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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Special Mobile Group (SMG).

The present document has been elaborated by the Layer 1 expert group of SMG2 "Radio aspects", as a part of the work in defining and describing Layer 1 of the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (UTRA).

The present document describes the transport channels and physical channels in UTRA/FDD Layer 1.

1 Scope

This Technical Report establishes the characteristics of the Layer 1 transport channels and physicals channels in the FDD mode of UTRA. The main objectives of the document are to be a part of the full description of the UTRA Layer 1, and to serve as a basis for the drafting of the actual technical specification (TS).

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
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- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] Reference 1.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:
<defined term>: <definition>.

3.2 Symbols

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

<symbol> <Explanation>

3.3 Abbreviations

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

AICH	Acquisition Indication Channel
BCH	Broadcast Channel
CCPCH	Common Control Physical Channel
DCH	Dedicated Channel
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DPDCH	Dedicated Physical Data Channel
DSCH	Downlink Shared Channel
FACH	Forward Access Channel
FAUSCH	Fast Uplink Signalling Channel
FBI	Feedback Information
MUI	Mobile User Identifier
PCH	Paging Channel
PDSCH	Physical Downlink Shared Channel
PI	Paging Indication
PRACH	Physical Random Access Channel
PSCCCH	Physical Shared Channel Control Channel
RACH	Random Access Channel
RNC	Radio Network Controller
SCH	Synchronisation Channel
SF	Spreading Factor
SFN	System Frame Number
STTD	Space Time Transmit Diversity

TFCI	Transport Format Combination Indicator
TPC	Transmit Power Control
UE	User Equipment

4 Transport channels

< Documentation status: Everything in this clause is to be considered as working assumption, except otherwise explicitly stated. The use of DCH and/or DSCH Control Channel to control the downlink shared channel DSCH is for further study. >

Transport channels are the services offered by Layer 1 to the higher layers.

4.1 Dedicated transport channels

There are two types of dedicated transport channel, the Dedicated Channel (DCH) and the Fast Uplink Signalling Channel (FAUSCH).

4.1.1 DCH – Dedicated Channel

The Dedicated Channel (DCH) is a downlink or uplink transport channel that is used to carry user or control information between the network and the UE. The DCH thus corresponds to the three channels Dedicated Traffic Channel (DTCH), Stand-Alone Dedicated Control Channel (SDCCH), and Associated Control Channel (ACCH) defined within ITU-R Recommendation M.1035. The DCH is transmitted over the entire cell or over only a part of the cell using lobe-forming antennas.

4.1.2 FAUSCH – Fast Uplink Signalling Channel

The Fast Uplink Signalling Channel (FAUSCH) is an optional uplink transport channel that is used to carry control information from a UE. The FAUSCH is always received from the entire cell.

4.2 Common transport channels

There are six types of common transport channels: BCH, FACH, PCH, RACH, DSCH, and DSCH control channel.

4.2.1 BCH – Broadcast Channel

The Broadcast Channel (BCH) is a downlink transport channel that is used to broadcast system- and cell-specific information. The BCH is always transmitted over the entire cell.

4.2.2 FACH – Forward Access Channel

The Forward Access Channel (FACH) is a downlink transport channel that is used to carry control information to a UE when the system knows the location cell of the UE. The FACH may also carry short user packets. The FACH is transmitted over the entire cell or over only a part of the cell using lobe-forming antennas.

4.2.3 PCH – Paging Channel

The Paging Channel (PCH) is a downlink transport channel that is used to carry control information to a UE when the system does not know the location cell of the UE. The PCH is always transmitted over the entire cell.

4.2.4 RACH – Random Access Channel

The Random Access Channel (RACH) is an uplink transport channel that is used to carry control information from the UE. The RACH may also carry short user packets. The RACH is always received from the entire cell.

4.2.5 DSCH – Downlink Shared Channel

The downlink shared channel (DSCH) is a downlink transport channel shared by several Ues carrying dedicated control or traffic data.

Two possibilities exist for the DSCH:

- the DSCH is associated with a DCH;
- the DSCH is associated with a DSCH control channel.

It is for further study whether both possibilities are needed.

4.2.6 DSCH Control Channel

The DSCH control channel is a downlink transport channel carrying control information to the UE for operating the DSCH when not associated with a DCH. Such control information corresponds among other things to resource allocation messages and L1 control information such as TPC, that are not available on the DSCH.

5 Physical channels

< Documentation status: Everything in this clause is to be considered as working assumption, except otherwise explicitly stated. >

5.1 The physical resource

The basic physical resource is the code/frequency plane. In addition, on the uplink, different information streams may be transmitted on the I and Q branch. Consequently, a physical channel corresponds to a specific carrier frequency, code, and, on the uplink, relative phase (0 or $\pi/2$).

5.2 Uplink physical channels

5.2.1 Dedicated uplink physical channels

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

The uplink DPDCH is used to carry dedicated data generated at Layer 2 and above, i.e. the dedicated transport channel (DCH). There may be zero, one, or several uplink DPDCHs on each Layer 1 connection.

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 parameters of the different transport channels multiplexed on the uplink DPDCH, and corresponds to the data transmitted in the same frame. It is the UTRAN that determines if a TFCI should be transmitted, hence making it is mandatory for all Ues to support the use of TFCI in the uplink. There is one and only one uplink DPCCH on each Layer 1 connection.

Figure 1 shows the frame structure of the uplink dedicated physical channels. Each frame of length 10 ms is split into 16 slots, each of length T_{slot} = 0,625 ms, corresponding to one power-control period. A super frame corresponds to 72 consecutive frames, i.e. the super-frame length is 720 ms.

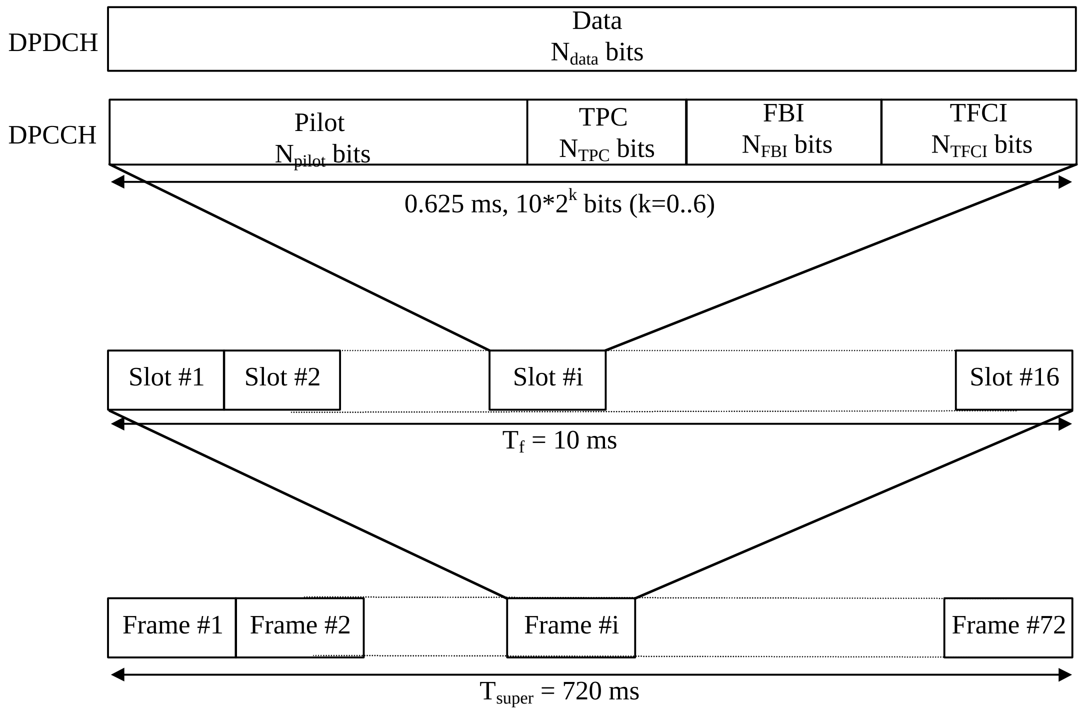


Figure 1: Frame structure for uplink DPDCH/DPCCH

The parameter k in Figure 1 determines the number of bits per uplink DPDCH/DPCCH slot. It is related to the spreading factor SF of the physical channel as $SF = 256/2^k$. The spreading factor may thus range from 256 down to 4. Note that an uplink DPDCH and uplink DPCCH on the same Layer 1 connection generally are of different rates, i.e. have different spreading factors and different values of k.

The exact number of bits of the different uplink DPCCH fields in Figure 1 (N_{pilot}, N_{TPC}, N_{FBI}, and N_{TFCI}) is yet to be determined. The spreading factor for the DPCCH fields and the length (in bits) of each field is negotiated at connection set up. Both the spreading factor and the length of the fields may be negotiated during the connection through higher layer signalling. A "reserved" field should be introduced, its length is to be defined and is currently assumed to be zero bits.

The N_{FBI} bits are used to support techniques requiring feedback between the UE and the UTRAN Access Point (=cell transceiver), including feedback (FB) mode transmit diversity, and site selection diversity. The exact details of the FBI field in the frame structure shown in Figure 1 are for further study.

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 UMTS XX.05. However, there is only one DPCCH per connection.

5.2.2 Common uplink physical channels

5.2.2.1 Physical Random Access Channel

The Physical Random Access Channel (PRACH) is used to carry the RACH and the FAUSCH.

5.2.2.1.1 RACH transmission

The random-access transmission is based on a Slotted ALOHA approach with fast acquisition indication, i.e. a UE can start the transmission at a number of well-defined time-offsets, relative to the frame boundary of the received BCH of the current cell. The different time offsets are denoted *access slots* and are spaced 1,25 ms apart as illustrated in Figure 2. Information on what access slots are available in the current cell is broadcast on the BCH.

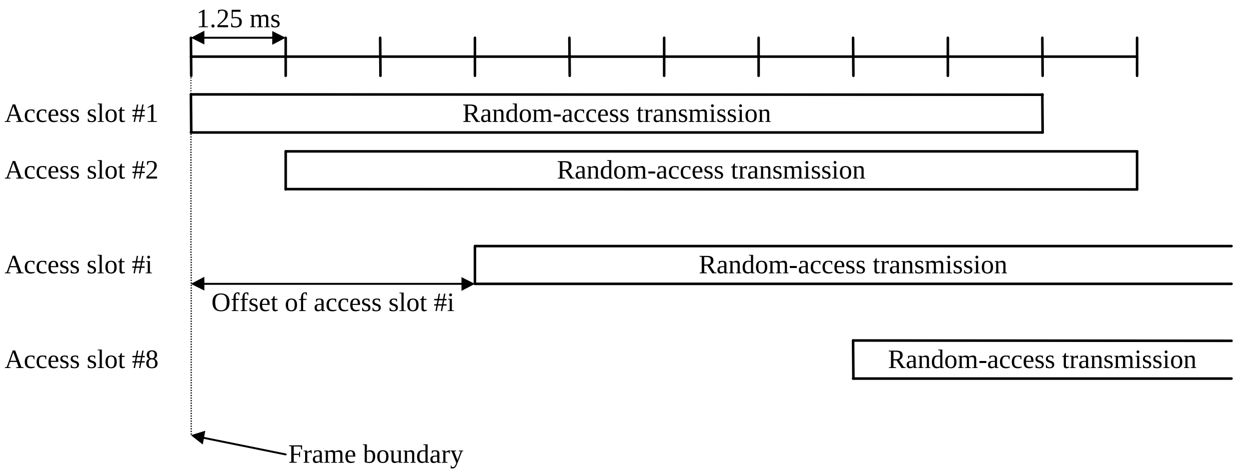


Figure 2: PRACH allocated for RACH access slots

The structure of the random-access transmission of Figure 2, is shown in Figure 3. The random-access transmission consists of one or several *preambles* of length 1 ms and a *message* of length 10 ms.

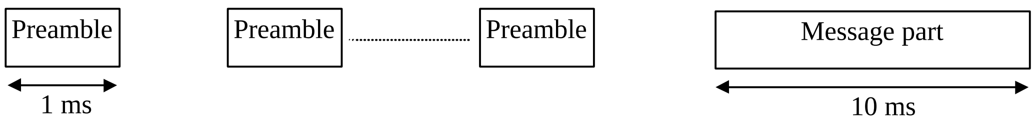


Figure 3: Structure of the random-access transmission

5.2.2.1.2 RACH preamble part

The preamble part of the random-access burst consists of a *signature* of length 16 complex symbols ±1(+j). Each preamble symbol is spread with a 256 chip real Orthogonal Gold code. There are a total of 16 different signatures, based on the Orthogonal Gold code set of length 16 (see UMTS XX.05 for more details).

5.2.2.1.3 RACH message part

The message part of the random-access burst has the same structure as the uplink dedicated physical channel. It consists of a data part, corresponding to the uplink DPDCH, and a Layer 1 control part, corresponding to the uplink DPCCH, see Figure 4. The data and control parts are transmitted in parallel. The data part carries the random access request or user packet. The spreading factor of the data part is limited to SF∈{256, 128, 64, 32} corresponding to channel bit rates of 16, 32, 64, and 128 kbps respectively. The control part carries pilot bits and rate information, using a spreading factor of 256. The rate information indicates which channelization code (or rather the spreading factor of the channelization code) is used on the data part, see further UMTS XX.05.

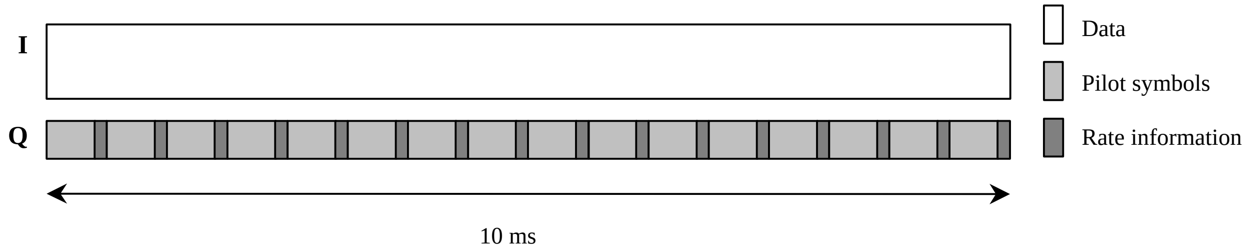


Figure 4: The message part of the random-access burst

5.2.2.1.4 FAUSCH transmission

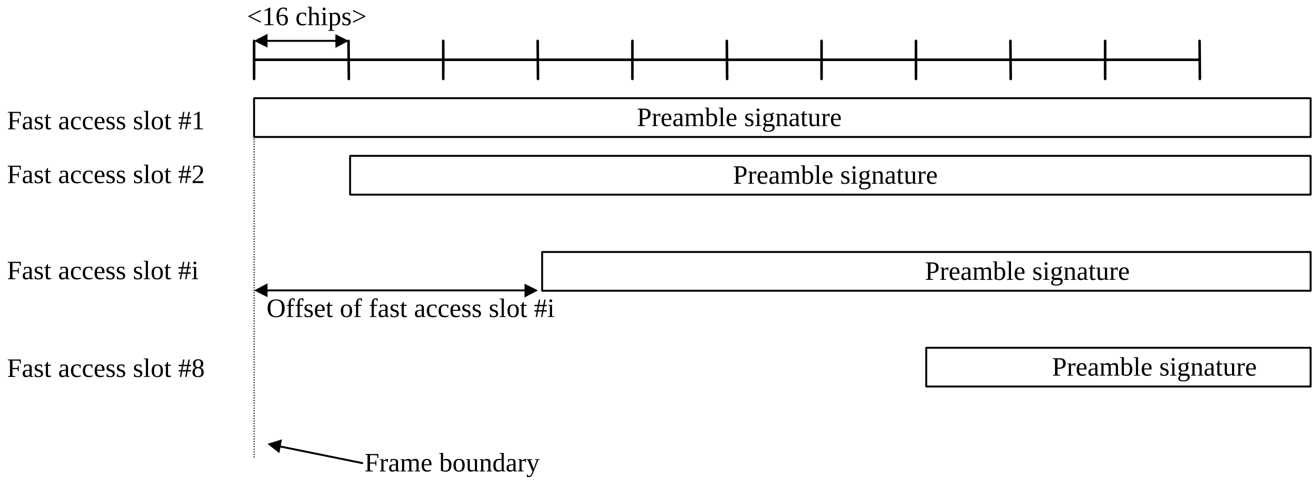


Figure 5: PRACH used for FAUSCH fast access slots

The Fast Uplink Physical Channel (FAUSCH) is based on the transmission of a signature of length 16 complex symbols ±(1+j). The signature is one of the set of signatures used for the RACH preamble. Signature no. [8] is selected because it has the best correlation properties. Each symbol is spread with a 256 chip real Orthogonal Gold code. A time slot is allocated to the UE by the network when entering Connected Mode but the allocation may be updated with appropriate signalling. To avoid the possibility of collisions only one UE is allowed to transmit with a given signature in a particular time slot. Thus the UE can start the transmission of the FAUSCH at an assigned time offset relative to the frame boundary of the received BCH of the current cell. The different time offsets are denoted *fast access slots* and are spaced [16] chips apart as illustrated in Figure 5. To avoid possible confusion of transmissions from different UE’s the separation between allocations of fast access slots to different UE’s must be sufficient to allow for any round-trip delay resulting from the physical distance between network and UE. Therefore the allocation of fast access slots may be limited by the network to a subset of those available, depending on the deployment scenario.

5.2.2.1.5 Sharing of PRACH by RACH and FAUSCH

FAUSCH uses only the preamble part of PRACH. The RACH and FAUSCH transmissions could use different Gold Codes for spreading the signatures, but the complexity of the uplink receiver is significantly reduced if the same Gold Code is used. Low interference between RACH and FAUSCH can then be achieved by restricting the allocation of RACH access slots and FAUSCH fast access slots so that the respective transmissions occur in different parts of the 10 ms frame. The partitioning of the frame is flexible. For example, if RACH access slots are spaced 2,5 ms apart, then FAUSCH fast access slots could be allocated in the gaps. The UE can determine the available RACH access slots my monitoring the BCH. The FAUSCH fast access slots are individually allocated to a specific UE.

5.3 Downlink physical channels

5.3.1 Dedicated 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, compare subclause 5.2.1. It is the UTRAN that determines if a TFCI should be transmitted, hence making it is mandatory for all Ues to support the use of TFCI in the downlink.

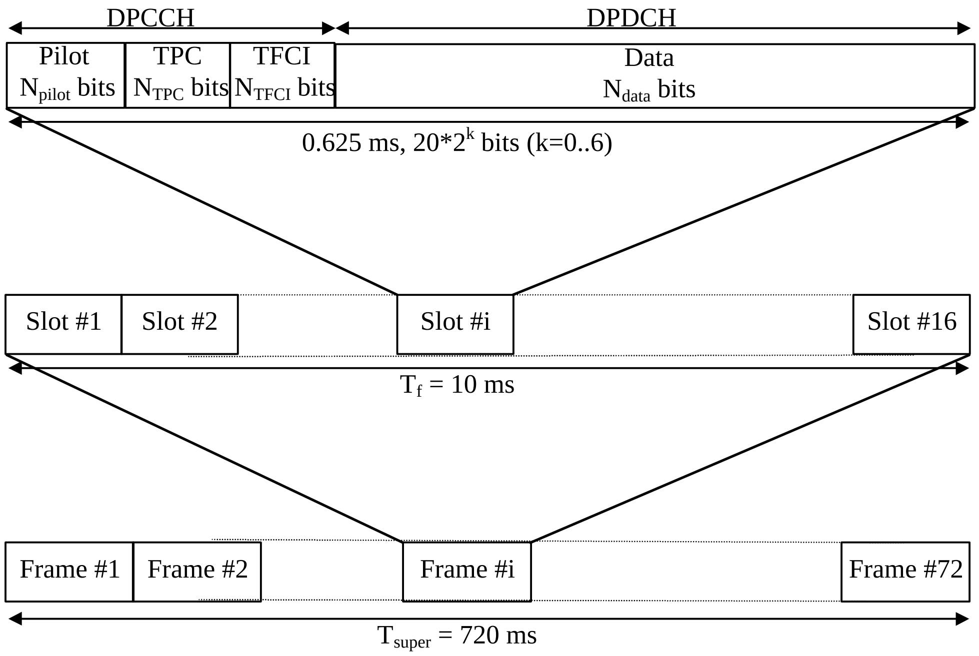


Figure 6 shows the frame structure of the downlink DPCH. Each frame of length 10 ms is split into 16 slots, each of length T_{slot} = 0,625 ms, corresponding to one power-control period. A super frame corresponds to 72 consecutive frames, i.e. the super-frame length is 720 ms.

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 $SF = 256/2^k$. The spreading factor may thus range from 256 down to 4.
The exact number of bits of the different downlink DPCH fields in Figure 6 (N_{pilot}, N_{TPC}, N_{TFCI}, and N_{data}) is yet to be determined. The overhead due to the DPCCH transmission has to be negotiated at the connection set-up and can be re-negotiated during the communication, in order to match particular propagation conditions.

The DPCCH fields are spread using the same channelization code used for the DPDCH field. A channelization code for the highest bit rate to be served during the connection (for a given DPCH) should be assigned (with spreading factor SF_1).

NOTE: Connection-dedicated pilot bits are transmitted also for the downlink in order to support the use of downlink adaptive antennas.

When the total bit rate to be transmitted on one downlink connection exceeds the maximum bit rate for a downlink physical channel, multicode transmission is employed, i.e. several parallel downlink DPCHs are transmitted for one connection using the same spreading factor. In this case, the Layer 1 control information is put on only the first downlink DPCH. The additional downlink DPCHs belonging to the connection do not transmit any data during the corresponding time period, see Figure 7.
Multiple codes may also transmitted in order to transmit different transport channels on different codes (code multiplex). In that case, the different parallel codes may have different spreading factors and the Layer 1 control information is transmitted on each code independently.

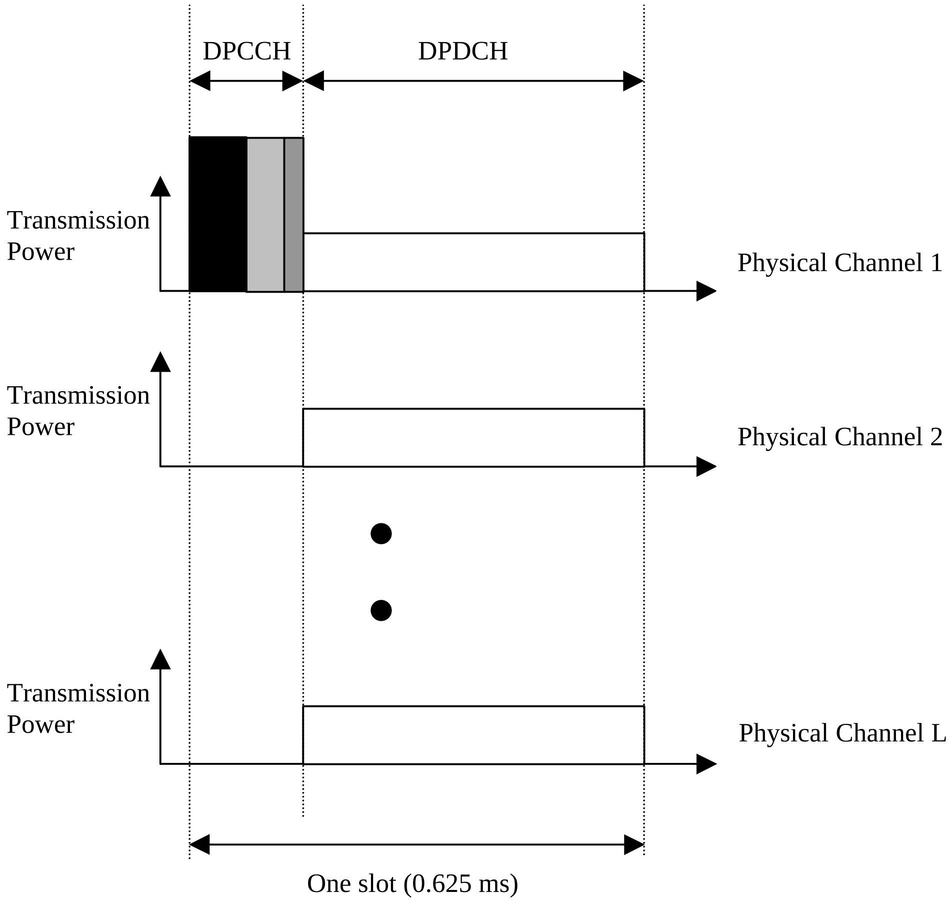
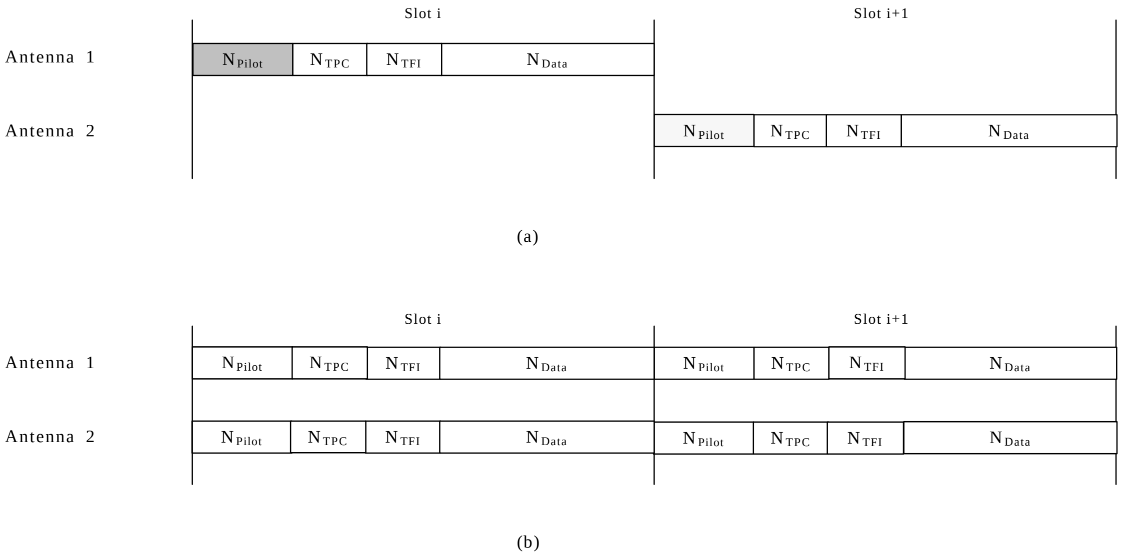


Figure 7: Downlink slot format in case of multi-code transmission

5.3.1.1 Dedicated channel pilots with feedback mode transmit diversity

For certain sub-modes of feedback mode transmit diversity, in which transmission antennas are selected, the pilot patterns can be varied according to which antenna is transmitted upon (see Figure 8 a, where the different shading indicates different pilot patterns). This assists in some types of antenna verification (see XX.07 for a description of antenna verification). Pilot symbol patterns are TBD. Otherwise, the pilot symbol patterns from both of the antennas are the same (see Figure 8 b).



NOTE: FB diversity does set any requirements to the length and position of different fields in the DPCH slot structure. The slot structure shown in Figure 8 can be considered as an example.

Figure 8: Slot structures for downlink dedicated physical channel diversity transmission. Structure (a) may be used in conjunction with antenna verification. Structure (b) is used otherwise

5.3.1.2 Open loop transmit diversity

The open loop downlink transmit diversity employs a space time block coding based transmit diversity (STTD). A block diagram of the transmitter using STTD for DPCH and common control channels is shown in the Figure 9 below.

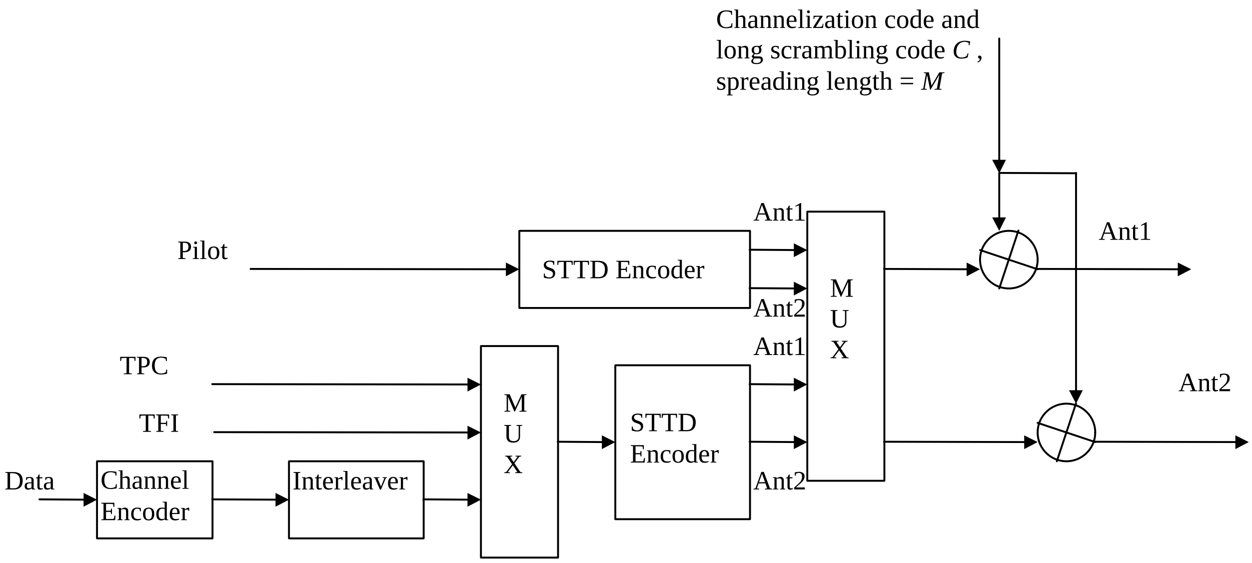


Figure 9: Block diagram of the transmitter

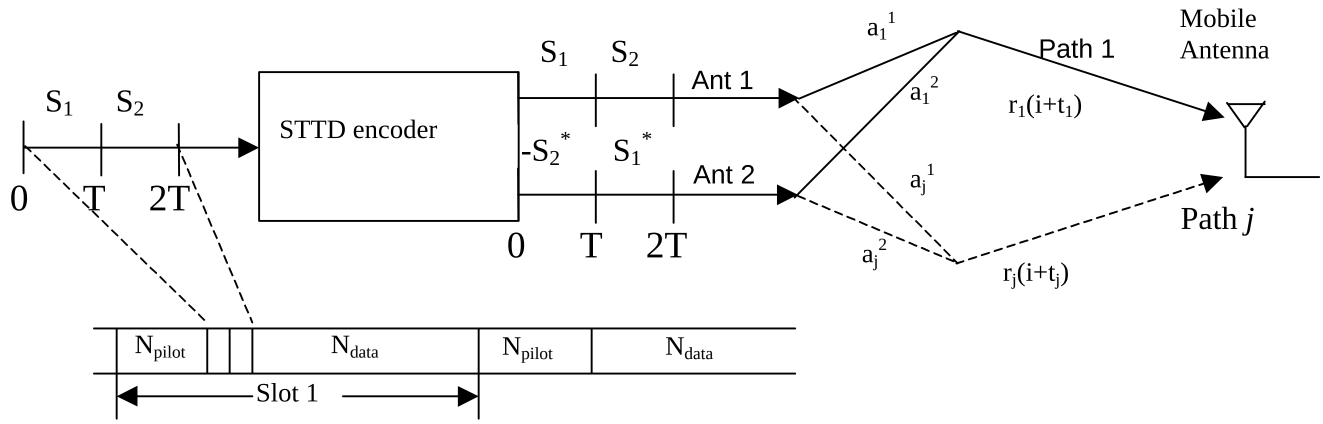


Figure 10: Block diagram of STTD encoder

The T denotes the symbol time and let the chip time be denoted $T_c = T/M$, M being the spreading gain. The received signal for the j^{th} path of the i^{th} chip transmitted between 0 and T after matched filtering and A/D sampling is given by:

$$r_j\,(i + t_j) = (a_j^1\, S_1 - a_j^2 S_2^*)\, C(i+t_j) + n_j(i)\ ;\ i = 0, ..., M-1 \qquad (1)$$

The $r_j\,(i + t_j)$ and $n_j(i)$ denote (figure 1b) the received signal and the additive AWGN noise, t_j denotes the propagation delay and a_j^i denotes the Rayleigh fading coefficients. Similarly, the received signal for transmission time [T , 2T) is given by:

$$r_j\,(i + t_j) = (a_j^2\, S_1^* + a_j^1 S_2)\, C(i+t_j) + n_j(i)\ ;\ i = M, ..., 2M-1 \qquad (2)$$

5.3.2 Common physical channels

5.3.2.1 Primary Common Control Physical Channel (CCPCH)

The Primary CCPCH is a fixed rate (32 kbps, SF=256) downlink physical channels used to carry the BCH.
Figure 11 shows the frame structure of the Primary CCPCH. The frame structure differs from the downlink DPCH in that no TPC commands or TFCI is transmitted. The only Layer 1 control information is the common pilot bits needed for coherent detection.

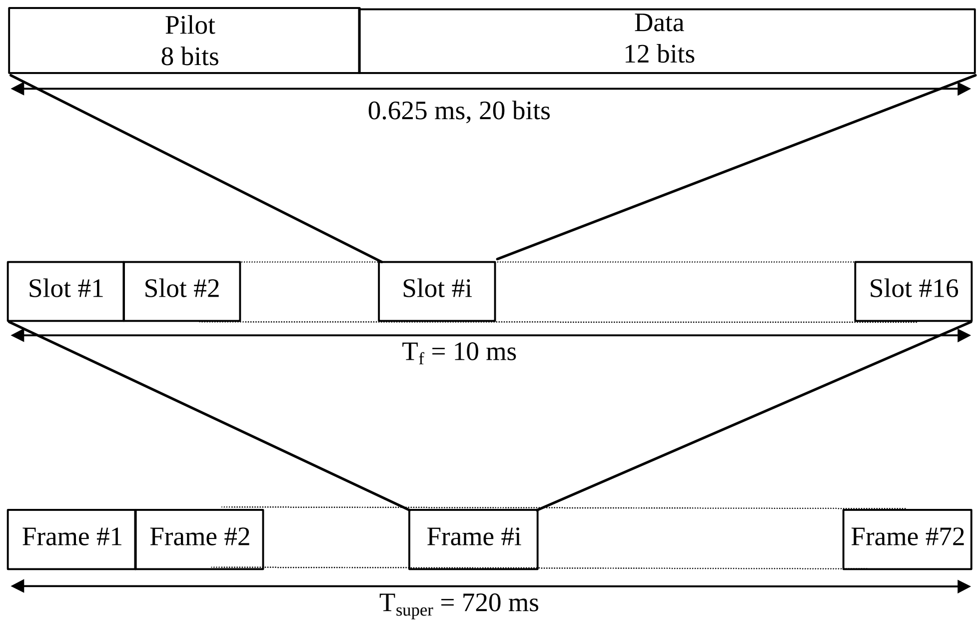


Figure 11: Frame structure for Primary Common Control Physical Channel

5.3.2.1.1 Primary CCPCH structure with FB mode transmit diversity

If diversity transmission is applied on dedicated forward link channels, the Primary CCPCH pilot is transmitted in parallel from both of the antennas as shown in Figure 12. Different pilot patterns are applied to the different antennas, indicated in Figure 12 by the difference in shading.

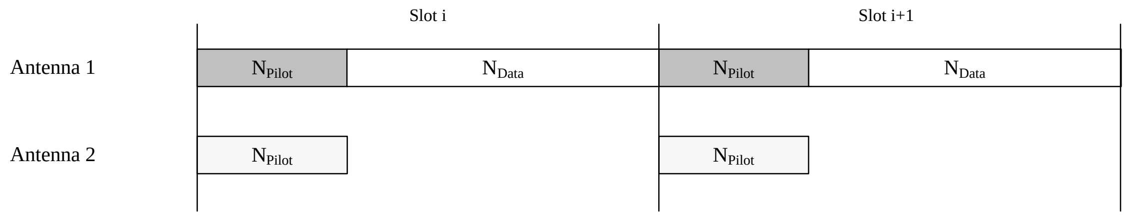


Figure 12: Slot structure of Primary CCPCH when diversity transmission is applied on dedicated channels

Pilot patterns of the antennas are different and (TBD). The transmission powers of the pilot signals on both of the antennas are the same.

5.3.2.2 Secondary Common Control Physical Channel

< Documentation status: The mapping of FACH and PCH to two separate secondary CCPCHs is to be considered a proposal. >

The secondary CCPCH is used to carry the FACH and PCH. It is of constant rate. However, in contrast to the Primary CCPCH, the rate may be different for different secondary CCPCH within one cell and between cells, in order to be able to allocate different amount of FACH and PCH capacity to a cell. The rate and spreading factor of each secondary CCPCH is broadcast on the BCH. The set of possible rates is the same as for the downlink DPCH, see subclause 5.3.1. The frame structure of the Secondary CCPCH is shown in Figure 13.

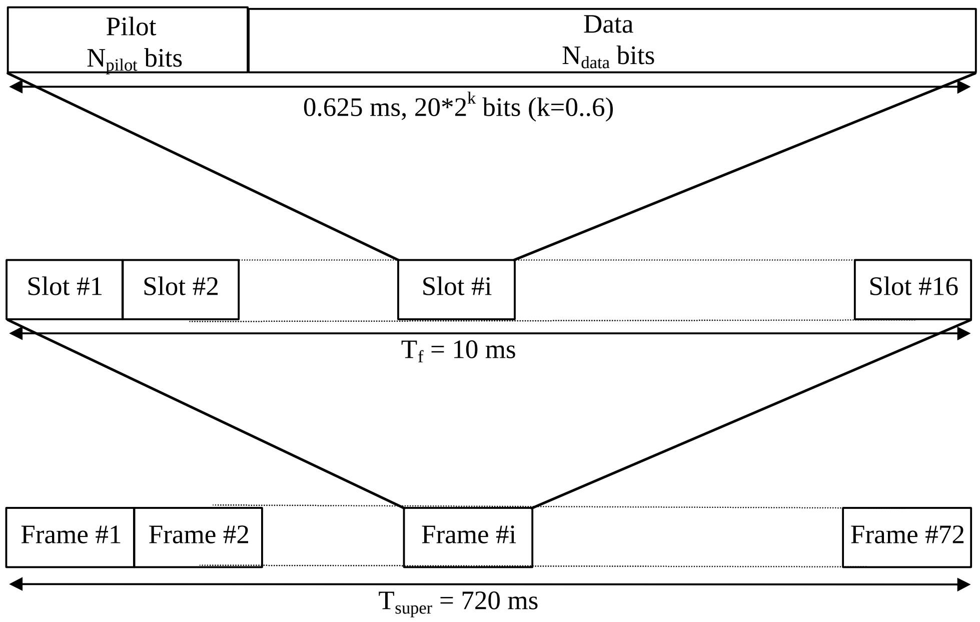
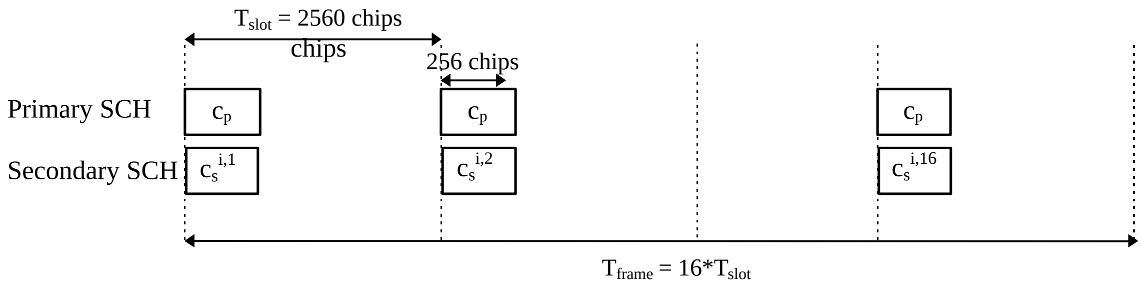


Figure 13: Frame structure for Secondary Common Control Physical Channel

The FACH and PCH are mapped to separate Secondary CCPCHs. The main difference between a CCPCH and a downlink dedicated physical channel is that a CCPCH is not power controlled. The main difference between the Primary and Secondary CCPCH is that the Primary CCPCH has a fixed predefined rate while the Secondary CCPCH has a constant rate that may be different for different cells, depending on the capacity needed for FACH and PCH. Furthermore, a Primary CCPCH is continuously transmitted over the entire cell while a Secondary CCPCH is only transmitted when there is data available and may be transmitted in a narrow lobe in the same way as a dedicated physical channel (only valid for a Secondary CCPCH carrying the FACH).

5.3.2.3 Synchronisation Channel

The Synchronisation Channel (SCH) is a downlink signal used for cell search. The SCH consists of two sub channels, the Primary and Secondary SCH. Figure 14 illustrates the structure of the SCH:



c_p : Primary Synchronization Code
$c_s^{i,k}$: One of 17 possible Secondary Synchronization Codes
$(c_s^{i,1}, c_s^{i,2}, ..., c_s^{i,16})$ encode cell specific long scrambling code group i

Figure 14: Structure of Synchronisation Channel (SCH)

The Primary SCH consists of an *unmodulated* code of length 256 chips, the Primary Synchronisation Code, transmitted once every slot. The Primary Synchronisation Code is the same for every cell in the system and is transmitted time-aligned with the BCH slot boundary as illustrated in Figure 14.

The Secondary SCH consists of repeatedly transmitting a length 16 sequence of *unmodulated* codes of length 256 chips, the Secondary Synchronisation Codes, transmitted in parallel with the Primary Synchronisation channel. Each Secondary Synchronisation code is chosen from a set of 17 different codes of length 256. This sequence on the Secondary SCH indicates to which of the 32 different code groups (see UMTS XX.05, subclause 5.2.2) the ’ell's downlink scrambling code belongs. 32 sequences are used to encode the 32 different code groups each containing 16 scrambling codes. The 32 sequences are constructed such that their cyclic-shifts are unique, i.e., a non-zero cyclic shift less than 16 of any of the 32 sequences is not equivalent to some cyclic shift of any other of the 32 sequences. Also, a non-zero cyclic shift less than 16 of any of the sequences is not equivalent to itself with any other cyclic shift less than 16. This property is used to uniquely determine both the long code group and the frame timing in the second step of acquisition (see UMTS XX.07, subclause 5.1). The following sequences are used to encode the 32 different code groups each containing 16 scrambling codes (note that c_i indicates the i’th Secondary Short code of the 17 codes).

$(c_1\ c_1\ c_2\ c_{11}\ c_6\ c_3\ c_{15}\ c_7\ c_8\ c_8\ c_7\ c_{15}\ c_3\ c_6\ c_{11}\ c_2)$
$(c_1\ c_2\ c_9\ c_3\ c_{10}\ c_{11}\ c_{13}\ c_{13}\ c_{11}\ c_{10}\ c_3\ c_9\ c_2\ c_1\ c_{16}\ c_{16})$
$(c_1\ c_3\ c_{16}\ c_{12}\ c_{14}\ c_2\ c_{11}\ c_2\ c_{14}\ c_{12}\ c_{16}\ c_3\ c_1\ c_{13}\ c_4\ c_{13})$
$(c_1\ c_4\ c_6\ c_4\ c_1\ c_{10}\ c_9\ c_8\ c_{17}\ c_{14}\ c_{12}\ c_{14}\ c_{17}\ c_8\ c_9\ c_{10})$
$(c_1\ c_5\ c_{13}\ c_{13}\ c_5\ c_1\ c_7\ c_{14}\ c_3\ c_{16}\ c_8\ c_8\ c_{16}\ c_3\ c_{14}\ c_7)$
$(c_1\ c_6\ c_3\ c_5\ c_9\ c_9\ c_5\ c_3\ c_6\ c_1\ c_4\ c_2\ c_{15}\ c_{15}\ c_2\ c_4)$
$(c_1\ c_7\ c_{10}\ c_{14}\ c_{13}\ c_{17}\ c_3\ c_9\ c_9\ c_3\ c_{17}\ c_{13}\ c_{14}\ c_{10}\ c_7\ c_1)$
$(c_1\ c_8\ c_{17}\ c_6\ c_{17}\ c_8\ c_1\ c_{15}\ c_{12}\ c_5\ c_{13}\ c_7\ c_{13}\ c_5\ c_{12}\ c_{15})$
$(c_1\ c_9\ c_7\ c_{15}\ c_4\ c_{16}\ c_{16}\ c_4\ c_{15}\ c_7\ c_9\ c_1\ c_{12}\ c_{17}\ c_{17}\ c_{12})$
$(c_1\ c_{10}\ c_{14}\ c_7\ c_8\ c_7\ c_{14}\ c_{10}\ c_1\ c_9\ c_5\ c_{12}\ c_{11}\ c_{12}\ c_5\ c_9)$
$(c_1\ c_{11}\ c_4\ c_{16}\ c_{12}\ c_{15}\ c_{12}\ c_{16}\ c_4\ c_{11}\ c_1\ c_6\ c_{10}\ c_7\ c_{10}\ c_6)$
$(c_1\ c_{12}\ c_{11}\ c_8\ c_{16}\ c_6\ c_{10}\ c_5\ c_7\ c_{13}\ c_{14}\ c_{17}\ c_9\ c_2\ c_{15}\ c_3)$
$(c_1\ c_{13}\ c_1\ c_{17}\ c_3\ c_{14}\ c_8\ c_{11}\ c_{10}\ c_{15}\ c_{10}\ c_{11}\ c_8\ c_{14}\ c_3\ c_{17})$
$(c_1\ c_{14}\ c_8\ c_9\ c_7\ c_5\ c_6\ c_{17}\ c_{13}\ c_{17}\ c_6\ c_5\ c_7\ c_9\ c_8\ c_{14})$
$(c_1\ c_{15}\ c_{15}\ c_1\ c_{11}\ c_{13}\ c_4\ c_6\ c_{16}\ c_2\ c_2\ c_{16}\ c_6\ c_4\ c_{13}\ c_{11})$
$(c_1\ c_{16}\ c_5\ c_{10}\ c_{15}\ c_4\ c_2\ c_{12}\ c_2\ c_4\ c_{15}\ c_{10}\ c_5\ c_{16}\ c_1\ c_8)$
$(c_1\ c_{17}\ c_{12}\ c_2\ c_2\ c_{12}\ c_{17}\ c_1\ c_5\ c_6\ c_{11}\ c_4\ c_4\ c_{11}\ c_6\ c_5)$
$(c_2\ c_8\ c_{11}\ c_{15}\ c_{14}\ c_1\ c_4\ c_{10}\ c_{10}\ c_4\ c_1\ c_{14}\ c_{15}\ c_{11}\ c_8\ c_2)$
$(c_2\ c_9\ c_1\ c_7\ c_1\ c_9\ c_2\ c_{16}\ c_{13}\ c_6\ c_{14}\ c_8\ c_{14}\ c_6\ c_{13}\ c_{16})$
$(c_2\ c_{10}\ c_8\ c_{16}\ c_5\ c_{17}\ c_{17}\ c_5\ c_{16}\ c_8\ c_{10}\ c_2\ c_{13}\ c_1\ c_1\ c_{13})$
$(c_2\ c_{11}\ c_{15}\ c_8\ c_9\ c_8\ c_{15}\ c_{11}\ c_2\ c_{10}\ c_6\ c_{13}\ c_{12}\ c_{13}\ c_6\ c_{10})$
$(c_2\ c_{12}\ c_5\ c_{17}\ c_{13}\ c_{16}\ c_{13}\ c_{17}\ c_5\ c_{12}\ c_2\ c_7\ c_{11}\ c_8\ c_{11}\ c_7)$
$(c_2\ c_{13}\ c_{12}\ c_9\ c_{17}\ c_7\ c_{11}\ c_6\ c_8\ c_{14}\ c_{15}\ c_1\ c_{10}\ c_3\ c_{16}\ c_4)$
$(c_2\ c_{14}\ c_2\ c_1\ c_4\ c_{15}\ c_9\ c_{12}\ c_{11}\ c_{16}\ c_{11}\ c_{12}\ c_9\ c_{15}\ c_4\ c_1)$
$(c_2\ c_{15}\ c_9\ c_{10}\ c_8\ c_6\ c_7\ c_1\ c_{14}\ c_1\ c_7\ c_6\ c_8\ c_{10}\ c_9\ c_{15})$
$(c_2\ c_{16}\ c_{16}\ c_2\ c_{12}\ c_{14}\ c_5\ c_7\ c_{17}\ c_3\ c_3\ c_{17}\ c_7\ c_5\ c_{14}\ c_{12})$
$(c_2\ c_{17}\ c_6\ c_{11}\ c_{16}\ c_5\ c_3\ c_{13}\ c_3\ c_5\ c_{16}\ c_{11}\ c_6\ c_{17}\ c_2\ c_9)$
$(c_2\ c_1\ c_{13}\ c_3\ c_3\ c_{13}\ c_1\ c_2\ c_6\ c_7\ c_{12}\ c_5\ c_5\ c_{12}\ c_7\ c_6)$
$(c_2\ c_2\ c_3\ c_{12}\ c_7\ c_4\ c_{16}\ c_8\ c_9\ c_9\ c_8\ c_{16}\ c_4\ c_7\ c_{12}\ c_3)$
$(c_2\ c_3\ c_{10}\ c_4\ c_{11}\ c_{12}\ c_{14}\ c_{14}\ c_{12}\ c_{11}\ c_4\ c_{10}\ c_3\ c_2\ c_{17}\ c_{17})$
$(c_2\ c_4\ c_{17}\ c_{13}\ c_{15}\ c_3\ c_{12}\ c_3\ c_{15}\ c_{13}\ c_{17}\ c_4\ c_2\ c_{14}\ c_5\ c_{14})$
$(c_2\ c_5\ c_7\ c_5\ c_2\ c_{11}\ c_{10}\ c_9\ c_1\ c_{15}\ c_{13}\ c_{15}\ c_1\ c_9\ c_{10}\ c_{11})$

The use of the SCH for cell search is described in detail in UMTS XX.07.

5.3.2.4 Physical Shared Channel Control Channel (PSCCCH)

The frame structure for the PSCCCH is shown in Figure 15.

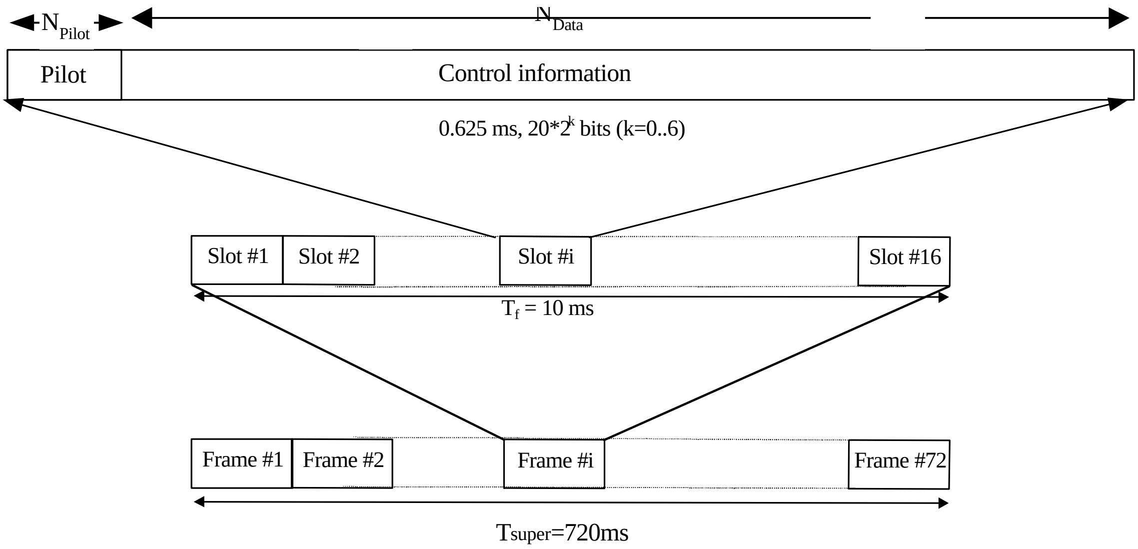


Figure 15: Frame structure of the Physical Shared Channel Control Channel (PSCCCH)

The PSCCCH contains pilot symbols, and a control information field. The control information field can include TPC commands concerning several users. Other control information includes code assignment for the DSCH, but could also comprise other type of information if needed. The TPC commands would come in support of fast closed loop power control of the PDSCH, and thus, would have to be decoded on a slot-by-slot basis. The exact structure of the control information field is for further study.

5.3.2.5 Physical Downlink Shared Channel

The Physical Downlink Shared Channel (PDSCH), used to carry the Downlink Shared Channel (DSCH), is shared by users based on code multiplexing. It is always associated with another physical channel, as follows:

- If the DSCH is associated with a DCH, the PDSCH is associated with a DPCH;
- If the DSCH is associated with a DSCH control channel, the PDSCH is associated with a PSCCCH.

This is described respectively in subclauses 5.3.2.5.1 and 5.3.2.5.2.
In both cases, the PDSCH does not comprise any pilot symbols, since this does not seem to be required at this stage, given information provided on the associated DPCH or PSCCCH. This still needs to be verified.

5.3.2.5.1 DSCH associated with a DCH

The frame structure of the DSCH, when associated with a DCH, is shown in Figure 16.

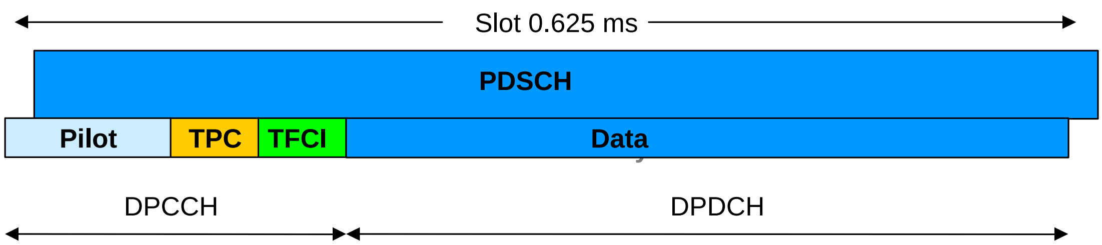


Figure 16: Frame structure for the DSCH when associated to a DCH

To indicate for UE that there is data to decode on the DSCH, two signalling methods are possible, either using the TFCI field, or higher layer signalling.

5.3.2.5.2 DSCH associated with a DSCH control channel

The frame structure of the DSCH when associated with a DSCH control channel is shown in Figure 17.

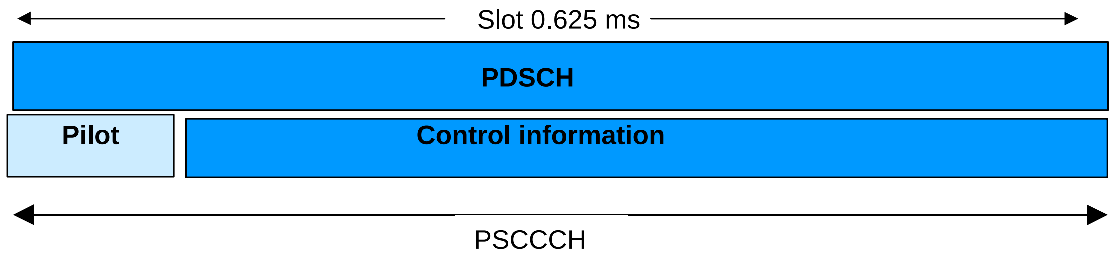


Figure 17: Frame structure for the DSCH when associated to a DSCH control channel

5.3.2.6 Acquisition Indication Channel (AICH)

The acquisition indication channel (AICH) carries the acquisition indicators. The acquisition indicator AI_i corresponding to signature *i* is transmitted on the downlink, as a response to the detection of signature *i* on a PRACH. AI_i is signature *i* (16 symbols, see UMTS XX.05) spread by a channelization code of length 256.

6 Mapping of transport channels to physical channels

Figure 18 summarises the mapping of transport channels to physical channels.

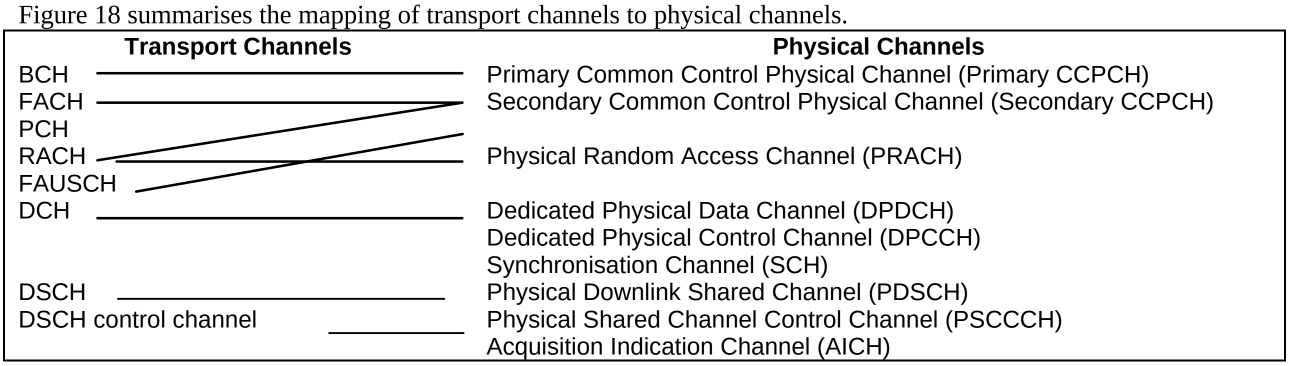


Figure 18: Transport-channel to physical-channel mapping

The DCHs are coded and multiplexed as described in UMTS XX.04, and the resulting data stream is mapped sequentially (first-in-first-mapped) directly to the physical channel(s). The mapping of BCH and FACH 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 random access burst on the PRACH. The mapping of the PCH to the Secondary CCPCH is slightly more complicated to allow for an efficient sleep mode, and is described in the next subclause. The mapping of the DSCH to the PDSCH is done by mapping the data stream sequentially (first-in-first-mapped) directly to the physical channel.

6.1 Method for mapping of PCH to Secondary CCPCH

< Documentation status: The mapping of the PCH to a secondary CCPCH is to be considered a proposal. >
The method used to map the paging blocks to the Secondary CCPCH is shown in Figure 19.
The PCH is divided into several blocks in one superframe. Paging groups are mapped to the paging blocks where layer 3 information to each group is transmitted.
The mapping between a paging group "i" and the paging block f(i), which is numbered between 1 and 288, is according

$f(i)=((i+SUFN) \bmod N_{PB}) +1$

where SUFN is the superframe number and N_{PB}=288 paging blocks per superframe. Thereby a paging group is mapped to the paging blocks
(i, i+1, i+2….,288,1,2,…)
when the superframe number increases.

Each block on the PCH carries information amount worth of 4 slots, and consists of a total of 6 information parts: 2 Paging Indication (PI) parts - for indicating whether there are paging messages or not, and 4 Mobile User Identifier (MUI) parts - for indicating the identity of the UE and carrying the actual paging message.
In each block, PI parts are transmitted ahead of MUI parts.
In all groups, 6 information parts are allocated with a certain pattern in the range of 24 slots. By shifting each pattern by 4 slots, multiple 288 blocks of PCH can be allocated on one Secondary Common Control Physical Channel.

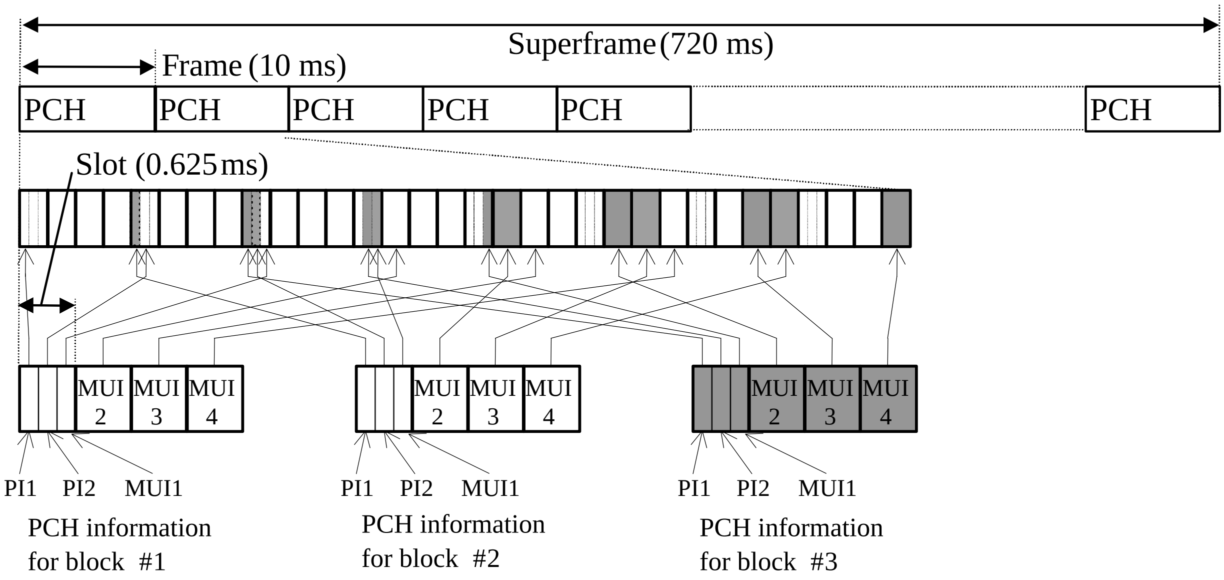


Figure 19: PCH mapping method

7 Timing relationship between physical channels

< Documentation status: Everything in this clause is to be considered as working assumption, except otherwise explicitly stated. >

In general, a Node B covers *N* cells, where *N ³1*. Each Node B has a Reference System Frame Number (SFN), which counts from *0* to *M-1* in Radio Frame (10 ms) intervals. *M* is a multiple of the superframe (72), and is TBD. The purpose of the Reference SFN is to make sure that the correct frames are combined at soft handover. Each cell has a Cell SFN, which is broadcast on the BCH.
Figure 20 shows the proposed physical channel timing parameters in a soft handover situation including two Node Bs, NB1 and NB2. The timing parameters in Figure 20 refer to frame-timing.

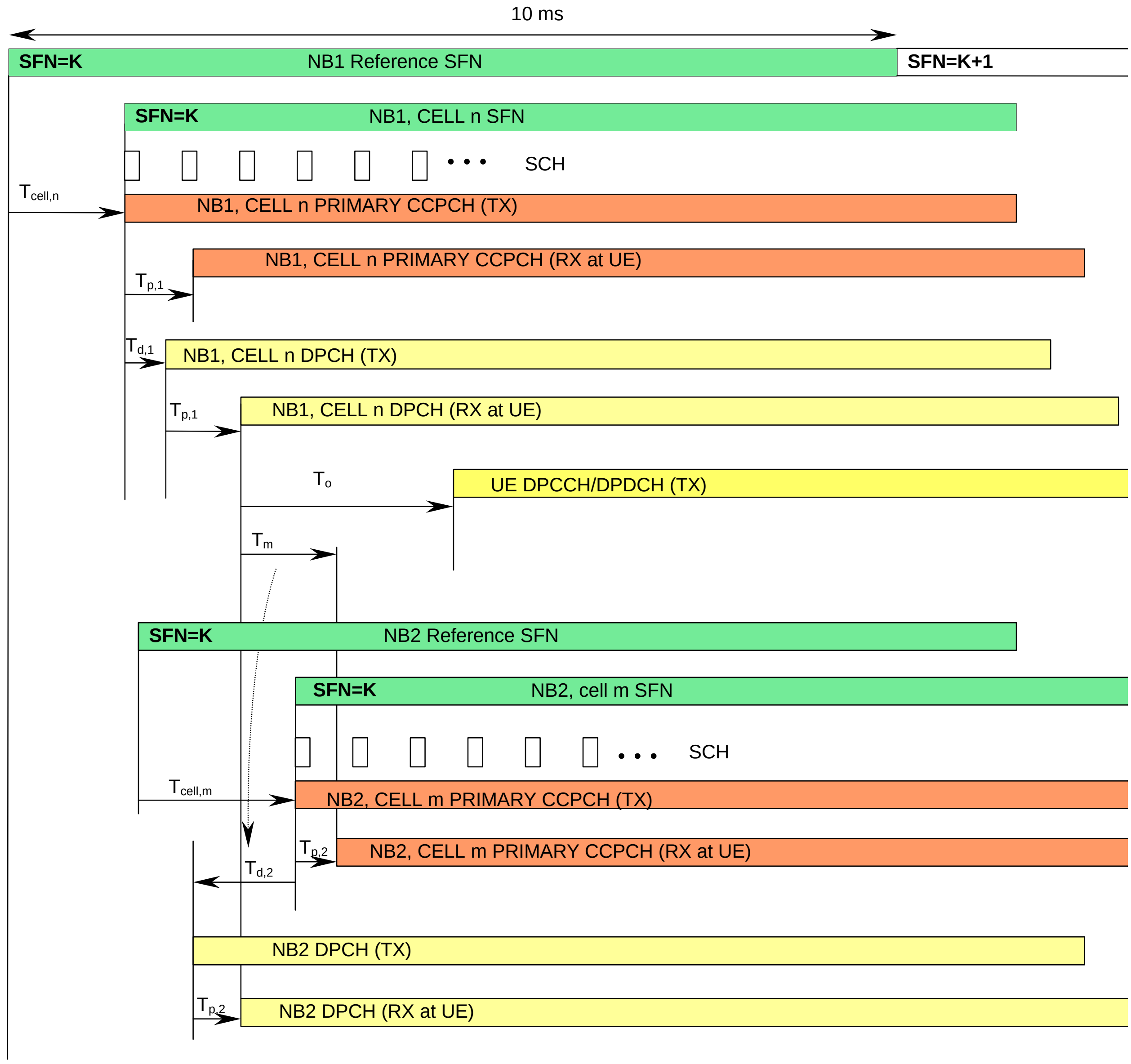


Figure 20: Physical channel timing relations

The parameters in Figure 20 are explained below:

- $\mathbf{T_p}$: Propagation delay between Node B and UE.
- $\mathbf{T_{cell}}$: This timing offset is used for the frame timing of SCH, Primary CCPCH and the starting phase of all downlink scrambling codes in a cell. The main purpose is to avoid having overlapping SCHs in different cells belonging to the same Node B. The resolution, which affects the number of possible cells in a Node B, is TBD and depends on the maximum expected time-dispersion. The range is one slot. T_{cell} is also the reference frame timing for the PRACH.
- $\mathbf{T_d}$: This timing offset is used for the frame timing of DPCHs and Secondary CCPCHs. It can be individually set up for each DPCH and Secondary CCPCH. The T_d values for the latter may be broadcast on the BCH, or known a-priori. The purpose of T_d is:
  - In an originating/terminating cell, to distribute discontinuous transmission periods in time, and also to distribute Node B-RNC transmission traffic in time.
  - At soft handover, to synchronise downlink DPCHs to the same UE, in order to minimise the buffering requirements at the UE.

    The resolution is 256 chips in order to maintain downlink orthogonality and the range is TBD.
- $\mathbf{T_o}$: This constant timing offset is used to set up the transmission frame timing of an uplink DPCCH/DPDCH in the UE. The uplink DPCCH/DPDCH transmission frame timing should be set to T_o seconds after the frame timing of the earliest received path of the downlink DPCH. T_o should be chosen to minimise the closed loop PC delay in as large cell-radii as possible. The value is TBD.

  The starting phase of the uplink scrambling code is synchronised with the uplink DPCCH/DPDCH frame timing.

- **T_m**: This value is measured by the UE and reported to the RNC prior to soft handover. The RNC can then notify this value to the target cell, which then knows how to set T_d to achieve proper reception and transmission frame timing of the dedicated physical channel.

Note that since the UE reports the value T_m as the time-difference between the received Primary CCPCH frame-timing from the target cell and the earliest received existing DPCH path, the propagation delay to the target cell is already compensated for in the setting of T_d at the target cell. The DPCH signal from the target cell will reach the UE at the same time as the earliest received existing DPCH path. The only remaining error, besides frequency-drift and UE mobility related errors, is due to a (known) rounding error at the target cell in order to maintain downlink orthogonality.

History

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V1.1.0	1999-01-11	Updated terminology.
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