

Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Considerations on possible harmonization between A, C and G family Satellite Radio Interface features

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Foreword

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

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1 Scope

The present document identifies all differences and commonalities between the A, C and G family satellite radio interfaces (ITU-R Recommendation M.1457 [i.13]) in order to assess harmonization.

It also includes a synthetic view of new features proposed by SAT-CDMA and SW-CDMA vs W-CDMA radio interface and what are their expected benefits, with respect to the context (type of constellation and service requirements)

2 References

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The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

- [i.1] ETSI TS 101 851-1-2: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 1: Physical channels and mapping of transport channels into physical channels; Sub-part 2: A-family (S-UMTS-A 25.211)".
- [i.2] ETSI TS 101 851-2-2: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 2: Multiplexing and channel coding; Sub-part 2: A-family (S-UMTS-A 25.212)".

- [i.3] ETSI TS 101 851-3-2: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 3: Spreading and modulation; Sub-part 2: A-family (S-UMTS-A 25.213)".
- [i.4] ETSI TS 101 851-4-2: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 4: Physical layer procedures; Sub-part 2: A-family (S-UMTS-A 25.214)".
- [i.5] ETSI TS 101 851-1-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 1: Physical channels and mapping of transport channels into physical channels; Sub-part 1: G-family (S-UMTS-G 25.211)".
- [i.6] ETSI TS 101 851-2-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 2: Multiplexing and channel coding; Sub-part 1: G-family (S-UMTS-G 25.212)".
- [i.7] ETSI TS 101 851-3-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 3: Spreading and modulation; Sub-part 1: G-family (S-UMTS-G 25.213)".
- [i.8] ETSI TS 101 851-4-1: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 4: Physical layer procedures; Sub-part 1: G-family (S-UMTS-G 25.214)".
- [i.9] TTAS.KO-06.0090: "IMT-2000 SAT-CDMA - Physical channel and mapping of transport channels onto physical channels (Release A) (TTAE-3G-SAT-25.211)".
- [i.10] TTAS.KO-06.0091: "IMT-2000 SAT-CDMA - Multiplexing and channel coding (Release A) (TTAE-3G-SAT-25.212)".
- [i.11] TTAS.KO-06.0092: "IMT-2000 SAT-CDMA - Spreading and modulation (Release A) (TTAE-3G-SAT-25.213)".
- [i.12] TTAS.KO-06.0093: "IMT-2000 SAT-CDMA - Physical layer procedure (Release A) (TTAE-3G-SAT-25.214)".
- [i.13] ITU-R Recommendation M.1457-6: "Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".
- [i.14] ETSI TR 102 058: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Evaluation of the W-CDMA UTRA FDD as a Satellite Radio Interface".
- [i.15] ETSI TS 125 331: "Universal Mobile Telecommunications System (UMTS); RRC Protocol Specification (3G TS 25.331 version 3.3.0 Release 1999)".
- [i.16] IEEE Journal on Selected Areas in Communications, Vol. 19, No. 2, February 2001.
- [i.17] IEEE Journal on Selected Areas in Communications, Vol. 7, No.18, July 2000.
- [i.18] IEEE Journal on Selected Areas in Communications, Vol. 17, No. 2, February 1999.
- [i.19] ETSI TS 125 213: "Universal Mobile Telecommunications System (UMTS); Spreading and modulation (FDD) (3GPP TS 25.213)".
- [i.20] ETSI TS 125 214: "Universal Mobile Telecommunications System (UMTS); Physical layer procedures (FDD) (3GPP TS 25.214)".
- [i.21] TTAS.KO-06.0094: "Physical layer - measurements (Release A) (TTAE-3G-SAT-25.215)".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

SW-CDMA: satellite radio interface referenced as SRI-A of IMT-2000 satellite component at ITU-R Recommendation M.1457 [i.13]

NOTE: The SW-CDMA radio interface was produced by the ETSI SES Technical Committee as S-UMTS A-family standard.

W-CDMA: satellite radio interface referenced at SRI-G of IMT-2000 satellite component at ITU-R Recommendation M.1457 [i.13]

NOTE: The W-CDMA radio interface was produced by the ETSI SES Technical Committee as S-UMTS G-family standard.

SAT-CDMA: satellite radio interface referenced at SRI-C of IMT-2000 satellite component at ITU-R Recommendation M.1457 [i.13]

NOTE 1: The SAT-CDMA was produced by TTA of Korea.

NOTE 2: These radio interfaces are based on the FDD mode of UTRA defined by 3GPP Technical Specifications and adapted for operation over satellite transponders.

3.2 Symbols

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

r	code rate
K	constraint length
R	number of rows for a block interleaver
C	number of columns for a block interleaver

3.3 Abbreviations

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

AI	Acquisition Indicator
AICH	Acquisition Indicator Channel
AP	Access Preamble
APA	aAccess Preamble Acquisition
APA/CD/CA-ICH	Access Preamble Acquisition/Collision Detection/Channel Assignment-Indicator Channel
API	Access Preamble acquisition Indicator
BCH	Broadcast CHannel
BSDT	Beam Selection Diversity Transmission
CA	Channel Assignment
CAI	Channel Assignment Indicator
CCC	CPCH Control Command
CCTrCH	Coded Composite Transport CHannel
CD	Collision Detection
CDI	Collision Detection Indicator
CDP	Collision Detection Preamble
CLPC	Closed Loop Power Control
CPCH	Common Packet CHannel
CPCH-CCPCH	CPCH-Common Control Physical CHannel
CPICH	Common Pilot Channel
CRC	Cyclic Redundancy Check
CSICH	CPCH Status Indicator Channel

DL	Downlink
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DS	Direct Spread
DTX	Discontinuous Transmission
FACH	Forward Access Channel
FBI	FeedBack Information
FSW	Frame Synchronization Word
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
I	I-branch
LC	Long Code
LEO	Low Earth Orbit
MAC	Medium Access Control
MUD	MultiUser Detection
MSS	Mobile Satellite Service
NACK	Negative ACKnowledgment
NI	Notification Indicator
OLPC	Open Loop Power Control
OVSF	Orthogonal Variable Spreading Factor
P-CCPCH	Primary Common Control Physical Channel
PCH	Paging Channel
PCPCH	Physical Common Packet Channel
PDSCH	Physical Downlink Shared Channel
PG	Processing Gain
PhCH	Physical Channel
PHPPCH	Physical High Penetration Paging Channel
PI	Paging Indicator
PICH	Paging Indicator Channel
PRACH	Physical Random Access Channel
PSC	Primary Synchronization Code
RAN	Radio Access Network
RLC	Radio Link Control
RRC	Radio Resource Control
RSSI	Received Signal Strength Indicator
RTD	Round Trip Delay
SC	Short Code
S-CCPCH	Secondary Common Control Physical Channel
SCH	Synchronization Channel
SF	Spreading Factor
SFN	System Frame Number
SI	CPSH Status Indicator
SIR	Signal to Interference Ratio
SSC	Secondary Synchronization Code
SSDT	Site Selection Diversity Transmission
TF	Transport Format
TFC	Transport Format Combination
TFCI	Transport-Format Combination Indicator
TG	Transmission Gap
TPC	Transmit Power Control
TrBk	Transport Block
TrCH	Transport Channel
TTI	Transmission Time Interval
UE	User Equipment
UL	Uplink

4 Presentation of (S)W-CDMA and SAT-CDMA

4.1 SW-CDMA

SW-CDMA is a satellite radio interface designed to meet the requirements of the satellite component of the third generation (3G) wireless communication systems. The SW-CDMA radio interface was produced by TS 101 851.

SW-CDMA is based on the adaptation to the satellite environment of the IMT-2000 CDMA Direct Spread terrestrial radio interface (UTRA FDD or WCDMA). The intention is to reuse the same core network and reuse the radio interface specifications for the Iu and Cu interface. Only the Uu interface will be adapted to the satellite environment.

SW-CDMA operates in FDD mode with RF channel bandwidth of either 2,350 MHz or 4,700 MHz for each transmission direction.

SW-CDMA provides a wide range of bearer services from 1,2 kbit/s up to 144 kbit/s. High-quality telecommunication service can be supported including voice quality telephony and data services in a global coverage satellite environment. SW-CDMA deviation from the above-mentioned terrestrial radio interface are summarized hereafter:

- Maximum bit rate supported limited to 144 kbit/s.
- Permanent softer handover forward link operations for constellations providing satellite diversity.
- Permanent reverse link satellite diversity combining for constellations providing satellite diversity.
- Feeder link (gateway-satellite) and satellite to user link beam centre Doppler pre-compensation.
- Two-steps (instead of three-steps as terrestrial) forward link acquisition procedure.
- Introduction of a high-power paging channel for in-building penetration.
- Optional (not standard) use of pilot symbols in the communication channels.
- Reduced power control rate with multi-level predictive power control loop to cope with longer propagation delay.
- Shorter scrambling sequence length (2 560 chips) in the forward link.
- Optional use in the forward link of a short scrambling sequence (256 chips) to allow CDMA interference mitigation.
- Single user terminal level.
- Longer random access preamble sequence.

SW-CDMA offers a great degree of commonality with the terrestrial radio interface making the interoperability between the IMT-2000 terrestrial and the satellite components easier.

For the comparison, the present document refers to Technical Specification (TS) describing the SRI as follows:

- ETSI TS 101 851-1-2 [i.1].
- ETSI TS 101 851-2-2 [i.2].
- ETSI TS 101 851-3-2 [i.3].
- ETSI TS 101 851-4-2 [i.4].

4.2 W-CDMA

This satellite radio interface is also based on the W-CDMA UTRA FDD radio interface already standardized in 3GPP. Mobile satellite systems intending to use this interface will address user equipment fully compatible with 3GPP UTRA FDD W-CDMA, with adaptation for agility to the Mobile Satellite Service (MSS) frequency band.

The use of a 3GPP standardized technology as well as a satellite IMT-2000 frequency band adjacent to a terrestrial IMT-2000 frequency band allows to accommodate these MSS system's features in 3G handsets with no waveform modification and consequently low cost impact. This optimizes considerably the market entry and penetration.

The key service and operational features of the W-CDMA radio interface are following:

- Support for low data rate services (e.g. 1,2 kbps) up to high data rate transmission (384 kbps) with wide area coverage.
- High service flexibility with support of multiple parallel variable-rate services on each connection.
- Efficient packet access.
- Built-in Support for future capacity/coverage-enhancing technologies, such as adaptive antennas, advanced receiver structures, and transmitter diversity.
- Support of inter-frequency handover for operation with hierarchical cell structures and handover to other systems, including handover to GSM.

For the comparison, the present document refers to Technical Specification (TS) describing the SRI as followed:

- ETSI TS 101 851-1-1 [i.5].
- ETSI TS 101 851-2-1 [i.6].
- ETSI TS 101 851-3-1 [i.7].
- ETSI TS 101 851-4-1 [i.8].

4.3 SAT-CDMA

The SAT-CDMA is a satellite radio interface to provide the various advanced mobile telecommunications services defined for the IMT-2000 satellite environment with maximum data rate, 384 kbit/s. This system could be applied for LEO and GEO satellite for the global international communications.

The major technical scheme in SAT-CDMA is also wideband code division multiple access (W-CDMA) whose chip rate is 3.84 Mchip/s.

The system has a high degree of commonality with the terrestrial radio specification, IMT-2000 Direct Spread (DS), but it also has a number of different features. Those features, which are necessary to reflect the satellite-specific characteristics, such as long round trip delay and high Doppler shift, are implemented in the form of downlink synchronization, uplink packet access, and closed loop power control.

For the comparison, the present document refers to Technical Specification (TS) describing the SRI as followed:

- TTAS.KO-06.0090 [i.9].
- TTAS.KO-06.0091 [i.10].
- TTAS.KO-06.0092 [i.11].
- TTAS.KO-06.0093 [i.12].

5 Commonalties and differences

5.1 Introduction

This clause provides a short list with all the points of divergence identified in the analysis of the (S)W-CDMA and SAT-CDMA specifications. This list is intended as a guide to the more detailed comments provided in clauses 2 and 3. This means practically that in many cases an item covers several points of clauses 2 and 3. Additionally, this list is a pure description of the differences; where appropriate, a short technical discussion and a possible way of harmonization, are included in the comments of clause 2.

The following tables show the differences and commonalties between the draft specifications of (S)W-CDMA and SAT-CDMA, item-by-item.

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5.2 Commonalties and differences between SW-CDMA and SAT-CDMA

5.2.1 Physical channel structure

Table 1-1: Commonality in radio frame structure

Item ref.	Item	SW-CDMA	SAT-CDMA	Difference	Commonality
1.1.1	Radio frame	• 10 ms = 15 slots = 38 400 chips	• 10 ms = 15 slots = 38 400 chips	• There is no difference.	High
1.1.2	Time slot	• 2 560 chips	• 2 560 chips	• There is no difference.	High
Abbreviations					

Table 1-2: Commonality in the type of physical channels

Item ref.	Item	SW-CDMA	SAT-CDMA	Difference	Commonality
1.2.1	Uplink dedicated	DPDCH DPCCH	DPDCH DPCCH	• There is no difference.	High
1.2.2	Uplink common	PRACH	PRACH PCPCH	• SAT-CDMA offers the PCPCH for fast uplink packet-mode transmission.	Medium
1.2.3	Downlink dedicated	DPCH - DPDCH and DPCCH	DPCH - DPDCH and DPCCH	• There is no difference	High
1.2.4	Downlink common	SCH CPICH P-CCPCH S-CCPCH PDSCH PICH HPPICH	SCH CPICH P-CCPCH S-CCPCH CPCH-CCPCH PDSCH PICH AICH APA/CD/CA-ICH CSICH	<ul style="list-style-type: none"> • SAT-CDMA offers secondary SCH and AICH to assist mobile's beam search and uplink RACH transmission, respectively • SW-CDMA defines HPPICH for high penetration paging. • SAT-CDMA defines the indicator channels and the CPCH-CCPCH for supporting the uplink PCPCH. 	Medium
Abbreviations					
AICH - Acquisition Indicator Channel		PCPCH - Physical Common Packet Channel			
APA/CD/CA-ICH - Access Preamble Acquisition/Collision Detection/Channel Assignment - Indicator Channel		PDSCH - Physical Downlink Shared Channel			
CPCH-CCPCH - CPCH - Common Control Physical Channel		PICH - Paging Indicator Channel			
CPICH - Common Pilot Channel		PHPPCH - Physical High Penetration Paging Channel			
CSICH - CPCH Status Indicator Channel		PRACH - Physical Random Access Channel			
DPCH - Dedicated Physical Channel		P-CCPCH - Primary Common Control Physical Channel			
DPCCH - Dedicated Physical Control Channel		SCH - Synchronization Channel			
DPDCH - Dedicated Physical Data Channel		S-CCPCH - Secondary Common Control Physical Channel			