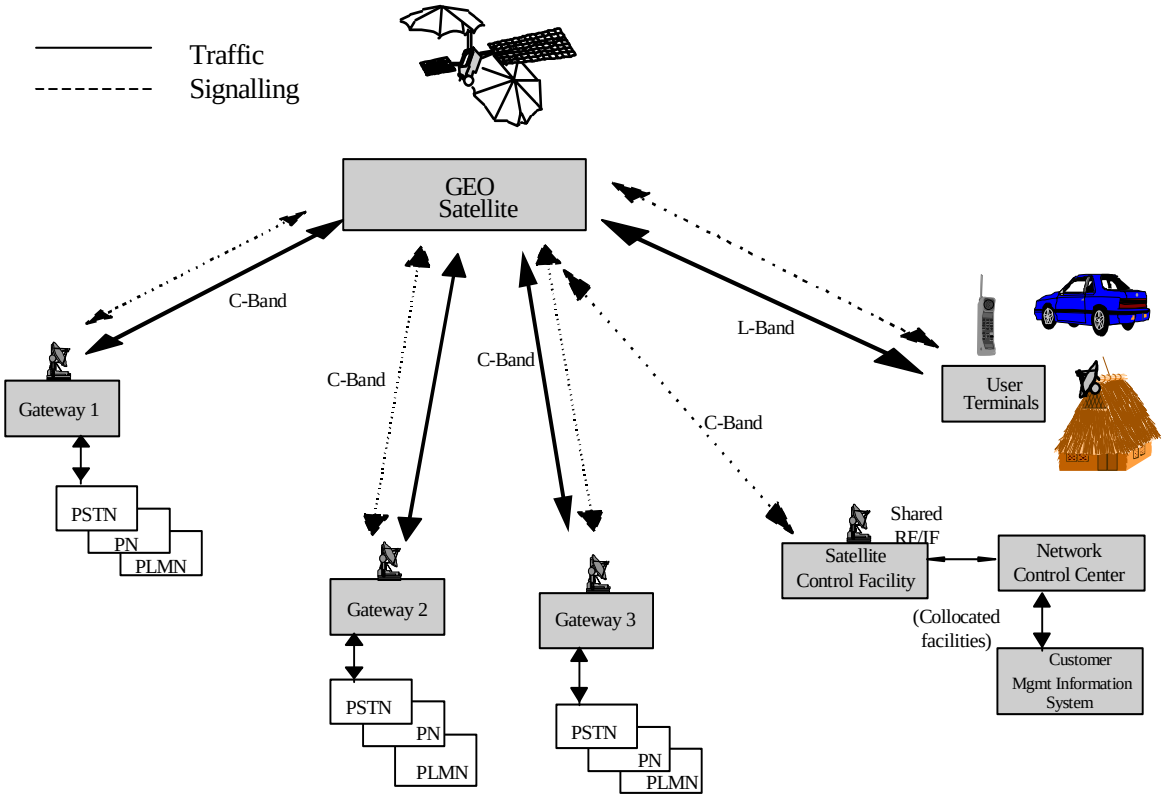

Figure 4.1.2: System Elements

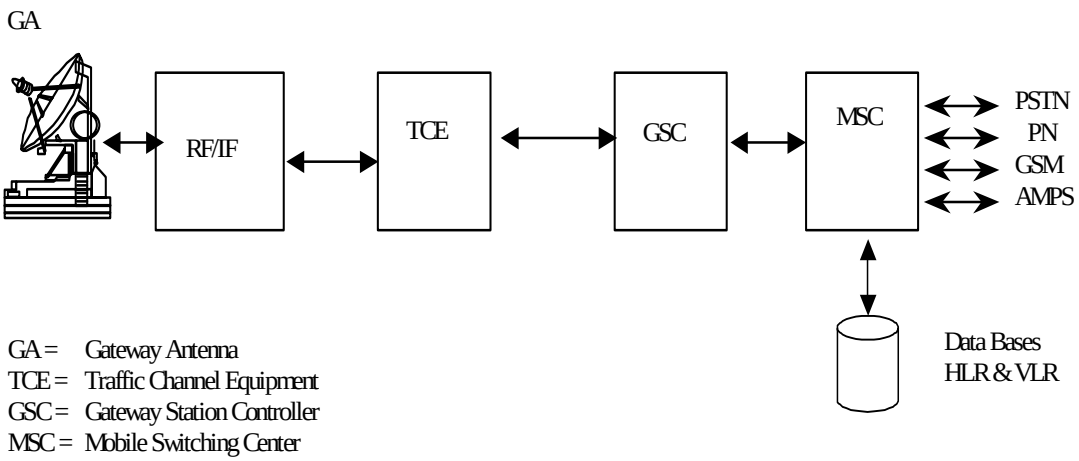

Figure 4.1.3: Gateway Internal structure

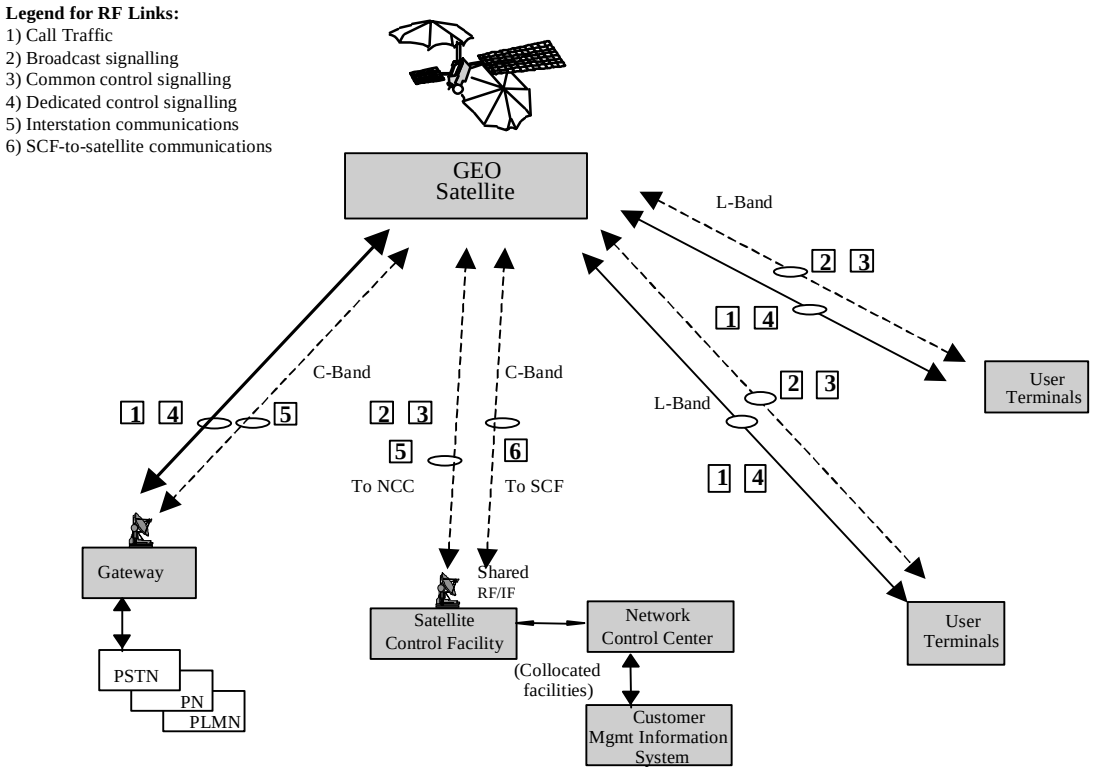

Figure 4.1.4: Connectivity in a GMR-2 system

4.2 Comparison to Terrestrial Cellular Systems such as GSM

There are a number of similarities and differences between a terrestrial cellular system such as GSM and GMR-2. They are as follows.

Similarities:

1) Spotbeams in the GMR-2 system play the role as cells in GSM.
2) Both GMR-2 and GSM exploit a frequency reuse concept.
3) Layers above the physical layer in both GMR-2 and GSM are very similar to each other.

Differences:

1) Geosynchronous Satellite: The distance between the user terminals and the Gateways in a GMR-2 system (user terminal to satellite + satellite to gateway) is much larger than the distance between user terminals and the Base Stations in GSM. This fact has several consequences:
   a) large attenuation of radio signals;
   b) large propagation delays in GMR-2 systems compared to GSM systems.
2) Propagation Delay: The large propagation delay in GMR-2 systems has several consequences:
   a) impact on conversational dynamics in voice communications;
   b) increased annoyance due to echoes in the system;
   c) a need for a single hop connection for a mobile-to mobile-voice call;
   d) impact on handshake protocols such as Fax protocol T.30;
   e) impact on System Timing Synchronization.

3) Spotbeam Size: Spotbeams in a GMR-2 system are much larger than cells in GSM. This leads to several consequences:

   a) reduced benefits from frequency reuse;

   b) larger variation of propagation delay across a spotbeam compared to the variation across a cell, necessitating sophisticated timing synchronization schemes;

   c) reduced need for inter-spotbeam handovers.

4) Satellite Power: In GMR-2 systems, the satellite power is a system resource that is shared by all the spotbeams in the entire coverage region. In contrast, in GSM systems, the power of a BTS is not shared directly between various cells. Thus, system power control is needed in GMR-2 systems.

5) Link Margins: Due to the fact that satellite power is shared, forward (from satellite-to-user terminal) link margins are low in GMR-2 systems compared to GSM systems. Due to the fact that the user terminal signals are highly attenuated, (because of the large distance between the user terminal and the satellite) the return (user terminal-to-satellite) link margins are low compared to GSM.

6) Line-of-Sight operation: Due to the high attenuation of radio signals, it is necessary to require line-of-sight operation for GMR-2 systems. In other words, radio communication is not possible using multipath signals alone, as it is possible in GSM systems. If the user is not in line-of-sight with the satellite, then the user is said to be in a disadvantaged situation or mode.

7) User co-operation: Due to the fact that line-of-sight is required in GMR-2 systems, the user has to co-operate for Mobile Originated calls. If the user is in a disadvantaged mode, then Mobile Terminated calls cannot be established. This leads to special alerting procedures, that alert the user of an incoming call, following which the user has to co-operate by moving to an advantaged location.

8) Radio Channel characteristics: Due to the assumption of a line-of-sight with the satellite, the radio channel has a Ricean characteristic rather than a Rayleigh characteristic, as in GSM systems.

9) Interference: The interference from adjacent cells in a GSM system is primarily due to transmitted power and cell size. In GMR-2 systems, the interference from adjacent spotbeams is due to power and sidelobe characteristics of the satellite antenna array producing the multiple spotbeams.

10) Network Architecture: In a GMR-2 system, a user terminal located anywhere in the coverage area can access any of the Gateways (entry points into the fixed network), whereas in a terrestrial cellular system, a given cell can access only one particular MSC.

11) Optimal Call Routing: In GMR-2 system, a Mobile Originated (M0) call can be routed to a gateway that is nearest to the called party, thereby minimizing the cost of the landline connection. In GSM systems, such optimization is not possible.

12) Doppler Shift: During the initial period of operation of the GMR-2 system, the satellite is typically in an inclined orbit (approximately 3 degrees for about 3 years). During this period, the satellite exhibits periodic motion with respect to user terminals and causes considerable Doppler shift even for fixed user terminals.

4.3 Functional description of system elements

Table 4.3.1 shows the top-level functions performed by each of the system elements given in the previous figure. Beacon receive terminals, described at the bottom of the table, are part of beam congruency operations. The example GMR-2 system uses separate L-band transmit and receive antennas and the Beam congruency system ensures that the corresponding beams are aligned on the ground.

Table 4.3.1: System Elements and Functional Descriptions

System Element	Functional Description
NCC, Network Control Centre	Network Management: Develop call traffic profiles; Manage system resources and network synchronization; Provide Operations & Maintenance functions; Manage inter-station signalling links; Perform congestion control; Provide support in user terminal commissioning. Call Control: Perform common channel signalling functions; Manage Gateway selection for mobile origination; Define payload configurations;
GW, Gateway	Manages dedicated signalling and traffic channels; Provide connectivity to external fixed networks; Perform mobility management; provide interoperability with AMPS and GSM; Provide authentication and encryption services; Assign frequencies/slots & map traffic channel equipment to beams; Provide support in user terminal commissioning.
SCF, Satellite Control Facility	Satellite Control: Generate & distribute satellite ephemera; Generate and transmit commands for payload & bus & receive and process telemetry; Transmit beam pointing commands for congruency; Generate and transmit commands for inclined orbit operations; Perform range calibration and real-time ranging; Call Control: provide real-time switching for mobile-mobile calls.
Satellite	Receive & implement payload and bus commands; Collect, process, and transmit telemetry & payload configuration data; Implement real-time switching for mobile-to-mobile calls.
CMIS, Customer Management Information System	Maintain Gateway configuration data; Perform system billing and accounting; process call detail records;
User Terminal	Receive broadcast, paging, and access grant data; Perform call request, authentication, and encryption functions; Provide SIM capability; Transmit & receive two-way voice communication; Transmit DTMF signalling messages from handheld and vehicle phones over an established voice link; Provide interface for data and fax; Support commissioning procedures.
Beacon Receive Terminals	Receive forward beacons; Perform beam congruency measurements;

5 Features of the GMR-2 System

5.1 GSM Roaming

The GMR-2 system supports GMR subscribers roaming to GSM networks with their SIM card assuming appropriate roaming agreements are in place, and the participating networks can support MAP protocols.

The GMR-2 system also supports non-GMR GSM subscribers roaming to GMR-2 with their SIM card, assuming that appropriate roaming agreements are in place, and the participating networks can support MAP protocols.

5.2 Single number routing

The GMR-2 system provides the capability to support dual mode GMR-2/GSM stations with automatic routing to a single number.

The GMR-2 system also provides the capability to support dual mode GMR-2/AMPS stations with automatic routing to a single number.

5.3 Optimal MO-Call Routing

The GMR-2 supports optimal routing of MO calls, such that the landline segment of the end-to-end connection is minimized. During call set-up, the NCC determines the gateway which is closest to the called PSTN terminal and assigns the call to that gateway. This procedure minimizes the landline costs of 'long-haul' calls.

5.4 Single-Hop Mobile-to-Mobile Voice Calls

Due to the large propagation delay, voice calls from a GMR-2 user to another GMR-2 user are implemented using switching on the satellite. This makes the connection a single hop connection and minimizes the end-to-end propagation delay.

5.5 Handovers

Due to the large size of the spotbeams, handovers from one spotbeam to another spotbeam are not necessary and are not implemented. However, intra-spotbeam handovers to different frequency, time slot and/or error correction coding assignments are supported to improve circuit quality in cases of local interference or blockage.

5.6 Satellite Power Control

Due to the fact that satellite power is shared among all the spotbeams of the GMR-2 system, a global power optimization is performed.

6 Features of Handheld User Terminals

6.1 General Features

1) Hand-held MES interface and performance are selected to minimize complexity and physical size of the MES.

2) The antennas for the hand-held MES provide essentially hemispheric coverage through a combination of antenna field-of-view and proper Hand-held MES orientation.

3) The handheld MESs may be implemented as dual mode devices, which can be operated in either cellular or GMR-2 mode.

6.2 Functional Features

1) The MES may typically be equipped to:

   a) set-up and answer voice calls;

   b) set-up and answer data calls;

   c) set-up and answer facsimile calls;

   d) use the Voice Service Features;

   e) provide responses required as a result of commissioning procedures;

   f) transmit DTMF signalling messages from the hand-held MES for external purposes over an established voice link.

2) The hand-held MES automatically conducts all power-up and shutdown operations. It automatically conducts all required signalling and supervisory functions necessary to set-up, maintain or disconnect a call. It automatically responds to commissioning and other system control directives.

3) The hand-held MES may have self-test capabilities that detect and inhibit improper operation. It inhibits all transmissions unless it is properly receiving a signalling channel or a communications channel.

4) The signalling channel and communications channel design facilitate the ability of the hand-held MES to recover properly from signal fades and dropouts.

6) The hand-held MES supports transmission and reception with voice activation.

7) The hand-held MES supports power control of its transmissions under the management of the GMR-2 system.

History

Document history		
V1.1.1	March 2001	Publication