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Technical Specification

**GEO-Mobile Radio Interface Specifications;
Part 5: Radio interface physical layer specifications;
Sub-part 1: Physical Layer on the Radio Path;
GMR-2 05.001**

Reference

DTS/SES-002-05001

Keywords

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

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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

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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

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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

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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:

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, 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; GMR-2 05.001";

Sub-part 2: "Multiplexing and Multiple Access on the Radio Path; GMR-2 05.002";

Sub-part 3: "Channel Coding; GMR-2 05.003";

Sub-part 4: "Modulation; GMR-2 05.004";

Sub-part 5: "Radio Transmission and Reception; GMR-2 05.005";

Sub-part 6: "Radio Subsystem Link Control; GMR-2 05.008";

Sub-part 7: "Radio Subsystem Synchronization; GMR-2 05.010";

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 is an introduction to the 05-series of the GMR-2 technical specifications for the system. It 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.

Operating frequencies for the GMR-2 Ground Terminal (Gateway or NCC) -to-Satellite Terminal (ST) uplink/downlink are not specified, however, for ease of understanding, the present document describes the requirements for a GMR-2 Ground Terminal-to-Satellite Terminal uplink/downlink operating in the 3 000 MHz/6 000 MHz C-Band.

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".

[2] GMR-2 03.003 (ETSI TS 101 377-3-3): "GEO-Mobile Radio Interface Specifications; Part 3: Network specifications; Sub-part 3: Numbering, Addressing and Identification; GMR-2 03.003".

[3] GMR-2 03.020 (ETSI TS 101 377-3-10): "GEO-Mobile Radio Interface Specifications; Part 3: Network specifications; Sub-part 10: Security related Network Functions; GMR-2 03.020".

[4] GMR-2 03.022 (ETSI TS 101 377-3-11): "GEO-Mobile Radio Interface Specifications; Part 3: Network specifications; Sub-part 11: Functions Related to Mobile Earth Station (MES) in idle Mode; GMR-2 03.022".

[5] GMR-2 04.003 (ETSI TS 101 377-4-2): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 2: GMR-2 Mobile Earth Station-Network Interface; Channel Structures and Access capabilities; GMR-2 04.003".

[6] GMR-2 04.008 (ETSI TS 101 377-4-7): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 7: Mobile radio interface Layer 3 Specifications; GMR-2 04.008".

[7] GMR-2 04.021 (ETSI TS 101 377-4-10): "GEO-Mobile Radio Interface Specifications; Part 4: Radio interface protocol specifications; Sub-part 10: Rate Adaptation on the Mobile earth Station (MES)- Gateway System Interface. GMR-2 04.021".

[8] GMR-2 05.002 (ETSI TS 101 377-5-2): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access on the Radio Path; GMR-2 05.002".

[9] GMR-2 05.003 (ETSI TS 101 377-5-3): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 3: Channel Coding. GMR-2 05.003".

[10] GMR-2 05.004 (ETSI TS 101 377-5-4): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation; GMR-2 05.004".

[11] GMR-2 05.005 (ETSI TS 101 377-5-5): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception; GMR-2 05.005".

[12] GMR-2 05.008 (ETSI TS 101 377-5-6): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control; GMR-2 05.008".

[13] GMR-2 05.010 (ETSI TS 101 377-5-7): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronization; GMR-2 05.010".

[14] ANSI/IEEE Std. 149-1979: "Standard Test Procedure for Antennas".

3 Abbreviations

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

4 Set of channels

The radio subsystem provides a certain number of logical channels that can be separated into two categories according to GMR-2 04.003 [5]:

Satellite Traffic Channels (S-TCH) and Satellite Control Channels (S-CCH).

4.1 Satellite Traffic Channels (S-TCH)

The Satellite Traffic Channels (S-TCH) are intended to carry two types of user information streams: encoded speech and data. Four types of Satellite mode traffic channels are defined:

a) Full Rate Traffic Channel (S-TCH/F). This channel carries information at a gross rate of 24 kbps.

b) Half Rate Traffic Channel (S-TCH/H). This channel carries information at a gross rate of 12 kbps.

c) Quarter Rate Traffic Channel (S-TCH/Q). This channel carries information at a gross rate of 6 kbps.

d) Eighth Rate Traffic Channel (S-TCH/E). This channel carries information at a gross rate of 3 kbps.

For the purpose of this series of technical specifications, the specific traffic channel available in the categories of speech and user data are defined in the following clauses:

4.1.1 Speech Traffic Channel

The following traffic channels are defined to carry encoded speech:

a) Satellite half-rate traffic channel for enhanced speech (S-TCH/HES);

b) Satellite half-rate traffic channel for robust speech (S-TCH/HRS);

c) Satellite quarter-rate traffic channel for basic speech (S-TCH/QBS);

d) Satellite eighth-rate traffic channel for low-rate speech (S-TCH/ELS).

NOTE: The full-rate traffic channel defined in GSM is not used for speech over the satellite.

4.1.2 Data Traffic Channels

The following traffic channels are defined to carry user data:

a) Satellite full-rate traffic channel for 9,6 kbps user data (S-TCH/F9.6);

b) Satellite half-rate traffic channel for 4,8 kbps user data (S-TCH/H4.8);

c) Satellite half-rate robust traffic channel for 2,4 kbps user data (S-TCH/HR2.4);

d) Satellite quarter-rate traffic channel for 2,4 kbps user data (S-TCH/Q2.4).

NOTE: The eighth-rate traffic channel, as defined above for speech, is not used for data over the satellite.

4.2 Satellite Control Channels (S-CCH)

The Signalling Channels can be sub-divided into:

a) S-BCCH (Satellite Broadcast Control Channel);

b) S-CCCH (Satellite Common Control Channel);

c) S-DCCH (Satellite Dedicated Control Channel).

Satellite dedicated control channels include standalone and associated control channels. An associated control channel is always allocated in conjunction with a S-TCH. Two types of ACCH are defined: continuous stream (slow ACCH or S-SACCH) and burst stealing mode (fast ACCH or S-FACCH). For the purpose of this series of technical specifications, the satellite signalling channels are distinguished in the following clauses.

4.2.1 Satellite Broadcast Control Channel (S-BCCH)

The following satellite broadcast control channels are provided:

a) Satellite Synchronization Channel (S-SCH);

b) Satellite Broadcast Control Channel (S-BCCH);

c) Satellite High Margin Synchronization Channel (S-HMSCH));

d) Satellite High Margin Broadcast Control Channel (S-HBCCH);

e) Satellite Beam Broadcast Channel (S-BBCH) (Option currently not supported by GMR-2 system).

4.2.2 Satellite Common Control Channel (S-CCCH)

The following satellite common control channels are provided:

a) Satellite High Penetration Alerting Channel (S-HPACH);

b) Satellite Paging Channel (S-PCH);

c) Satellite Random Access Channel (S-RACH);

d) Satellite Access Grant Channel (S-AGCH);

e) Satellite Robust Paging Channel (S-PCH/R) (Currently not supported by GMR-2 system);

f) Satellite Robust Access Grant Channel (S-AGCH/R) (Currently not supported by GMR-2 system).

4.2.3 Satellite Dedicated Control Channels

The dedicated control channels include two types: standalone dedicated and associated control channels. These types are defined in the following clauses.

4.2.3.1 Satellite Standalone Dedicated Control Channel (S-SDCCH)

a) Satellite Half Rate Robust Standalone Dedicated Control Channel (S-SDCCH/HR).

b) Satellite Quarter Rate Standalone Dedicated Control Channel (S-SDCCH/Q).

c) Satellite Eighth Rate Standalone Dedicated Control Channel (S-SDCCH/E).

4.2.3.2 Satellite Associated Control Channel (S-ACCH)

The associated control channels are divided into two groups Fast Associated and Slow Associated:

Fast Associated Control Channels:

a) Satellite S-TCH/HRS Fast Associated Control Channel (S-FACCH/HRS);

b) Satellite S-TCH/HES Fast Associated Control Channel (S-FACCH/HES);

c) Satellite S-TCH/QBS Fast Associated Control Channel (S-FACCH/QBS);

d) Satellite S-TCH/ELS Fast associated Control Channel (S-FACCH/ELS);

e) Satellite S-TCH/Q2.4 Fast Associated Control Channel (S-FACCH/Q2.4);

f) Satellite S-TCH/HR2.4 Fast Associated Control Channel (S-FACCH/HR2.4);

g) Satellite S-TCH/H4.8 Fast Associated Control Channel (S-FACCH/H4.8);

h Satellite S-TCH/F9.6 Fast associated Control Channel (S-FACCH/F9.6).

Slow Associated Control Channels:

a) Satellite Slow, S-TCH/F Associated Control Channel (S-SACCH/TF);

b) Satellite Slow, S-TCH/H Associated Control Channel (S-SACCH/TH);

c) Satellite Slow, S-TCH/HR Associated Control Channel (S-SACCH/THR);

d) Satellite Slow, S-SDCCH/HR Associated Control Channel (S-SACCH/CHR);

e) Satellite Slow, S-SDCCH/Q Associated Control Channel (S-SACCH/CQ);

f) Satellite Slow, S-TCH/Q Associated Control Channel (S-SACCH/TQ);

g) Satellite Slow, S-TCH/E Associated Control Channel (S-SACCH/TE);

h) Satellite Slow, S-SDCCH/E Associated Control Channel (S-SACCH/CE).

The logical channels mentioned above are mapped on physical channels that are described in this set of technical specifications. The different physical channels provide for the transmission of information pertaining to higher layers according to a block structure.

5 Reference configuration

For the purpose of elaborating 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 details in which technical specification. 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:

1) GMR-2 05.002 [8]: Multiplexing and multiple access on the radio path;
2) GMR-2 05.003 [9]: Channel coding;
3) GMR-2 05.004 [10]: Modulation;
4) GMR-2 05.005 [11]: Radio transmission and reception.

This reference configuration defines also a number of points of vocabulary in relation to the name of bits at different levels in the configuration. It must be outlined, in the case of the encrypted bits, that they are named only with respect to their position after the encryption unit, and not to the fact that they pertain to a flow of information that is actually encrypted.

6 Block structures

Table 6.1: Channel block structures

Type of Channel	Net Bit Rate (kbit/s)	Block Length (bits)	Block Recurrence (ms)
(S-TCH/HES)	Reserved	Reserved	Reserved
(S-TCH/HRS)	3,6	72	20
(S-TCH/QBS)	3,6	72	20
(S-TCH/ELS)	Reserved	Reserved	Reserved
(S-TCH/F9.6)	Reserved	Reserved	Reserved
(S-TCH/H4.8)	Reserved	Reserved	Reserved
(S-TCH/HR2.4) (Note 2)	3	30	10
(S-TCH/Q2.4)	3	30	10
(S-SDCCH/HR)	Reserved	Reserved	Reserved
(S-SDCCH/Q)	Reserved	Reserved	Reserved
(S-SDCCH/E)	0,766 6	184	240
(S-FACCH/HES)	Reserved	Reserved	Reserved
(S-FACCH/HRS)	1,533 3	184	120
(S-FACCH/HR2.4) (Note 2)	1,533 3	184	120
(S-FACCH/QBS)	1,533 3	184	120
(S-FACCH/Q2.4)	1,533 3	184	120
(S-FACCH/ELS)	Reserved	Reserved	Reserved
(S-FACCH/H4.8)	Reserved	Reserved	Reserved
(S-FACCH/F9.6)	Reserved	Reserved	Reserved
(S-SACCH/TF)	0,383 3	184	480
(S-SACCH/TH)	0,383 3	184	480
(S-SACCH/THR)	0,383 3	184	480
(S-SACCH/TQ)	0,191 7	184	960
(S-SACCH/TE)	0,095 83	184	1 920
(S-SACCH/CHR)	Reserved	Reserved	Reserved
(S-SACCH/CQ)	Reserved	Reserved	Reserved
(S-SACCH/CE)	0,095 83	184	1 920
(S-BCCH)	0,390 8	184	6 120/13
(S-HBCCH)	0,015 3	194	165 240/13
(S-HMSCH)	0,314 4	148	6 120/13
(S-RACH)	r × 0,059 5 (Note 1)	28	61 20/13
(S-PCH)	n × 0,390 8 (Note 1)	184	6 120/13
(S-AGCH)	p × 0,390 8 (Note 1)	184	6 120/13
(S-HPACH) (IMSI)	0,112 6	53	6 120/13
(S-HPACH) (TMSI) (Note 2)	0,063 7	30	6 120/13
(S-SCH)	0,053 1	25	6 120/13
(S-BBCH) (Note 2)	0,007 24	184	330 480/13
(S-PCH/R)	Reserved	Reserved	Reserved
(S-AGCH/R)	Reserved	Reserved	Reserved
NOTE 1: n, p, and r refer to the total number of blocks per recurrence period. NOTE 2: Implementation of this channel is optional.			

7 Multiple access and timeslot structure

The access scheme is a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) with eight in the forward direction or two in the return direction full rate physical channels per carrier. The carrier separation is 200 kHz in the forward direction and 50 kHz in the return. A physical channel is therefore defined as a sequence of TDMA frames, a time slot number, and an FDMA carrier frequency.

In the forward direction the basic radio resource is a time slot lasting ≈ 576,9 μs (15/26 ms) and transmitting information at a modulation (burst) rate of ≈ 270,833 kbit/s (1625/6 kbit/s). In the return direction the basic radio resource is a time slot lasting ≈ 2,3 ms (60/26 ms) and transmitting information at a modulation rate of ≈ 67,708 kbit/s (1 625/24 kbit/s). The time slot duration, including guard time, is 156,25 bit durations.

We shall describe successively the time frame structures, the time slot structures and the channel organization. The appropriate specifications will be found in GMR-2 05.002 [8] (Multiplexing and Multiple Access).

7.1 Hyperframes, superframes and multiframes

A diagrammatic representation of all the time frame structures is shown in figure 7.1.1. The longest recurrent time period of the structure is called hyperframe and has a duration of 3h 28 min 53 sec 760 ms (or 12 533,76 sec). The TDMA frames are numbered modulo this hyperframe (TDMA frame number, or FN, from 0 to 2 715 647). This long period is needed to support cryptographic mechanisms defined in GMR-2 03.020 [3].

One hyperframe is subdivided in 2 048 superframes which have a duration of 6,12 seconds. The superframe is the least common multiple of the time frame structures. The superframe is itself subdivided into multiframes: two types of multiframes exist in the system:

1) A 26-frame multiframe (51 per superframe) with a duration of 120 ms, comprising 26 TDMA frames. This multiframe is used to carry S-TCH (and S-SACCH/T), S-FACCH and S-SDCCH (and S-SACCH/C);

2) A 51-frame multiframe (26 per superframe) with a duration of ≈ 235,4 ms (3 060/13 ms), comprising 51 TDMA frames. This multiframe is used to carry S-BCCH, S-AGCH, S-PCH, S-RACH, S-HPACH, S-HBCCH, S-HMSCH, S-AGCH/R, S-PCH/R, S-BBCH, and S-SCH.

A TDMA frame, comprising eight time slots has a duration of ≈ 4,62 ms (60/13 ms).

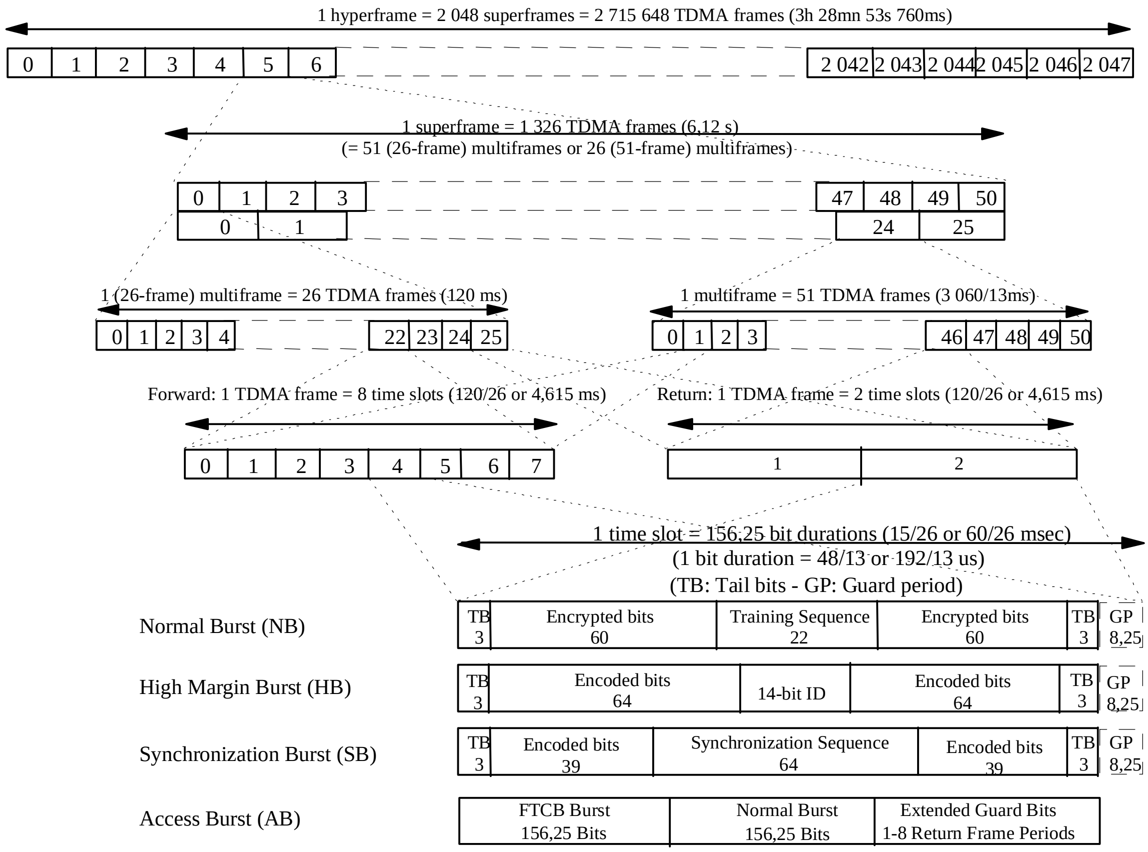

Figure 7.1.1: Timeframe Structure and Bursts

7.2 Timeslots and Bursts

The time slot is a time interval of ≈ 576,9 µs (15/26 ms), that is 156,25 bit durations, and its physical content is called a "burst". The burst rate in the forward direction is ≈ 270,833 kbit/s (1 625/6 kbit/s) and is ≈ 67,708 kbit/s (1 625/24 kbit/s) for the return. Six different types of bursts exist in the system:

1) Normal burst (NB): this burst is used to carry information on traffic and some control channels. It contains two packets of 60 bits data surrounding a 22 bit training (synchronization) sequence. Three tail bits are added to each side and include a guard time of 8,25 bit durations (≈ 30,46 µs).

2) Synchronization Burst (SB): this burst is used for time synchronization of the mobile. It contains a long training sequence and carries the information of the TDMA frame number (FN) and Gateway Identity Code. It contains two packets of 39 bits data surrounding a 64 bit training (synchronization) sequence. Three tail bits are added to each side and includes a guard time of 8,25 bit durations. The repetition of synchronization bursts is also named synchronization channel (S-SCH).

3) Access Burst (AB): this burst is used for random access by the Mobile Earth Station (MES). It is actually composed of two bursts: the Normal burst (item 1.) and the Frequency and Time Correction burst (item 6). It also contains an extended guard period of up to 16 return time slots (i.e., 8 return frame periods).

4) High Margin Burst (HB): this burst is used to carry the information of either the S-HPACH or the S-HBCCH. It consists of two 64 bit information packets surrounding a 14 bit midamble. Three tail bits are added to each side and includes a guard time of 8,25 bit durations.

5) High Margin Burst (HB) or M-Sequence Burst (HDB or HMB): this burst is used to carry a known pattern of bits for the S-HMSCH. It consists of 148 bits based on a defined pattern (either a dotting sequence or an M-sequence) and a guard time of 8,25 bit durations.

6) Frequency and Time Correction Burst (FTCB): This burst is used for the initial new channel transmission from both the MES and the Gateway.

A diagram of these bursts appears in figure 7.1.1. The HDB, HMB, and FTCB bursts correspond to a sequence of a 142-bit designated bit pattern, surrounded by 3 tail bits on either side, and with an 8,25 bit guard band.

NOTE: For additional information on High Margin Burst (HB) and M-Sequence Burst (HDB or HMB) refer to the figures in GMR-2 05.002 [8] clauses 7.2.9 and 7.2.10 respectively.

7.3 Channel Organization

The channel organization for the S-TCH's, S-SDCCH's, S-FACCH's, S-SACCH/C's, and S-SACCH/T's uses a 26-frame Multiframe and is 120 ms in duration. Twenty-four of these TDMA frames are used for traffic and two are used for in-band signalling (S-SACCH). The S-FACCH is transmitted by preempting information bits of the S-TCH bursts that support speech (see GMR-2 05.003 [9]).

The Multiframe for the control channels is 3 060/13 ms in duration and consists of 51 TDMA frames. A TDMA frame for both Traffic and Control is 120/26 ms in duration.

In the forward direction the TDMA frame consists of 8 time slots (burst periods). In the return, it consists of two time slots. It is organized as described in GMR-2 05.002 [8].

8 Coding and interleaving

A brief description of the coding schemes that are used for the logical channels mentioned in clause 4 is provided in table 6.1. For these channels the following operations are performed:

1) external coding (block coding);

2) internal coding (convolutional coding);

3) interleaving.

Coding for the basic voice channel (S-TCH/QBS) is based on a rate 1/2, 64-state punctured convolutional code with generator polynomials, as specified in GMR-2 05.003 [9]. Coding for the robust voice channel (S-TCH/HRS) is based on a rate 1/4, 64-state punctured convolutional code with generator polynomials, as specified in GMR-2 05.003 [9]. The associated and dedicated signalling channels (S-SACCH, S-FACCH, and S-SDCCH) are coded with a rate 1/2, 64-state convolutional code along with a Fire Code with generator polynomials, as specified in GMR-2 05.003 [9]. Robust versions of these channels use a 1/4-rate code. The data (and fax) channels (S-TCH/Q2.4) are coded with a rate 1/2, 64-state convolutional code with generator polynomials, as specified in GMR-2 05.003 [9]. Robust versions of these channels (S-TCH/HR2.4) use a 1/4-rate code.

The information bits in the other control channels (S-BCCH, S-AGCH, S-PCH) are coded with a rate 1/2, 16-state Convolutional code and a Fire Code with generator polynomials, as specified in GMR-2 05.003 [9]. The S-SCH channel is coded with a rate 1/2, 16-state Convolutional code, as specified in GMR-2 05.003 [9]. The S-RACH channel is coded with a rate 1/3, 64-state Convolutional Code, as specified in GMR-2 05.002 [8]. The S-HPACH and S-HBCCH channel are coded with a rate 1/2, 16-state Convolutional code, and a Walsh code, as specified in GMR-2 05.003 [9].

Interleaving dimensions for the communications channels are indicated in table 8.1.

Table 8.1: Coding and interleaving

Type of Channel	Bits/Block Data + Parity + Tail	Convolutional Code Rate	Coded Bits Per Block	Interleaving Depth
(S-TCH/HES)	Reserved	Reserved	Reserved	Reserved
(S-TCH/HRS) Class I & II Class III	78 (12 + 33) + (6 + 0) + 0 27 + 0 + 0	 1/4 (w/ 18 punc) Repeat	240 186 54	6 Bursts
(S-TCH/QBS) Class I & II Class III	78 (12 + 33) + (6 + 0) + 0 27 + 0 + 0	 1/2 (w/ 9 punc) -	120 93 27	3 Bursts
(S-TCH/ELS)	Reserved	Reserved	Reserved	Reserved
(S-TCH/F9.6)	Reserved	Reserved	Reserved	Reserved
(S-TCH/H4.8)	Reserved	Reserved	Reserved	Reserved
(S-TCH/HR2.4) (Note)	8 × 30 + 0 + 6	1/4 (w/ 24 punc)	960	22 Bursts
(S-TCH/Q2.4)	8 × 30 + 0 + 6	1/2 (w/ 12 punc)	480	11 Bursts
(S-SDCCH/HR)	Reserved	Reserved	Reserved	Reserved
(S-SDCCH/Q)	Reserved	Reserved	Reserved	Reserved
(S-SDCCH/E)	184 + 40 + 4 × 6	1/2 w/ 4 punc	480	4 Bursts
(S-FACCH/HES)	Reserved	Reserved	Reserved	Reserved
(S-FACCH/HRS)	184 + 40 + 4 × 6	1/4 (w/ 8 punc)	960	12 Bursts
(S-FACCH/HR2.4) (Note)	184 + 40 + 4 × 6	1/2 (w/ 8 punc)	960	22 Bursts
(S-FACCH/QBS)	184 + 40 + 4 × 6	1/2 (w/ 4 punc)	480	6 Bursts
(S-FACCH/Q2.4)	184 + 40 + 4 × 6	1/2 (w/ 4 punc)	480	11 Bursts
(S-FACCH/ELS)	Reserved	Reserved	Reserved	Reserved
(S-FACCH/H4.8)	Reserved	Reserved	Reserved	Reserved
(S-FACCH/F9.6)	Reserved	Reserved	Reserved	Reserved
(S-SACCH/TF)	184 + 40 + 4 × 6	1/2 w/ 4 punc	480	4 Bursts
(S-SACCH/TH)	184 + 40 + 4 × 6	1/2 w/ 4 punc	480	4 Bursts
(S-SACCH/THR)	184 + 40 + 4 × 6	1/4 w/ 8 punc	960	8 Bursts
(S-SACCH/TQ)	184 + 40 + 4 × 6	1/2 w/ 4 punc	480	4 Bursts
(S-SACCH/TE)	184 + 40 + 4 × 6	1/2 w/ 4 punc	480	4 Bursts
(S-SACCH/CHR)	Reserved	Reserved	Reserved	Reserved
(S-SACCH/CQ)	Reserved	Reserved	Reserved	Reserved
(S-SACCH/CE)	184 + 40 + 6	1/2	480	4 Bursts
(S-BCCH)	184 + 40 + 4	1/2	456	4 Bursts
(S-HBCCH)	194 10 + 4 184 + 40 4 × (56 + 6 + 4)	 1/2 & Walsh 1/2 & Walsh	 28/7 × 128 4 × [(133/7) × 128]	81 Bursts 4 Bursts 4 × 19 Bursts
(S-RACH)	28 + 6 + 6	1/3	120	N/A
(S-PCH)	184 + 40 + 4	1/2	456	4 Bursts
(S-AGCH)	184 + 40 + 4	1/2	456	4 Bursts
(S-HPACH) (IMSI)	53 + 5 + 0 10 + 4 48 + 4	1/2 & Walsh 1/2 & Walsh	133/7 × 128 28/7 × 128 105/7 × 128	19 Bursts 4 Bursts 15 Bursts
(S-HPACH) (TMSI) (Note)	30 + 4 + 0 10 + 4 24 + 4	 1/2 & Walsh 1/2 & Walsh	133/7 × 128 28/7 × 128 56/7 × 128	12 Bursts 4 Bursts 8 Bursts
(S-SCH)	25 + 10 + 4	1/2	78	N/A
(S-BBCH) (Note)	Refer to GMR-2 05.00 [9]	Refer to GMR-2 05.003 [9]	Refer to GMR-2 05.003 [9]	Refer to GMR-2 05.003 [9]
(S-PCH/R)	Reserved	Reserved	Reserved	Reserved
(S-AGCH/R)	Reserved	Reserved	Reserved	Reserved
NOTE: Implementation of this channel is optional				

9 Modulation

In the forward direction (Ground Station-to-MES) the modulation is filtered OQPSK (Offset Quadrature Phase Shift Keying). The filtering characteristic is a square root raised cosine with a rolloff of 0,35. In the return direction (MESto-Ground Station) the modulation is GMSK (Gaussian Minimum Shift Keying) with a BT of 0,3. GMSK is precoded in the same manner as specified in standard GSM. In single hop MES-to-MES links, MESs will transmit GMSK as in the case of MES-to-Ground Station modulation. In single hop MES-to-MES links, the MESs will receive GMSK for the S-TCH and S-FACCH as in the case of MES-to-Ground Station modulation, and OQPSK for the S-SACCH as in the case of Ground Station-to-MES modulation.

As mentioned previously the modulation rate is ≈ 270,83 kbit/s (1 625/6 kbit/s) in the forward direction (MES receive) and ≈ 67,708 kbit/s (1 625/24 kbit/s) in the return (MES transmit). This scheme is specified in detail in GMR-2 05.004 [10] (Modulation and Demodulation).

10 Transmission and reception

The modulated stream is then transmitted on a radio frequency carrier. The frequency bands and channel arrangement are as follows:

L-band Frequencies: Forward D/L: 1 525,0 MHz to 1 559,0 MHz Right Hand Circular Polarization, as defined by ANSI/IEEE Std. 149-1979 [14]
Return U/L: 1 626,5 MHz to 1 660,5 MHz Right Hand Circular Polarization, as defined by ANSI/IEEE Std. 149-1979 [14]

C-band Frequencies: Forward U/L: 6 425,0 MHz to 6 725,0 MHz Linear Horizontal Polarization, as defined by ANSI/IEEE Std. 149-1979 [14]
Return D/L: 3 400,0 to 3 700,0 MHz Linear Vertical Polarization, as defined by IEEE Std. 149-1979 [14]

The carrier spacing is 200 kHz on the forward link. The carrier spacing is 50 kHz on the return link.

The carrier frequency is designated by the absolute radio frequency channel number (ARFCN) defined as nL for the L-Band channels and can be defined as nC for feeder link operation at C-Band. In addition, for the return links the definition of the carrier frequency also requires specification of the TN (Time slot Number). Therefore, if we call Fl(n) the frequency of the carrier n in the lower band, Fu(n) the corresponding frequency value in the upper band, and FO the frequency offset, we have:

a) L-Band User-Satellite Links:
   $FlL(nL) = 1\,525,1 + nL \times 0,2$ for $0 < nL < 169$, FO = 0
   $FlL(nL) = 1\,525,1 + nL \times 0,2 + 0,075$ for $0 < nL < 168$, FO = 1
   $FuL(nL,TN) = FlL(nL) + 101,425 + (TN \text{ modulo } 4) \times 0,05$

b) As an example, for C-Band Ground-Satellite Links:
   $FuC(nc) = 6\,425,1 + nc \times 0,2$ for $0 < nc < 1\,499$
   $FlC(nc,k) = FuC(nC) - 3\,025,075 + (TN \text{ modulo } 4) \times 0,05$

Frequencies are in MHz.

The output powers for each transmitter and the corresponding G/T at each receiver is specified in GMR-2 05.005 [11].

The specific RF channels, together with the requirements on the transmitter and the receiver will be found in GMR-2 05.005 [11] (Transmission and Reception). The requirements on the overall transmission quality together with the measurement conditions are also in GMR-2 05.005 [11].

11 Other Layer 1 Functions

The transmission involves other functions. These functions may necessitate the handling of specific protocols between the Gateway and MES. Relevant topics for these cases are:

1) The power control mechanisms which adjust the output level of the Mobile Earth Station (and of the Gateway) in order to ensure that the required quality is achieved with the least possible radiated power. Power levels with steps have been defined for that purpose as described in GMR-2 05.008 [12] (Radio Subsystem Link Control) and GMR-2 05.005 [11] (Transmission and Reception).

2) The synchronization of the receiver with regards to frequency and time (time acquisition and time frame alignment). The synchronization problems are described in GMR-2 05.010 [13] (Synchronization Aspects).

3) The measurements and sub-procedures used in the first selection or reselection of a satellite spotbeam by a MES are specified in GMR-2 05.008 [12] (Radio Subsystem Link Control). The overall selection and reselection procedures, together with the idle mode activities of a mobile are defined in GMR-2 03.022 [4] (Functions Related to MES in Idle Mode).

Annex A (informative): Reference configuration

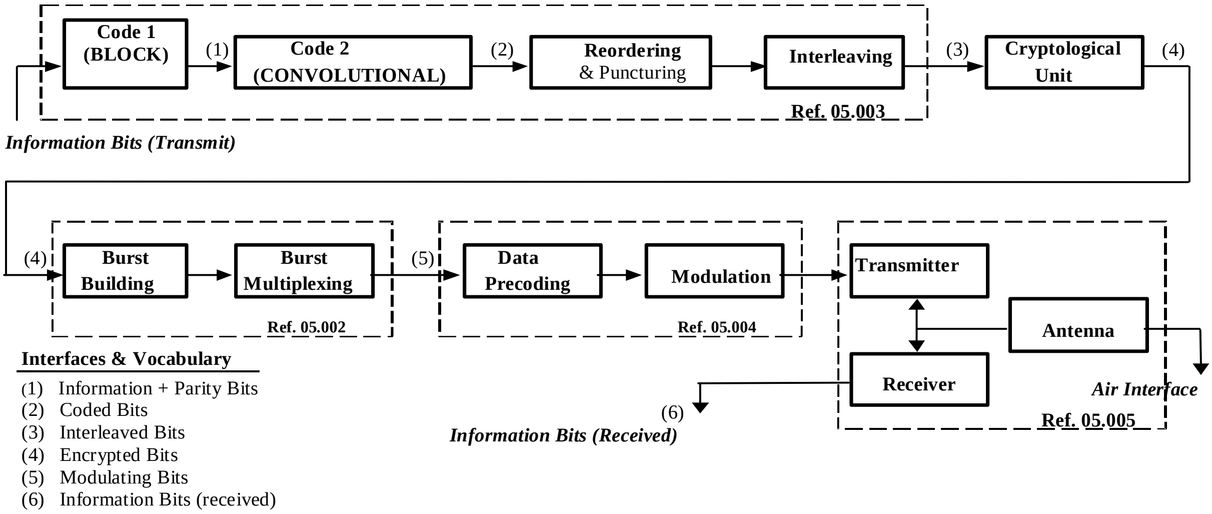

Figure A.1: Relationship of GMR-2 05-series documents to air interface functionality

Annex B (informative): Relations between specifications

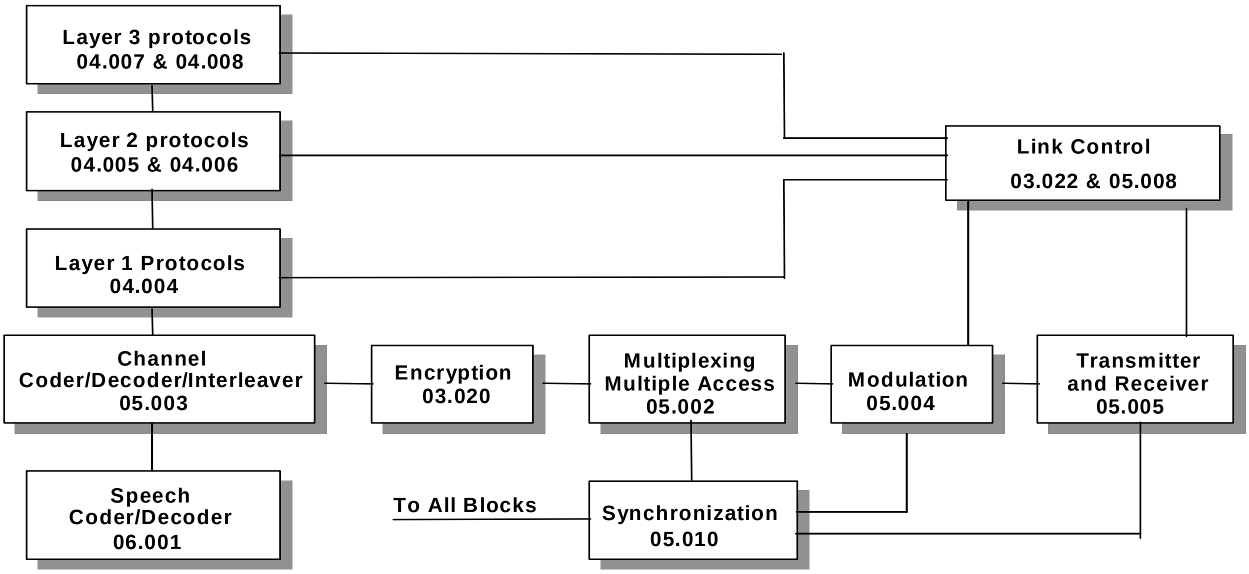

Figure B.1: Relationship of GMR-2 05-series documents to other air interface

History

Document history		
V1.1.1	March 2001	Publication