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Technical Specification

GEO-Mobile Radio Interface Specifications (Release 1);
Part 5: Radio interface physical layer specifications;
Sub-part 1: Physical Layer on the Radio Path:
General Description;
GMR-1 05.001

Reference

RTS/SES-00215-5-1

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Contents

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Foreword

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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 5, sub-part 1 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications (Release 1), as identified below:

Part 1: "General specifications";

Part 2: "Service specifications";

Part 3: "Network specifications";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications";

Sub-part 1: "Physical Layer on the Radio Path: General Description";

Sub-part 2: "Multiplexing and Multiple Access; Stage 2 Service Description";

Sub-part 3: "Channel Coding";

Sub-part 4: "Modulation";

Sub-part 5: "Radio Transmission and Reception";

Sub-part 6: "Radio Subsystem Link Control";

Sub-part 7: "Radio Subsystem Synchronization";

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.

The present document is part of the GMR Release 1 specifications. Release 1 specifications are identified in the title and can also be identified by the version number:

- Release 1 specifications have a GMR-1 prefix in the title and a version number starting with "1" (V1.x.x.).
- Release 2 specifications have a GMPRS-1 prefix in the title and a version number starting with "2" (V2.x.x.).

The GMR release 1 specifications introduce the GEO-Mobile Radio interface specifications for circuit mode mobile satellite services (MSS) utilizing geostationary satellite(s). GMR release 1 is derived from the terrestrial digital cellular standard GSM (phase 2) and it supports access to GSM core networks.

The GMR release 2 specifications add packet mode services to GMR release 1. The GMR release 2 specifications introduce the GEO-Mobile Packet Radio Service (GMPRS). GMPRS is derived from the terrestrial digital cellular standard GPRS (included in GSM Phase 2+) and it supports access to GSM/GPRS 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. This GMR number has a different prefix for Release 2 specifications as follows:

- Release 1: GMR-n xx.zyy.
- Release 2: GMPRS-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 is an introduction to the 05 series of technical specifications for the GMR-1 Mobile Satellite System. It is not of a mandatory nature, but consists of a general description of the organization of the physical layer with reference to the technical specifications where each part is specified in detail. It introduces furthermore, the reference configuration that will be used throughout this series of technical specifications. Finally, the present document introduces several characteristics of the mobile satellite operating environment, and summarizes several important properties of the physical layer that are developed in detail within the rest of the 05 series.

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.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[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;".

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

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

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

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

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

[4] GMR-1 05.003 (ETSI TS 101 376-5-3): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 3: Channel Coding".

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

[5] GMR-1 05.004 (ETSI TS 101 376-5-4): "GEO-Mobile Radio Interface Specifications (Release 1); Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation".

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

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

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

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

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

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

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

[9] GMR-1 04.006 (ETSI TS 101 376-4-6): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 6: Mobile earth Station-Gateway Station Interface Data Link Layer Specifications".

NOTE: This is a reference to a GMR-1 Release 1 specification. See the introduction for more details.

[10] GSM 05.01 (ETSI ETS 300 573): "Digital cellular telecommunications system (Phase 2); Physical layer on the radio path; General description". (Version 4.6.0 GSM Phase 2).

3 Definitions and abbreviations

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

4 Reference configuration

For the purpose of elaborating on the physical layer specification, a reference configuration of the transmission chain is used, as shown in annex A. This reference configuration also indicates which parts are dealt with in detail and in which technical specification these details occur. It shall be noted that only the transmission part is specified, the receiver being specified only via the overall performance requirements. With reference to this configuration, the technical specifications in the 05 series address the following functional units:

- GMR-1 05.002 [3]: Multiplexing and Multiple Access; Stage 2 Service Description;
- GMR-1 05.003 [4]: Channel Coding;
- GMR-1 05.004 [5]: Modulation;
- GMR-1 05.005 [6]: Radio Transmission and Reception;
- GMR-1 05.008 [7]: Radio Subsystem Link Control;
- GMR-1 05.010 [8]: Radio Subsystem Synchronization.

5 Channel description

5.1 Physical channels

5.1.1 Radio Frequency Channels

Operational frequencies in the mobile band may be anywhere within the 34 MHz L-band 1,525 GHz to 1,559 GHz (downlink) and 1,6265 GHz to 1,6605 GHz (uplink); each carrier will be centered on an integer multiple of 31,25 kHz. L-band RF carriers are configured for each spot beam, depending on traffic demand, frequency reuse considerations, and available spectrum as a result of coordination with other systems using the same spectrum.

In the Frequency Division Multiplexing (FDM) scheme, L-band downlink (forward) radio frequency (RF) carriers in the satellite-to-MES (Mobile Earth Station) direction are always paired with L-band uplink (return) RF carriers in the MES-to-satellite direction at a frequency offset of 101,5 MHz.

The 34 MHz operating frequency band is divided into 1 087 paired carriers, with carrier spacing of 31,250 kHz. When assigning carriers to spot beams, the smallest addressable unit is a subband. A subband is the combination of five carriers. Any subband can be assigned to any spot beam, regardless of the location of the spot beam.

In addition to carrying traffic, a subset of RF carriers is assigned to control channels. A carrier can be either dedicated to a control channel or shared by both traffic and control channels.

5.1.2 Multiple access and timeslot structure

The GMR-1 satellite system is a Time Division Multiple Access (TDMA) system. Timing configuration in the system is composed of hyperframe, superframe, multiframe, frame, and timeslot.

- **Hyperframe**: 3 hours 28 minutes 53 seconds 760 msec in duration, including 4 896 superframes, 19 584 multiframes or 313 344 TDMA frames.
- **Superframe**: 2,56 seconds in duration, including four multiframes or 64 TDMA frames.
- **Multiframe**: 640 msec in duration, including 16 TDMA frames.
- **Frame**: 40 msec in duration, including 24 timeslots.
- **Timeslot**: approximately 1,67 msec (5/3 msec) in duration, including 78 bits.

The complete timeframe structure is given in figure 5.1.

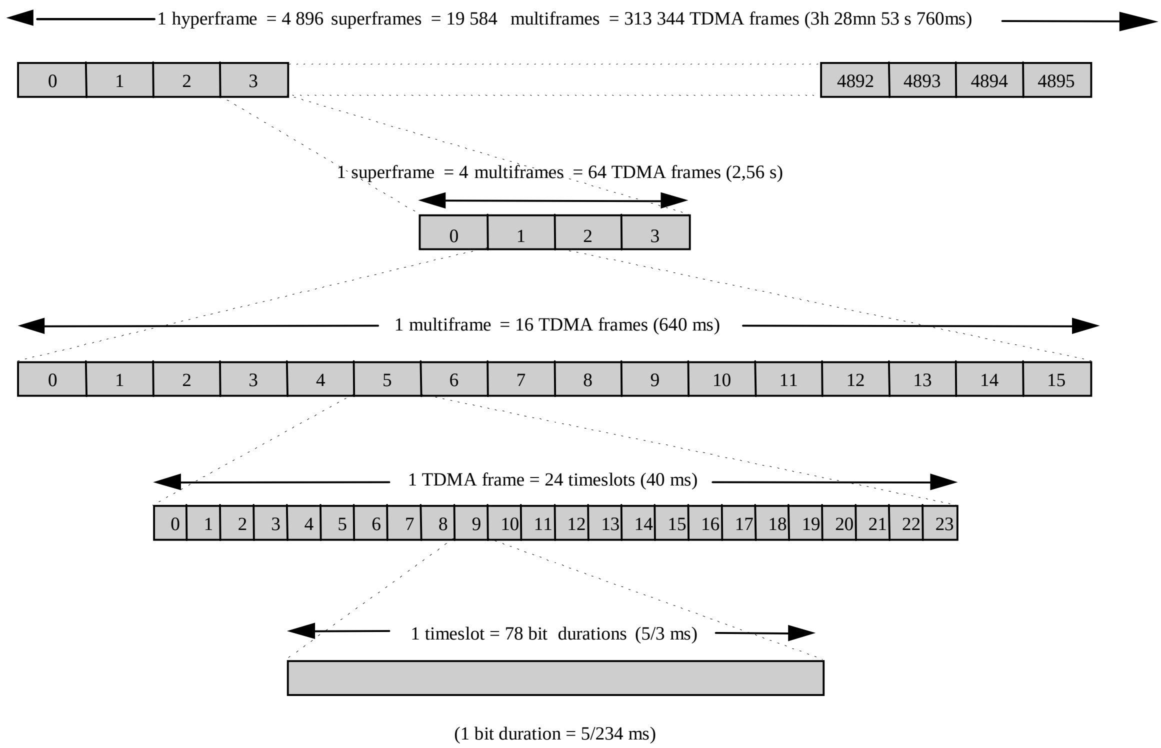


Figure 5.1: Timeframe and timeslot structure

5.2 Logical channels

The logical channels associated with the GMR-1 system may either be a Traffic CHannel (TCH) or a control channel. For details, refer to GMR-1 05.002 [3].

5.2.1 Traffic channels

TCHs are intended to carry encoded speech or user data. These are all bidirectional channels.

- TCH3: This channel carries normal speech and has a gross information rate of 5,2 kbps, it takes 3 contiguous timeslots.
- TCH6: This channel carries 2,4 kbps and 4,8 kbps user data and has a gross transmission rate of 10,75 kbps, it takes 6 contiguous timeslots.
- TCH9: This channel carries 2,4 kbps, 4,8 kbps, and 9,6 kbps user data and has a gross transmission rate of 16,45 kbps, it takes 9 contiguous timeslots.

5.2.2 Control channels

The control channels are intended to carry signalling or synchronization data. There are three different categories of control channels:

a) Broadcast channel: this is a downlink (forward) only channel and consists of the following:

   1) Frequency Correction CHannel (FCCH) is used by the MES for system synchronization and for frequency correction of the MES.

   2) GPS Broadcast Control CHannel (GBCH) carries Global Positioning System (GPS) time information and GPS satellite ephemeris information.

   3) Broadcast Control CHannel (BCCH) is used to broadcast system information and informs the MESs about the system timing.

   4) Cell Broadcast CHannel (CBCH) is used to broadcast Short Message Service (SMS) cell broadcast information to the MESs on a spot beam basis. This channel is allocated on demand basis. To achieve the best resource efficiency, the same physical channel can be shared by CBCH and SDCCH in a spotbeam.

b) Common Control CHannel (CCCH): This consists of the following:

   1) Paging CHannel (PCH) is a downlink only channel and used to page MESs.

   2) Random Access CHannel (RACH) is an uplink-only channel and is used to request a channel (SDCCH (Standalone Dedicated Control Channel) or TCH) allocation.

   3) Access Grant CHannel (AGCH) is a downlink-only channel used to allocate a standalone SDCCH or TCH.

   4) Basic Alerting CHannel (BACH) is a downlink-only channel and used to alert MESs. It is transmitted with higher power and more coding gain than the normal Paging Channel. When the user is in a disadvantaged position and the downlink signal is heavily shadowed, the BACH channel is used to page the user after several unsuccessful paging attempts through the PCH.

   5) Common Idle CHannel (CICH) is a downlink-only channel and used by the MESs for calibration measurements. During a beam selection process, the MES may decide the optimized beam based on the power difference measured from BCCH and CICH channels. For details of the CICH channel requirement, see GMR-1 05.005 [6].

c) Dedicated Control CHannel (DCCH): This is a channel resource that is dedicated for MES. They are all bidirectional except for the TACCH, which is downlink only. The SACCH3 channel is a logical channel with the same physical burst structure as the FACCH3. The multiplexing of the FACCH3 and SACCH3 with the TCH3 is described in GMR-1 04.006 [9].

d) Slow TCH6-Associated Control CHannel (SACCH6):

1) Slow TCH9-Associated Control CHannel (SACCH9);

2) Fast TCH3-Associated Control CHannel (FACCH3);

3) Fast TCH6-Associated Control CHannel (FACCH6);

4) Fast TCH9 Associated Control CHannel (FACCH9);

5) Standalone Dedicated Control CHannel (SDCCH);

6) Terminal-to-Terminal (TtT) Associated Control CHannel (TACCH) can be shared among a subset of TtT calls and is not necessarily dedicated to a single TtT call;

7) Power control subchannel. The information bits of the power control sub-channel are multiplexed into 6 consecutive bursts during TCH3/6/9 calls, so that a constant power control information throughput can be maintained during the call.

5.2.3 Block structure

Burst building and multiplexing for various GMR-1 channels are described in more detail in GMR-1 05.002 [3]. A summarized description is given in table 5.1, in terms of net bit rate, length of information block, and duration of block repetition.

Table 5.1: Block structure

Type of Channel	Net Bit Rate (bit/sec) (note 5)	Information Block Length (bits) (note 6)	Block Recurrence (msec)
TCH3	4 000	160	40
TCH6 2,4 kbps Fax/Data 4,8 kbps Fax/Data	 3 600 6 000	 144 240	40
TCH9 2,4 kbps Fax 4,8 kbps Fax 9,6 kbps Fax/Data	 3 600 6 000 12 000	 144 240 480	40
FACCH3	475	76	160
FACCH6	4 700	188	40
FACCH9	7 500	300	40
SACCH6	95	76	800
SACCH9	95	76	800
SDCCH/4 (note 1)	MES to GS: 262,5 GS to MES: variable	84	MES to GS: 320 GS to MES: variable
CBCH (note 2)	variable	184	variable
FCCH	N/A	N/A	N/A
CICH	N/A	N/A	320
BACH	14	36	2 560
BCCH	600	192	320
PCH	300	192	640
AGCH	300	192	N/A
GBCH	1 350	108	80
RACH (note 3)	N/A	16+123	N/A
TACCH/2 (note 4)	675	108	160
PC subchannel	50	12	240

NOTE 1: The downlink SDCCH/4 subchannel does not follow a fixed repetition pattern. A subchannel is identified by its Unique Word. See GMR-1 05.002 [3]. Notation "4": an SDCCH logical channel has 4 sub-channels.
NOTE 2: CBCH channel information rate and repetition period is configurable based on BCCH parameter SA_CBCH_CONFIG, see GMR-1 05.002 [3].
NOTE 3: The RACH channel includes 16 class-1 bits and 123 class-2 bits.
NOTE 4: Notation "2": a TACCH logical channel has 2 sub-channels.
NOTE 5: Definition of Net Bit Rate is the same as GSM 05.01 [10].
NOTE 6: Definition of Information Block Length is the same as GSM 05.01 [10].

6 Coding and interleaving

The channel coding consists of the following basic operations. The exact configuration of these varies from channel to channel, depending on the size of the information bit blocks, the amount of coding gain that the channel needs to achieve required performance, etc. For all types of channels, the operations follow the order given below:

a) Outer Code - Cyclic Redundancy Check (CRC) which is 8 bits, 12 bits, or 16 bits of parity depending on the channel.

b) Inner Code:

   1) Convolutional Coding: Most channels use a convolutional coder with constraint length of 5 and rates of 1/2, 1/3, 1/4, and 1/5, as required by the particular channel.

   2) Golay Coding: The power control messages that are embedded into various bursts use the (24,12) systematic Golay encoder. The Golay decoder used is a soft-decision Golay decoder, which gives additional gain over the traditional hard decision decoding.

   3) Reed-Solomon Coding: The BACH uses a systematic (15,9) Reed-Solomon code generated over the Galois Field, GF(2^4).

c) Puncturing: Various puncture masks are used to fit the coded bits into the physical channel bit carrying capacity. The masks are designed to minimize the performance degradation from the unpunctured case.

d) Interleaving: It can be intraburst or interburst interleaving, which is based on block interleaving methods with pseudorandom permutations and is channel dependent.

e) Scrambling: The scrambler adds a binary pseudonoise sequence (masking sequence) to the input bit stream to randomize the number of "0"s and "1"s in the output bit stream. The masking sequence is generated by a linear feedback shift register.

f) Encryption: Certain channels have data encryption to prevent eavesdropping, including TCH3/6/9, FACCH3/6/9, SACCH6/9 and SDCCH.

The operations applied to various logical channels are summarized in table 6.1.

Table 6.1: Operations applied to various channels (see note 4)

Channel Type	Modulation Type	Channel Repetition Cycle (msec)	Informa-tion + CRC (bits)	Base Code Rate (note 1)	Punctu ring	Coded Bits per Channel	Interleave Depth, Intraburst, (Interburst)	Coded Bits + Status Field Bits per Burst	Burst Type
TCH3	π/4-CQPSK	40	80+0	(note 2)	yes	104	24	208+4	NT3
TCH6 2,4 kbps fax 2,4 kbps data 4,8 kbps fax/data	π/4-CQPSK	40	 144+0 240+0 240+0	 1/3 1/2 1/2	yes	420	52, (3)	420+4	NT6
TCH9 2,4 kbps fax 4,8 kbps fax 9,6 kbps fax/data	π/4-CQPSK	40	 144+0 240+0 480+0	 1/5 1/3 1/2	yes	648	81, (3)	648+4	NT9
FCCH	Dual Chirp	320							FCCH
GBCH	π/4-CQPSK	80	108+16	1/2		264	32	132+0	DC2
BCCH	π/4-CQPSK	320	192+16	1/2		424	53	424+0	BCCH
CBCH	π/4-CQPSK	var.	184+16	1/2		424	53	432+0	DC6
PCH	π/4-CQPSK	640	192+16	1/2		424	53	432+0	DC6
RACH Class I Class II	π/4-CQPSK		 16+8 123+12	1/4	 yes	494	 14 33	494+0	RACH
AGCH	π/4-CQPSK	N/A	192+16	1/2		424	53	432+0	DC6
BACH	BACH 6PSK	2 560	36+0	(note 3)		60		4	BACH
CICH		320							CICH
SACCH/6	π/4-CQPSK	640	76+16	1/2		200	20	10	NT6
SACCH/9	π/4-CQPSK	640	76+16	1/2		2 000	20	10	NT9
FACCH3	π/4-CBPSK	160	76+16	1/4		384	12	96+8	NT3
FACCH/6	π/4-CQPSK	40	188+16	1/2		420	52	420+4	NT6
FACCH/9	π/4-CQPSK	40	300+16	1/2		648	80	648+4	NT9
SDCCH	π/4-CBPSK	Up: 320 Dn: var.	84+16	1/4		416	52	208+0	SDCCH
PC subchannel	π/4-CQPSK	240		1/2		24		4	
TACCH	π/4-CQPSK	160	108+16	1/2		264	32	132+0	DC2

NOTE 1: Unless indicated otherwise, the base code rate specifies convolutional code of constraint length 5 that uses 4-bit zero-valued tail to flush the encoder.

NOTE 2: Rate ½ convolutional code of constraint length 7 that uses a circular encoding (tail-biting) method.

NOTE 3: (15,9) Reed-Solomon code generated over Galois Field GF(2^4).

NOTE 4: Burst types are defined in GMR-1 05.002 [3].

7 Modulation

The modulating symbol rate is 23,4 ksps for all burst types. The symbol period *T* is defined as 1/23,4 msec.

The modulation scheme used for all traffic and control channels except for Dual Keep-Alive Burst (DKAB), BACH, and FCCH, whether they are uplink or downlink, is one of the two following schemes:

a) π/4-CQPSK (coherent quadrature phase shift keying) which is pulse shaped using a root raised cosine filter with a rolloff factor of 0,35. This is used by the TCH3, TCH6, TCH9, CCCHs, and BCCHs.

b) π/4-CBPSK (coherent binary phase shift keying), which is pulse shaped using a root-raised cosine filter with a rolloff factor of 0,35. This is used by the FACCH3 and SDCCH channels. This modulation scheme, along with some additional Forward Error Correction (FEC), allows these channels to operate in a disadvantaged channel condition compared to the normal traffic channels. All the call setup signalling can take place even if the MES may not be optimally deployed for traffic operation.

A DKAB is transmitted during periods of speech inactivity and is proposed by the GMR-1 system to save the battery life, satellite power, reduce cochannel interference, add-comfort noise, and maintain the power control and timing/frequency synchronization. The modulation scheme used by DKABs is π/4-DBPSK (differential binary phase shift keying), which is pulse shaped using a root-raised cosine filter with a rolloff factor of 0,35.

The BACH is modulated using a 6-PSK (Phase Shift Keying), which is pulse shaped using a root raised cosine filter with a rolloff factor of 0,35. The FCCH burst is a real chirp signal spanning three slots.

8 Transmission and reception

The MES transmitter and receiver characteristics are as follows:

a) The transmitter output power is measured in terms of Effective Isotropic Radiated Power (EIRP) and ranges from 5 dBW to 9 dBW, depending on the terminal type, which may be a handheld, Vehicular Terminal (VT) with or without an adjustable antenna or a fixed terminal.

b) The transmitter is characterized in detail in GMR-1 05.005 [6], specifying the antenna radiation pattern, its polarization, carrier off EIRP, power control range and accuracy, adjacent channel interference, and spurious emissions.

c) The receiver is characterized in detail in GMR-1 05.005 [6], specifying the antenna radiation pattern, its polarization, figure of merit, sensitivity, selectivity, intermodulation, and blocking characteristics.

d) The receiver sensitivity is defined under various channel conditions. The conditions are a static (AWGN) channel, which represents strong direct line-of-sight to the satellite; Rician fading channel, with a K factor (direct-to-multipath ratio) of 9 dB and fade bandwidth of 10 Hz, which represents a typical handheld with the user walking; and Rician fading channel with a K factor of 12 dB and fade bandwidth of 200 Hz, which represents a typical VT moving at 60 mph.

9 Link control

9.1 RF power control

The power control in the GMR-1 system is performed for all the active TCHs in the Gateway Station (GS)-to-MES direction, the MES-to-GS direction, and in the MES-to-MES configuration. There is no power control for the CCCHs. The MES transmits the RACH and SDCCH at full power.

RF power control is employed to minimize the transmit power required at the MES or the GS while maintaining the quality of the radio links. By minimizing the transmit power levels, the unnecessary power source drain at the satellite and the MES is prevented, and the cochannel interference due to the signals received from different MESs is reduced.

The power control aims at a fast transient response to mitigate sudden shadowing events, a steady-state condition that accurately achieves the designated received signal quality, and a robust operation with respect to the error conditions. Power control is governed by many different parameters, e.g. target signal quality, power control loop gain, etc. These parameters provide the capability to adjust the power control response for different channel conditions, terminal types, operation policies, etc.

The power control mechanism has two ends. One end is an MES. The other end is either a GS or an MES. In the open-loop power control mechanism, each power control end increases the transmit power if the quality of the received signal suddenly deteriorates by a designated amount. The use of open loop power control assumes a useful degree of statistical correlation between the receive and the transmit links. In closed loop power control, the receiver end estimates the quality of the signal received from the transmitter end and, based on the estimated signal quality, conveys to the transmit end a request for attenuation relative to the maximum transmit power level. Closed-loop power control is performed in both the downlink (the control of the GS transmit power based on the received signal quality measurement at the MES) and in the uplink (the control of the MES transmit power based on the signal quality measurement at the GS).

9.2 Idle mode tasks

While in idle mode, an MES shall implement the spot beam selection and reselection procedures. These procedures ensure that the MES is camped on a spot beam from which it can reliably decode downlink data and with which it has a high probability of communications on the return link. An accurate spot beam selection is crucial to minimize satellite power cost and timeslot assignment blockage, and to limit the number of spot beam reselection procedures.

For the purposes of spot beam selection and reselection, the MES shall be capable of detecting and synchronizing to a BCCH carrier and reading the BCCH data at reference sensitivity and reference interference levels. The MES is also required to maintain an average of the received signal strength for all the monitored frequencies.

9.3 Radio link measurement

The MES will make radio link measurements for the RF power control, radio link failure criterion, idle mode beam selection/reselection procedures, idle mode selection criteria, and received signal strength indication. The GS will make radio link measurements for RF power control, radio link failure criterion, and time and frequency synchronization processes. These measurements are as follows:

- Received Signal Strength Indicator (RSSI): The RSSI is the rms value of the signal received at the antenna.
- Signal Quality Indicator (SQI): The SQI is defined as an estimate of the ratio of the desired signal power to the noise and interference power in the received burst.
- Link Quality Indicator (LQI): The LQI is the amount of reserve link margin with respect to the target signal quality. A negative value of LQI indicates that the target signal quality is not being met by the indicated value.
- Receive Symbol Time and Carrier Frequency Offsets.
- INR [(Interference + Noise)/Noise]: It is the ratio of the interference and the noise power to the noise power. It indicates the increase in the additive noise floor due to the presence of the interference.

10 Synchronization

GMR-1 is a multiple spot beam, multicarrier, synchronous system where the timing and frequency on the satellite serve as the reference to synchronize the TDMA transmissions for the MESs, the network GSs, and other network elements. The satellite includes a switch designed to provide single-hop, TtT connectivity at L-band.

Synchronization in the GMR-1 system has three different aspects: timing synchronization, frequency synchronization, and message synchronization. See GMR-1 05.010 [8] for details.

10.1 Timing synchronization

The general requirement for MES timing synchronization is that the MES will transmit signals that are time aligned and frame number aligned with the system timing on the satellite reference point.

The whole system is synchronized on the satellite. The network adjusts FCCH and BCCH transmissions so that each of these channels leaves from the satellite antenna at the predefined system timing. An MES derives its local timing reference from the signals received from the satellite. By listening to the FCCH, both timing and frequency synchronization can be achieved for CCCH channels.

From a cold start, MESs initially search for and acquire the FCCH sent in each spot beam. The MES's frame timing is then synchronized to system timing.

In idle mode, after initial timing acquisition, the MES needs to track system timing continuously to compensate the timing drift caused by its local oscillator frequency uncertainty and the relative motion between the satellite and the user.

At initial access, an MES accesses the network using a RACH offset precalculated for the spot beam centre. This RACH offset is distributed by the BCCH in each spot beam. The round-trip delay variation caused by the difference of MES position relative to the beam centre will be detected from the network, and this value will be passed to the MES as a timing correction via the AGCH. After receiving the AGCH, the MES will be able to transmit such that timing of burst arrival on the satellite is nominal.

At the beginning of a call, to achieve frame/timeslot synchronization on the satellite, a transmission frame offset relative to the start of downlink reference frame is provided from the network. During a call, both MES transmitter and receiver adjust their burst timing to maintain the frame/timeslot synchronization. The MES receiver timing is maintained by using its internal timebase. For the MES transmitter, a closed-loop synchronization scheme is adopted. Any transmission timing drift at the MES will be detected from the network by comparing the actual burst arrival with the expected arrival, and a timing correction is passed to the MES if the difference exceeds a threshold defined by the network.

10.2 Frequency synchronization

Both forward and return link signals are required to align their nominal frequencies on the satellite. The task of frequency synchronization is to precompensate the transmission signal to align the nominal frequency on the satellite and to track the received signal in frequency to achieve effective demodulation.

The MES frequency alignment is achieved by correcting transmission frequency with messages provided by a network. RACH frequency is set up by messages provided over the BCCH. SDCCH/TCH frequency is corrected with corrective factors given over the AGCH. During a call, frequency correction is provided through FACCH (TCH3) or SACCH (TCH6/TCH9).

In the initial frequency acquisition, an MES looks for one control carrier with the highest signal level. After the FCCH acquisition process, the MES will use the BCCH frequency as its frequency reference and lock on to the BCCH carrier.

At the initial access, the MES switches to the specified RACH frequency, using a downlink BCCH signal as reference, offset by a beam centre Doppler value provided from the BCCH message. During a call, any frequency drift at the MES will be detected from the network by comparing the actual arrived frequency with the expected frequency, and a frequency correction is passed to the MES if the difference exceeds a threshold defined by the network.

10.3 Message synchronization

The signalling messages in several channels require multiple frames for a single message transmission. The objective of message synchronization is to identify the start of a signalling message for both transmit and receive sides. The following channels require a message synchronization mechanism:

a) BACH message: Synchronization of the BACH message is based on the frame number counter. See GMR-1 05.002 [3] and GMR-1 05.010 [8] for details.

b) GBCH message: Synchronization of the GBCH message is based on the frame number counter. See GMR-1 05.002 [3] and GMR-1 05.010 [8] for details.

c) FACCH3 message: The message synchronization in both uplink and downlink is based on the detection of the Unique Word (UW) and frame number. The Uws contained in the four bursts of the same message are identical and vary from message to message.

d) SACCH6/9 message: Synchronization of the SACCH6/9 message in both uplink and downlink is based on the frame number counter. See GMR-1 05.010 [8] for details.

e) SDCCH/4 message:

   1) in the MES-to-GS direction, each SDCCH/4 channel takes the fourth frame pair. Message synchronization can be either based on UW detection or frame number counter;

   2) in the GS-to-MES direction, the SDCCH/4 uses a statistically multiplexed paired-frame sequence. Each subchannel of the paired frames is identified by its Uws. Synchronization is based on UW detection.

f) TACCH/2 message: The TACCH/2 message has a two-burst block structure. It is transmitted in every second frame. A physical channel can contain two TACCH/2 subchannels. Message synchronization is based on the frame number counter.

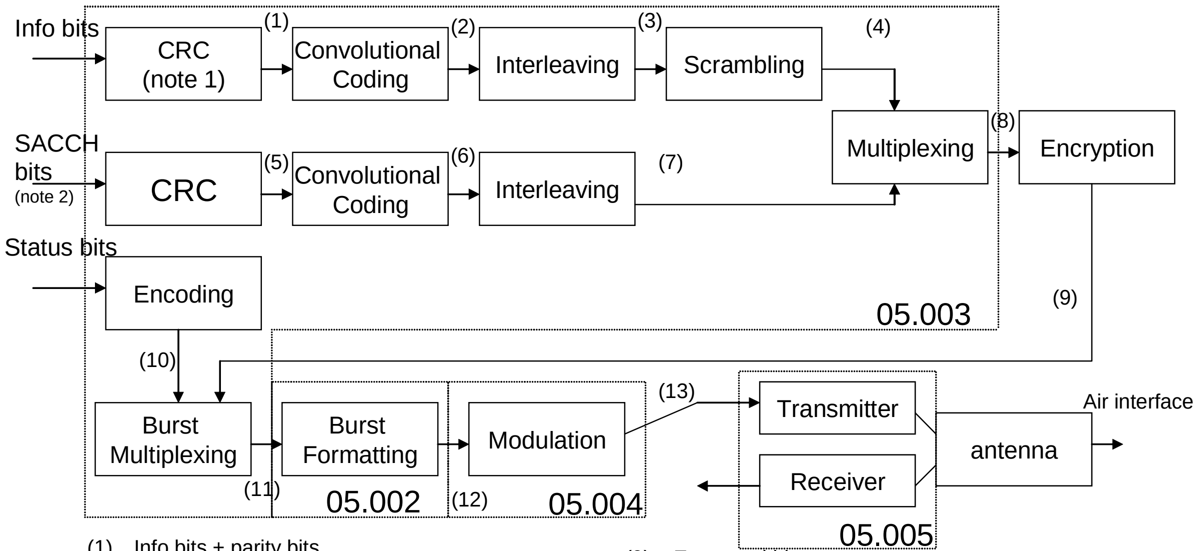
g) Power Control message: Each Power Control message takes six contiguous frames (240 msec) for transmission, with the messages being sent back-to-back (no gaps). For message synchronization purposes, one of the two entities involved in the call functions as master and the other functions as slave. Two different schemes are used. In the master-to-slave direction, synchronization is based on the frame number counter. In the slave-to-master direction, synchronization is based on the detection of error-free Golay coding bits. See GMR-1 05.010 [8] for details.

Various message synchronization schemes are summarized in table 10.1.

Table 10.1: Outline of GMR-1 Message Synchronization Schemes

Message Type	Number of Bursts per Message	Synchronization Scheme
BACH	15	Frame number FN
GBCH	2	FN
FACCH3	4	FN and UW detection
SACCH6/9	20	FN
SDCCH/4	2	MES to GS: FN and UW detection GS to MES: UW detection
TACCH/2	2	FN
PC message	6	Master-to-slave: FN Slave-to-master: detection of error free Golay coding bits

Annex A (informative): Reference configuration



(1) Info bits + parity bits
(2) Coded bits
(3) Interleaved bits
(4) Scrambled bits
(5) SACCH bits + parity bits
(6) Coded SACCH bits
(7) Interleaved SACCH bits
(8) Multiplexed info and SACCH bits
(9) Encrypted bits
(10) Coded Status bits
(11) Multiplexed info, SACCH and Status bits
(12) Burst formatted bits, including uW
(13) Modulated symbols

Note 1 : not all channels use CRC
Note 2 : not all channels multiplex SACCH

Annex B (informative): Change Record

This annex lists the CRs that have been applied to the present document.

CR	REV	CATEGORY	SUBJECT
CR001	1	Editorial	Annex A missing
CR002	0	Editorial	Improvement to BACH description

History

Document history		
V1.1.1	March 2001	Publication
V1.2.1	February 2005	Publication