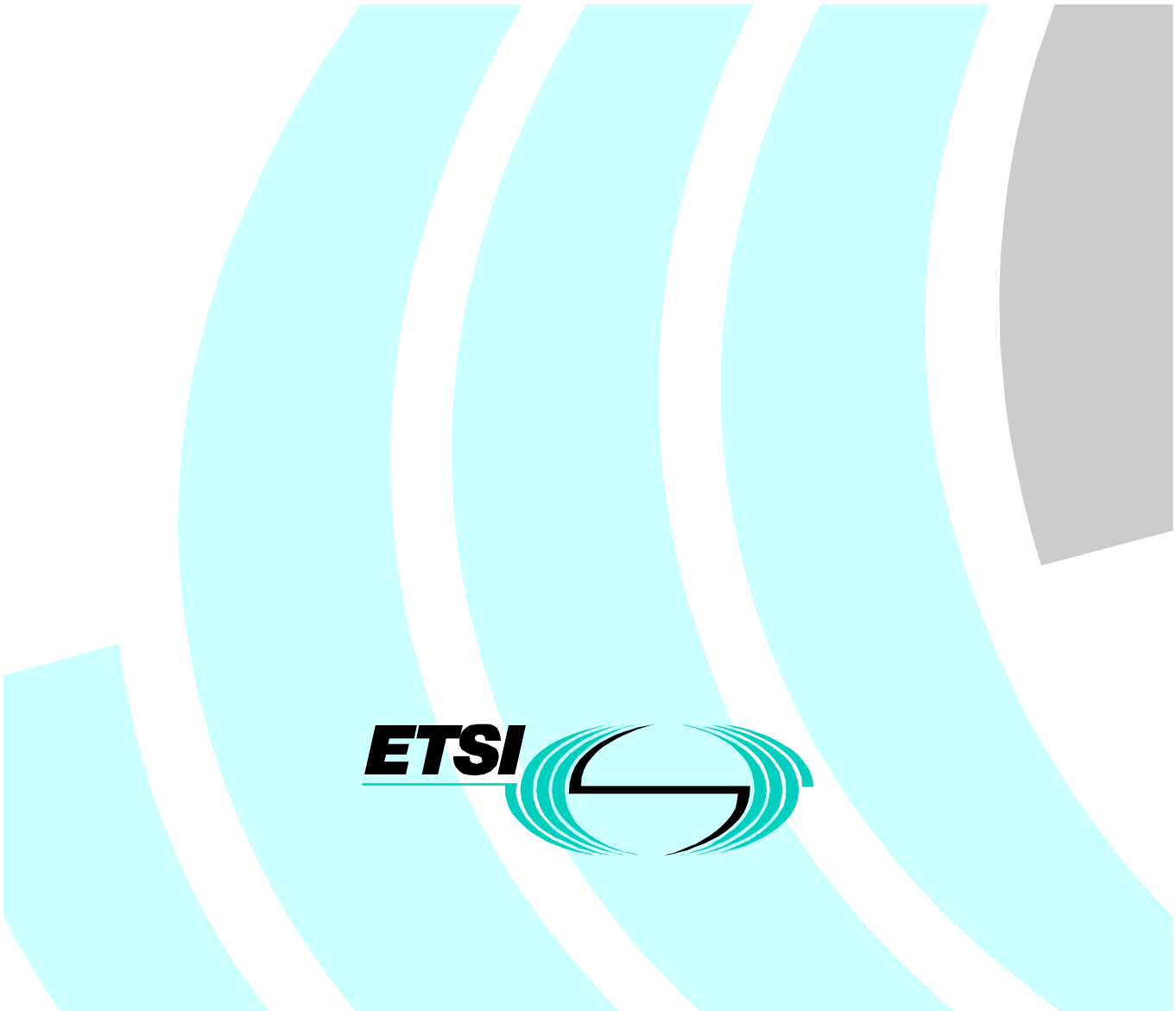
ETSI TS 101 376-6-1 V1.1.1 (2001-03)

Technical Specification

GEO-Mobile Radio Interface Specifications;
Part 6: Speech coding specifications;
Sub-part 1: Speech Processing Functions;
GMR-1 06.001



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Contents

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IPRs:

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 376 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	GB	GB 2 215 567	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 376 V1.1.1	Ericsson Mobile Communication	Transmitter Power Control for Radio Telephone System	GB	GB 2 233 517	GB

IPR Owner: Ericsson Mobile Communications (UK) Limited
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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Hughes Network Systems		US	Pending	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	2.4-to-3 KBPS Rate Adaptation Apparatus for Use in Narrowband Data and Facsimile Communication Systems	US	US 6,108,348	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic ThroughputCellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Enhanced Access Burst for Random Access Channels in TDMA Mobile Satellite System	US	US 5,875,182	
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-argin Forward Control Signals	US	US 6,072,985	US
TS 101 376 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Spot Beam Pairing for Reduced Updates	US	US 6,118,998	US

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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 6, 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";

Part 6: "Speech coding specifications";

Sub-part 1: "Speech Processing Functions; GMR-1 06.001";

Sub-part 2: "Vocoder: Speech Transcoding; GMR-1 06.010";

Sub-part 3: "Vocoder: Substitution and Muting of Lost Frames; GMR-1 06.011";

Sub-part 4: "Vocoder: Comfort Noise Aspects; GMR-1 06.012";

Sub-part 5: "Vocoder: Discontinuous Transmission (DTX); GMR-1 06.031";

Sub-part 6: "Vocoder: Voice Activity Detection (VAD); GMR-1 06.032";

Part 7: "Terminal adaptor specifications".

Introduction

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for mobile satellite services (MSS) utilizing geostationary satellite(s). GMR is derived from the terrestrial digital cellular standard GSM and supports access to GSM core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM standard are necessary. Some GSM specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM specifications do not apply, while some GMR specifications have no corresponding GSM specification.

Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. The GMR numbers have been designed to correspond to the GSM numbering system. All GMR specifications are allocated a unique GMR number as follows:

GMR-n xx.zyy

where:

xx.0yy (z=0) is used for GMR specifications that have a corresponding GSM specification. In this case, the numbers xx and yy correspond to the GSM numbering scheme.

xx.2yy (z=2) is used for GMR specifications that do not correspond to a GSM specification. In this case, only the number xx corresponds to the GSM numbering scheme and the number yy is allocated by GMR.

n denotes the first (n=1) or second (n=2) family of GMR specifications.

A GMR system is defined by the combination of a family of GMR specifications and GSM specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM specification (if any). This precedence rule applies to any references in the corresponding GSM specifications.

NOTE: Any references to GSM specifications within the GMR specifications are not subject to this precedence rule. For example, a GMR specification may contain specific references to the corresponding GSM specification.

- If a GMR specification does not exist, the corresponding GSM specification may or may not apply. The applicability of the GSM specifications is defined in GMR-1 01.201 [10].

1 Scope

The present document is an introduction to the GMR-1 06-series of technical specifications, which deal with the speech processing systems functions in the GMR-1 System. A general overview of each speech processing function is given with reference to the technical specification where each part is specified in detail.

2 References

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

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

[1] GMR-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and acronyms; GMR-1 01.004".

[2] GMR-1 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; GMR-1 05.003".

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

[4] GMR-1 06.010 (ETSI TS 101 376-6-2): "GEO-Mobile Radio Interface Specifications; Part 6: Speech coding specifications; Sub-part 2: Vocoder: Speech Transcoding; GMR-1 06.010".

[5] GMR-1 06.011 (ETSI TS 101 376-6-3): "GEO-Mobile Radio Interface Specifications; Part 6: Speech coding specifications; Sub-part 3: Vocoder: Substitution and Muting of Lost Frames; GMR-1 06.011".

[6] GMR-1 06.012 (ETSI TS 101 376-6-4): "GEO-Mobile Radio Interface Specifications; Part 6: Speech coding specifications; Sub-part 4: Vocoder: Comfort Noise Aspects; GMR-1 06.012".

[7] GMR-1 06.031 (ETSI TS 101 376-6-5): "GEO-Mobile Radio Interface Specifications; Part 6: Speech coding specifications; Sub-part 5: Vocoder: Discontinuous Transmission (DTX); GMR-1 06.031".

[8] GMR-1 06.032 (ETSI TS 101 376-6-6): "GEO-Mobile Radio Interface Specifications; Part 6: Speech coding specifications; Sub-part 6: Vocoder: Voice Activity Detection (VAD); GMR-1 06.032".

[9] Digital Voice Systems, Inc. http://www.dvsinc.com/.

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

3 Definitions and abbreviations

3.1 Definitions

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

Voice Activity Detection (VAD): method of classifying short segments of speech as either "voice" or "background noise." The decision is based upon comparing the current level and spectral characteristics of the input signal with that of a typical level and spectral characteristics

Comfort Noise Insertion (CNI): method of synthesizing low-level noise on the receive side during breaks in voice transmission. To increase the perceived voice quality, the synthesized noise has characteristics that are similar to the background noise present on the transmit side

Forward Error Correction (FEC): method of introducing redundancy to binary data that allows for the detection and/or correction of errors introduced during transmission of that data

V/UV(Voiced/Unvoiced): each spectral band is declared either "voiced" or "unvoiced", depending upon the amount of periodic energy in that band. This voicing decision is frequently referred to as a V/UV decision

frame: data representing a full 40 msec of continuous data input to or output from the vocoder. The frame data may consist of model parameters, quantized bits, FEC encoded channel data, or speech samples at various points in the vocoder

subframe: data representing 10 msec of continuous data input to or output from the vocoder, or the result of processing that data through various points in the vocoder. For example, "The second subframe of model parameters is passed to the quantizer" is a valid use of the term as is "The decoder outputs one subframe of 8 kHz speech samples"

subframe number: each frame is composed of four consecutive subframes that are each assigned a subframe number. The first, second, third, and fourth subframes within a frame are assigned subframe numbers 0, 1, 2, and 3 respectively

quantizer-frame: data representing the 20 msec of continuous vocoder data that is formed by combining subframes 0 and 1 or subframes 2 and 3

quantizer-frame number: each frame is composed of two consecutive quantizer-frames that are each assigned a quantizer frame number. The first and second quantizer-frames within a frame are assigned quantizer-frame numbers 0 and 1 respectively

voice frame: 40-msec frame that contains some voice data but no tone data. It may also contain comfort noise data

SID frame: (Silence Descriptor): 20-msec frame that contains only comfort noise data. No voice or tone data may be present in a SID frame

tone frame: 40-msec frame that contains tone data. It may also contain voice data or comfort noise data

3.2 Abbreviations

Abbreviations used in the present document are listed in GMR-1 01.004 [1].

4 Introduction

The speech processing functions in the GMR-1 system include the following.

Speech transcoding, which includes a speech encoder that converts digitized speech samples into a compressed binary bit stream and a speech decoder that converts a compressed binary bit stream into digital speech samples.

Discontinuous transmission (DTX), which is used to reduce the transmission rate during periods of voice inactivity.

VAD, which is used to identify periods of voice activity, as required by DTX.

CNI, which is used to convey the characteristics of the background noise from the transmit end to the receive end of the connection, in an effort to reduce the modulation of background noise that would otherwise occur with DTX.

Lost speech frame substitution and muting, which is used to mask transmission errors and stolen frames.

Detection and regeneration of single-frequency and dual-tone multifrequency (DTMF) signals.

All of the above functions are integrated into the GMR-1 5,2 kbps Version 1 vocoder [9].

5 Speech transcoding

Speech transcoding is described in GMR-1 06.010 [4].

The speech encoder takes 16-bit uniform pulse code modulation (PCM) samples as input. One frame of encoded speech consists of two quantizer-frames, which each contain 80 bits. The encoded speech at the output of the voice encoder is delivered to the channel coding function defined in GMR-1 05.003 [2] to produce an encoded frame consisting of two quantizer-frames, each containing 104 bits. The vocoder therefore produces a gross bit rate of 5,2 kbps where 4,0 kbps are used for voice data and the remaining 1,2 kbps are used for error control.

In the receive direction, the inverse operation takes place.

The GMR-1 system utilizes a 40-msec frame size and employs the vocoder. The vocoder accepts 160 ± 8 samples, at a sampling rate of 8 000 samples per second, in each 20-msec frame. The voice encoder processes the samples in 80 ± 4 sample segments. These 10 ms segments are called subframes, and each 20-msec frame is divided into two subframes. The voice encoder must process two successive 10-msec subframes before it outputs any encoded data. The encoded data is output at 20-msec intervals, called quantizer-frames.

6 Discontinuous transmission (DTX)

Discontinuous transmission is described in GMR-1 06.031 [7].

During a normal conversation, the talkers alternate so that, on average, each direction of transmission is occupied about 50 % of the time. Discontinuous transmission (DTX) is a mode of operation where the transmitters are switched on only for those frames that contain useful information, which may be done for the following purposes:

- in a mobile earth station the battery life would be prolonged or a smaller battery could be used for a given operational duration, due to decreased power requirements;
- to reduce the average interference level on the "air," leading to better system performance;
- to provide better link margin in the system;
- the overall DTX mechanism is implemented in the TX and RX DTX handlers described in GMR-1 06.031 [7] and requires the following functions, which are described in separate technical specifications;
- a VAD on the transmit side;
- evaluation of the background acoustic noise on the transmit side, in order to transmit characteristic parameters to the receive side;
- generation on the receive side of a similar noise, called comfort noise, during periods where the radio transmission is cut.

The above functions are all integral to the vocoder.

The transmission of comfort noise information to the receive side is achieved by means of a special SID frame. A SID frame is a 104-bit quantizer-frame representing a 20-msec segment that contains no voice activity. A SID frame is contained within the final 40-msec frame of a voice burst, and serves as an end of voice marker at the receive side. In order to update the comfort noise characteristics at the receive side, SID frames are continuously transmitted during periods of voice inactivity but at a much lower data rate (100 bps). The actual transmission aspects of the SID frame on the radio link are described in GMR-1 05.008 [3].

For the overall DTX functionality, the DTX handlers use various flags to interface with the radio subsystem, which is in control of the transmitter keying on the TX side and performs preprocessing functions on the RX side, as also described in GMR-1 06.031 [7].

7 Voice activity detection (VAD)

Voice activity detection (VAD) is described in GMR-1 06.032 [8].

The VAD is an integral part of the voice encoder described in GMR-1 06.010 [4]. The VAD is used to determine which frames contain voice activity and which frames contain only background noise. The VAD outputs a flag that is passed to the TX DTX handler.

8 Comfort noise aspects

Comfort noise aspects are described in GMR-1 06.012 [6].

When switching the transmission on and off during DTX operation, the effect would be a modulation of the background noise if no precautions were taken. When transmission is on, the background noise is transmitted together with the speech to the receiving end. As the speech burst ends, the connection is off and the perceived noise would drop to a very low level. This step modulation of noise is perceived as very annoying and may reduce the intelligibility of speech if presented to the listener without modification.

This noise contrast effect is reduced in the GMR-1 system by inserting an artificial noise, called comfort noise, at the receiving end when speech is absent.

The CNI functions are integral to the vocoder as described in GMR-1 06.010 [4]. The CNI functions handle the following CNI tasks:

- the evaluation of the spectral characteristics of the background noise at the transmitter;
- encoding and decoding the noise information in SID frames;
- generation of similar noise at the receive end.

9 Lost speech frame substitution and muting

Lost speech frame substitution and muting is described in GMR-1 06.011 [5].

In the receiver, frames may be lost due to transmission errors or frame stealing. GMR-1 06.011 [5] describes the actions to be taken in these cases, both for lost speech frames and lost SID frames during DTX operation.

In order to hide the effects of an isolated lost frame, a predicted frame that is based upon previously received frames replaces the lost frame. When multiple consecutive frames are lost, muting is employed in order to indicate to the user at the receiving end that the transmission is interrupted.

History

Document history		
V1.1.1	March 2001	Publication