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Technical Specification

Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT2000; G-family; Part 1: Physical channels and mapping of transport channels into physical channels (S-UMTS-A 25.211)

Reference
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Contents

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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.1457-5. This modification has been approved at ITU-R SG8 meeting in November 2005.

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- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 1 of a multi-part deliverable covering Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT2000; G-family, as identified below:

Part 1: "Physical channels and mapping of transport channels into physical channels (S-UMTS-A 25.211)";

Part 2: "Multiplexing and channel coding (S-UMTS-A 25.212)";

Part 3: "Spreading and modulation (S-UMTS-A 25.213)";

Part 4: "Physical layer procedures (S-UMTS-A 25.214)";

Part 5: "UE Radio Transmission and Reception";

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

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 3rd 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 3rd 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, …) 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 shall be defined at a later stage.

1 Scope

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

It is based on the FDD mode of UTRA defined by TS 125 201 [4], TS 125 211 [5], TS 125 302 [6] and TS 125 435 [7] and adapted for operation over satellite transponders.

2 References

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

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

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

[1] ETSI TS 101 851-2: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT2000; G-family; Part 2: Multiplexing and channel coding (S-UMTS-A 25.212)".

[2] ETSI TS 101 851-3: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT2000; G-family; Part 3: Spreading and modulation (S-UMTS-A 25.213)".

[3] ETSI TS 101 851-4: "Satellite Earth Stations and Systems (SES); Satellite Component of UMTS/IMT2000; G-family; Part 4: Physical layer procedures (S-UMTS-A 25.214)".

[4] ETSI TS 125 201: "Universal Mobile Telecommunications System (UMTS); Physical layer - general description (3GPP TS 25.201)".

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

[6] ETSI TS 125 302: "Universal Mobile Telecommunications System (UMTS); Services provided by the physical layer (3GPP TS 25.302)".

[7] ETSI TS 125 435: "Universal Mobile Telecommunications System (UMTS); UTRAN Iub interface user plane protocols for CCH data streams (3GPP TS 25.435)".

[8] ETSI TS 125 427: "Universal Mobile Telecommunications System (UMTS); UTRAN Iur and Iub interface user plane protocols for DCH data streams (3GPP TS 25.427)".

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:

AI	Acquisition Indicator
AICH	Acquisition Indicator CHannel
BCH	Broadcast CHannel
CCPCH	Common Control Physical CHannel
CCTrCH	Coded Composite Transport CHannel
CPICH	Common Pilot 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
FSW	Frame Synchronization Word
GEO	Geostationary Earth Orbit
ICH	Indicator CHannel
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
MICH	MBMS Indicator CHannel
MSS	Mobile Satellite Services
NI	MBMS Notification Indicator
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
RACH	Random Access CHannel
S-CCPCH	Secondary Common Control Physical CHannel
SCH	Synchronization CHannel
SF	Spreading Factor
SFN	System Frame Number
SSC	Secondary Synchronization Code
TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
UE	User Equipment
USRAN	UMTS Satellite Radio Access Network

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 [6].

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 DCH - Dedicated Channel

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 BCH - Broadcast Channel

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 FACH - Forward Access Channel

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 [7], i.e. with "Transmit Power Level" of the "FACH DATA FRAME" Frame Protocol message.

4.1.2.3 PCH - Paging Channel

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 RACH - Random Access Channel

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 current version of the specifications 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 are specified in TS 101 851-3 [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 DPDCHand DPCCH are I/Q code multiplexed (see TS 101 851-3 [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_{slot} = 2 560 chips, corresponding to one power-control period. The DPDCH and DPCCH are always frame aligned with each other.

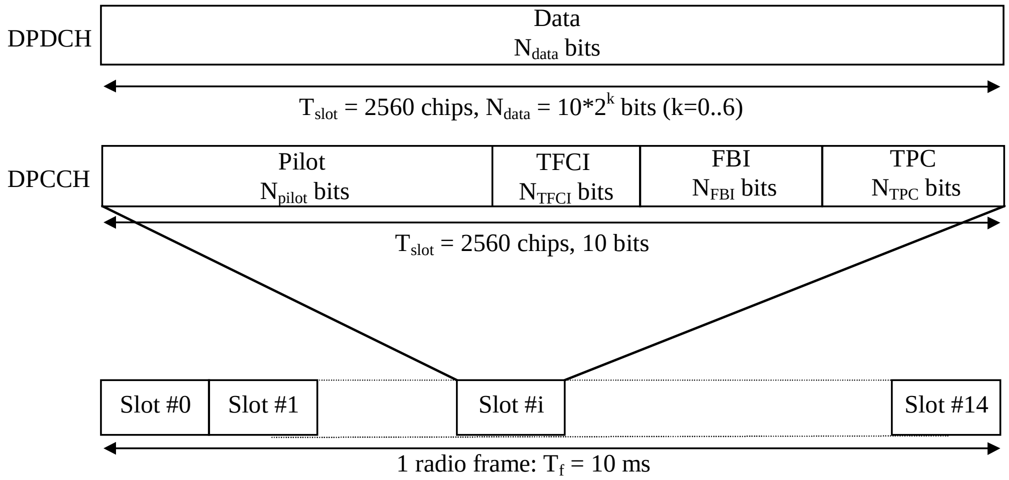

Figure 1: Frame structure for uplink DPDCH/DPCCH

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_{pilot}, N_{TFCI}, N_{FBI}, and N_{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.

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.

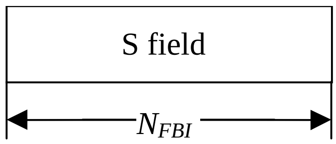

Figure 2: FBI field

The S field is used for SSDT signalling. It consists of 0, 1 or 2 bits. The total FBI field size N_{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].

Table 1: DPDCH 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
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 [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 Form at #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TPC}	N_{TFCI}	N_{FBI}	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 - 14
0B	15	15	256	150	10	4	2	4	0	8 - 9
1	15	15	256	150	10	8	2	0	0	8 - 15
2	15	15	256	150	10	5	2	2	1	15
2A	15	15	256	150	10	4	2	3	1	10 - 14
2B	15	15	256	150	10	3	2	4	1	8 - 9
3	15	15	256	150	10	7	2	0	1	8 - 15
4	15	15	256	150	10	6	2	0	2	8 - 15
5	15	15	256	150	10	5	1	2	2	15
5A	15	15	256	150	10	4	1	3	2	10 - 14
5B	15	15	256	150	10	3	1	4	2	8 - 9

The pilot bit patterns are described in tables 3 and 4. 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_{pilot} = 3, 4, 5 and 6

	N_{pilot} = 3			N_{pilot} = 4				N_{pilot} = 5					N_{pilot} = 6					
Bit #	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_{pilot} = 7 and 8

	N_{pilot} = 7							N_{pilot} = 8							
Bit #	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	0
1	1	0	0	1	1	0	1	1	0	1	0	1	1	1	0
2	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1
3	1	0	0	1	0	0	1	1	0	1	0	1	0	1	0
4	1	1	0	1	0	1	1	1	1	1	0	1	0	1	1
5	1	1	1	1	1	0	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
7	1	1	0	1	0	0	1	1	1	1	0	1	0	1	0
8	1	0	1	1	1	0	1	1	0	1	1	1	1	1	0
9	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
11	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1
12	1	1	0	1	0	0	1	1	1	1	0	1	0	1	0
13	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1
14	1	0	0	1	1	1	1	1	0	1	0	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_{TPC} = 1	N_{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 [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_{pcp} , signalled by the network TS 101 851-4 [3]. The UL DPCCH shall take the same slot format in the power control preamble as afterwards, as given in table 2. When $N_{pcp} > 0$ the pilot patterns of tables 3 and 4 shall be used. The timing of the power control preamble is described in TS 101 851-4 [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.

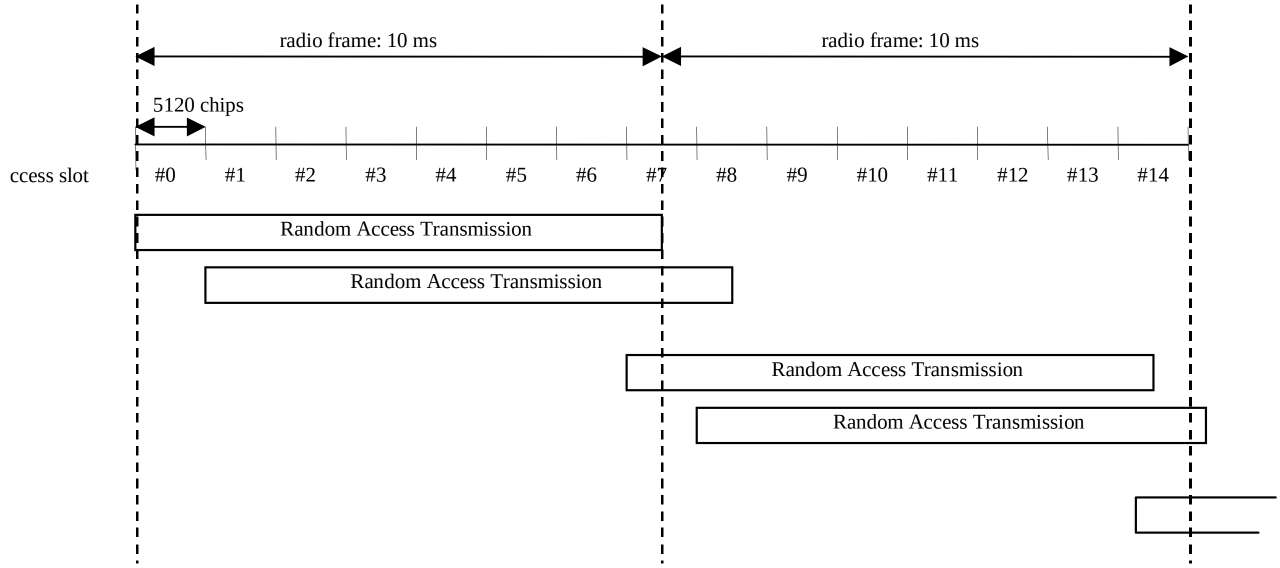

Figure 3: RACH access slot numbers and their spacing

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.

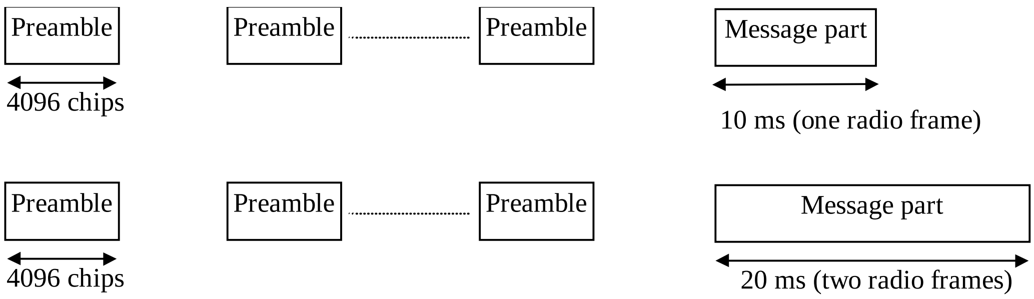

Figure 4: Structure of the random-access transmission

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 [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 10×2^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 × 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.

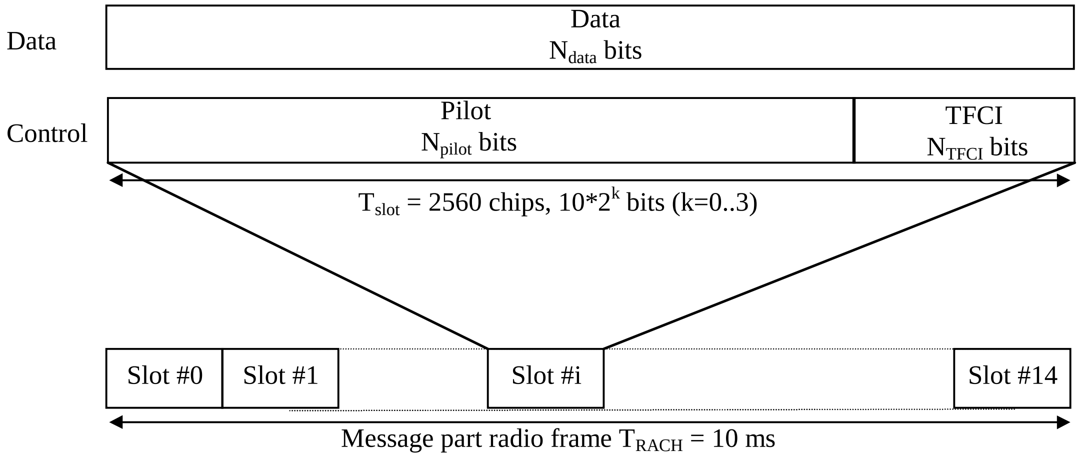

Figure 5: Structure of the random-access message part radio frame

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_{pilot}	N_{TFCI}
0	15	15	256	150	10	8	2

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

	N_{pilot} = 8							
Bit #	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_{slot} = 2 560 chips, corresponding to one power-control period.

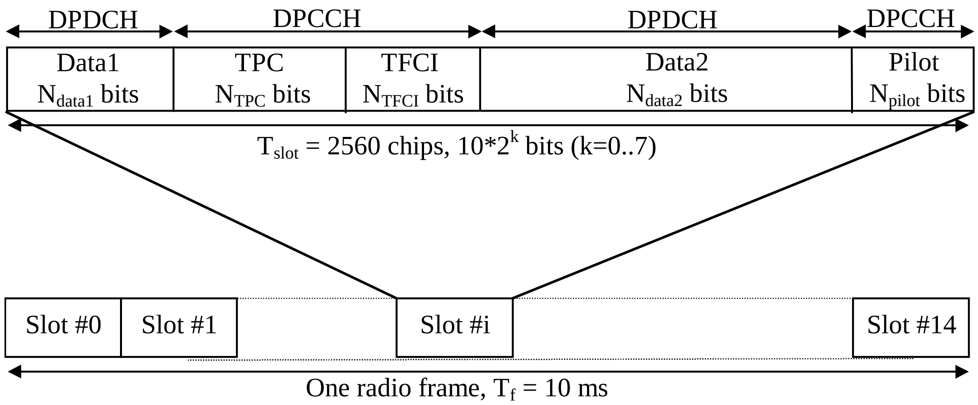

Figure 6: Frame structure for downlink DPCH

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].

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	2	0	4	15
0A	15	7,5	512	10	0	4	2	0	4	8 - 14
0B	30	15	256	20	0	8	4	0	8	8 - 14
1	15	7,5	512	10	0	2	2	2	4	15
1B	30	15	256	20	0	4	4	4	8	8 - 14
2	30	15	256	20	2	14	2	0	2	15
2A	30	15	256	20	2	14	2	0	2	8 - 14
2B	60	30	128	40	4	28	4	0	4	8 - 14
3	30	15	256	20	2	12	2	2	2	15
3A	30	15	256	20	2	10	2	4	2	8 - 14
3B	60	30	128	40	4	24	4	4	4	8 - 14
4	30	15	256	20	2	12	2	0	4	15
4A	30	15	256	20	2	12	2	0	4	8 - 14
4B	60	30	128	40	4	24	4	0	8	8 - 14
5	30	15	256	20	2	10	2	2	4	15
5A	30	15	256	20	2	8	2	4	4	8 - 14
5B	60	30	128	40	4	20	4	4	8	8 - 14
6	30	15	256	20	2	8	2	0	8	15
6A	30	15	256	20	2	8	2	0	8	8 - 14
6B	60	30	128	40	4	16	4	0	16	8 - 14
7	30	15	256	20	2	6	2	2	8	15
7A	30	15	256	20	2	4	2	4	8	8 - 14
7B	60	30	128	40	4	12	4	4	16	8 - 14
8	60	30	128	40	6	28	2	0	4	15
8A	60	30	128	40	6	28	2	0	4	8 - 14
8B	120	60	64	80	12	56	4	0	8	8 - 14
9	60	30	128	40	6	26	2	2	4	15
9A	60	30	128	40	6	24	2	4	4	8 - 14
9B	120	60	64	80	12	52	4	4	8	8 - 14
10	60	30	128	40	6	24	2	0	8	15
10A	60	30	128	40	6	24	2	0	8	8 - 14
10B	120	60	64	80	12	48	4	0	16	8 - 14
11	60	30	128	40	6	22	2	2	8	15
11A	60	30	128	40	6	20	2	4	8	8 - 14
11B	120	60	64	80	12	44	4	4	16	8 - 14
12	120	60	64	80	12	48	4	8 (see note 4)	8	15
12A	120	60	64	80	12	40	4	16 (see note 4)	8	8 - 14
12B	240	120	32	160	24	96	8	16 (see note 4)	16	8 - 14
13	240	120	32	160	28	112	4	8 (see note 4)	8	15
13A	240	120	32	160	28	104	4	16 (see note 4)	8	8 - 14
13B	480	240	16	320	56	224	8	16 (see note 4)	16	8 - 14
14	480	240	16	320	56	232	8	8 (see note 4)	16	15
14A	480	240	16	320	56	224	8	16 (see note 4)	16	8 - 14
14B	960	480	8	640	112	464	16	16 (see note 4)	32	8 - 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	8	8 (see note 4)	16	15
15A	960	480	8	640	120	480	8	16 (see note 4)	16	8 - 14
15B	1 920	960	4	1 280	240	976	16	16 (see note 4)	32	8 - 14
16	1 920	960	4	1 280	248	1 000	8	8 (see note 4)	16	15
16A	1 920	960	4	1 280	248	992	8	16 (see note 4)	16	8 - 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 Node B receives an invalid combination of data frames for downlink transmission, the procedure specified in TS 125 427 [8], 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.

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 are 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, …, 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,…, x_X.

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

	N_{pilot} = 2	N_{pilot} = 4 (see note 1)		N_{pilot} = 8 (see note 2)				N_{pilot} = 16 (see note 3)							
Symbol #	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 *n*B where *n* = 0, …, 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_{TPC} = 2	N_{TPC} = 4	N_{TPC} = 8	
11 00	1111 0000	11111111 00000000	1 0

Multicode transmission may be employed in the downlink, i.e. the CCTrCH (see TS 101 851-2 [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 current release.

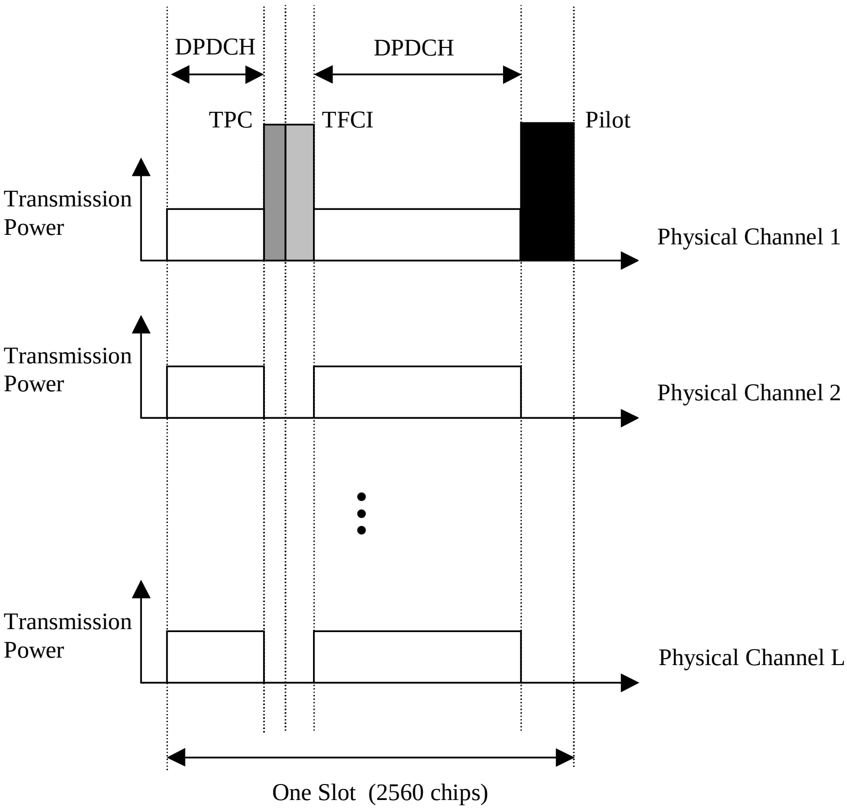

Figure 7: Downlink slot format in case of multi-code transmission

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.

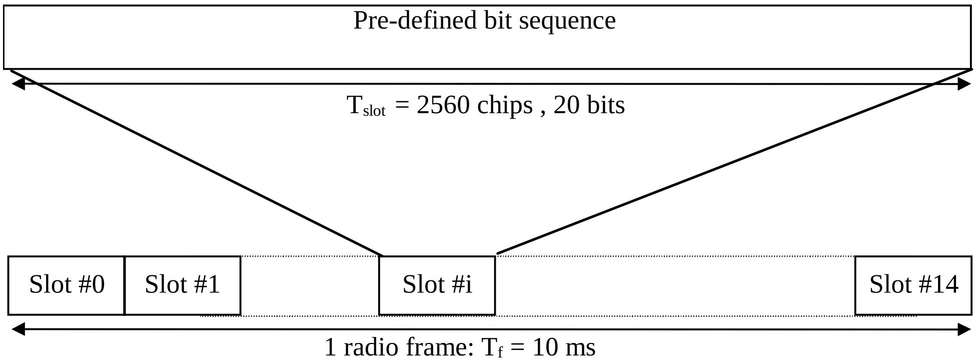

Figure 8: Frame structure for Common Pilot Channel

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 [2];
- The P-CPICH is scrambled by the primary scrambling code, see TS 101 851-3 [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 [2];
- A S-CPICH is scrambled by either the primary or a secondary scrambling code, see TS 101 851-3 [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 "X" - can be applied, "-" - not applied

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	-	-

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).

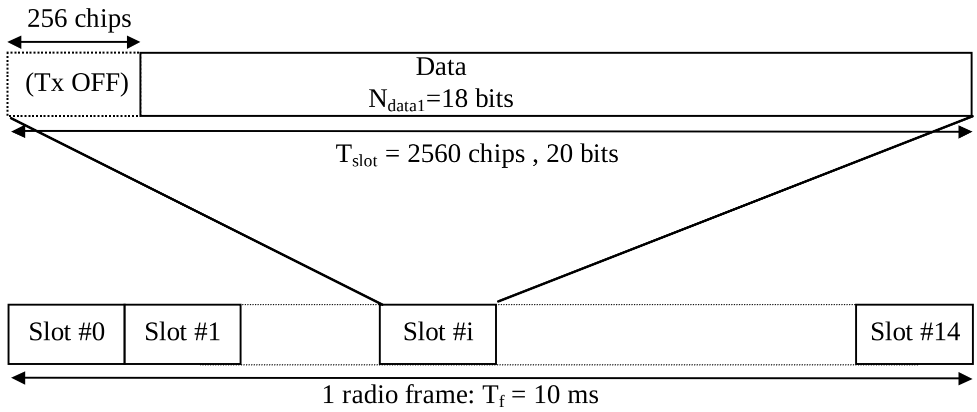

Figure 9: Frame structure for Primary Common Control Physical Channel

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.

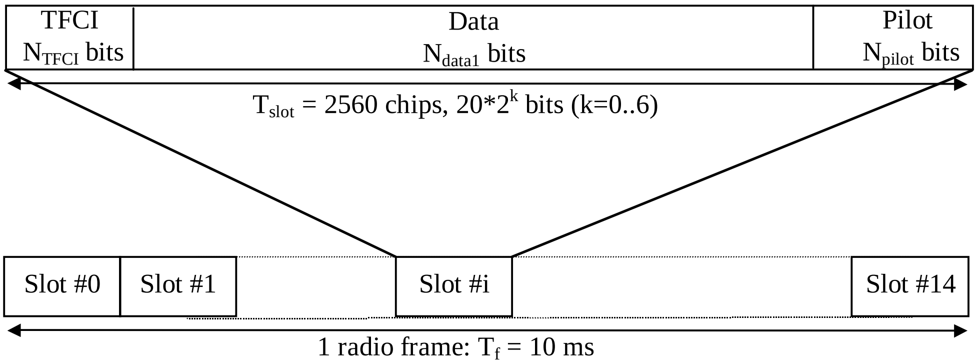

Figure 10: Frame structure for Secondary Common Control Physical Channel

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 (ksps)	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)
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

	N_{pilot} = 8				N_{pilot} = 16							
Symbol #	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 [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.

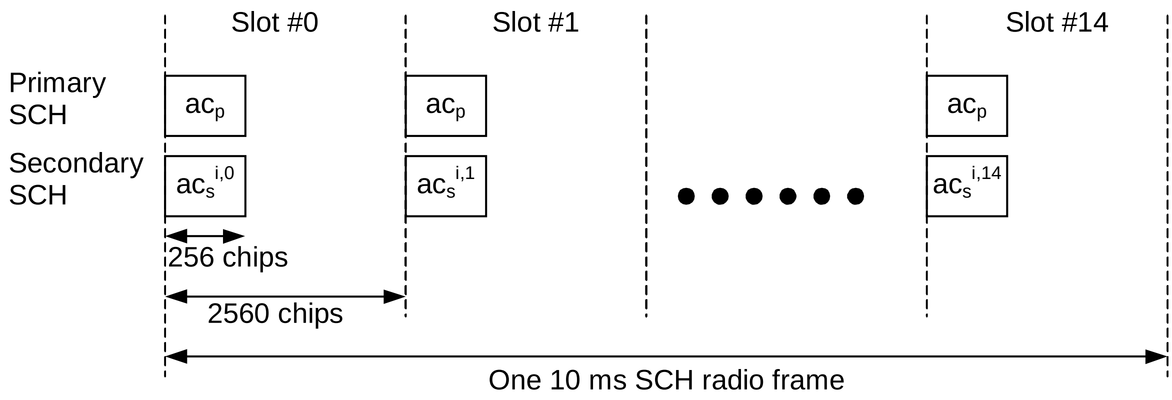

Figure 11: Structure of Synchronization CHannel (SCH)

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, …, 63 is the number of the scrambling code group, and k = 0, 1, …, 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, …, 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.

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

The phase reference for the AICH is the Primary CPICH.

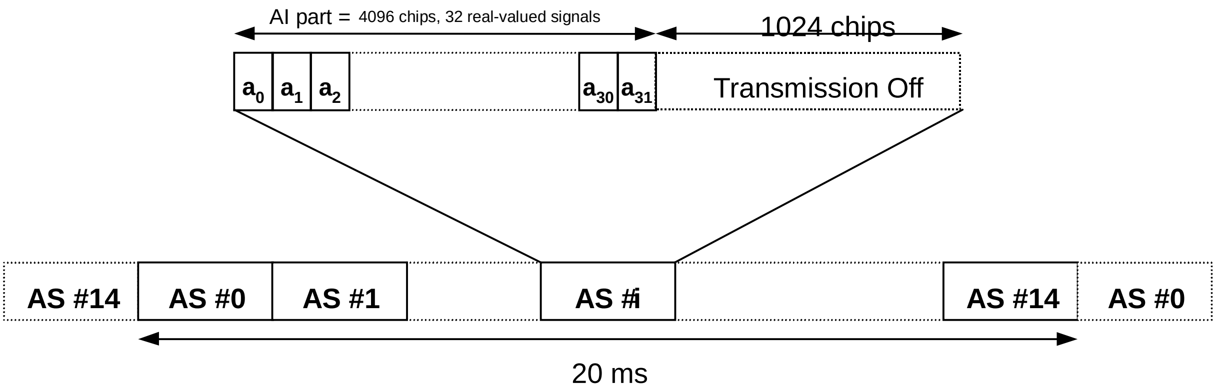

Figure 12: Structure of Acquisition Indicator CHannel (AICH)

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

$$a_j = \sum_{s=0}^{15} AI_s b_{s,j}$$

where AI_s, taking the values +1, -1, and 0, is the acquisition indicator corresponding to signature s and the sequence $b_{s,0}$, …, $b_{s,31}$ 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]), then AI_s shall be set to 0.

The use of acquisition indicators is described in TS 101 851-4 [3]. If an Acquisition Indicator is set to +1, it represents a positive acknowledgement. If an Acquisition Indicator is set to -1, it represents a negative acknowledgement.

The real-valued signals, a_j, are spread and modulated in the same fashion as bits when represented in { +1, -1 } form.

Table 15: AICH signature patterns

s	$b_{s,0}, b_{s,1}\ldots, b_{s,31}$																														
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1
2	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1
3	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1
4	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
5	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1
6	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
7	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
9	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1
10	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1
11	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1
12	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	1	1	1	1
13	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1
14	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	1	1	1	1	-1	-1	-1	-1
15	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1

5.3.2.7 Paging Indicator CHannel (PICH)

The Paging Indicator CHannel (PICH) is a fixed rate (SF = 256) physical channel used to carry the paging indicators. The PICH is always associated with an S-CCPCH to which a PCH transport channel is mapped.

Figure 13 illustrates the frame structure of the PICH. One PICH radio frame of length 10 ms consists of 300 bits (b_0, b_1, …, b_{299}). Of these, 288 bits (b_0, b_1, …, b_{287}) are used to carry paging indicators. The remaining 12 bits are not formally part of the PICH and shall not be transmitted (DTX). The part of the frame with no transmission is reserved for possible future use.

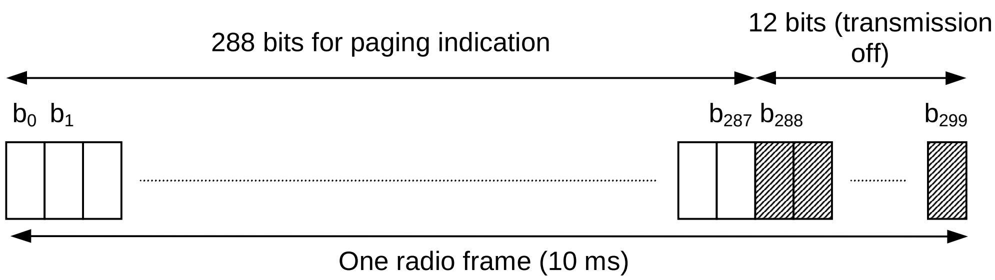

Figure 13: Structure of Paging Indicator CHannel (PICH)

In each PICH frame, Np paging indicators {P_0, …, P_{Np-1}} are transmitted, where Np = 18, 36, 72, or 144.

The PI calculated by higher layers for use for a certain UE, is associated to the paging indicator P_q, where q is computed as a function of the PI computed by higher layers, the SFN of the P-CCPCH radio frame during which the start of the PICH radio frame occurs, and the number of paging indicators per frame (Np):

$$q = \left(PI + \left\lfloor \left(\left(18 \times \left(SFN + \lfloor SFN/8 \rfloor + \lfloor SFN/64 \rfloor + \lfloor SFN/512 \rfloor \right) \right) \bmod 144 \right) \times \frac{Np}{144} \right\rfloor \right) \bmod Np$$

Further, the PI calculated by higher layers is associated with the value of the paging indicator P_q. If a paging indicator in a certain frame is set to "1" it is an indication that UEs associated with this paging indicator and PI should read the corresponding frame of the associated S-CCPCH.

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 formula above is to be performed in Node B to make the association between PI and P_q.

The mapping from {P_0, …, P_{Np-1}} to the PICH bits {b_0, …, b_{287}} are according to table 16.

Table 16: Mapping of paging indicators P_q to PICH bits

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

5.3.2.8 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, …, b_{299}). Of these, 288 bits (b_0, b_1, …, 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).

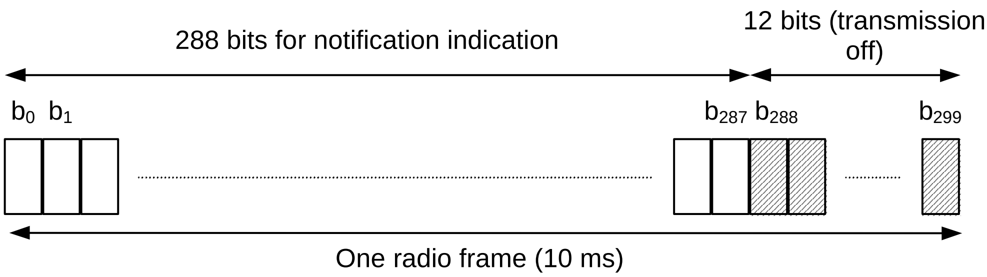

Figure 14: Structure of MBMS Indicator CHannel (MICH)

In each MICH frame, Nn notification indicators $\{N_0, \ldots, N_{Nn-1}\}$ are transmitted, where Nn = 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 (Nn):

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

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 formula above shall be performed in the Node B every MICH frame to make the association between NI and N_q.

The mapping from $\{N_0, \ldots, N_{Nn-1}\}$ to the MICH bits $\{b_0, \ldots, b_{287}\}$ are according to table 17.

Table 17: Mapping of paging indicators N_q to MICH bits

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

Transport Channels	**Physical Channels**
DCH	Dedicated Physical Data Channel (DPDCH)
	Dedicated Physical Control Channel (DPCCH)
RACH	Physical Random Access Channel (PRACH)
	Common Pilot Channel (CPICH)
BCH	Primary Common Control Physical Channel (P-CCPCH)
FACH, PCH	Secondary Common Control Physical Channel (S-CCPCH)
	Synchronisation Channel (SCH)
	Acquisition Indicator Channel (AICH)
	Paging Indicator Channel (PICH)
	MBMS Notification Indicator Channel (MICH)

Figure 15: Transport-channel to physical-channel mapping

The DCHs are coded and multiplexed as described in TS 101 851-2 [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.

Physical Signals	**Physical Channels**
PRACH preamble part	Physical Random Access Channel (PRACH)

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 below 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.

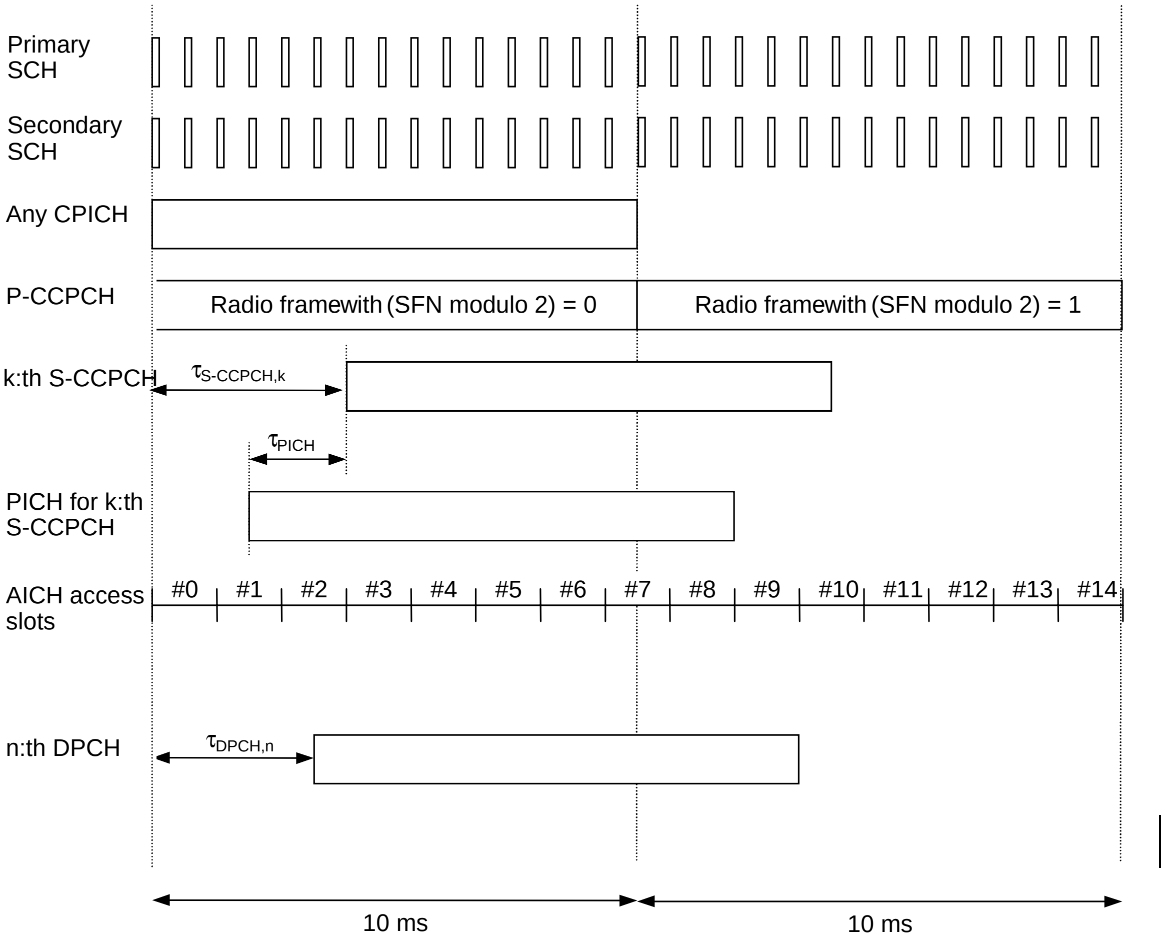

Figure 17: Radio frame timing and access slot timing of downlink physical channels

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. $\tau_{S\text{-}CCPCH,k} = T_k \times 256$ chip, $T_k \in \{0, 1, \ldots, 149\}$.
- The PICH timing is τ_{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 clauses 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. $\tau_{DPCH,n} = T_n \times 256$ chip, $T_n \in \{0, 1, \ldots, 149\}$. 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 τ_{PICH} chips after the transmitted PICH frame. τ_{PICH} is defined in clause 7.1.

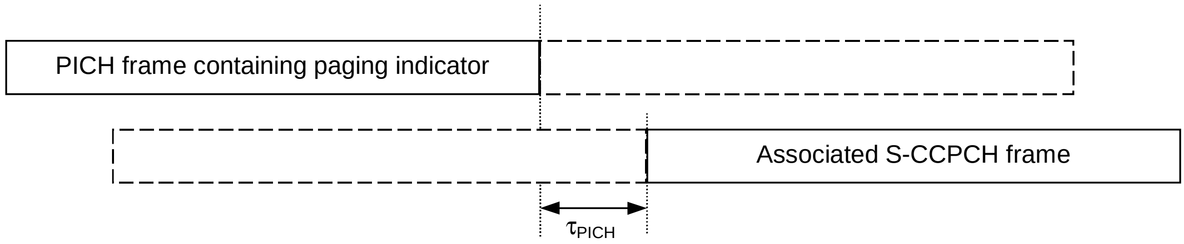

Figure 18: Timing relation between PICH frame and associated S-CCPCH frame

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 τ_{p-a} chips prior to the reception of downlink access slot number *n*, *n* = 0, 1, …, 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.

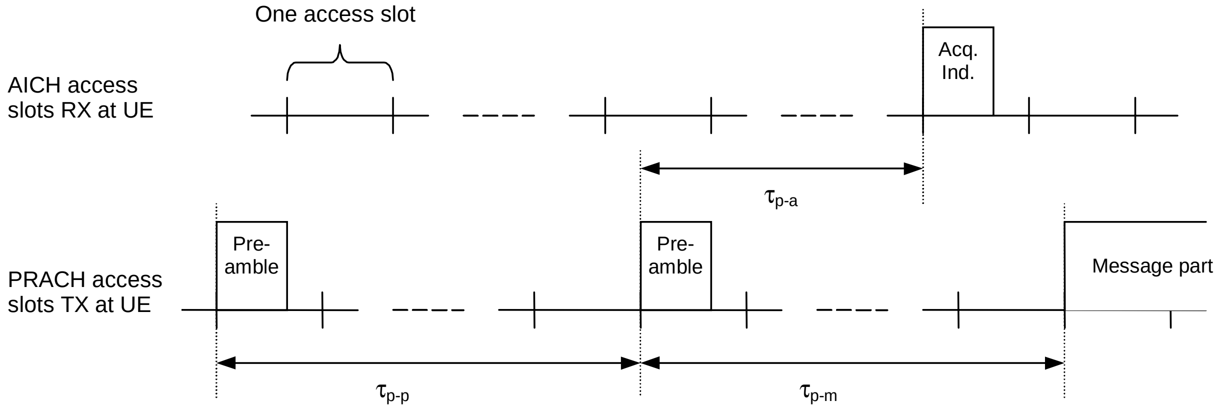

Figure 19: Timing relation between PRACH and AICH as seen at the UE

The preamble-to-preamble distance τ_{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 τ_{p-a} and preamble-to-message distance τ_{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.
- τ_{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.
- τ_{p-a} = 2 073 600 chips (27 access frames) = 540 ms.

The parameter AICH_Transmission_Timing is signalled by higher layers.

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 current release.

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].

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 τ_{MICH} chips before the associated S-CCPCH start of radio frame boundary. τ_{MICH} is equal to 7 680 chips.

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

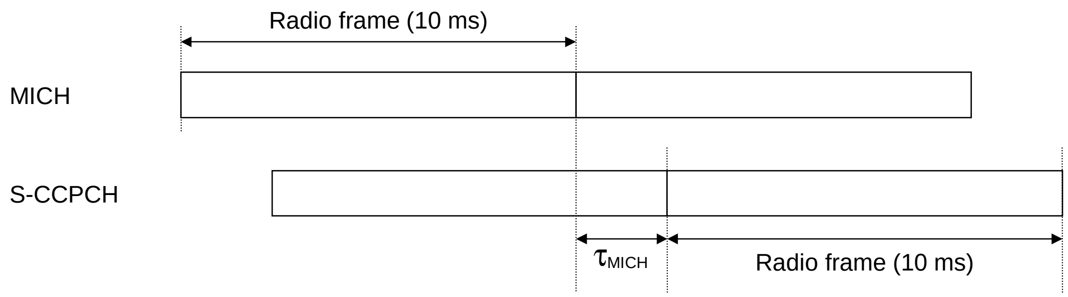

Figure 20: Timing relation between MICH frame and associated S-CCPCH frame

Annex A (informative): Bibliography

ITU-R Recommendation M.1457: "Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".

History

Document history		
V1.1.1	December 2000	Publication
V1.2.1	January 2006	Publication