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Technical Specification

Satellite Earth Stations and Systems (SES);
Air Interface for S-band Mobile Interactive Multimedia (S-MIM);
Part 3: Physical Layer Specification,
Return Link Asynchronous Access

Reference
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Keywords
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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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

The present document is part 3 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.11].

Introduction

The S-MIM system specified herein is designed to provide:

- Interactive mobile broadcast services enhancing DVB-SH services.
- Messaging services for handhelds and vehicular terminals, capable of serving millions of terminals due to a novel optimized radio-interface in the RTN link.
- Real-time emergency services such as voice and file transfer, mainly addressing institutional users on-the-move such as fire brigades, civil protection, etc.

Inside the S-band, the 2 GHz MSS band is of particular interest for interactive multimedia, since it allows two-way transmission. Typically, the DVB-SH standard [i.7] is applied for broadcast transmission; ETSI SDR [i.3] or DVB-NGH [i.8] standards are other alternatives. Essential requirements under the R&TTE directive are covered by the harmonized standard EN 302 574 [i.4], [i.5] and [i.6].

The technology applied has been developed in the framework of the ESA funded project "DENISE" (ESTEC/Contract Number 22439/09/NL/US).

1 Scope

The present document specifies the S-MIM (S-band Mobile Interactive Multimedia) system in which a standardized S-band satellite mobile broadcast system is complemented by the addition of a return channel

The present document is part 3 of the multi-part deliverable and concerns aspects of the air interface for the S-band Mobile Interactive Multimedia (S-MIM) system, and in particular it specifies the Physical Layer for Return Link Asynchronous Access.

The other parts are listed in the foreword of part 1 [i.11].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 102 721-6: "Satellite Earth Stations and Systems (SES); Air interface for S-band Mobile Interactive Multimedia (S-MIM); Part 6: Protocol Specifications, System Signalling".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IEEE Journal on Selected Areas in Communications: "Bandlimited Quasi-Synchronous CDMA: A Novel Satellite Access Technique for Mobile and Personal Communications Systems", R. De Gaudenzi, C. Elia, R. Viola, 1992.

[i.2] Patent: US201 010054131 A 1: "Methods, Apparatuses and System for Asynchronous Spread-Spectrum Communication".

[i.3] ETSI EN 302 550 (all parts and sub-parts): "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems".

[i.4] ETSI EN 302 574-1: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 1: Complementary Ground Component (CGC) for wideband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.5] ETSI EN 302 574-2: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 2: User Equipment (UE) for wideband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.6] ETSI EN 302 574-3: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 3: User Equipment (UE) for narrowband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.7] ETSI TS 102 585: "Digital Video Broadcasting (DVB); System Specifications for Satellite services to Handheld devices (SH) below 3 GHz".

[i.8] DVB BlueBook A160: "Next Generation broadcasting system to Handheld, physical layer specification (DVB-NGH)".

[i.9] ETSI TS 125 212: "Universal Mobile Telecommunications System (UMTS); Multiplexing and channel coding (FDD) (3GPP TS 25.212)".

[i.10] ETSI TS 125 213: "Universal Mobile Telecommunications System (UMTS); Spreading and modulation (FDD) (3GPP TS 25.213)".

[i.11] ETSI TS 102 721-1: "Satellite Earth Stations and Systems (SES); Air Interface for S-band Mobile Interactive Multimedia (S-MIM); Part 1: General System Architecture and Configurations".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

2 GHz MSS band: 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands

NOTE: These paired bands are assigned to MSS.

architecture: abstract representation of a communications system

NOTE: Three complementary types of architecture are defined:

- Functional Architecture: the discrete functional elements of the system and the associated logical interfaces.
- Network Architecture: the discrete physical (network) elements of the system and the associated physical interfaces.
- Protocol Architecture: the protocol stacks involved in the operation of the system and the associated peering relationships.

collector: terrestrial components that "collect" return link transmissions from terminals and forward them towards the ground segment

control plane: plane that has a layered structure and performs the call control and connection control functions; it deals with the signalling necessary to set up, supervise and release calls and connections

repeater: terrestrial components that (mainly) repeat the satellite signal in the forward link

S-band: equivalent to 2 GHz MSS band

3.2 Symbols

For the purposes of the present document, the following symbols apply:

N_0 Single-sided noise power spectral density
I_0 Single-sided interference power spectral density

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACK	Acknowledgement signalling
ACLR	Adjacent Channel Leakage power Ratio
C	number of Columns
C	Received signal (carrier) power
CDMA	Code Division Multiple Access
CGC	Complementary Ground Component
CRC	Cyclic Redundancy Check
DL	Down-Link
DVB-SH	Digital Video Broadcasting, Satellites services to Handhelds
EIRP	Effective Isotropic Radiated Power
FEC	Forward Error Correction
FL	Forward-Link
GF	Gallois Field
GW	Gateway
LOS	Line Of Sight
ML	Maximal Length
MSB	Most Significant Bit
MSS	Mobile Satellite Services
OVSF	Orthogonal Variable Spreading Factor
PCCC	Parallel Concatenated Convolutional Code
PCCH	Physical Control Channel
PDCH	Physical Data Channel
PN	Pseudo-Noise
PPM	Parts Per Million
RACH	Random Access Channel
RF	Radio Frequency
RL	Return-Link
RTN	Return (link)
Rx	Receive
SAT	SSA Access Table
SCT	SSA Configuration Table
SDR	Satellite Digital Radio
SDT	SSA Dynamic Configuration Table
SF	Spreading Factor
S-MIM	S-band Mobile Interactive Multimedia
SNR	Signal to Noise Ratio
SRRC	Square Root Raised Cosine
SSA	Spread Spectrum Aloha
TFI	Transport Format Indication
TTI	Transmission Time Interval
Tx	Transmitter
UL	Up-Link
ULB	Up-Link Burst
WCDMA	Wideband CDMA

4 General description

The present document specifies the physical layer for the Asynchronous Access option of the Return Link using the Spread Spectrum Aloha (SSA) technique [i.1] and [i.2].

The present document has similarities with 3GPP specifications [i.9], [i.10] and the differences are described.

The present document covers the Return-Link (RL) satellite transmission and the Up-Link (UL) transmission to the terrestrial collectors. Although different configurations and parameters may apply to the RL and to UL, the radio interface is in both cases the one defined in the present document.

S-MIM asynchronous access is intended for access to interactive messaging services, since it does not require coordination between users thus minimizing the signalling overhead required for the access control. Other advantages of S-MIM asynchronous access are:

- Ability for the space segment to operate with full frequency reuse. This will contribute to further improvement of the system efficiency.
- Feasibility of band sharing with other access schemes due to the spread spectrum characteristics.

4.1 Relationship to other layers

4.1.1 General Protocol Architecture

The overall protocol architecture for the return link of S-MIM asynchronous access is shown in Figure 4.1.

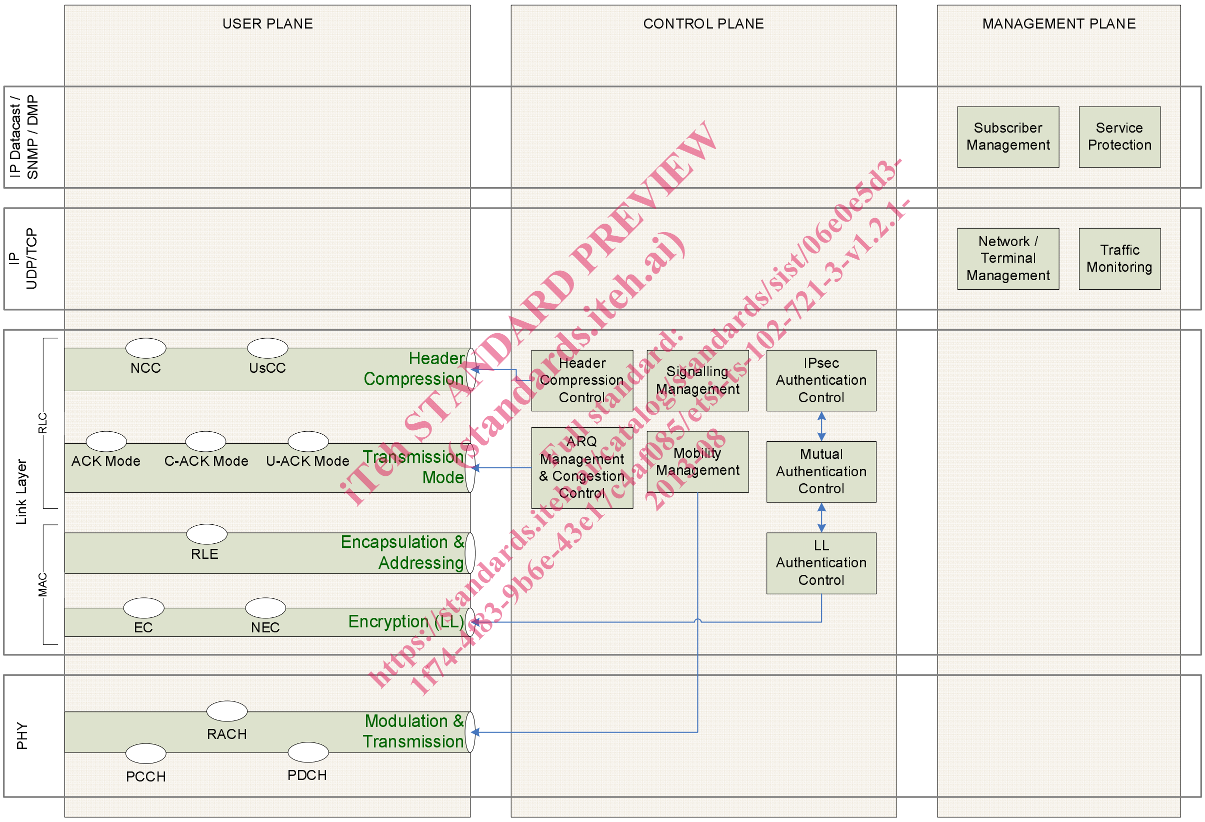

Figure 4.1: Protocol Architecture for the Asynchronous Return Link

The circles between different layer/sub-layers indicate Service Access Points (SAPs).

The physical layer provides an interface to the Medium Access Control (MAC) sub-layer via Transport channel(s). A transport channel is characterized by how and which information is transferred over the radio interface.

Physical Channels are defined in the physical layer and are characterized by the physical resources (time, frequency, code, and space) that are used to transport data/control/signalling to/from a single user or a multitude of users.

The Control Plane is concerned with all aspects of signalling, for example the signalling of the Return Link scrambling sequence to the user terminal as described in TS 102 721-6 [1].

The present document is concerned with the Physical Layer.

4.1.2 Services provided to higher layers

The physical layer offers data transport services to higher layers. The physical layer is expected to perform the following functions in order to provide the data transport service:

- Error detection on transport channel and indication to higher layers.
- FEC encoding/decoding of transport channels.
- Rate matching of coded transport channel to physical data channel.
- Mapping of coded transport channel on physical data channel.
- Power weighting and combining of physical channels.
- Modulation and spreading/demodulation and de-spreading of physical channels.
- Frequency and time (chip, bit, burst) synchronization.
- Radio characteristics measurements and indication to higher layers (for further study).
- RF processing.

4.2 Transmitter functional architecture

In the transmission direction Physical Layer functional block diagram is shown in Figure 4.2.

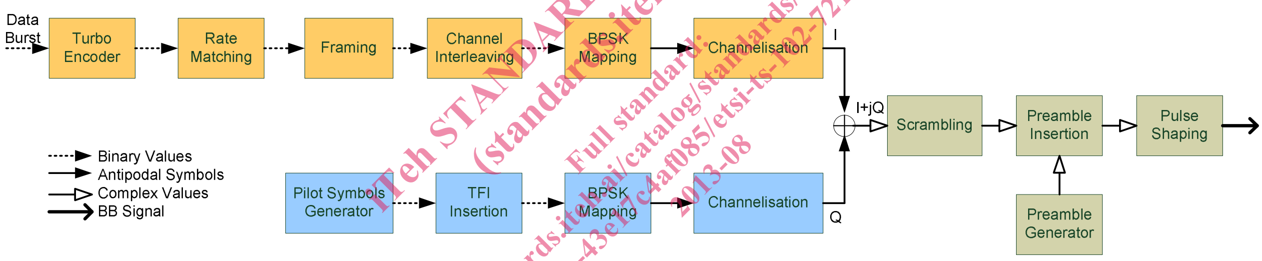

Figure 4.2: Transmitter Functional Block Diagram

4.3 Channel descriptions

4.3.1 Transport channel

There is a single transport channel: the Random Access Channel (RACH). The RACH is characterized by limited size data burst length, a collision risk and by the use of open loop power control.

Three possible nominal sizes of the RACH data burst length are supported, namely 300, 600 and 1 200 bits. Depending on the effective size of the RACH data burst length and of the size of the optional CRC, rate matching will be performed after FEC encoding.

NOTE: It is recommended to keep the effective size of the RACH data burst length within ±10 % of the nominal sizes.

4.3.2 Physical channels

Two physical channels are defined, namely the PDCH (Physical Data Channel) used to carry the RACH data burst and the PCCH (Physical Control Channel) used to carry physical layer signalling information. The PDCH and the PCCH are I/Q code multiplexed to form an Up-Link Burst (ULB), composed of three parts (Figure 4.3):

- a preamble;

- a Physical Data Channel (PDCH), uniquely determined by its chip rate, spreading factor and data burst length as detailed in clause 5.1;
- the Physical Control Channel (PCCH), uniquely determined by its chip rate as detailed in clause 5.2.

The preamble is transmitted before the start of the PDCH and PCCH.

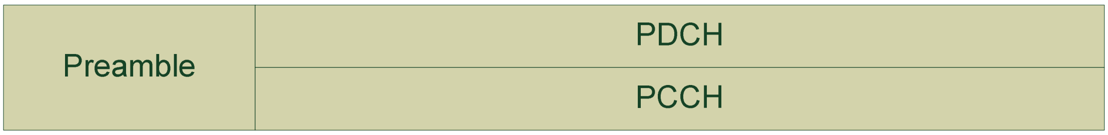

Figure 4.3: The Up-Link Burst and its constituent parts

The PDCH will carry the RACH data burst followed by an optional CRC defined in clause 5.1.1.

The PCCH carries physical layer signalling and reference symbols to allow coherent demodulation of the PDCH channel. The physical layer signalling conveys the Transport Format Indication (TFI) to the receiving side as defined in clause 5.2.1.

For Radio Channel details see clause 8.

5 Physical Channel Structure

5.1 PDCH structure

As shown in Figure 5.1, the PDCH data burst (after channel encoding according to clause 6.1), is divided into a variable number of frames ranging from 3 (Option 1) up to 24 (Option 4). Each frame has a fixed duration of 10 ms. The PDCH length (in time or, equivalently, in frames) is indicated with the term TTI (Transmission Time Interval).

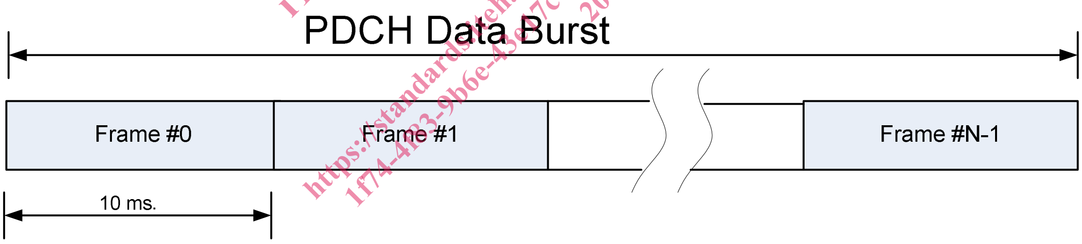

Figure 5.1: PDCH Composition

Figure 5.2 shows the structure of the 10 ms frame, which is split into 15 slots, each of length T_{slot} = 0,667 ms. Each slot consists of 10 × 2^k bits, where k=0 or 1 (k only equal to 0 for chip rate 240 kchip/s).

The set of allowed parameters of the PDCH is reported in Table 5.1. Note that the number of info bits reported in Table 5.1 is only indicative. Exploiting the rate matching mechanism, the code rate can be changed to accommodate variations in the RACH data burst length without impacting the PDCH data burst length. Clearly for not penalizing system performance it is expected that the code rate is not increased significantly above the 1/3 nominal code rate.

Rate matching as specified in clause 6.2 may thus be used to adapt the code rate to the RACH data burst length, as defined in TS 102 721-6 [1].