



**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 3: G-family enhancements  
(S-UMTS-G enhanced 25.211)**

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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 specifying the Satellite Radio Interface referenced as SRI Family G at ITU-R, in the frame of the modification of ITU-R Recommendation M.1457 [i.4]. This modification has been approved at ITU-R SG8 meeting in November 2005.

The present document is part 1, sub-part 3 of a multi-part deliverable covering Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; G-family enhancements as identified below:

**Part 1: "Physical channels and mapping of transport channels into physical channels";**

Sub-part 1: "G-family (S-UMTS-G 25.211)";

Sub-part 2: "A-family (S-UMTS-A 25.211)";

**Sub-part 3: "G-family enhancements (S-UMTS-G enhanced 25.211)";**

Part 2: "Multiplexing and channel coding";

Part 3: "Spreading and modulation";

Part 4: "Physical layer procedures";

Part 5: "UE Radio Transmission and Reception";

Part 6: "Ground stations and space segment radio transmission and reception".

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## Introduction

S-UMTS stands for the Satellite component of the Universal Mobile Telecommunication System. S-UMTS systems will complement the terrestrial UMTS (T-UMTS) and inter-work with other IMT-2000 family members through the UMTS core network. S-UMTS will be used to deliver 3<sup>rd</sup> generation Mobile Satellite Services (MSS) utilizing either geostationary (GEO), or low (LEO) or medium (MEO) earth orbiting satellite(s). S-UMTS systems are based on terrestrial 3GPP specifications and will support access to GSM/UMTS core networks.

NOTE 1: The term T-UMTS will be used in the present document to further differentiate the Terrestrial UMTS component.

Due to the differences between terrestrial and satellite channel characteristics, some modifications to the terrestrial UMTS (T-UMTS) standards are necessary. Some specifications are directly applicable, whereas others are applicable with modifications. Similarly, some T-UMTS specifications do not apply, whilst some S-UMTS specifications have no corresponding T-UMTS specification.

Since S-UMTS is derived from T-UMTS, the organization of the S-UMTS specifications closely follows the original 3<sup>rd</sup> Generation Partnership Project (3GPP) structure. The S-UMTS numbers have been designed to correspond to the 3GPP terrestrial UMTS numbering system. All S-UMTS specifications are allocated a unique S-UMTS number as follows:

S-UMTS-n xx.yyy

Where:

- The numbers xx and yyy correspond to the 3GPP-numbering scheme.
- n (n = A, B, C, etc.) denotes the family of S-UMTS specifications.

An S-UMTS system is defined by the combination of a family of S-UMTS specifications and 3GPP specifications, as follows:

- If an S-UMTS specification exists it takes precedence over the corresponding 3GPP specification (if any). This precedence rule applies to any references in the corresponding 3GPP specifications.

NOTE 2: Any references to 3GPP specifications within the S-UMTS specifications are not subject to this precedence rule.

EXAMPLE: An S-UMTS specification may contain specific references to the corresponding 3GPP specification.

- If an S-UMTS specification does not exist, the corresponding 3GPP specification may or may not apply. The exact applicability of the complete list of 3GPP specifications may be defined at a later stage.

The present document is part of the S-UMTS sub-part 3 specifications. Sub-part 3 specifications are identified in the title and can also be identified by the specification number:

- Sub-part 1 specifications have a S-UMTS-G prefix in the title and a sub-part number of "1" (TS 101 851-x-1).
- Sub-part 2 specifications have a S-UMTS-A prefix in the title and a sub-part number of "2" (TS 101 851-x-2).
- Sub-part 3 specifications have a S-UMTS-G enhanced prefix in the title and a sub-part number of "3" (TS 101 851-x-3).

The sub-part 1 specifications introduce the WCDMA satellite radio interface (ITU-R G-family) specifications for the third generation (3G) wireless communication systems. It is also based on the WCDMA 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 WCDMA, with adaptation for agility to the Mobile Satellite Service (MSS) frequency band.

The sub-part 2 specifications introduce the SW-CDMA satellite radio interface (ITU-R A-family) specifications for third generation (3G) wireless communication systems. SW-CDMA is based on the adaptation to the satellite environment of terrestrial WCDMA. The intention is to reuse the same core network and reuse the radio interface specifications for the Is and Cu interface. Only the Uu interface is 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.

The sub-part 3 specifications introduce the WCDMA satellite radio interface enhancement (G-family enhancements). It considers G-family as radio interface basis, adding as option selected enhancing features from ITU-R A and/or C-family in order to optimize the radio interface over satellite. It harmonizes ITU-R C and G-families, based on the results of the TR 102 278 [i.3] identifying a way to achieve possible harmonization between A,C and G-family satellite radio interfaces for IMT-2000 in ITU-R. The G-family enhancements made of A, C and G features are described in annex A.

The sub-parts 1 will be withdrawn if the C family will be removed from the satellite radio interface list of IMT-2000 in ITU-R Recommendation M.1850 [i.2] and then, the sub-part 3 will be revised.

---

# 1 Scope

The present document defines the Layer 1 transport channels and physical channels used for family G enhanced of the satellite component of UMTS (S-UMTS-G enhanced).

It is based on the FDD mode of UTRA defined by TS 125 201 [4], TS 125 211 [i.1], TS 125 302 [5] and TS 125 435 [6] and adapted for operation over satellite transponders.

Furthermore, it specifies enhancing features optimizing the basic G-family radio interface performances over satellite and new functions.

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## 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 reference document (including any amendments) applies.

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

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

### 2.1 Normative references

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

- [1] ETSI TS 101 851-2-3: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 2: Multiplexing and channel coding; Sub-part 3: G-family enhancements (S-UMTS-G enhanced 25.212)".
- [2] ETSI TS 101 851-3-3: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 3: Spreading and modulation; Sub-part 3: G-family enhancements (S-UMTS-G enhanced 25.213)".
- [3] ETSI TS 101 851-4-3: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT-2000; Part 4: Physical layer procedures; Sub-part 3: G-family enhancements (S-UMTS-G enhanced 25.214)".
- [4] ETSI TS 125 201: "Universal Mobile Telecommunications System (UMTS); Physical layer - general description (3GPP TS 25.201)".
- [5] ETSI TS 125 302: "Universal Mobile Telecommunications System (UMTS); Services provided by the physical layer (3GPP TS 25.302)".
- [6] ETSI TS 125 435: "Universal Mobile Telecommunications System (UMTS); UTRAN Iub interface user plane protocols for Common Transport Channel data streams (3GPP TS 25.435)".
- [7] ETSI TS 125 427: "Universal Mobile Telecommunications System (UMTS); UTRAN Iub/Iur interface user plane protocol for DCH data streams (3GPP TS 25.427)".

### 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] ETSI TS 125 211: "Universal Mobile Telecommunications System (UMTS); Physical channels and mapping of transport channels onto physical channels (FDD) (3GPP TS 25.211)".

- [i.2] ITU-R Recommendation M.1850: "Detailed specifications of the satellite radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".
- [i.3] ETSI TR 102 278: "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".
- [i.4] ITU-R Recommendation M.1457: "Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".
- [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] 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.10] 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.11] 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.12] 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)".

## 3 Symbols and abbreviations

### 3.1 Symbols

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

$N_{data1}$	The number of data bits per downlink slot in Data1 field
$N_{data2}$	The number of data bits per downlink slot in Data2 field (If the slot format does not contain a Data2 field, $N_{data2} = 0$ )

### 3.2 Abbreviations

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

3GPP	3 <sup>rd</sup> Generation Partnership Project
AI	Acquisition Indicator
AICH	Acquisition Indicator CHannel
AS	Access Slot
ASC	Access Service Class
BCH	Broadcast CHannel
BPSK	Binary Phase Shift Keying
CCPCH	Common Control Physical CHannel

CCTrCH	Coded Composite Transport CHannel
CLPC	Closed Loop Power Control
CPICH	Common Pilot CHannel
CRC	Cyclic Redundancy Check
CSICH	CPCH Status Indicator CHannel
DCH	Dedicated CHannel
DPCCH	Dedicated Physical Control CHannel
DPCH	Dedicated Physical CHannel
DPDCH	Dedicated Physical Data CHannel
DTX	Discontinuous Transmission
FACH	Forward Access CHannel
FBI	FeedBack Information
FDD	Frequency Division Duplex
FSW	Frame Synchronization Word
GEO	Geostationary Earth Orbit
HPPICH	High Penetration Paging Indicator CHannel
ICH	Indicator CHannel
ITU-R	International Telecommunication Union Radiocommunication sector
LEO	Low Earth Orbit
MBMS	Multimedia Broadcasting and Multicasting Service
MEO	Medium Earth Orbit
MICH	MBMS Indicator Channel
ML	Maximum Likelihood
MSS	Mobile Satellite Services
NI	MBMS Notification Indicator
NFBI	Number of bits of FBI field
NTFCI	Number of bits of TFCI field
NTPC	Number of bits of TPC field
OLPC	Open Loop Power Control
P-CCPCH	Primary Common Control Physical CHannel
PCH	Paging CHannel
PI	Page Indicator
PICH	Page Indicator CHannel
PRACH	Physical Random Access CHannel
PSC	Primary Synchronization Code
QPSK	Quaternary Phase Shift Keying
RACH	Random Access CHannel
RF	Radio Frequency
S-CCPCH	Secondary Common Control Physical CHannel
SCH	Synchronization CHannel
SF	Spreading Factor
SFN	System Frame Number
SIR	Signal to Interference power Ratio
SRI	Satellite Radio Interface
SRI-A	Satellite Radio Interface A family
SRI-C	Satellite Radio Interface C family
SRI-G	Satellite Radio Interface G family
SSC	Secondary Synchronization Code
SSDT	Site Selection Diversity Transmission
S-UMTS	Satellite component of the Universal Mobile Telecommunication System
S-UMTS-A	Satellite Universal Mobile Telecommunications Systems A family
S-UMTS-G	Satellite Universal Mobile Telecommunications Systems G family
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
TTI	Transmission Time Interval
T-UMTS	Terrestrial UMTS
UE	User Equipment
UL	UpLink
UMTS	Universal Mobile Telecommunication System
USRAN	UMTS Satellite Radio Access Network
UTRA	UMTS Terrestrial Radio Access
UW	Unique Word

---

## 4 Services offered to higher layers

### 4.1 Transport channels

Transport channels are services offered by Layer 1 to the higher layers. General concepts about transport channels are described in TS 125 302 [5].

A transport channel is defined by how and with what characteristics data is transferred over the air interface. A general classification of transport channels is into two groups:

- dedicated channels, using inherent addressing of UE;
- common channels, using explicit addressing of UE if addressing is needed.

#### 4.1.1 Dedicated transport channels

There exists only one type of dedicated transport channel, the Dedicated CHannel (DCH).

##### 4.1.1.1 Dedicated CHannel (DCH)

The Dedicated CHannel (DCH) is a downlink or uplink transport channel. The DCH is transmitted over the entire spot or over only a part of the spot using e.g. beam-forming antennas.

#### 4.1.2 Common transport channels

There are four types of common transport channels:

- BCH;
- FACH;
- PCH; and
- RACH.

##### 4.1.2.1 Broadcast CHannel (BCH)

The Broadcast CHannel (BCH) is a downlink transport channel that is used to broadcast system- and spot-specific information. The BCH is always transmitted over the entire spot and has a single transport format.

##### 4.1.2.2 Forward Access CHannel (FACH)

The Forward Access CHannel (FACH) is a downlink transport channel. The FACH is transmitted over the entire spot. The FACH can be transmitted using power setting described in TS 125 435 [6], i.e. with "Transmit Power Level" of the "FACH DATA FRAME" Frame Protocol message.

##### 4.1.2.3 Paging CHannel (PCH)

The Paging CHannel (PCH) is a downlink transport channel. The PCH is always transmitted over the entire spot. The transmission of the PCH is associated with the transmission of physical-layer generated Paging Indicators, to support efficient sleep-mode procedures.

#### 4.1.2.4 Random Access CHannel (RACH)

The Random Access CHannel (RACH) is an uplink transport channel. The RACH is always received from the entire spot. The RACH is characterized by a collision risk and by being transmitted using open loop power control.

## 4.2 Indicators

Indicators are means of fast low-level signalling entities which are transmitted without using information blocks sent over transport channels. The meaning of indicators is specific to the type of indicator.

The indicators defined in the present document are:

- Acquisition Indicator (AI);
- Page Indicator (PI); and
- MBMS Notification Indicator (NI).

Indicators may be either Boolean (two-valued) or three-valued. Their mapping to indicator channels is channel specific.

Indicators are transmitted on those physical channels that are Indicator CHannels (ICH).

## 5 Physical channels and physical signals

Physical channels are defined by a specific carrier frequency, scrambling code, channelization code (optional), time start and stop (giving a duration) and, on the uplink, relative phase (0 or  $\pi/2$ ). Scrambling and channelization codes and modulating chip rate are specified in TS 101 851-3-3 [2]. Time durations are defined by start and stop instants, measured in integer multiples of chips. Suitable multiples of chips also used in specification are:

Radio frame:	A radio frame is a processing duration which consists of 15 slots. The length of a radio frame corresponds to 38 400 chips.
Slot:	A slot is a duration which consists of fields containing bits. The length of a slot corresponds to 2 560 chips.

The default time duration for a physical channel is continuous from the instant when it is started to the instant when it is stopped. Physical channels that are not continuous will be explicitly described.

Transport channels are described (in more abstract higher layer models of the physical layer) as being capable of being mapped to physical channels. Within the physical layer itself the exact mapping is from a Composite Coded Transport CHannel (CCTrCH) to the data part of a physical channel. In addition to data parts there also exist channel control parts and physical signals.

### 5.1 Physical signals

Physical signals are entities with the same basic on-air attributes as physical channels but do not have transport channels or indicators mapped to them. Physical signals may be associated with physical channels in order to support the function of physical channels.

### 5.2 Uplink physical channels

#### 5.2.1 Dedicated uplink physical channels

There are three types of uplink dedicated physical channels, the uplink Dedicated Physical Data CHannel (uplink DPDCH) and the uplink Dedicated Physical Control CHannel (uplink DPCCH).

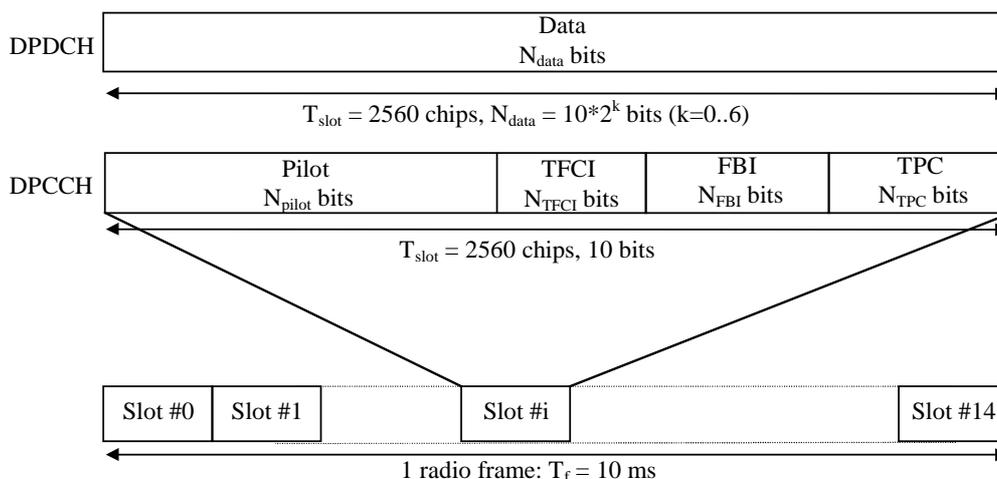
The DPDCH and DPCCH are I/Q code multiplexed (see TS 101 851-3-3 [2]).

The uplink DPDCH is used to carry the DCH transport channel. There may be zero, one, or several uplink DPDCHs on each radio link.

The uplink DPCCH is used to carry control information generated at Layer 1. The Layer 1 control information consists of known pilot bits to support channel estimation for coherent detection, Transmit Power-Control (TPC) commands, FeedBack Information (FBI), and an optional Transport Format Combination Indicator (TFCI). The Transport-Format Combination Indicator informs the receiver about the instantaneous transport format combination of the transport channels mapped to the simultaneously transmitted uplink DPDCH radio frame. There is one and only one uplink DPCCH on each radio link.

Figure 1 shows the frame structure of the uplink DPDCH and the uplink DPCCH. Each radio frame of length 10 ms is split into 15 slots, each of length  $T_{\text{slot}} = 2\,560$  chips, corresponding to one power-control period. The DPDCH and DPCCH are always frame aligned with each other.

In Optional mode C, a radio frame corresponds to one power-control period.



**Figure 1: Frame structure for uplink DPDCH/DPCCH**

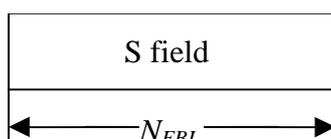
The parameter  $k$  in figure 1 determines the number of bits per uplink DPDCH slot. It is related to the spreading factor SF of the DPDCH as  $SF = 256 / 2^k$ . The DPDCH spreading factor may range from 256 down to 4. The spreading factor of the uplink DPCCH is always equal to 256, i.e. there are 10 bits per uplink DPCCH slot.

The exact number of bits of the uplink DPDCH and the different uplink DPCCH fields ( $N_{\text{pilot}}$ ,  $N_{\text{TFCI}}$ ,  $N_{\text{FBI}}$  and  $N_{\text{TPC}}$ ) is given by tables 1 and 2. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

The channel bit and symbol rates given in tables 1 and 2 are the rates immediately before spreading. The pilot patterns are given in tables 3 and 4, the TPC bit pattern is given in table 5.

In Optional mode C, the tables 2a and 4a are applied instead of tables 2 and 4, respectively.

The FBI bits are used to support techniques requiring feedback from the UE to the USRAN Access Point, including Spot Selection Diversity Transmission (SSDT). The structure of the FBI field is shown in figure 2 and described below.



**Figure 2: FBI field**

The S field is used for SSDT signalling. It consists of 0 bit, 1 bit or 2 bits. The total FBI field size  $N_{\text{FBI}}$  is given by table 2. If total FBI field is not filled with S field, FBI field shall be filled with "1". The use of the FBI fields is described in detail in TS 101 851-4-3 [3].

Table 1: DPDCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N <sub>data</sub>
0	15	15	256	150	10	10
1	30	30	128	300	20	20
2	60	60	64	600	40	40
3	120	120	32	1 200	80	80
4	240	240	16	2 400	160	160
5	480	480	8	4 800	320	320
6	960	960	4	9 600	640	640

There are two types of uplink dedicated physical channels; those that include TFCI (e.g. for several simultaneous services) and those that do not include TFCI (e.g. for fixed-rate services). These types are reflected by the duplicated rows of table 2. It is the USRAN that determines if a TFCI should be transmitted and it is mandatory for all UEs to support the use of TFCI in the uplink. The mapping of TFCI bits onto slots is described in TS 101 851-2-3 [1].

In compressed mode, DPCCH slot formats with TFCI fields are changed. There are two possible compressed slot formats for each normal slot format. They are labelled A and B and the selection between them is dependent on the number of slots that are transmitted in each frame in compressed mode.

Table 2: DPCCH fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N <sub>pilot</sub>	N <sub>TPC</sub>	N <sub>TFCI</sub>	N <sub>FBI</sub>	Transmitted slots per radio frame
0	15	15	256	150	10	6	2	2	0	15
0A	15	15	256	150	10	5	2	3	0	10 to 14
0B	15	15	256	150	10	4	2	4	0	8 to 9
1	15	15	256	150	10	8	2	0	0	8 to 15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10 to 14
2B	15	15	256	150	10	3	2	4	1	8 to 9
3	15	15	256	150	10	7	2	0	1	8 to 15
4	15	15	256	150	10	6	2	0	2	8 to 15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10 to 14
5B	15	15	256	150	10	3	1	4	2	8 to 9

Table 2a: DPCCH fields (Optional mode C)

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N <sub>pilot</sub>	N <sub>TPC</sub>	N <sub>TFCI</sub>	N <sub>FBI</sub>	Transmitted slots per radio frame
0	15	15	256	150	10	7	1	2	0	15
0A	15	15	256	150	10	6	1	3	0	10 to 14
0B	15	15	256	150	10	7	1	4	0	8 to 9
1	15	15	256	150	10	9	1	0	0	8 to 15
2	15	15	256	150	10	6	1	2	1	15
2A	15	15	256	150	10	5	1	3	1	10 to 14
2B	15	15	256	150	10	4	1	4	1	8 to 9
3	15	15	256	150	10	8	1	0	1	8 to 15

The pilot bit patterns are described in tables 3, 4 and 4a. The shadowed column part of pilot bit pattern is defined as FSW and FSWs can be used to confirm frame synchronization. (The value of the pilot bit pattern other than FSWs shall be "1".)

Table 3: Pilot bit patterns for uplink DPCCH with  $N_{\text{pilot}} = 3, 4, 5$  and 6

Bit #	$N_{\text{pilot}} = 3$			$N_{\text{pilot}} = 4$				$N_{\text{pilot}} = 5$					$N_{\text{pilot}} = 6$					
	0	1	2	0	1	2	3	0	1	2	3	4	0	1	2	3	4	5
Slot #0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
1	0	0	1	1	0	0	1	0	0	1	1	0	1	0	0	1	1	0
2	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
3	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
4	1	0	1	1	1	0	1	1	0	1	0	1	1	1	0	1	0	1
5	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
6	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0
7	1	0	1	1	1	0	1	1	0	1	0	0	1	1	0	1	0	0
8	0	1	1	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1
11	1	0	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1
12	1	0	1	1	1	0	1	1	0	1	0	0	1	1	0	1	0	0
13	0	0	1	1	0	0	1	0	0	1	1	1	1	0	0	1	1	1
14	0	0	1	1	0	0	1	0	0	1	1	1	1	0	0	1	1	1

Table 4: Pilot bit patterns for uplink DPCCH with  $N_{\text{pilot}} = 7$  and 8

Bit #	$N_{\text{pilot}} = 7$							$N_{\text{pilot}} = 8$								
	0	1	2	3	4	5	6	0	1	2	3	4	5	6	7	
Slot #0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0
1	1	0	0	1	1	0	1	1	0	1	0	1	1	1	1	0
2	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1
3	1	0	0	1	0	0	1	1	0	1	0	1	0	1	0	0
4	1	1	0	1	0	1	1	1	1	1	0	1	0	1	1	1
5	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0
6	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0	0
7	1	1	0	1	0	0	1	1	1	1	0	1	0	1	0	0
8	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	0
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1
11	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1
12	1	1	0	1	0	0	1	1	1	1	0	1	0	1	0	0
13	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1
14	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1

Table 4a: Pilot bit patterns for uplink DPCCH with  $N_{\text{pilot}} = 9$  (Optional mode C)

Bit #	$N_{\text{pilot}} = 9$								
	0	1	2	3	4	5	6	7	8
Slot #0	1	1	1	1	1	1	1	0	1
1	1	0	1	0	1	1	1	0	1
2	1	0	1	1	1	0	1	1	1
3	1	0	1	0	1	0	1	0	1
4	1	1	1	0	1	0	1	1	1
5	1	1	1	1	1	1	1	0	1
6	1	1	1	1	1	0	1	0	1
7	1	1	1	0	1	0	1	0	1
8	1	0	1	1	1	1	1	0	1
9	1	1	1	1	1	1	1	1	1
10	1	0	1	1	1	0	1	1	1
11	1	1	1	0	1	1	1	1	1
12	1	1	1	0	1	0	1	0	1
13	1	0	1	0	1	1	1	1	1
14	1	0	1	0	1	1	1	1	1

The relationship between the TPC bit pattern and transmitter power control command is presented in table 5.

**Table 5: TPC Bit Pattern**

TPC Bit Pattern		Transmitter power control command
$N_{\text{TPC}} = 1$	$N_{\text{TPC}} = 2$	
1	11	1
0	00	0

Multi-code operation is possible for the uplink dedicated physical channels. When multi-code transmission is used, several parallel DPDCH are transmitted using different channelization codes, see TS 101 851-3-3 [2]. However, there is only one DPCCH per radio link.

A period of uplink DPCCH transmission prior to the start of the uplink DPDCH transmission (uplink DPCCH power control preamble) shall be used for initialization of a DCH. The length of the power control preamble is a higher layer parameter,  $N_{\text{pcp}}$ , signalled by the network TS 101 851-4-3 [3]. The UL DPCCH shall take the same slot format in the power control preamble as afterwards, as given in table 2. When  $N_{\text{pcp}} > 0$  the pilot patterns of tables 3, 4 and 4a shall be used. The timing of the power control preamble is described in TS 101 851-4-3 [3]. The TFCI field is filled with "0" bits.

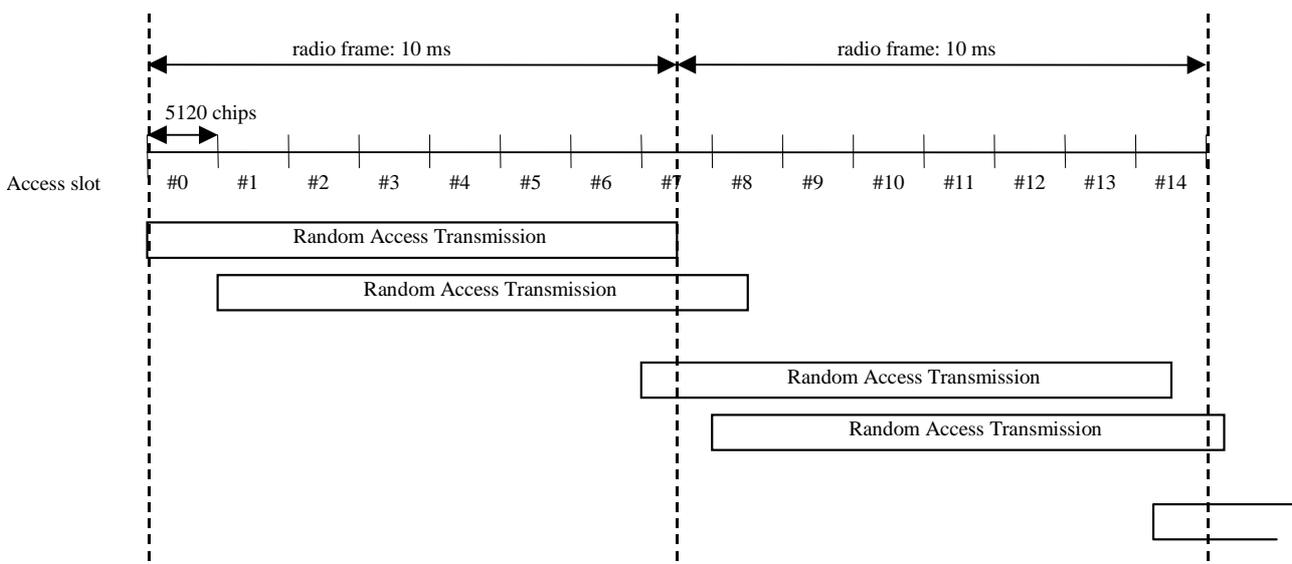
## 5.2.2 Common uplink physical channels

### 5.2.2.1 Physical Random Access CHannel (PRACH)

The Physical Random Access CHannel (PRACH) is used to carry the RACH.

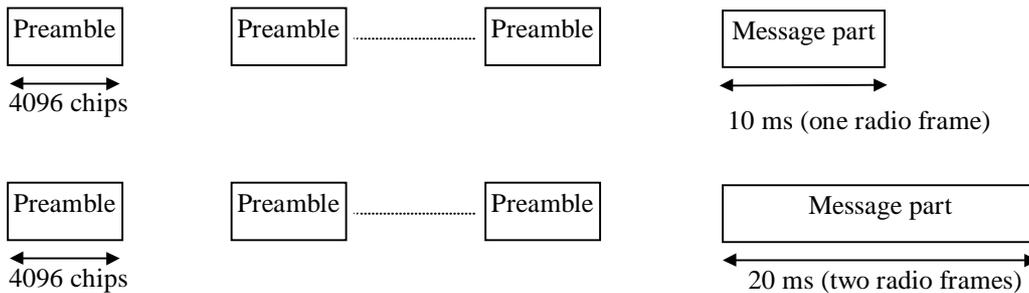
#### 5.2.2.1.1 Overall structure of random-access transmission

The random-access transmission is based on a Slotted ALOHA approach with fast acquisition indication. The UE can start the random-access transmission at the beginning of a number of well-defined time intervals, denoted *access slots*. There are 15 access slots per two frames and they are spaced 5 120 chips apart, see figure 3. The timing of the access slots and the acquisition indication is described in clause 7.3. Information on what access slots are available for random-access transmission is given by higher layers.



**Figure 3: RACH access slot numbers and their spacing**

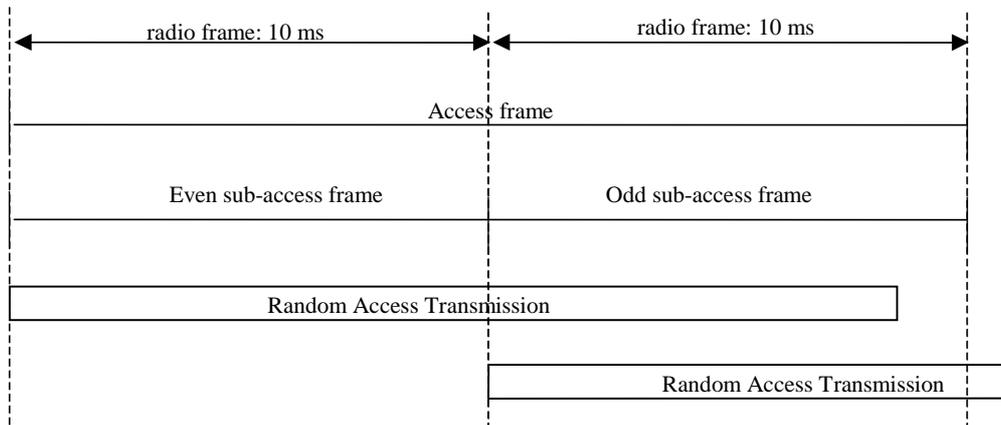
The structure of the random-access transmission is shown in figure 4. The random-access transmission consists of one or several *preambles* of length 4 096 chips and a *message* of length 10 ms or 20 ms.



**Figure 4: Structure of the random-access transmission**

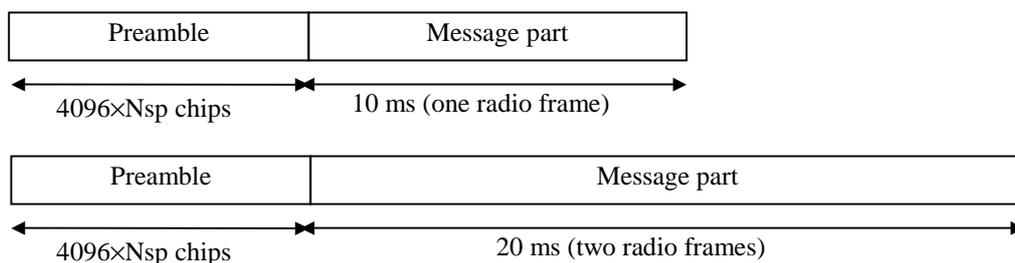
In Optional mode C, the following is applied:

The random-access transmission is based on an ALOHA approach with fast acquisition indication. The UE can start the random-access transmission at the beginning of a number of well-defined time intervals, denoted *access frame*. Each access frame has a length of two radio frames. Each access frame can consist of two sub-access frames, even sub-access frame and odd sub-access frame, see figure 3a. The timing of the access frames and the acquisition indication is described in clause 7.3. Information on what access slots are available for random-access transmission is given by higher layers.



**Figure 4a: Structure of the random-access transmission (Optional mode C)**

The structure of the random-access transmission is shown in figure 4a. The random-access transmission consists of one preamble of  $N_{sp}$  sub-preambles and a message of length 10 ms or 20 ms.



**Figure 4b: Structure of the random-access transmission (Optional mode C)**

### 5.2.2.1.2 RACH preamble part

Each preamble is of length 4 096 chips and consists of 256 repetitions of a signature of length 16 chips. There are a maximum of 16 available signatures, see TS 101 851-3-3 [2] for more details.

In Optional mode C, the following is applied: the preamble is of length  $N_{sp} \times 4\,096$  chips and consists of  $N_{sp}$  sub-preambles. The value of  $N_{sp}$  ( $> 0$ ) is provided by high layers. The sub-preamble is of length 4 096 chips and consists of 256 repetitions of a signature of length 16 chips. There are a maximum of 16 available signatures, see [2] for more detail. Every sub-preamble has the identical length, signature and scrambling code. The last sub-preamble code is a conjugate of the code rate in the previous sub-preamble, see [2] for more details.

### 5.2.2.1.3 RACH message part

Figure 5 shows the structure of the random-access message part radio frame. The 10 ms message part radio frame is split into 15 slots, each of length  $T_{slot} = 2\,560$  chips. Each slot consists of two parts, a data part to which the RACH transport channel is mapped and a control part that carries Layer 1 control information. The data and control parts are transmitted in parallel. A 10 ms message part consists of one message part radio frame, while a 20 ms message part consists of two consecutive 10 ms message part radio frames. The message part length is equal to the Transmission Time Interval of the RACH Transport channel in use. This TTI length is configured by higher layers.

The data part consists of  $10 \times 2^k$  bits, where  $k = 0, 1, 2, 3$ . This corresponds to a spreading factor of 256, 128, 64 and 32 respectively for the message data part.

The control part consists of 8 known pilot bits to support channel estimation for coherent detection and 2 TFCI bits. This corresponds to a spreading factor of 256 for the message control part. The pilot bit pattern is described in table 8. The total number of TFCI bits in the random-access message is  $15 \times 2 = 30$ . The TFCI of a radio frame indicates the transport format of the RACH transport channel mapped to the simultaneously transmitted message part radio frame. In case of a 20 ms PRACH message part, the TFCI is repeated in the second radio frame.

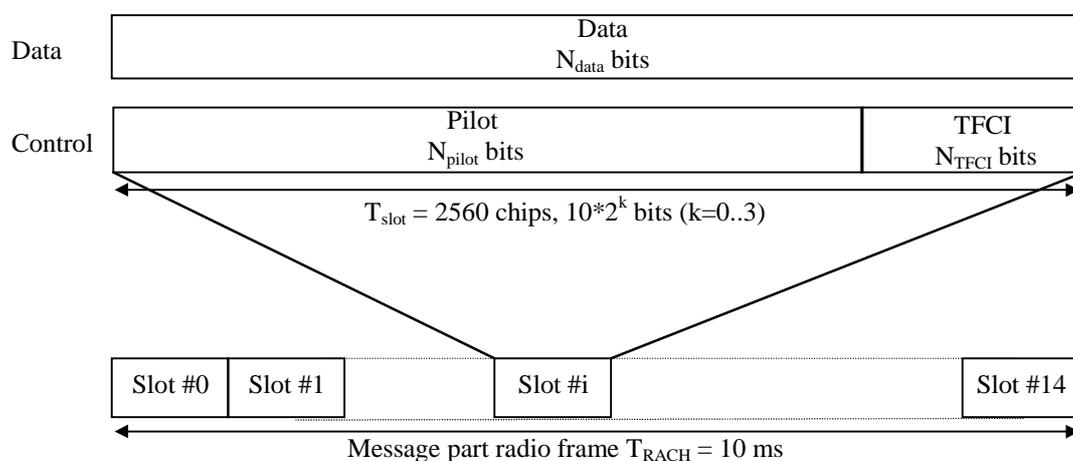


Figure 5: Structure of the random-access message part radio frame

Table 6: Random-access message data fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	$N_{data}$
0	15	15	256	150	10	10
1	30	30	128	300	20	20
2	60	60	64	600	40	40
3	120	120	32	1 200	80	80

Table 7: Random-access message control fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	$N_{\text{pilot}}$	$N_{\text{TFCI}}$
0	15	15	256	150	10	8	2

Table 8: Pilot bit patterns for RACH message part with  $N_{\text{pilot}} = 8$ 

Bit #	$N_{\text{pilot}} = 8$							
	0	1	2	3	4	5	6	7
Slot #0	1	1	1	1	1	1	1	0
1	1	0	1	0	1	1	1	0
2	1	0	1	1	1	0	1	1
3	1	0	1	0	1	0	1	0
4	1	1	1	0	1	0	1	1
5	1	1	1	1	1	1	1	0
6	1	1	1	1	1	0	1	0
7	1	1	1	0	1	0	1	0
8	1	0	1	1	1	1	1	0
9	1	1	1	1	1	1	1	1
10	1	0	1	1	1	0	1	1
11	1	1	1	0	1	1	1	1
12	1	1	1	0	1	0	1	0
13	1	0	1	0	1	1	1	1
14	1	0	1	0	1	1	1	1

## 5.3 Downlink physical channels

### 5.3.1 Dedicated downlink physical channels

There is only one type of downlink dedicated physical channel, the Downlink Dedicated Physical CHannel (downlink DPCH).

Within one downlink DPCH, dedicated data generated at Layer 2 and above, i.e. the Dedicated transport CHannel (DCH), is transmitted in time-multiplex with control information generated at Layer 1 (known pilot bits, TPC commands, and an optional TFCI). The downlink DPCH can thus be seen as a time multiplex of a downlink DPDCH and a downlink DPCCH.

Figure 6 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 15 slots, each of length  $T_{\text{slot}} = 2\,560$  chips. A power control period corresponds to a slot. However, in Optional mode C, a power-control period corresponds to a frame.

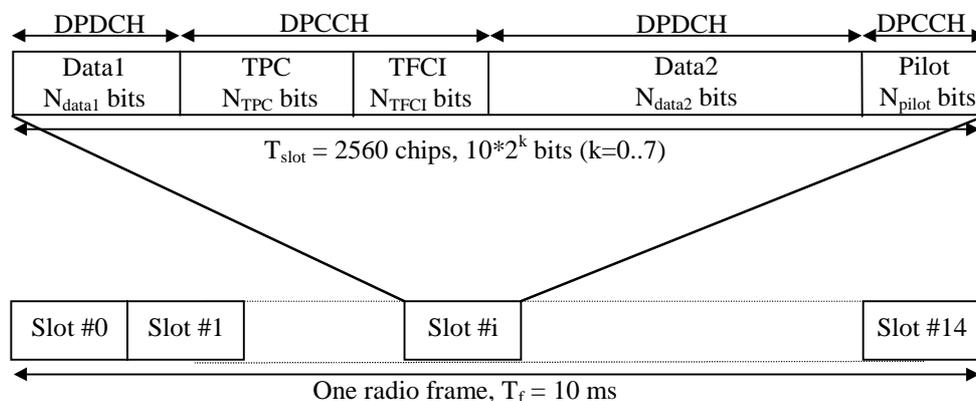


Figure 6: Frame structure for downlink DPCH

The parameter  $k$  in figure 6 determines the total number of bits per downlink DPCH slot. It is related to the spreading factor  $SF$  of the physical channel as  $SF = 512/2^k$ . The spreading factor may thus range from 512 down to 4.

The exact number of bits of the different downlink DPCH fields ( $N_{pilot}$ ,  $N_{TPC}$ ,  $N_{TFCI}$ ,  $N_{data1}$  and  $N_{data2}$ ) is given in table 9. What slot format to use is configured by higher layers and can also be reconfigured by higher layers.

There are basically two types of downlink Dedicated Physical Channels; those that include TFCI (e.g. for several simultaneous services) and those that do not include TFCI (e.g. for fixed-rate services). These types are reflected by the duplicated rows of table 9. It is the USRAN that determines if a TFCI should be transmitted and it is mandatory for all UEs to support the use of TFCI in the downlink. The mapping of TFCI bits onto slots is described in TS 101 851-2-1 [i.6].

In compressed frames, a different slot format is used compared to normal mode. There are two possible compressed slot formats that are labelled A and B. Slot format B shall be used in frames compressed by spreading factor reduction and slot format A shall be used in frames compressed by puncturing or higher layer scheduling. The channel bit and symbol rates given in table 9 are the rates immediately before spreading.

**Table 9: DPDCH and DPCCH fields**

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame $N_{Tr}$
					$N_{Data1}$	$N_{Data2}$	$N_{TPC}$	$N_{TFCI}$	$N_{Pilot}$	
0	15	7,5	512	10	0	4 (5)	2 (1)	0	4	15
0A	15	7,5	512	10	0	4 (5)	2 (1)	0	4	8 to 14
0B	30	15	256	20	0	8 (10)	4 (2)	0	8	8 to 14
1	15	7,5	512	10	0	2 (3)	2 (1)	2	4	15
1B	30	15	256	20	0	4 (6)	4 (2)	4	8	8 to 14
2	30	15	256	20	2	14 (15)	2 (1)	0	2	15
2A	30	15	256	20	2	14 (15)	2 (1)	0	2	8 to 14
2B	60	30	128	40	4	28 (30)	4 (2)	0	4	8 to 14
3	30	15	256	20	2	12 (13)	2 (1)	2	2	15
3A	30	15	256	20	2	10 (11)	2 (1)	4	2	8 to 14
3B	60	30	128	40	4	24 (26)	4 (2)	4	4	8 to 14
4	30	15	256	20	2	12 (13)	2 (1)	0	4	15
4A	30	15	256	20	2	12 (13)	2 (1)	0	4	8 to 14
4B	60	30	128	40	4	24 (26)	4 (2)	0	8	8 to 14
5	30	15	256	20	2	10 (11)	2 (1)	2	4	15
5A	30	15	256	20	2	8 (9)	2 (1)	4	4	8 to 14
5B	60	30	128	40	4	20 (22)	4 (2)	4	8	8 to 14
6	30	15	256	20	2	8 (9)	2 (1)	0	8	15
6A	30	15	256	20	2	8 (9)	2 (1)	0	8	8 to 14
6B	60	30	128	40	4	16 (18)	4 (2)	0	16	8 to 14

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame $N_{Tr}$
					$N_{Data1}$	$N_{Data2}$	$N_{TPC}$	$N_{TFCI}$	$N_{Pilot}$	
7	30	15	256	20	2	6 (7)	2 (1)	2	8	15
7A	30	15	256	20	2	4 (5)	2 (1)	4	8	8 to 14
7B	60	30	128	40	4	12 (14)	4 (2)	4	16	8 to 14
8	60	30	128	40	6	28 (29)	2 (1)	0	4	15
8A	60	30	128	40	6	28 (29)	2 (1)	0	4	8 to 14
8B	120	60	64	80	12	56 (58)	4 (2)	0	8	8 to 14
9	60	30	128	40	6	26 (27)	2 (1)	2	4	15
9A	60	30	128	40	6	24 (25)	2 (1)	4	4	8 to 14
9B	120	60	64	80	12	52 (54)	4 (2)	4	8	8 to 14
10	60	30	128	40	6	24 (25)	2 (1)	0	8	15
10A	60	30	128	40	6	24 (25)	2 (1)	0	8	8 to 14
10B	120	60	64	80	12	48 (50)	4 (2)	0	16	8 to 14
11	60	30	128	40	6	22 (23)	2 (1)	2	8	15
11A	60	30	128	40	6	20 (21)	2 (1)	4	8	8 to 14
11B	120	60	64	80	12	44 (46)	4 (2)	4	16	8 to 14
12	120	60	64	80	12	48 (50)	4 (2)	8 (see note 4)	8	15
12A	120	60	64	80	12	40 (42)	4 (2)	16 (see note 4)	8	8 to 14
12B	240	120	32	160	24	96 (100)	8 (4)	16 (see note 4)	16	8 to 14
13	240	120	32	160	28	112 (114)	4 (2)	8 (see note 4)	8	15
13A	240	120	32	160	28	104 (106)	4 (2)	16 (see note 4)	8	8 to 14
13B	480	240	16	320	56	224 (228)	8 (4)	16 (see note 4)	16	8 to 14
14	480	240	16	320	56	232 (236)	8 (4)	8 (see note 4)	16	15
14A	480	240	16	320	56	224 (228)	8 (4)	16 (see note 4)	16	8 to 14
14B	960	480	8	640	112	464 (472)	16 (8)	16 (see note 4)	32	8 to 14

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Transmitted slots per radio frame $N_{Tr}$
					$N_{Data1}$	$N_{Data2}$	$N_{TPC}$	$N_{TFCI}$	$N_{Pilot}$	
15	960	480	8	640	120	488 (492)	8 (4)	8 (see note 4)	16	15
15A	960	480	8	640	120	480 (484)	8 (4)	16 (see note 4)	16	8 to 14
15B	1 920	960	4	1 280	240	976 (984)	16 (8)	16 (see note 4)	32	8 to 14
16	1 920	960	4	1 280	248	1 000 (1004)	8 (4)	8 (see note 4)	16	15
16A	1 920	960	4	1 280	248	992 (996)	8 (4)	16 (see note 4)	16	8 to 14

NOTE 1: Compressed mode is only supported through spreading factor reduction for SF = 512 with TFCI.  
NOTE 2: Compressed mode by spreading factor reduction is not supported for SF = 4.  
NOTE 3: If the satellite gateway receives an invalid combination of data frames for downlink transmission, the procedure specified in TS 125 427 [7], clause 5.1.2, may require the use of DTX in both the DPDCH and the TFCI field of the DPCCH.  
NOTE 4: If TFCI bits are not used, then DTX shall be used in TFCI field.  
NOTE 5: ( ) in  $N_{Data2}$  and  $N_{TPC}$  indicate the values for Optional mode C.

The pilot bit patterns are described in table 10. The shadowed column part of pilot bit pattern is defined as FSW and FSWs can be used to confirm frame synchronization. (The value of the pilot bit pattern other than FSWs shall be "11".) In table 10, the transmission order is from left to right.

In downlink compressed mode through spreading factor reduction, the number of bits in the TPC and Pilot fields is doubled. Symbol repetition is used to fill up the fields. Denote the bits in one of these fields in normal mode by  $x_1, x_2, x_3, \dots, x_X$ . In compressed mode the following bit sequence is sent in corresponding field:  $x_1, x_2, x_1, x_2, x_3, x_4, x_3, x_4, \dots, x_X$ .

**Table 10: Pilot bit patterns for downlink DPCCH with  $N_{pilot} = 2, 4, 8$  and 16**

Symbol #	$N_{pilot} = 2$	$N_{pilot} = 4$ (see note 1)		$N_{pilot} = 8$ (see note 2)				$N_{pilot} = 16$ (see note 3)							
	0	0	1	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	11	11	11	10	11	11	11	10	11	11	11	10
1	00	11	00	11	00	11	10	11	00	11	10	11	11	11	00
2	01	11	01	11	01	11	01	11	01	11	01	11	10	11	00
3	00	11	00	11	00	11	00	11	00	11	00	11	01	11	10
4	10	11	10	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	11	11	11	00	11	11	11	00	11	10	11	11
7	10	11	10	11	10	11	00	11	10	11	00	11	10	11	00
8	01	11	01	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	11	11	11	00	11	11
10	01	11	01	11	01	11	01	11	01	11	01	11	11	11	10
11	10	11	10	11	10	11	11	11	10	11	11	11	00	11	10
12	10	11	10	11	10	11	00	11	10	11	00	11	01	11	01
13	00	11	00	11	00	11	11	11	00	11	11	11	00	11	00
14	00	11	00	11	00	11	11	11	00	11	11	11	10	11	01

NOTE 1: This pattern is used except slot formats 2B and 3B.  
NOTE 2: This pattern is used except slot formats 0B, 1B, 4B, 5B, 8B, and 9B.  
NOTE 3: This pattern is used except slot formats 6B, 7B, 10B, 11B, 12B, and 13B.  
NOTE 4: For slot format  $nB$  where  $n = 0, \dots, 15$ , the pilot bit pattern corresponding to  $N_{pilot}/2$  is to be used and symbol repetition shall be applied.

The relationship between the TPC symbol and the transmitter power control command is presented in table 11.

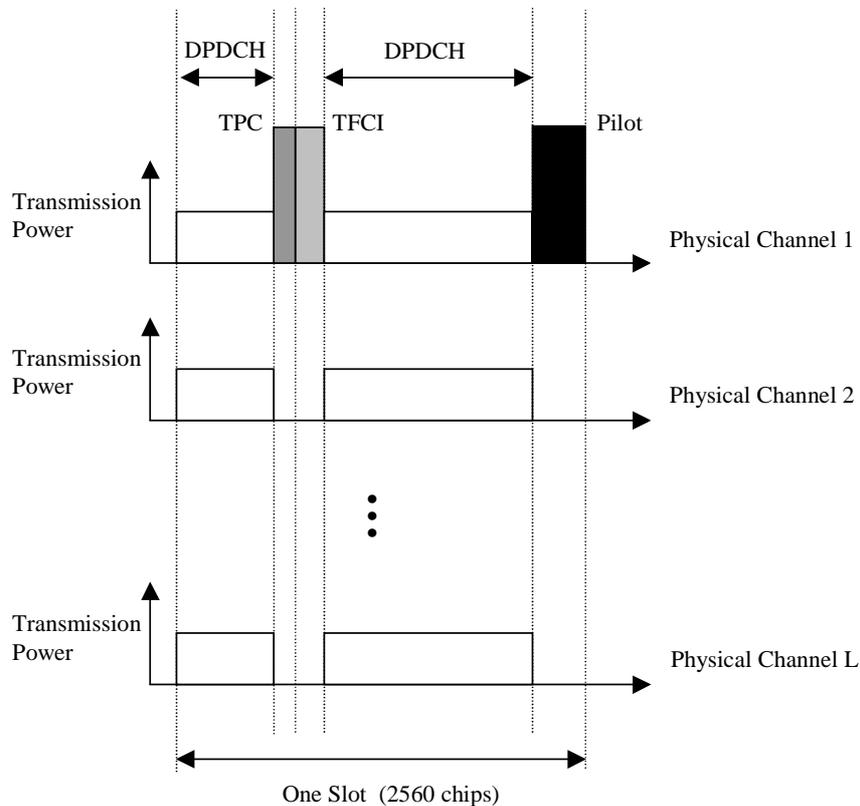
**Table 11: TPC Bit Pattern**

TPC Bit Pattern			Transmitter power control command
$N_{\text{TPC}} = 2$	$N_{\text{TPC}} = 4$	$N_{\text{TPC}} = 8$	
11	1111	11111111	1
00	0000	00000000	0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see TS 101 851-2-3 [1]) is mapped onto several parallel downlink DPCHs using the same spreading factor. In this case, the Layer 1 control information is transmitted only on the first downlink DPCH. DTX bits are transmitted during the corresponding time period for the additional downlink DPCHs, see figure 7.

In case there are several CCTrCHs mapped to different DPCHs transmitted to the same UE different spreading factors can be used on DPCHs to which different CCTrCHs are mapped. Also in this case, Layer 1 control information is only transmitted on the first DPCH while DTX bits are transmitted during the corresponding time period for the additional DPCHs.

NOTE: Support of multiple CCTrCHs of dedicated type is not part of the present document.

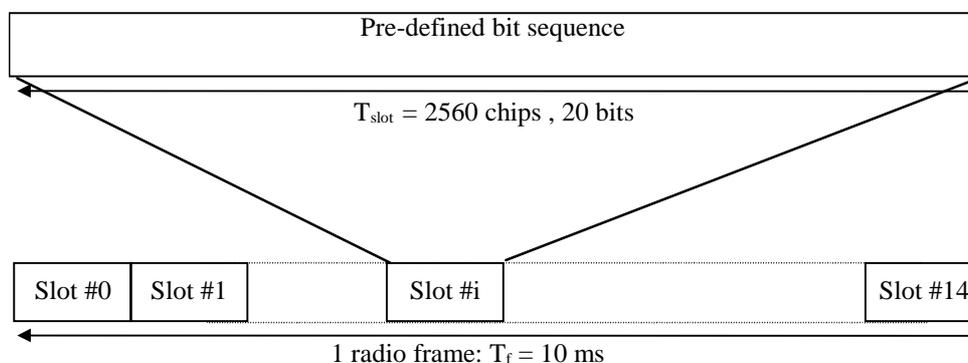


**Figure 7: Downlink slot format in case of multi-code transmission**

## 5.3.2 Common downlink physical channels

### 5.3.2.1 Common Pilot Channel (CPICH)

The CPICH is a fixed rate (30 kbps, SF = 256) downlink physical channel that carries a pre-defined bit sequence. Figure 8 shows the frame structure of the CPICH.



**Figure 8: Frame structure for Common Pilot Channel**

There are two types of Common pilot channels, the Primary and Secondary CPICH. They differ in their use and the limitations placed on their physical features.

#### 5.3.2.1.1 Primary Common Pilot Channel (P-CPICH)

The Primary Common Pilot Channel (P-CPICH) has the following characteristics:

- the same channelization code is always used for the P-CPICH, see TS 101 851-3-3 [2];
- the P-CPICH is scrambled by the primary scrambling code, see TS 101 851-3-3 [2];
- there is one and only one P-CPICH per spot;
- the P-CPICH is broadcast over the entire spot.

The Primary CPICH is a phase reference for the following downlink channels: SCH, Primary CCPCH, AICH, PICH and the S-CCPCH. By default, the Primary CPICH is also a phase reference for downlink DPCH. The UE is informed by higher layer signalling if the P-CPICH is not a phase reference for a downlink DPCH.

#### 5.3.2.1.2 Secondary Common Pilot Channel (S-CPICH)

A Secondary Common Pilot Channel (S-CPICH) has the following characteristics:

- an arbitrary channelization code of SF = 256 is used for the S-CPICH, see TS 101 851-3-3 [2];
- a S-CPICH is scrambled by either the primary or a secondary scrambling code, see TS 101 851-3-3 [2];
- there may be zero, one, or several S-CPICH per spot;
- a S-CPICH may be transmitted over the entire spot or only over a part of the spot.

A Secondary CPICH may be a phase reference for a downlink DPCH. If this is the case, the UE is informed about this by higher-layer signalling.

Note that it is possible that neither the P-CPICH nor any S-CPICH is a phase reference for a downlink DPCH.

### 5.3.2.2 Downlink phase reference

Table 12 summarizes the possible phase references usable on different downlink physical channel types.

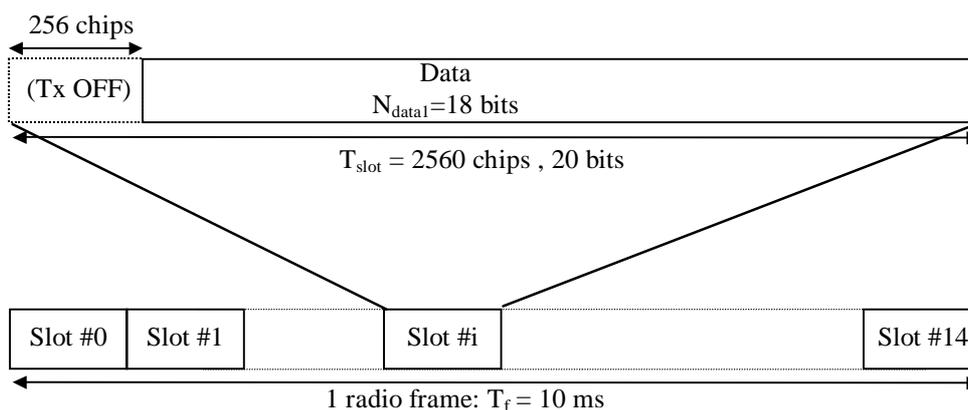
**Table 12: Application of phase references on downlink physical channel types**

Physical channel type	Primary-CPICH	Secondary-CPICH	Dedicated pilot
P-CCPCH	X	-	-
SCH	X	-	-
S-CCPCH	X	-	-
DPCH	X	X	X
PICH	X	-	-
AICH	X	-	-
NOTE	"X" - can be applied, "-" - not applied.		

### 5.3.2.3 Primary Common Control Physical CHannel (P-CCPCH)

The Primary CCPCH is a fixed rate (30 kbps, SF = 256) downlink physical channel used to carry the BCH transport channel.

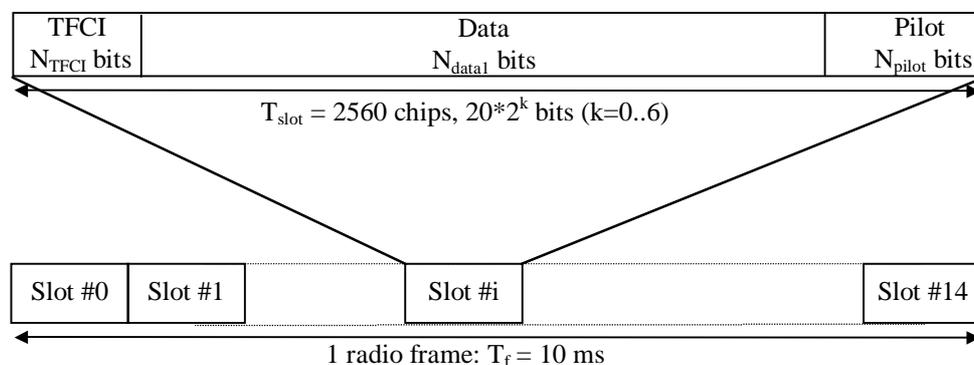
Figure 9 shows the frame structure of the Primary CCPCH. The frame structure differs from the downlink DPCH in that no TPC commands, no TFCI and no pilot bits are transmitted. The Primary CCPCH is not transmitted during the first 256 chips of each slot. Instead, Primary SCH and Secondary SCH are transmitted during this period (see clause 5.3.2.5).



**Figure 9: Frame structure for Primary Common Control Physical Channel**

### 5.3.2.4 Secondary Common Control Physical CHannel (S-CCPCH)

The Secondary CCPCH is used to carry the FACH and PCH. There are two types of Secondary CCPCH: those that include TFCI and those that do not include TFCI. It is the USRAN that determines if a TFCI should be transmitted, hence making it mandatory for all UEs to support the use of TFCI. The set of possible rates for the Secondary CCPCH is the same as for the downlink DPCH, see clause 5.3.1. The frame structure of the Secondary CCPCH is shown in figure 10.



**Figure 10: Frame structure for Secondary Common Control Physical Channel**

The parameter  $k$  in figure 10 determines the total number of bits per downlink Secondary CCPCH slot. It is related to the spreading factor  $SF$  of the physical channel as  $SF = 256/2^k$ . The spreading factor range is from 256 down to 4.

The values for the number of bits per field are given in table 13. The channel bit and symbol rates given in table 13 are the rates immediately before spreading. The slot formats with pilot bits are not supported in this release. The pilot patterns are given in table 14.

The FACH and PCH can be mapped to the same or to separate Secondary CCPCHs. If FACH and PCH are mapped to the same Secondary CCPCH, they can be mapped to the same frame. The main difference between a CCPCH and a downlink dedicated physical channel is that a CCPCH is not inner-loop power controlled. The main difference between the Primary and Secondary CCPCH is that the transport channel mapped to the Primary CCPCH (BCH) can only have a fixed predefined transport format combination, while the Secondary CCPCH support multiple transport format combinations using TFCI.

**Table 13: Secondary CCPCH fields**

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksp/s)	SF	Bits/Frame	Bits/Slot	$N_{data1}$	$N_{pilot}$	$N_{TFCI}$
0	30	15	256	300	20	20	0	0
1	30	15	256	300	20	12	8	0
2	30	15	256	300	20	18	0	2
3	30	15	256	300	20	10	8	2
4	60	30	128	600	40	40	0	0
5	60	30	128	600	40	32	8	0
6	60	30	128	600	40	38	0	2
7	60	30	128	600	40	30	8	2
8	120	60	64	1 200	80	72	0	8 (see note)
9	120	60	64	1 200	80	64	8	8 (see note)
10	240	120	32	2 400	160	152	0	8 (see note)
11	240	120	32	2 400	160	144	8	8 (see note)
12	480	240	16	4 800	320	312	0	8 (see note)
13	480	240	16	4 800	320	296	16	8 (see note)

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N <sub>data1</sub>	N <sub>pilot</sub>	N <sub>TFCI</sub>
14	960	480	8	9 600	640	632	0	8 (see note)
15	960	480	8	9 600	640	616	16	8 (see note)
16	1 920	960	4	19 200	1 280	1 272	0	8 (see note)
17	1 920	960	4	19 200	1 280	1 256	16	8 (see note)

NOTE: If TFCI bits are not used, then DTX shall be used in TFCI field.

The pilot symbol pattern described in table 14 is not supported in this release. The shadowed part can be used as frame synchronization words. (The symbol pattern of pilot symbols other than the frame synchronization word shall be "11"). In table 14, the transmission order is from left to right. (Each two-bit pair represents an I/Q pair of QPSK modulation.)

Table 14: Pilot Symbol Pattern

Symbol #	N <sub>pilot</sub> = 8				N <sub>pilot</sub> = 16							
	0	1	2	3	0	1	2	3	4	5	6	7
Slot #0	11	11	11	10	11	11	11	10	11	11	11	10
1	11	00	11	10	11	00	11	10	11	11	11	00
2	11	01	11	01	11	01	11	01	11	10	11	00
3	11	00	11	00	11	00	11	00	11	01	11	10
4	11	10	11	01	11	10	11	01	11	11	11	11
5	11	11	11	10	11	11	11	10	11	01	11	01
6	11	11	11	00	11	11	11	00	11	10	11	11
7	11	10	11	00	11	10	11	00	11	10	11	00
8	11	01	11	10	11	01	11	10	11	00	11	11
9	11	11	11	11	11	11	11	11	11	00	11	11
10	11	01	11	01	11	01	11	01	11	11	11	10
11	11	10	11	11	11	10	11	11	11	00	11	10
12	11	10	11	00	11	10	11	00	11	01	11	01
13	11	00	11	11	11	00	11	11	11	00	11	00
14	11	00	11	11	11	00	11	11	11	10	11	01

For slot formats using TFCI, the TFCI value in each radio frame corresponds to a certain transport format combination of the FACHs and/or PCHs currently in use. This correspondence is (re-)negotiated at each FACH/PCH addition/removal. The mapping of the TFCI bits onto slots is described in TS 101 851-2-3 [1].

### 5.3.2.5 Synchronization CHannel (SCH)

The Synchronization CHannel (SCH) is a downlink signal used for spot search. The SCH consists of two sub channels, the Primary and Secondary SCH. The 10 ms radio frames of the Primary and Secondary SCH are divided into 15 slots, each of length 2 560 chips. Figure 11 illustrates the structure of the SCH radio frame.

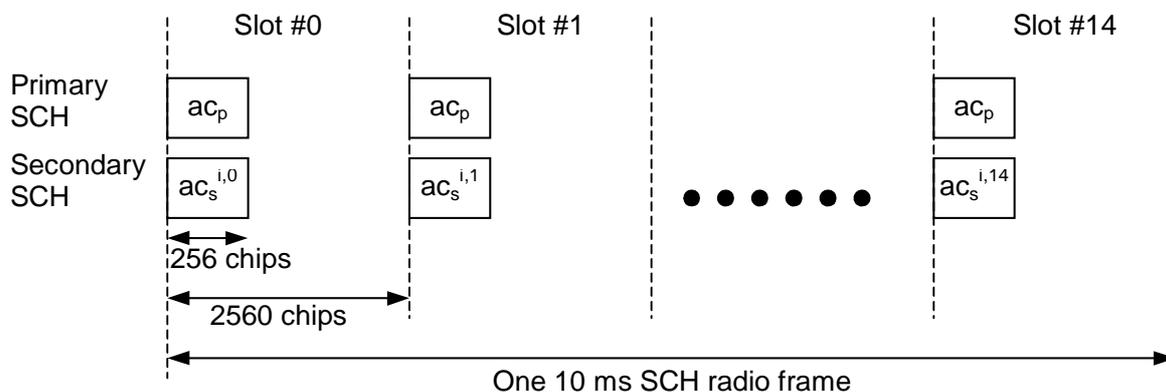


Figure 11: Structure of Synchronization CHannel (SCH)

The Primary SCH consists of a modulated code of length 256 chips, the Primary Synchronization Code (PSC) denoted  $c_p$  in figure 11, transmitted once every slot. The PSC is the same for every spot in the system.

The Secondary SCH consists of repeatedly transmitting a length 15 sequence of modulated codes of length 256 chips, the Secondary Synchronization Codes (SSC), transmitted in parallel with the Primary SCH. The SSC is denoted  $c_s^{i,k}$  in figure 11, where  $i = 0, 1, \dots, 63$  is the number of the scrambling code group, and  $k = 0, 1, \dots, 14$  is the slot number. Each SSC is chosen from a set of 16 different codes of length 256. This sequence on the Secondary SCH indicates which of the code groups the spot's downlink scrambling code belongs to.

The primary and secondary synchronization codes are modulated by the symbol  $a$  shown in figure 11, which can only take value  $a = -1$ .

### 5.3.2.6 Acquisition Indicator CHannel (AICH)

The Acquisition Indicator channel (AICH) is a fixed rate (SF = 256) physical channel used to carry Acquisition Indicators (AI). Acquisition Indicator  $AI_s$  corresponds to signature  $s$  on the PRACH.

Figure 12 illustrates the structure of the AICH. The AICH consists of a repeated sequence of 15 consecutive Access Slots (AS), each of length 5 120 chips. Each access slot consists of two parts, an Acquisition Indicator (AI) part consisting of 32 real-valued signals  $a_0, \dots, a_{31}$  and a part of duration 1 024 chips with no transmission that is not formally part of the AICH. The part of the slot with no transmission is reserved for possible use by CSICH or possible future use by other physical channels.

In Optional mode C, when sub-access frames are not used for the PRACH, the Acquisition Indicator part for the PRACH is transmitted only on the first access slot (AS#0). The AICH is not transmitted during the remaining 14 access slots. On the other hand, when sub-access frames are used for the PRACH, the Acquisition Indicator part for the PRACH is transmitted only on the first access slot (AS#0) and the 9<sup>th</sup> access slot (AS#8). The AICH is not transmitted during the remaining 13 access slots. The AI part of the first access slot carries the Acquisition Indicator corresponding to the signature of PRACH preamble transmitted at the even sub-access frame. The AI part of the 9<sup>th</sup> access slot carries the Acquisition Indicator corresponding to the signature of PRACH preamble transmitted at the odd sub-access frame.

The Spreading Factor (SF) used for channelization of the AICH is 256.

The phase reference for the AICH is the Primary CPICH.

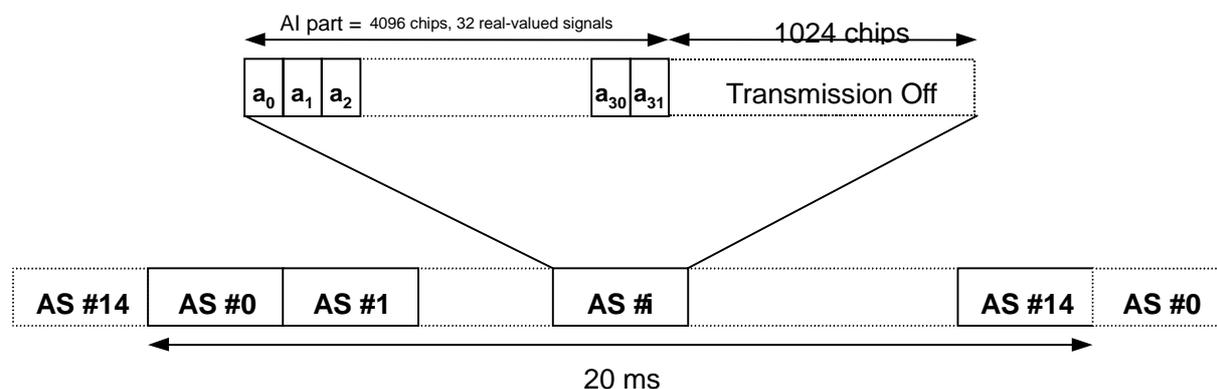


Figure 12: Structure of Acquisition Indicator CHannel (AICH)

The real-valued signals  $a_0, a_1, \dots, a_{31}$  in figure 12 are given by:

$$a_j = \sum_{s=0}^{15} AI_s b_{s,j} \quad (1)$$

where  $AI_s$ , taking the values +1, -1 and 0, is the acquisition indicator corresponding to signature  $s$  and the sequence  $b_{s,0}, \dots, b_{s,31}$  is given by table 15. If the signature  $s$  is not a member of the set of available signatures for all the Access Service Class (ASC) for the corresponding PRACH (see TS 101 851-4-3 [3]), then  $AI_s$  shall be set to 0.



The PI bitmap in the PCH data frames over Iub contains indication values for all higher layer PI values possible. Each bit in the bitmap indicates if the paging indicator associated with that particular PI shall be set to 0 or 1. Hence, the calculation in the equation (1) is to be performed in the satellite gateway to make the association between PI and  $P_q$ .

The mapping from  $\{P_0, \dots, P_{N_p-1}\}$  to the PICH bits  $\{b_0, \dots, b_{287}\}$  are according to table 16.

**Table 16: Mapping of paging indicators  $P_q$  to PICH bits**

Number of paging indicators per frame ( $N_p$ )	$P_q = 1$	$P_q = 0$
$N_p = 18$	$\{b_{16q}, \dots, b_{16q+15}\} = \{1, 1, \dots, 1\}$	$\{b_{16q}, \dots, b_{16q+15}\} = \{0, 0, \dots, 0\}$
$N_p = 36$	$\{b_{8q}, \dots, b_{8q+7}\} = \{1, 1, \dots, 1\}$	$\{b_{8q}, \dots, b_{8q+7}\} = \{0, 0, \dots, 0\}$
$N_p = 72$	$\{b_{4q}, \dots, b_{4q+3}\} = \{1, 1, \dots, 1\}$	$\{b_{4q}, \dots, b_{4q+3}\} = \{0, 0, \dots, 0\}$
$N_p = 144$	$\{b_{2q}, b_{2q+1}\} = \{1, 1\}$	$\{b_{2q}, b_{2q+1}\} = \{0, 0\}$

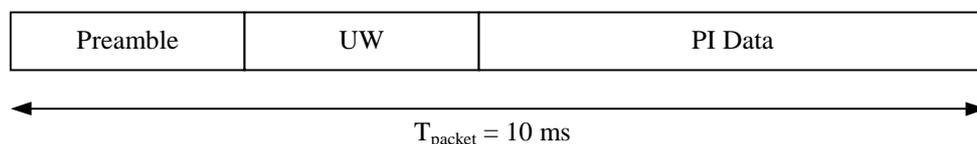
### 5.3.2.8 High Penetration Page Indication Channel (HPPICH)

In Optional mode A, the following new paging indication channel is applied.

The High Penetration Page Indication Channel (HPPICH) is a physical channel used to carry page indicators (PI). Normal paging operation makes use of both PICH and S-CCPCH (onto which the transport PCH is mapped). However, the system can decide to use this physical HPPICH in case paging was not successful. In this case, the transport PCH is not sent until a new trial in the PICH has been made.

Information is transmitted in short packets of length 10 ms. Transmission timing of this HPPICH does not depend on the general timing relationships described in clause 7, i.e. it is independent of the transmission of other channels.

Information is transmitted at a rate of 15 kbps, making a total of 150 bits. Frame structure is shown in figure 12. It is made of an unmodulated preamble of 24 bits (all bits set to zero), an UW of 12 bits (the sequence 110001001011) and a data field of 114 bits.



**Figure 13a: Packet structure for HPPICH**

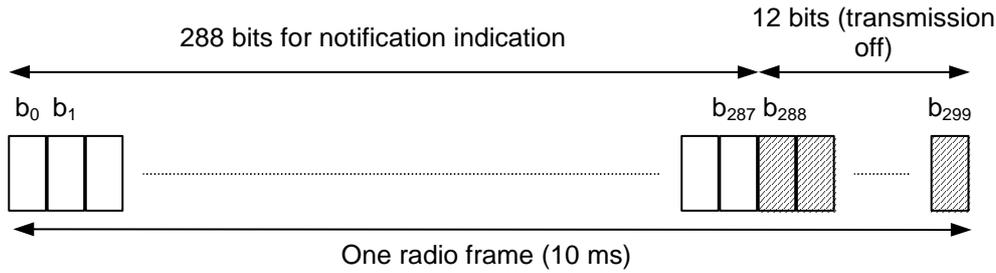
The data field carries a 24-bit word user identifier and an 8-bit CRC part. They are encoded with the convolutional code rate 1/3, and punctured to 114 bits. This encoding process is described in [1].

Differently from the rest of the physical channels, HPPICH is not spread. It is modulated onto a BPSK signal, as described in [2].

### 5.3.2.9 MBMS Indicator CHannel (MICH)

The MBMS Indicator CHannel (MICH) is a fixed rate ( $SF = 256$ ) physical channel used to carry the MBMS notification indicators. The MICH is always associated with an S-CCPCH to which a FACH transport channel is mapped.

Figure 14 illustrates the frame structure of the MICH. One MICH radio frame of length 10 ms consists of 300 bits ( $b_0, b_1, \dots, b_{299}$ ). Of these, 288 bits ( $b_0, b_1, \dots, b_{287}$ ) are used to carry notification indicators. The remaining 12 bits are not formally part of the MICH and shall not be transmitted (DTX).



**Figure 14: Structure of MBMS Indicator CHannel (MICH)**

In each MICH frame,  $N_n$  notification indicators  $\{N_0, \dots, N_{N_n-1}\}$  are transmitted, where  $N_n = 18, 36, 72$  or  $144$ .

The set of NI calculated by higher layers, is associated to a set of notification indicators  $N_q$ , where  $q$  is computed as a function of the NI computed by higher layers, the SFN of the P-CCPCH radio frame during which the start of the MICH radio frame occurs, and the number of notification indicators per frame ( $N_n$ ):

$$q = \left\lfloor \left( (C \times (NI \oplus ((C \times SFN) \bmod G))) \bmod G \right) \times \frac{N_n}{G} \right\rfloor \quad (3)$$

where  $G = 2^{16}$  and  $C = 25\,033$ .

The set of NI signalled over Iub indicates all higher layer NI values for which the notification indicator on MICH should be set to 1 during the corresponding modification period; all other indicators shall be set to 0. Hence, the calculation in the equation (3) shall be performed in the satellite gateway every MICH frame to make the association between NI and  $N_q$ .

The mapping from  $\{N_0, \dots, N_{N_n-1}\}$  to the MICH bits  $\{b_0, \dots, b_{287}\}$  is according to table 17.

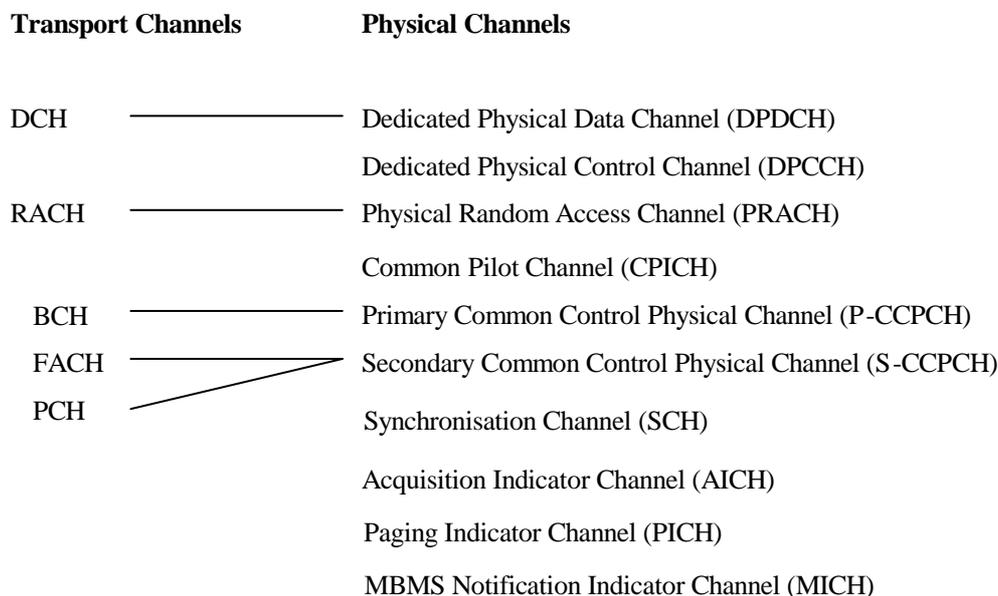
**Table 17: Mapping of paging indicators  $N_q$  to MICH bits**

Number of notification indicators per frame ( $N_n$ )	$N_q = 1$	$N_q = 0$
$N_n = 18$	$\{b_{16q}, \dots, b_{16q+15}\} = \{1, 1, \dots, 1\}$	$\{b_{16q}, \dots, b_{16q+15}\} = \{0, 0, \dots, 0\}$
$N_n = 36$	$\{b_{8q}, \dots, b_{8q+7}\} = \{1, 1, \dots, 1\}$	$\{b_{8q}, \dots, b_{8q+7}\} = \{0, 0, \dots, 0\}$
$N_n = 72$	$\{b_{4q}, \dots, b_{4q+3}\} = \{1, 1, \dots, 1\}$	$\{b_{4q}, \dots, b_{4q+3}\} = \{0, 0, \dots, 0\}$
$N_n = 144$	$\{b_{2q}, b_{2q+1}\} = \{1, 1\}$	$\{b_{2q}, b_{2q+1}\} = \{0, 0\}$

## 6 Mapping and association of physical channels

### 6.1 Mapping of transport channels onto physical channels

Figure 15 summarizes the mapping of transport channels onto physical channels.

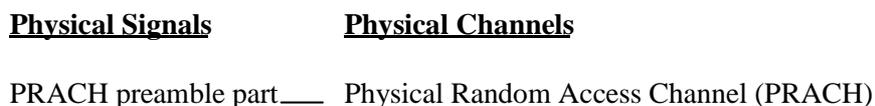


**Figure 15: Transport-channel to physical-channel mapping**

The DCHs are coded and multiplexed as described in TS 101 851-2-3 [1], and the resulting data stream is mapped sequentially (first-in-first-mapped) directly to the physical channel(s). The mapping of BCH and FACH/PCH is equally straightforward, where the data stream after coding and interleaving is mapped sequentially to the Primary and Secondary CCPCH respectively. Also for the RACH, the coded and interleaved bits are sequentially mapped to the physical channel, in this case the message part of the PRACH.

### 6.2 Association of physical channels and physical signals

Figure 16 illustrates the association between physical channels and physical signals.



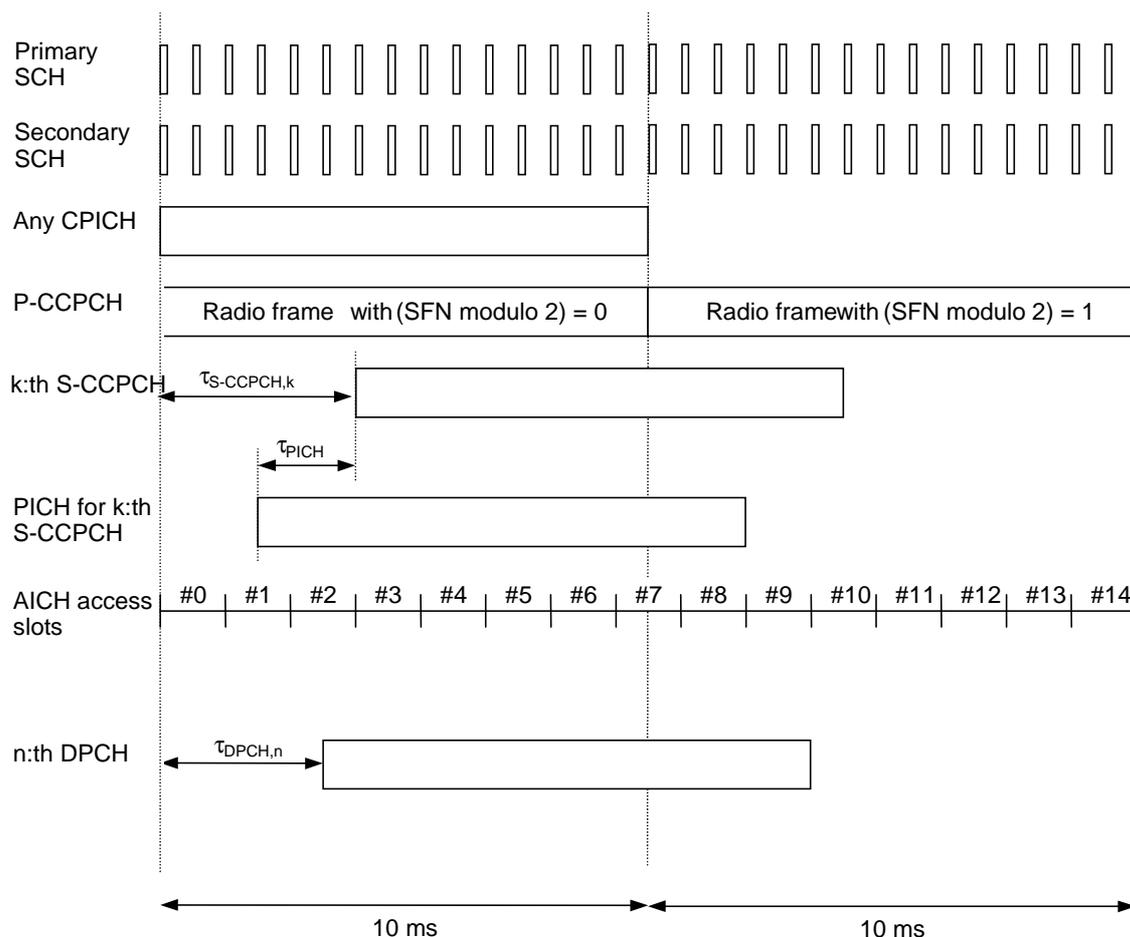
**Figure 16: Physical channel and physical signal association**

## 7 Timing relationship between physical channels

### 7.1 General

The P-CCPCH, on which the spot SFN is transmitted, is used as timing reference for all the physical channels, directly for downlink and indirectly for uplink.

Figure 17 describes the frame timing of the downlink physical channels. For the AICH the access slot timing is included. Transmission timing for uplink physical channels is given by the received timing of downlink physical channels, as described in the following clauses.



**Figure 17: Radio frame timing and access slot timing of downlink physical channels**

The following applies:

- SCH (primary and secondary), CPICH (primary and secondary) and P-CCPCH have identical frame timings.
- The S-CCPCH timing may be different for different S-CCPCHs, but the offset from the P-CCPCH frame timing is a multiple of 256 chips, i.e.  $\tau_{S-CCPCH,k} = T_k \times 256$  chips,  $T_k \in \{0, 1, \dots, 149\}$ .
- The PICH timing is  $\tau_{PICH} = 7\,680$  chips prior to its corresponding S-CCPCH frame timing, i.e. the timing of the S-CCPCH carrying the PCH transport channel with the corresponding paging information, see also clause 7.2.
- AICH access slots #0 starts the same time as P-CCPCH frames with (SFN modulo 2) = 0. The AICH/PRACH timing is described in clause 7.3.
- The DPCH timing may be different for different DPCHs, but the offset from the P-CCPCH frame timing is a multiple of 256 chips, i.e.  $\tau_{DPCH,n} = T_n \times 256$  chips,  $T_n \in \{0, 1, \dots, 149\}$ . The DPCH (DPCCH/DPDCH) timing relation with uplink DPCCH/DPDCHs is described in clause 7.4.

## 7.2 PICH/S-CCPCH timing relation

Figure 18 illustrates the timing between a PICH frame and its associated single S-CCPCH frame, i.e. the S-CCPCH frame that carries the paging information related to the paging indicators in the PICH frame. A paging indicator set in a PICH frame means that the paging message is transmitted on the PCH in the S-CCPCH frame starting  $\tau_{PICH}$  chips after the transmitted PICH frame.  $\tau_{PICH}$  is defined in clause 7.1.

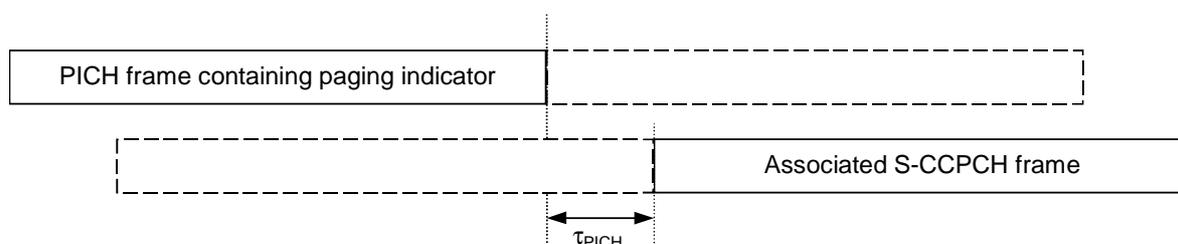


Figure 18: Timing relation between PICH frame and associated S-CCPCH frame

### 7.3 PRACH/AICH timing relation

The downlink AICH is divided into downlink access slots, each access slot is of length 5 120 chips. The downlink access slots are time aligned with the P-CCPCH as described in clause 7.1.

The uplink PRACH is divided into uplink access slots, each access slot is of length 5 120 chips. Uplink access slot number  $n$  is transmitted from the UE  $\tau_{p-a}$  chips prior to the reception of downlink access slot number  $n$ ,  $n = 0, 1, \dots, 14$ .

Transmission of downlink acquisition indicators may only start at the beginning of a downlink access slot. Similarly, transmission of uplink RACH preambles and RACH message parts may only start at the beginning of an uplink access slot.

The PRACH/AICH timing relation is shown in figure 19.

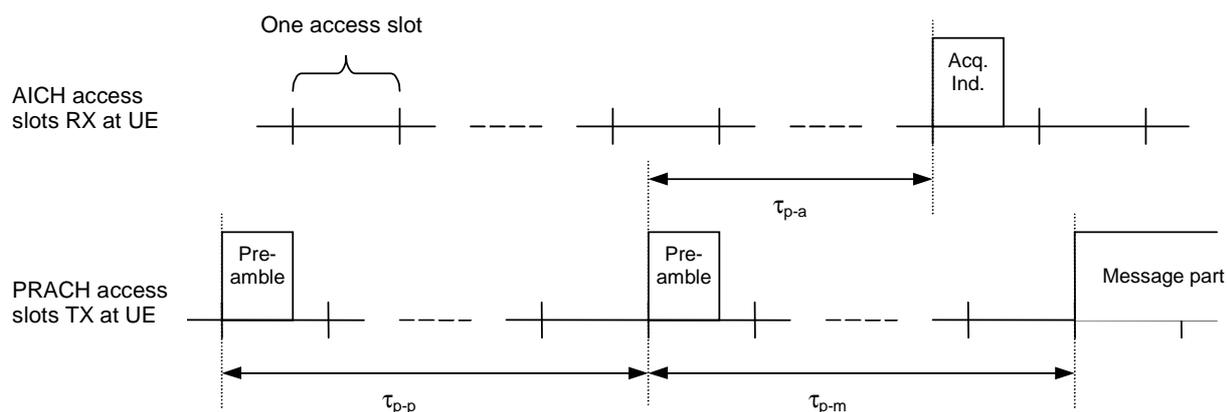


Figure 19: Timing relation between PRACH and AICH as seen at the UE

The preamble-to-preamble distance  $\tau_{p-p}$  shall be larger than or equal to the minimum preamble-to-preamble distance  $\tau_{p-p,min}$ , i.e.  $\tau_{p-p} \geq \tau_{p-p,min}$ .

In addition to  $\tau_{p-p,min}$ , the preamble-to-AI distance  $\tau_{p-a}$  and preamble-to-message distance  $\tau_{p-m}$  are defined as follows:

When AICH transmission timing was set to 0:

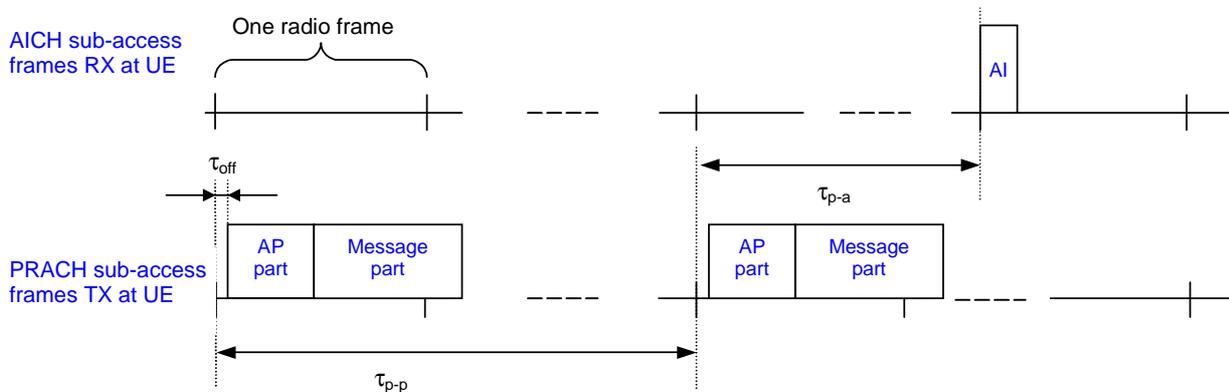
- $\tau_{p-p,min} = 1\ 152\ 000$  chips (15 access frames) = 300 ms.
- $\tau_{p-a} = 1\ 075\ 200$  chips (14 access frames) = 280 ms.

When AICH transmission timing was set to 1:

- $\tau_{p-p,min} = 2\ 150\ 400$  chips (28 access frames) = 560 ms.
- $\tau_{p-a} = 2\ 073\ 600$  chips (27 access frames) = 540 ms.

In all cases, the parameter AICH\_Transmission\_Timing is signalled by higher layers.

In Optional mode C, the following is applied: the downlink AICH access frames and sub-access frames are time aligned with the P-CCPCH as described in clause 7.1. The uplink PRACH access frame and sub-access frame are time aligned with the reception of downlink AICH access frame and sub-access frame. The PRACH/AICH timing relation is shown in figure 19a. Uplink access frame number  $n$  is transmitted from the UE  $\tau_{p-a}$  chips prior to the reception of downlink access frame number  $n$ ,  $n = 0, 1, \dots, 15$ .



**Figure 19a: Timing relation between PRACH and AICH as seen at the UE (Optional mode C)**

The transmission offset  $\tau_{off}$  shall be a value between the range of  $[-\tau_{off,max}, +\tau_{off,max}]$ , defined by the Maximum Transmission Offset  $\tau_{off,max}$ . The parameter Maximum Transmission Offset is signalled by higher layers.

The preamble-to-preamble distance  $\tau_{p-p}$  shall be larger than or equal to the minimum preamble-to-preamble distance  $\tau_{p-p,min}$ , i.e.  $\tau_{p-p} \geq \tau_{p-p,min}$ . In addition to  $\tau_{p-p,min}$ , the preamble-to-AI distance  $\tau_{p-a}$  is defined as follows:

For systems based on LEO satellites:

- when AICH\_Transmission\_Timing is set to 0, then:
  - $\tau_{p-p,min} = 230\ 400$  chips (6 radio frames);
  - $\tau_{p-a} = 153\ 600$  chips (4 radio frames);
- when AICH\_Transmission\_Timing is set to 1, then:
  - $\tau_{p-p,min} = 307\ 200$  chips (8 radio frames);
  - $\tau_{p-a} = 230\ 400$  chips (6 radio frames).

For systems based on GEO satellite:

- when AICH\_Transmission\_Timing is set to 0, then:
  - $\tau_{p-p,min} = 1\ 152\ 000$  chips (30 radio frames);
  - $\tau_{p-a} = 1\ 075\ 200$  chips (28 radio frames);
- when AICH\_Transmission\_Timing is set to 1, then:
  - $\tau_{p-p,min} = 2\ 150\ 400$  chips (56 radio frames);
  - $\tau_{p-a} = 2\ 073\ 600$  chips (54 radio frames).

## 7.4 DPCCH/DPDCH timing relations

### 7.4.1 Uplink

In uplink the DPCCH and all the DPDCHs transmitted from one UE have the same frame timing.

### 7.4.2 Downlink

In downlink, the DPCCH and all the DPDCHs carrying CCTrCHs of dedicated type to one UE have the same frame timing.

NOTE: Support of multiple CCTrCHs of dedicated type is not part of the present document.

### 7.4.3 Uplink/downlink timing at UE

At the UE, the uplink DPCCH/DPDCH frame transmission takes place approximately  $T_0$  chips after the reception of the first detected path (in time) of the corresponding downlink DPCCH/DPDCH frame.  $T_0$  is a constant defined to be 1 024 chips. The first detected path (in time) is defined implicitly by the relevant tests. More information about the uplink/downlink timing relation and meaning of  $T_0$  can be found in TS 101 851-4-3 [3].

## 7.5 MICH/S-CCPCH timing relation

Figure 20 illustrates the timing between the MICH frame boundaries and the frame boundaries of the associated S-CCPCH, i.e. the S-CCPCH that carries the MBMS control information related to the notification indicators in the MICH frame. The MICH transmission timing shall be such that the end of radio frame boundary occurs  $\tau_{\text{MICH}}$  chips before the associated S-CCPCH start of radio frame boundary.  $\tau_{\text{MICH}}$  is equal to 7 680 chips.

The MICH frames during which the satellite gateway shall set specific notification indicators and the S-CCPCH frames during which the satellite gateway shall transmit the corresponding MBMS control data is defined by higher layers.

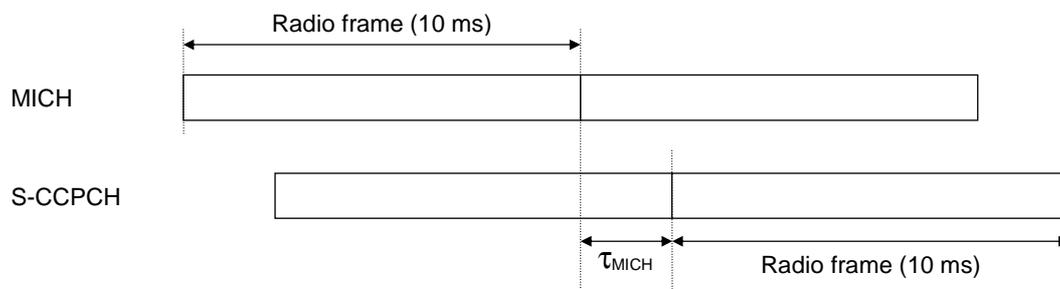


Figure 20: Timing relation between MICH frame and associated S-CCPCH frame

## Annex A (normative): Description of G-family enhancements

### A.1 Definition of the optional modes A and C

The following two optional modes are defined in the G-family enhancements:

- Optional mode A: Operation with G-family features and A-family optional features which are identified in clause A.2 for performance enhancement.
- Optional mode C: Operation with G-family features and C-family optional features which are identified in clause A.3 for performance enhancement.

In order to keep backward compatibility with G-family, the G-family enhancements system should support G basic terminals as well as G enhanced terminals and the G enhanced terminals should be operated in the G-family system. For this, the following terminal types are considered in the G-family enhancements system:

- Terminal type 1 including only G-family interface.
- Terminal type 2 including G-family interface as well as optional mode A.
- Terminal type 3 including G-family interface as well as Optional mode C.
- Terminal type 4 including G-family interface as well as both optional modes A and C.

The information which types of terminals are supported in the targeted frame and/or the considered Base Station could be sent via broadcasting channel.

### A.2 Description of optional mode A

The following new features of SRI-A family are considering for the standardization of SRI-G-family enhancements. They are based on partial harmonization of SRI-A and G families based on TR 102 278 [i.3].

**Table A.1: Description of A-family optional features**

Features	Description
HPPICH	<ul style="list-style-type: none"> <li>- Additional paging channel</li> <li>- Unspread BPSK signal packet of length 10 ms</li> <li>- Channel rate = 15 k symbol/s</li> <li>- Packet = preamble (24bits) + UW (12 bits) + data (114 bits)</li> </ul>
Downlink data scrambling	<ul style="list-style-type: none"> <li>- For downlink when interference mitigation is used</li> <li>- Prior to physical channel mapping</li> <li>- By a ML sequence with polynomial <math>1+X^{14}+X^{15}</math></li> <li>- Rate: 30 kbit/s</li> </ul>

## A.3 Description of Optional mode C

The following new features of SRI-C family are considering for the standardization of SRI-G-family enhancements. They are based on a synthetic view of SAT-CDMA and WCDMA identified in TR 102 278 [i.3] in order to harmonize ITU-R SRI-C and G families in the G-family enhancements specifications.

**Table A.2: Description of C-family optional features**

Features	Description
Uplink random access	<ul style="list-style-type: none"> <li>- Transmission of both preamble and message, together</li> <li>Access frame: 2 radio frames</li> </ul>
FBI/TPC bits generation and transmission	<ul style="list-style-type: none"> <li>- TPC field: the reduction of the half of TPC field</li> <li>- FBI field: removal of 2 bits FBI field</li> </ul>
Power control	<ul style="list-style-type: none"> <li>- CLPC: a delay compensation power control scheme + prediction algorithm</li> <li>- SIR estimation from CPICH and S-CCPCH</li> <li>- 2-bit TPC command</li> <li>- OLPC algorithm using pilot diversity in option</li> </ul>
Synchronization codes for downlink SCH in LEO constellation	<ul style="list-style-type: none"> <li>- One so-called generalized hierarchical Golay sequence</li> </ul>

## Annex B (informative): Change history

This annex describes the differences relevant to TS 101 851-1-1 [i.5], TS 101 851-2-1 [i.6], TS 101 851-3-1 [i.7], TS 101 851-4-1 [i.8], TS 101 851-1-2 [i.9], TS 101 851-2-2 [i.10], TS 101 851-3-2 [i.11] and TS 101 851-4-2 [i.12].

### B.1 A-family optional features

The following tables present summary on changes for TS 101 851-1-3 (the present document) to TS 101 851-4-3 [3] of SRI-G family in order to add some of SRI-A family features for performance enhancements.

**Table B.1: TS 101 851-1-3 (the present document); Physical channels and mapping of transport channels into physical channels**

Item Reference	Item	Actions
3.2 Abbreviations	- HPPICH for optional mode A	- To add HPPICH into abbreviation
5.3.2.8 High penetration page indication channel	- HPPICH for optional mode A	- To define HPPICH for high penetration paging + Unspread BPSK signal packet of length 10 ms + Channel rate = 15 k symbol/s + Packet = Preamble (24 bits) + UW (12 bits) + data (114 bits)

**Table B.2: TS 101 851-2-3 [1]; Multiplexing and channel coding**

Item Reference	Item	Actions
4.2 General coding/multiplexing of TrCHs	- Downlink data scrambling for optional mode A	- To add downlink data scrambling step between 2 <sup>nd</sup> interleaving and physical mapping
4.2.15 Downlink data scrambling	- Downlink data scrambling for optional mode A	- To define downlink data scrambling + A ML sequence with polynomial 1+X <sup>14</sup> +X <sup>15</sup> + Rate: 30 kbit/s

## B.2 C-family optional features

The following tables present summary on changes for TS 101 851-1-3 (the present document) to TS 101 851-4-3 [3] of SRI-G family, considering the harmonization with SRI-C family.

**Table B.3: TS 101 851-1-3 (the present document); Physical channels and mapping of transport channels into physical channels**

Item Reference	Item	Actions
5.2.1 Dedicated uplink physical channels	- FBI/TPC field generation for the Optional mode C	- Addition of statement related to deletion of FBI field for closed-loop transmit diversity and reduction as 1 bit for only SSDDT - Reduction of the number of slot formats: Deletion of 2 bits FBI - Reduction of TPC field and extension of pilot field - Identification of new pilot patterns
5.2.2 Common uplink physical channels	- Uplink random access for the Optional mode C	- Addition of modified structure of random-access transmission: transmission of both a preamble and a message - Identification of access frame - Based on ALOHA approach with fast acquisition indication - Optional RACH preamble: $N_p$ repetition of a sub-preamble and conjugation in the final sub-preamble
6.3.1 Dedicated downlink physical channels	- FBI/TPC field generation for the Optional mode C	- Modification of TPC duration as one radio frame - Reduction of the TPC field as 1/2 and extension of the Data2 field
6.3.2 Common downlink physical channels	- Uplink random access for the Optional mode C	- Identification on transmission of AI only on the first and 9 <sup>th</sup> access slots
8.1 Timing relation between physical channels	- Uplink random access for the Optional mode C	- Identification on AICH sub-access frame
8.3 PRACH/AICH timing relation	- Uplink random access for the Optional mode C	- Identification of modified PRACH/AICH timing relation in order to consider long round trip delay of satellite system and transmission of both preamble and message parts

**Table B.4: TS 101 851-2-3 [1]; Multiplexing and channel coding**

Item Reference	Item	Actions
4.5 TPC command coding	- FBI/TPC field generation for the Optional mode C	- Identification of a new coding method of TPC command: 8 repetition of 2 bits TPC command - identification of mapping of TPC words

**Table B.5: TS 101 851-3-3 [2]; Spreading and modulation**

Item Reference	Item	Actions
5.3.3 PRACH preamble codes	- Uplink random access transmission for the Optional mode C	- Addition of new code construction: $N_{sp}$ repetition of a sub-preamble and conjugation in the final sub-preamble - Identification of usage of other codes in order to distinguish even and odd sub-access frames
6.2.3 Synchronization codes	- Synchronization codes for downlink SCH in LEO constellation	- Identification of a new code generation method for LEO based mobile satellite system - Addition of modified synchronization codes as two hierarchical Golay sequences with 128 chip length

**Table B.6: TS 101 851-4-3 [3]; Physical layer procedure**

<b>Item Reference</b>	<b>Item</b>	<b>Actions</b>
5.1 Uplink power control	- Power control method for the Optional mode C	- Identification of one power control per one frame duration - Identification of a new closed-loop power control with delay compensation algorithm in order to optimize the basic power control loop parameters, including the power control rate, power control step size, and the number of control levels - Identification of a new open-loop power control algorithm considering pilot diversity
5.2 Downlink power control	- Synchronization codes for downlink SCH in LEO constellation for the Optional mode C	- Identification of one power control per one frame duration - Identification of a new closed-loop power control with delay compensation and prediction algorithms in order to optimize the basic power control loop parameters, including the power control rate, power control step size, and the number of control levels. - Deletion of ID codes for 2 bit FBI in spot selection diversity transmit power control
6.1 Random access procedure	- Uplink random access transmission for the Optional mode C	- Identification of access frame, even access frame and odd access frame - Identification of a new PRACH procedure with addition to selection of sub-access frame
6.1.1 RACH sub-channels	- Uplink random access transmission for the Optional mode C	- Identification of a RACH sub-channel as a set of access frame
6.1.2 RACH access frame sets	- Uplink random access transmission for the Optional mode C	- Identification of a new RACH access frame sets

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## History

<b>Document history</b>		
V3.1.1	September 2011	Publication
V3.2.1	November 2012	Publication