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0 Content

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2 Intellectual Property Rights

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4 Scope

5 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply;
b) publications without mention of a specific version, in which case the latest version applies.

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] B. Steiner; P. Jung: Uplink channel estimation in synchronous CDMA mobile radio systems with joint detection. The fourth International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'93), Yokohama, Japan, September 8-11, 1993.

[2] UMTS XX.03 „UTRA FDD, Transport channels and physical channels description"

6 Definitions and abbreviations

<Editor's note: This section covers TDD relevant abbreviations only.>

BCH	Broadcast Channel
CCPCH	Common Control Physical Channel
CDMA	Code Division Multiple Access
DPCH	Dedicated Physical Channel
FACH	Forward Access Channel
FDD	Frequency Division Duplex
FEC	Forward Error Correction
GP	Guard Period
GSM	Global System for Mobile Communication
NRT	Non-Real Time
ODCH	ODMA Dedicated Transport Channel
ODMA	Opportunity Driven Multiple Access
ORACH	ODMA Random Access Channel
PCH	Paging Channel
PDU	Protocol Data Unit
PRACH	Physical Random Access Channel
PSCH	Physical Synchronisation Channel
RACH	Random Access Channel
RLC	Radio Link Control
RT	Real Time
RU	Resource Unit

SACCH	Slow Associated Control Channel
SCH	Synchronisation Channel
SDCCH	Stand-alone Dedicated Control Channel
TCH	Traffic Channel
TDD	Time Division Duplex
TDMA	Time Division Multiple Access

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8 Transport channels

8.1 Transport channels

The chapter describes transport channels that are required for data transfer. Transport channels are the services offered by layer 1 to the higher layers. A general classification of transport channels is into two groups:

- common channels
- dedicated channels

8.1.1 Dedicated transport channels

The Dedicated Channel (DCH) is a up- or down-link transport channel that is used to carry user or control information between the network and a mobile station.

? *[Editors Note : The sentence of DCH is added from ARIB document.]*

Two types of dedicated transport channels have been identified:

1. Dedicated Channel (DCH) characterized by:
    - possibility to use beamforming,
    - possibility to change rate fast (each 10ms),
    - possibility to use enhanced power control and
    - inherent addressing of MSs.
2. ODMA Dedicated Transport Channel (ODCH) characterized by:
    - possibility to use beamforming,
    - existence in relay links
    - possibility to quickly adapt the data rate (every 10ms),
    - closed loop power control and
    - inherent addressing of MSs.

? *[Editors Note : There is no ODCH in ARIB document.]*

8.1.2 Common transport channels

Common transport channel are:

1. Broadcast Channel (BCH) characterized by:
    - existence in downlink only,
    - low fixed bit rate and
    - requirement to be broadcasted in the entire coverage area of the cell.

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

? *[Editors Note : The sentence of BCH is added from ARIB document.]*

2. Paging Channel (PCH) characterized by:
    - existence in downlink only,
    - possibility for sleep mode procedures and
    - requirement to be broadcasted in the entire coverage area of the cell.

The Paging Channel (PCH) is a downlink transport channel that is used to carry control information to a mobile station when the system does not know the location cell of the mobile station.

? *[Editors Note : The sentence of PCH is added from ARIB document.]*

3. Forward Access Channel(s) (FACH) characterized by:

- existence in downlink only,
- possibility to use beamforming,
- possibility to use enhanced power control,
- lack of fast power control and
- requirement for in-band identification of MSs.

? *[Editors Note : The 4th point is added from ARIB document.]*

The Forward Access Channel (FACH) is a downlink transport channel that is used to carry control information to a mobile station when the system knows the location cell of the mobile station. The FACH may also carry short user packets.

? *[Editors Note : The sentence of FACH is added from ARIB document.]*

4. Random Access Channel(s) (RACH) characterized by:
    - existence in uplink only,
    - collision risk,
    - open loop power control,
    - limited data field, and
    - requirement for in-band identification of the MSs.

The Random Access Channel (RACH) is a reverse link transport channel that is used to carry control information from mobile station. The RACH may also carry short user packets.

? *[Editors Note : The sentence of RACH is added from ARIB document.]*

5. ODMA Random Access Channel (ORACH) characterized by:
    - existence in relay links,
    - collision risk,
    - open loop power control and
    - requirement for in-band identification of the MSs.

? *[Editors Note : There is no ORACH in ARIB document.]*

6. Synchronisation Channel (SCH) characterized by:
    - existence in TDD and downlink only,
    - low fixed bit rate and
    - requirement to be broadcasted in the entire coverage area of the cell.

? *[Editors Note : There is no SCH in ARIB document. In ARIB, SCH is defined as a part of Perch channel as same as common pilot symbols.]*

9 Physical channels

All physical channels take three-layer structure of superframes, radio frames, and timeslots. Depending on the physical channel and symbol rate, the configuration of radio frames or timeslots becomes different. All physical channels need guard symbols in every timeslot. The time slots are used in the sense of a TDMA component to separate different user signals in the time and the code domain. The physical channel signal format is presented in Figure 1.
The basic physical channel is defined as the association of one code, one time slot and one frequency.

? *[Editors Note : There is no figure of three-layer structure in ETSI. The sentence and figure of it are added from ARIB.]*

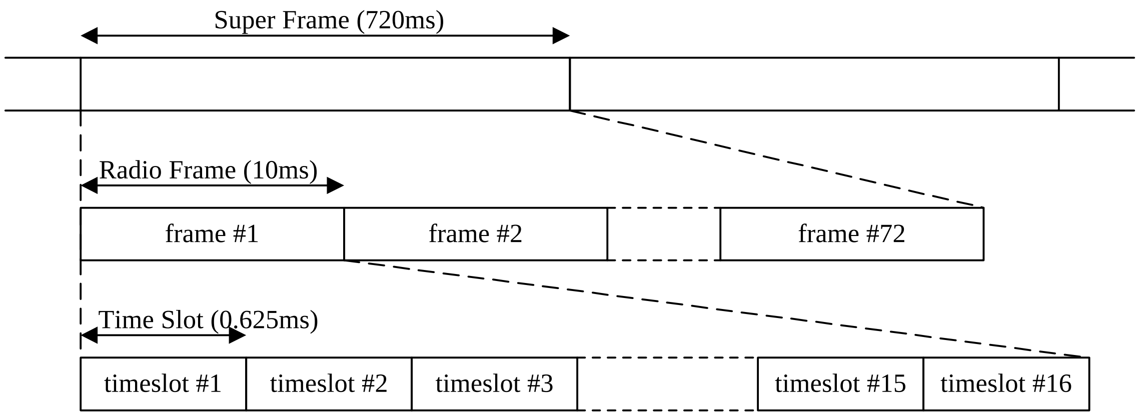

Figure 1 Physical channel signal format

9.1 Frame structure

The TDMA frame has a duration of 10 ms and is subdivided into 16 time slots (TS) of 625 µs duration each. A time slot corresponds to 2560 chips. The physical content of the time slots are the bursts of corresponding length as described in section 0.

? *[Editors Note : There is no definition by the number of chip in ARIB document, because several chip rates are proposed in ARIB.]*

Each 10 ms frame consists of 16 time slots, each allocated to either the uplink or the downlink (Figure 2). With such a flexibility , the TDD mode can be adapted to different environments and deployment scenarios. In any configuration at least one time slot has to be allocated for the downlink and at least one time slot has to be allocated for the uplink.

? *[Editors Note : There is the following differences in the ARIB document.*

- *First time slot is allocated for downlink*
- *Same timeslot allocation is needed for all base station within the whole area of synchronization*
- *Multiple-switching-point configuration is supported from a fast power control and transmit space diversity point-of-view.*
- *All time slots with the same direction are assumed to assign for each channel*

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ETSI:

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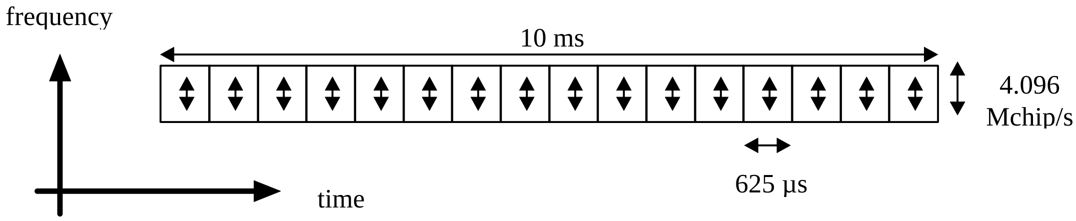
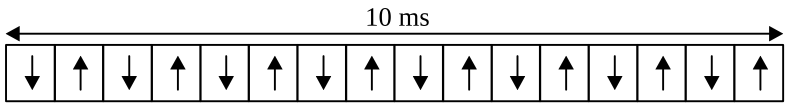
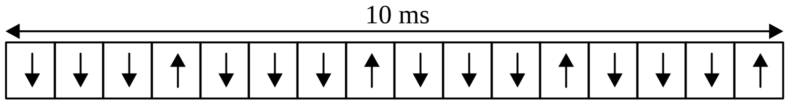


Figure 2 The TDD frame structure

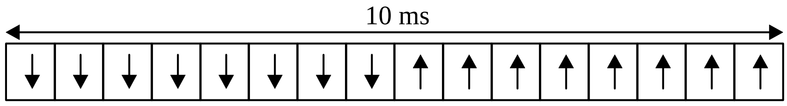
Examples for multiple and single switching point configurations as well as for symmetric and asymmetric UL/DL allocations are given in Figure 3.



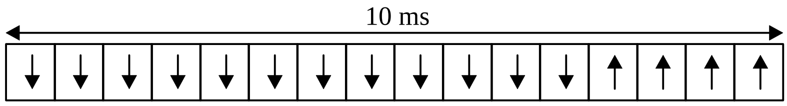
Mulitple-switching-point configuration (symmetric DL/UL allocation)



Multiple-switching-point configuration (asymmetric DL/UL allocation)



Single-switching-point configuration (symmetric DL/UL allocation)



Single-switching-point configuration (asymmetric DL/UL allocation)

Figure 3 TDD frame structure examples

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ARIB:
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In TDD mode, each 10ms frame consists of 16 time slots, each allocated to either reverse link (RL) and forward link (FL). An flexible time slot allocation, where time slots can be arbitrarily allocated to reverse link and forward link except the first time slot of forward link, is adopted as shown in Fig.3.3-1. Obviously, the same timeslot allocation is needed for all base station within the whole area of synchronization. This flexible allocation improves the ability of the TDD mode to efficiently work in different environments and deployment scenarios. MS starts searching perch channel of a default system first at power-on initial time and goes into the system successfully or tries to search the other probable candidate systems sequentially.

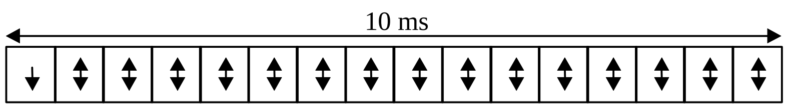

Fig. 3.3-1 Reverse link/Forward link Allocation

As an example, symmetric reverse link/ forward link allocation with multiple-switching-point configuration is presented in Fig.3.3-2. The multiple-switching-point configuration is obviously best from a fast power control and transmit space diversity point-of-view.

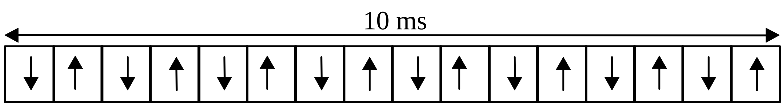

Fig.3.3-2 Multiple-switching-point Configuration (symmetric -RL/FL allocation)

Flexible uplink and downlink timeslot allocation except the first timeslot is performed.
Spreading factor of spreading code and the number of codes for multi code transmission are assigned independently for reverse link and forward link.

As an example, multiple-switching-point configuration can be generalized to an asymmetric RL/FL capacity allocation as e.g. illustrated in Fig.3.3.6-7.The single-switching-point configuration also can be generalized to an asymmetric RL/FL capacity allocation as e.g. illustrated in Fig.3.3.6-8.

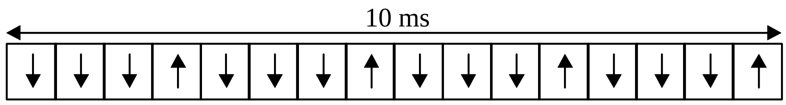

Fig.3.3.6-7 Multiple-switching-point configuration (asymmetric RL/FL allocation)

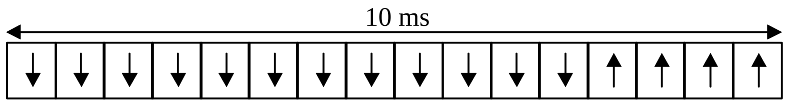

Fig.3.3.6-8 Single-switching-point configuration (asymmetric RL/FL allocation)

The following channel structure, frame format and channel coding are described on the assumption that the allocation shown in Fig.3.3-2 is used and all time slots with the same direction are assigned for each channel
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? *[Editors Note : In ARIB, asymmetric configuration is moved from the section 3.3.6.13.1(Asymmetric Transmission Control).]*

When operating ODMA at least one common timeslot has to be allocated for the ORACH. If large quantities of information have to be transferred between ODMA nodes then it is normal to use at least one timeslot for the ODCH (Figure 3). As Figure 3 shows, any timeslot in the TDD frame may potentially be used by the ODCH.
Note: a common timeslot indicates a carrier-timeslot combination which can be used for transmission and reception by a group of mobiles operating ODMA.

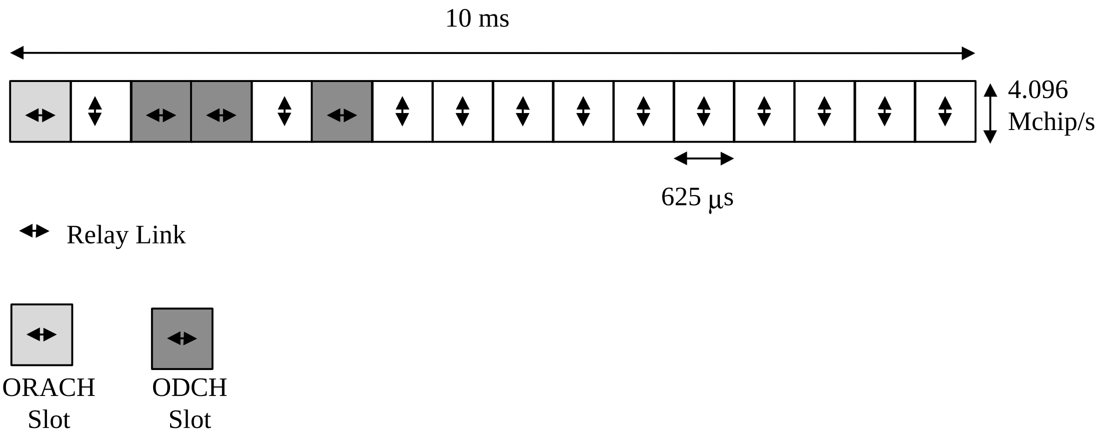

Figure 4 TDD frame structure example for ODMA operation.

? *[Editors Note : There is no ODMA operation and frame structure for ODMA in ARIB document.]*

9.2 Dedicated physical channel (DPCH)

The DCH or in case of ODMA networks the ODCH as described in section Dedicated transport channels are mapped onto the dedicated physical channel.
There are two types of dedicated physical channels, the Dedicated Physical Data Channel (DPDCH) and the Dedicated Physical Control Channel (DPCCH).
The DPDCH carries dedicated data generated at Layer 2. The DPCCH carries control information generated at Layer 1.

? *[Editors Note : There is no ODCH in ARIB. There is no definition and explanation of DPDCH and DPCCH in ETSI.]*

9.2.1 Spreading codes

Two options are being considered for the bursts that can be sent as described below. Both options allow a high degree of bit rate granularity and flexibility, thus allowing the implementation of the whole service range from low to high bit rates.

Spreading factor of scrambling code and the number of codes for multicode transmission are assigned independently for uplink and downlink. The number of timeslots is also assigned independently for uplink and downlink.

? *[Editors Note : There is no description of independent allocation for uplink and downlink in ETSI.]*

9.2.1.1 Multicode transmission with fixed spreading

Within each time slot of length 625 µs, an additional separation of user signals by spreading codes is used. This means, that within one time slot of length 625 µs, more than one burst of corresponding length as described in section 0 can be transmitted. These multiple bursts within the same time slot can be allocated to different users as well as partly or all to a single user. For the multiple bursts within the same time slot, different spreading codes are used to allow the distinction of the multiple bursts.

The bursts as described in section 0 are designed in such a way, that up to 8 bursts can be transmitted within one time slot, if the bursts are allocated to different users in the uplink. In the downlink or if several bursts in the time slot are allocated to one single user in the uplink, even more than 8 bursts (e.g. 9 or 10) can be transmitted within one time slot.

? *[Editors Note : Multicode transmission is described in section 3.3.6.8.2 as one procedure of multirate transmission and in ARIB. There is no limited number of multiplexed bursts within one time slot in ARIB.]*

9.2.1.2 Single code transmission with variable spreading

[Within each time slot of 625 µs,

- a mobile always uses single code transmission by adapting the spreading factor as a function of the data rate. This limits the peak-to-average ratio of the modulated signal and consequently the stress imposed to the power amplifier resulting in an improved terminal autonomy. Several mobiles can be received in the same time slot by the base station, they are separated by their codes and the individual decoding can take profit of the joint detection.
- a base station should broadcast a single burst per mobile again by adapting the spreading as a function of the data rate. High rate data transmissions requiring more than one timeslot per mobile can be supported by terminals having the processing power for joint detection on a single slot : the required throughput occupies in a general way an integer number of slots plus a fraction of an extra slot. Single burst transmission should occur in the integer number of slots, while the extra slot can be occupied by a burst for the considered mobile plus extra bursts for other mobiles, joint detection is only needed for this last time slot in the considered mobile.]

? *[Editors Note : There is no description of adapting for the spreading factor, transmission method of extra slot and joint detection (including profit and processing power) in ARIB.]*

9.2.2 Burst Types

? *[Editors Note : There are the following difference between ETSI and ARIB on time slot structure. But almost of all seems to be difference of parameter value. Both descriptions are shown.*

· *SF: 1-16(ETSI)/ 1-512(ARIB)*

· *TPC symbols: no(ETSI)/one(ARIB)*

· *TFCI symbols: no or several(negotiation)(ETSI)/ no or one(ARIB)*

· *Burst type: two(ETSI)/ one(ARIB)*

· *Guard symbol: 23.4us(ETSI)/ 31.25us(ARIB)*

· *Training sequence: midamble(ETSI)/ pilot symbol or midamble(optional)(ARIB)*

? *]*

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ETSI:

[

? As explained in the section *[Editors Note : There is no ODCH in ARIB. There is no definition and explanation of DPDCH and DPCCH in ETSI.]*

9.2.1 Spreading codes, two options are being considered for the spreading. The bursts described in this section can be used for both options.

Two types of bursts for dedicated physical channels are defined: The burst type 1 and the burst type 2. Both consist of two data symbol fields, a midamble and a guard period. The bursts type 1 has a longer midamble of 512 chips than the burst type 2 with a midamble of 256 chips. Sample sets of midambles are given in section 7.2.3.1 and 7.2.3.2.

Because of the longer midamble, the burst type 1 is suited for the uplink, where up to 8 different channel impulse responses have to be estimated. The burst type 2 can be used for the downlink and, if the bursts within a time slot are allocated to less than four users, also for the uplink.

Thus the burst type 1 can be used for

- uplink, independent of the number of active users in one time slot
- downlink, independent of the number of active users in one time slot

The burst type 2 can be used for

- uplink, if the bursts within a time slot are allocated to less than four users
- downlink, independent of the number of active users in one time slot

The data fields of the burst type 1 are 976 chips long, whereas the data fields length of the burst type 2 are 1104 chips long. The corresponding number of symbols depends on the spreading factor, as indicated in Table 1 below. The guard period for the burst type 1and type 2 is 96 chip periods long.

The bursts type 1 and type 2 are shown in figure Figure 5 and Figure 6. The contents of the burst fields are described in Table 2 and Table 3.

Table 1 number of symbols per data field in bursts 1 and 2

Spreading factor (Q)	Number of symbols (N) per data field in Burst 1	Number of symbols (N) per data field in Burst 2
1	976	1104
2	488	552
4	244	276
8	122	138
16	61	69

Table 2 The contents of the burst type 1 fields

Chip number (CN)	Length of field in chips	Length of field in symbols	Length of field in µs	Contents of field
0-975	976	cf Table 1	238.3	Data symbols
976-1487	512	-	125.0	Midamble
1488-2463	976	cf Table 1	238.3	Data symbols
2464-2559	96	-	23.4	Guard period

Figure 5 Burst structure of the burst type 1. GP denotes the guard period and CP the chip periods.

Table 3 The contents of the burst type 2 fields

Chip number (CN)	Length of field in chips	Length of field in symbols	Length of field in µs	Contents of field
0-1103	1104	cf Table 1	269.55	Data symbols
1104-1359	256	-	62.5	Midamble
1360-2463	1104	cf Table 1	269.55	Data symbols
2464-2559	96	-	23.4	Guard period

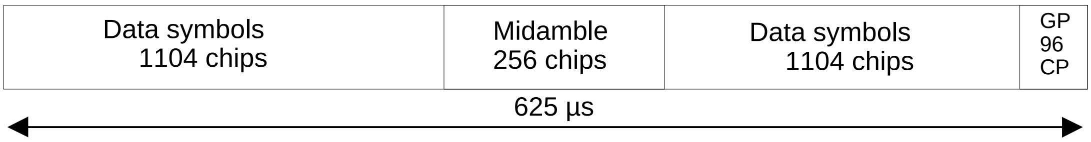

Figure 6 Burst structure of the burst type 2. GP denotes the guard period and CP the chip periods.

The two different bursts defined here are well-suited for the different applications mentioned above. It may be possible to further optimise the burst structure for specific applications, for instance for unlicensed operation.

9.2.2.1 Transmission of TFCI

Both burst types 1 and 2 for dedicated channels provide the possibility for transmission of TFCI both in up- and downlink.

The transmission of TFCI is negotiated at call setup and can be re-negotiated during the call. This means, it is indicated whether the TFCI is applied or not and how many bits are to be allocated for this purpose. If applied, transmission of TFCI is done in the data parts of the traffic burst. Hence the midamble structure and length is not changed. The TFCI information is to be transmitted directly adjacent to the midamble. Figure 6 shows the position of the TFCI in a traffic burst.

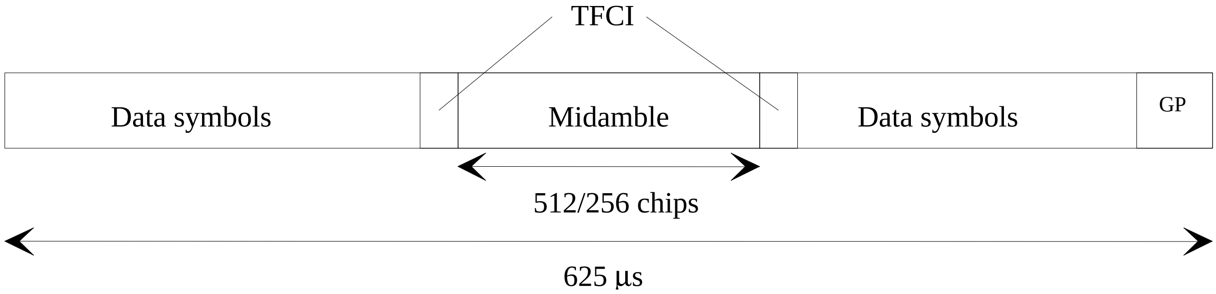

Figure 6: Position of TFCI information in the traffic burst

For every user the TFCI information is to be transmitted once per frame. Different numbers of symbols can be allocated for TFCI. The TFCI is spread with the same spreading factor (SF) as the data parts. The SF of the burst which contains the TFCI is applied to both data and signalling and shall be constant, except when a negotiation between transmitter and receiver initiates a change of the SF. Variable Data Rates shall be handled by DTX.

Two examples of TFCI transmission in the case of multiple resource units (RUs) used for a connection are given in the figures 7 and 8 below. Combinations of the two schemes shown are also applicable. It should be noted that the SF can vary for the RUs not carrying TFCI information.

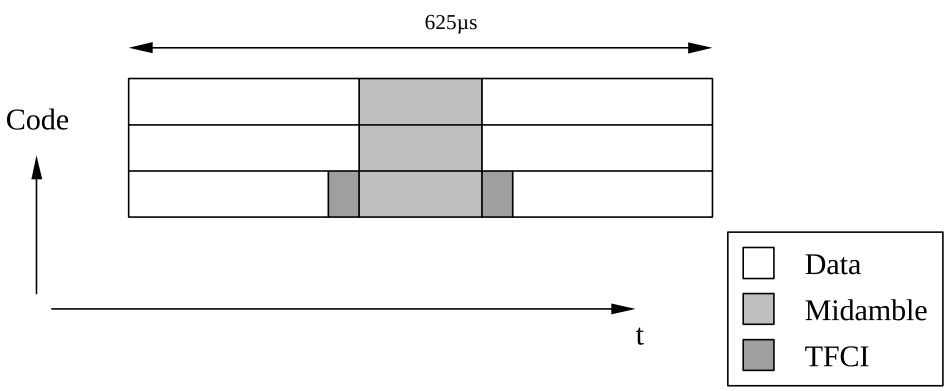

Figure 7: Example of TFCI transmission with RUs multiplexed in code domain

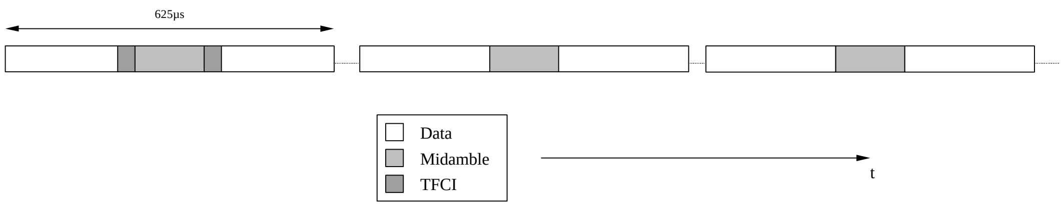

Figure 8: Example of TFCI transmission with RUs multiplexed in time domain

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ARIB:
[The DPDCH and DPCCH are time multiplexed within each radio frame and transmitted with QPSK modulation. Fig.3.3.2-4 shows the principle frame structure of the dedicated physical channels. Each frame of length 10ms is split into 16 slots, each of length Ts=0.625ms.

Fig.3.3.2-4 Frame structure for the Physical Channel

Table3.3.2-3 shows the number of bits per slot of the various fields. There are basically two types of Dedicated Physical Channel types. The channel bit and symbol rates given in Table 3.3.2-3 are the rates immediately before spreading.

Table 3.3.2-3 DPDCH and DPCCH fields

Channel Bit Rate	Channel Symbol Rate	SF	Bits/Frame	Bits/Slot	DPDCH Bits/Slot		DPCCH Bits/Slot			Guard Symbol Bits/Slot
					N_{data1}	N_{data2}	N_{TFCI}	N_{TPC}	N_{pilot}	N_{guard}
16kbps	8ksps	512	80	10	2	2	0	2	2	2
16kbps	8ksps	512	80	10	2	0	2	2	2	2
32kbps	16ksps	256	160	20	6	6	0	2	4	2
32kbps	16ksps	256	160	20	6	4	2	2	4	2
64kbps	32ksps	128	320	40	14	14	0	2	8	2
64kbps	32ksps	128	320	40	14	12	2	2	8	2
128kbps	64ksps	64	640	80	32	34	0	2	8	4
128kbps	64ksps	64	640	80	32	32	2	2	8	4
256kbps	128ksps	32	1280	160	70	72	0	2	8	8
256kbps	128ksps	32	1280	160	70	70	2	2	8	8
512kbps	256ksps	16	2560	320	142	144	0	2	16	16
512kbps	256ksps	16	2560	320	142	142	2	2	16	16
1024kbps	512ksps	8	5120	640	294	296	0	2	16	32
1024kbps	512ksps	8	5120	640	294	294	2	2	16	32
2048kbps	1024ksps	4	10240	1280	598	600	0	2	16	64
2048kbps	1024ksps	4	10240	1280	598	598	2	2	16	64
4096kbps	2048ksps	2	20480	2560	1198	1200	0	2	32	128
4096kbps	2048ksps	2	20480	2560	1198	1198	2	2	32	128
8192kbps	4096ksps	1	81920	5120	2414	2416	0	2	32	256
8192kbps	4096ksps	1	81920	5120	2414	2414	2	2	32	256

The spreading codes used at one particular dedicated physical channel shall be used only for the pilot symbol the TPC symbol and TFCI symbol part. (See Fig. 3.3.6-5)

Fig. 3.3.6-5 Spreading code in multi-code transmission

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9.2.2.2 Coding of TFCI

<to be determined>

9.2.2.3 Burst Structure when using DTX

<to be determined>

9.2.3Training sequences for spread bursts

? *[Editors Note : The same training sequence is described as special scrambling codes (PSC) in section of code generation (3.3.4.2.2) on ARIB. But there is no example midamble code.]*

As explained in the section *[Editors Note : There is no ODCH in ARIB. There is no definition and explanation of DPDCH and DPCCH in ETSI.]*

9.2.1 Spreading codes, two options are being considered for the spreading. The training sequences presented here are common to both options.

The training sequences, i.e. midambles, of different users active in the same time slot are time shifted versions of one single periodic basic code. Different cells use different periodic basic codes, i.e. different midamble sets. In this way a joint channel estimation for the channel impulse responses of all active users within one time slot can be done by one single cyclic correlation. The different user specific channel impulse response estimates are obtained sequentially in time at the output of the correlator. Following this principle it is shown hereafter how to derive the midambles from the periodic basic code.

? Section *[Editors Note : There is no description of adapting for the spreading factor, transmission method of extra slot and joint detection (including profit and processing power) in ARIB.]*

9.2.2 Burst Types contains a description of the spread speech/data bursts. These bursts contain Lm midamble chips, which are also termed midamble elements. The Lm elements $\underline{m}_i^{(k)}$; i=1,...,Lm; k=1,...,K; of the midamble codes $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; of the K users are taken from the complex set

$$\underline{\mathrm{V}}_{\mathrm{m}} = \{1,\ \mathrm{j},\ -1,\ -\mathrm{j}\}. \tag{1}$$

The elements $\underline{m}_i^{(k)}$ of the complex midamble codes $\underline{\mathbf{m}}^{(k)}$ fulfil the relation

$$\underline{m}_i^{(k)} = (\mathrm{j})^i \cdot m_i^{(k)} \qquad m_i^{(k)} \in \{1,\ -1\};\ i = 1,\ldots,L_m;\ k = 1,\ldots,K. \tag{2}$$

Hence, the elements $\underline{m}_i^{(k)}$ of the complex midamble codes $\underline{\mathbf{m}}^{(k)}$ of the K users are alternating real and imaginary.

With W being the number of taps of the impulse response of the mobile radio channels, the Lm binary elements $m_i^{(k)};\ \mathrm{i} = 1,\ldots,L_{\mathrm{m}};\ k = 1,\ldots,K;$ of (2) for the complex midambles $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; of the K users are generated according to Steiner's method [1] from a single periodic basic code

$$\mathbf{m} = \left(m_1, m_2, \ldots, m_{L_m+(K-1)W}\right)^{\mathrm{T}} \qquad m_i \in \{1,\ -1\};\ i = 1,\ldots,(L_m + (K-1)W). \tag{3}$$

The elements $m_i;\ i = 1,\ldots,(L_m + (K-1)W),$ of (3) fulfil the relation

$$m_i = m_{i-P} \qquad \text{for the subset} \qquad i = (P+1),\ldots,(L_m + (K-1)W). \tag{4}$$

The P elements $m_i;\ i = 1,\ldots,P,$ of one period of m according to (3) are contained in the vector

$$\mathbf{m}_{\mathrm{P}} = \left(m_1, m_2, \ldots, m_P\right)^{\mathrm{T}}. \tag{5}$$

With $\mathbf{m}$ according to (3) the Lm binary elements $m_i^{(k)};\ \mathrm{i} = 1,\ldots,\mathrm{L}_{\mathrm{m}};\ k = 1,\ldots,K;$ of (2) for the midambles of the K users are generated based on Steiner's formula

$$m_i^{(k)} = m_{i+(K-k)W} \qquad i = 1,\ldots,L_m;\ k = 1,\ldots,K. \tag{6}$$

In the following the term 'a midamble code set' or 'a midamble code family' denotes K specific midamble codes $\underline{\mathbf{m}}^{(k)}$; k=1,...,K. Different midamble code sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; are in the following specified based on different periods $\mathbf{m}_{\mathrm{P}}$ according (5).

In adjacent cells of the cellular mobile radio system, different midamble codes sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; should be used to guarantee a proper channel estimation.

As mentioned above a single midamble code set $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; consisting of K midamble codes is based on a single period $\mathbf{m}_{\mathrm{P}}$ according to (5).

In the following several exemplary periods $\mathbf{m}_{\mathrm{P}}$ according (5) which can be used to generate different midamble code sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; will be listed in tables in a hexadecimal representation. As shown in Table 4 always 4 binary elements m_i are mapped on a single hexadecimal digit.

Table 4 Mapping of 4 binary elements m_i on a single hexadecimal digits

4 binary elements m_i	mapped on hexadecimal digit
-1 -1 -1 -1	0
-1 -1 -1 1	1
-1 -1 1 –1	2
-1 -1 1 1	3
-1 1 -1 –1	4
-1 1 -1 1	5
-1 1 1 -1	6
-1 1 1 1	7
1 -1 -1 -1	8
1 -1 -1 1	9
1 -1 1 -1	A
1 -1 1 1	B
1 1 -1 -1	C
1 1 -1 1	D
1 1 1 -1	E
1 1 1 1	F

The mean degradations [2, equation (38)] which serve as a quality information of the periods $\mathbf{m}_{\mathrm{P}}$ according to (5) and hence of the specified midamble code sets $\underline{\mathbf{m}}^{(k)}$; k=1,...,K; will be also given.

9.2.3.1 Example Midamble Code Set for Burst Type 1

In the case of burst type 1 (see section [*Editors Note : There is no description of adapting for the spreading factor, transmission method of extra slot and joint detection (including profit and processing power) in ARIB.]*

9.2.2 Burst Types) the midamble has a length of Lm=512 , which is corresponding to:

K=8; W=57; P=456

Table 5 Example Periods $\mathbf{m}_{\mathrm{P}}$ according (8-5) for case of burst type 1.

Periods $\mathbf{m}_{\mathrm{P}}$ of length *P*=456	Degradation in dB
C482462CA7846266060D21688BA00B72E1EC84A3D5B7194C8DA39E21A3CE12BF512 C8AAB6A7079F73C0D3E4F40AC555A4BCC453F1DFE3F6C82	0.649471
56F3ACE0A65B96FC326A30B91665BD4380907C2B08DEC98C16A0B0339AEA855C3D 8BDD016E4C3E0F3DA5DF5C0891C851BA30A6C19ABE6C3ED4	0.695320
1D566C76440333CBF3CA2A405386068E19A2D6A53560CC50138B3A15BF7D9683F95F 66FF096431363E09A514D61099DD3EAD52903BF4A27D14	0.705751
9A0A349E49389CC184F7A3420D3FBE06B3A40BEE933D8E04E61FAA4A5214D918A1 ADD5BE25D833579FBCF17B422300D0CA1B419393F9722AA8	0.706513
B760E5694E49169C225A2FBCDACCCA8847F8486A6A351EB7D045BA2271B2A4CB90 0404C0D2BBA00F80F963861BD7DCE748F0F10AE6B785D0F0	0.707417

ECE93B83CE32E395405F7C889751970E84AFD632500B91E17C4E7846FE68D3C841013 5D3114D3281211214D1F5F1996A6B656259F11728AA52	0.708587
DE1B6F6219A0AD1A3EB5EEA02173D704C3340AAE7310B93A21BCF979BC7B6C081 7003AA300B1704BCE62524EC48C505977A1570F6C6BA1A2D8	0.711320

9.2.3.2 Example Midamble Code Set for Burst Type 2

In the case of burst type 2 (see section [*Editors Note : There is no description of adapting for the spreading factor, transmission method of extra slot and joint detection (including profit and processing power) in ARIB.]*

9.2.2 Burst Types) the midamble has a length of Lm=256 , which is corresponding to:

K=3; W=64; P=192

Table 6 Example Periods $\mathbf{m}_P$ according (8-5) for case of burst type 2.

Periods of length *P*=192	Degradation in dB
D4A124FE4D11BC14C258546A18C5DE0E3AA3F0617245DBFE	0.615566
48D76A687E21D22321C5201977F620D7A4CB5945F5693A1C	0.638404
9EEF5E79606DCAAB046769524691E09E816DC688ABC12030	0.663436
D2369A2B704878F55B58A300C853A2F62233E6207E39F944	0.677739
A26C7D9697B002714E9285D2AFC3AF1E233FC8C6C7486080	0.686287
8A615F5D7EE05668415E626482E90B11C95305E4707015B5	0.686660
5CC2D7409922FA463D2D14377EBCF0CC0E888426B06F0A82	0.688977
A68238D5BD37B2B4C48B466B9815087898409AFCB804FA0B	0.692613

9.2.3.3 Midamble Transmit Power

In the case of the downlink, 2K data blocks are transmitted in a burst simultaneously. Also in the uplink, if K' greater than one CDMA code are assigned to a single user, 2K' data blocks are transmitted in a burst simultaneously by this user. This is the so called multi-code uplink situation. In the downlink and the multi-code uplink, the mean power used to transmit the midambles on the one hand and the 2K (or 2K') data blocks on the other hand shall be equal. This shall be achieved by multiplying the midamble codes $\underline{\mathbf{m}}^{(k)}$, k=1,...,K, with a proper real factor to achieve an attenuation or an amplification.

9.3 Common control physical channels (CCPCH)

9.3.1 Downlink common control physical channel

Either the BCH, the PCH or the FACH as described in section [*Editors Note : There is no ODCH in ARIB document.]*

8.1.2 Common transport channels are mapped onto one or more downlink common control physical channels (CCPCH). In such a way the capacity of BCH, PCH and FACH can be adopted depending on the operators need.

? *[Editors Note : Specific physical channel for BCH is defined in ARIB. BCH is mapped onto Perch Channel.]*

? *[Editors Note : In ARIB, spreading factor and symbol rate are described on the assumption that downlink common transport channels are always mapped on eight time slot per frame.]*

? *[Editors Note : In ARIB, SCH is defined as a part of Perch channel.]*

9.3.1.1 Spreading codes

ETSI:

[The downlink CCPCH uses fixed spreading with a spreading factor SF = 16 as described in section [*Editors Note : There is no description of independent allocation for uplink and downlink in ETSI.]*

9.2.1.1 Multicode transmission with fixed spreading.]

ARIB:

[Perch channel uses fixed spreading with a spreading factor SF = 128. Common physical channel uses fixed spreading with a spreading factor SF = 32.]

9.3.1.2 Burst Types

ETSI:

[The bursts as described in section [*Editors Note : There is no description of adapting for the spreading factor, transmission method of extra slot and joint detection (including profit and processing power) in ARIB.]*

9.2.2 Burst Types are used for the downlink CCPCH.]

ARIB:

[The Perch channel carries BCH. The signal format of Perch Channel is presented in Fig.3.3.2-2. Common pilot which comprises of N_{pilot} symbols is time multiplexed in the middle of downlink timeslot. Data symbols which are split into 2 parts of N_{Data1} and N_{Data2} and the Search Code (1st and 2nd) which occupies N_{SCH} symbols are time multiplexed. The perch channel is only transmitted on the downlink timeslots. The values of the parameters are shown in the Table 3.3.2-1.

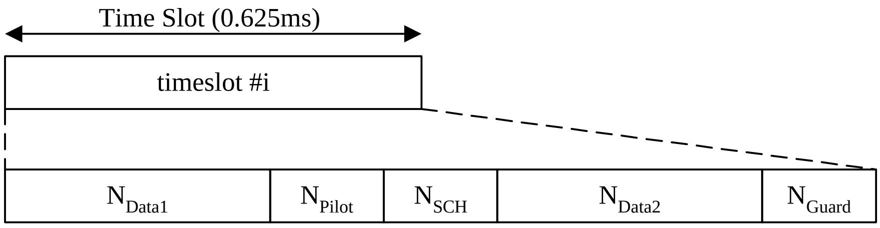

Fig.3.3.2-2 Perch Channel Signal Format

Table 3.3.2-1 Perch Channel fields

Parameter	Symbols per slot
N_{pilot}	7
N_{Data1}	5
N_{Data2}	5
N_{SCH}	2
N_{Guard}	1

The downlink Common Physical Channel carries PCH and FACH. The signal format of Common Physical Channel is presented in Fig.3.3.2-3. The values of the parameters are shown in the Table 3.3.2-2.

Fig.3.3.2-3 Common Physical Channel Signal Format

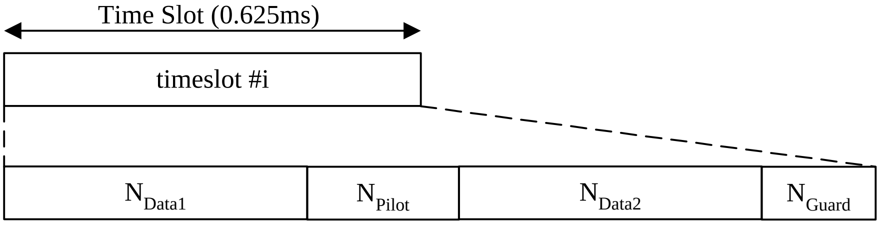

Table 3.3.2-2 Common Physical Channel fields

Parameter	Symbols per slot	
	128ksps	32ksps
N_{pilot}	4	4
N_{Data1}	36	7
N_{Data2}	36	8
N_{Guard}	4	1

]

9.3.1.3 Training sequences for spread bursts

The training sequences, i.e. midambles, as described in section 0 are used for the downlink CCPCH.

? *[Editors Note : This training sequence is described as special scrambling codes (PSC) of option in ARIB.]*

9.3.2The physical random access channel (PRACH)

? *[Editors Note : In ARIB, spreading factor and symbol rate are described on the assumption that uplink common transport channels are always mapped on eight time slot per frame. There are two types of symbol rate for RACH.]*

? *[Editors Note : In ARIB, there is no ORACH.]*

ETSI:

[The RACH or in case of ODMA networks the ORACH as described in section *[Editors Note : There is no ODCH in ARIB document.]*

8.1.2 Common transport channels are mapped onto one or more uplink physical random access channels (PRACH). In such a way the capacity of RACH and ORACH can be adopted depending on the operators need.]

9.3.2.1 Spreading codes

ETSI:

[The uplink PRACH uses fixed spreading with a spreading factor SF = 16 as described in section *[Editors Note : There is no description of independent allocation for uplink and downlink in ETSI.]*

9.2.1.1 Multicode transmission with fixed spreading.]

ARIB:

[The uplink common physical channel uses two types of fixed spreading with a spreading factor SF = 32 or 128.]

9.3.2.2 Burst Types

? *[Editors Note : There is the following difference between ETSI and ARIB on time structure.*

- *Burst length: half(ETSI)/ full(ARIB)*
- *Guard Period: 23.4us or 312.5us(Exteded GP)(ETSI)/ 31.25us(ARIB)*
- *Training sequence: midamble(ETSI)/ pilot symbol or midamble(optional)(ARIB)*

? *]*

ETSI:

[The mobiles send the uplink access bursts randomly in the uplink PRACH. This leads to time-divided collision groups. The usage of up to 8 orthogonal codes per time slot increases the amount of collision groups and throughput, respectively.

A further improvement is achieved by using two distinct access bursts, which can both be transmitted within one time slot without collision. Access burst 1 uses only the first half of a time slot, access burst 2 the second. Both access bursts are depicted in Figure 7 and Figure 8, respectively. The contents of the access burst fields are listed in Table 7 and Table 8.

Table 7 The contents of the access burst 1 fields

Chip Number (CN)	Length of field in chips	Length of field in symbols	Length of field in µs	Contents of field
0-335	336	21	82.0	Data symbols
336-847	512	-	125.0	Midamble
848-1183	336	21	82.0	Data symbols
1184-1279	96	-	23.4	Guard period
1279-2559	1280	-	312.5	Extended guard period

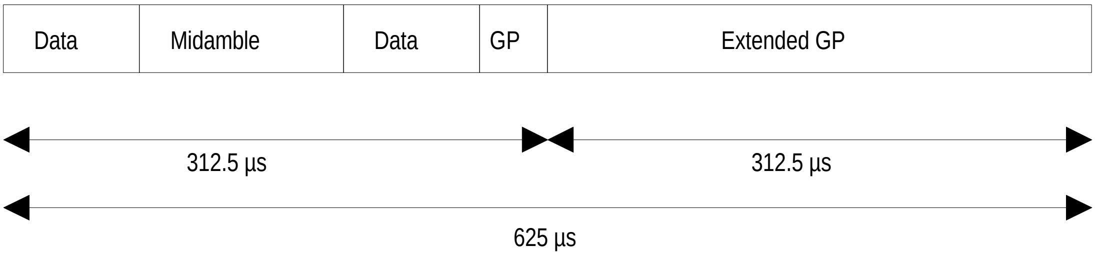

Figure 7 Access burst 1, GP denotes the guard period

Table 8 The contents of the access burst 2 fields

Chip Number (CN)	Length of field in chips	Length of field in symbols	Length of field in µs	Contents of field
0-1279	1280	-	312.5	Extended guard period
1280-1615	336	21	82.0	Data symbols
1616-2127	512	-	125.0	Midamble
2128-2463	336	21	82.0	Data symbols
2464-2559	96	-	23.4	Guard period

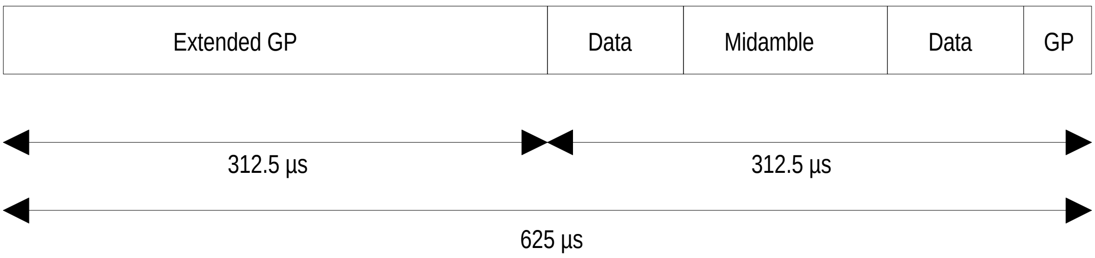

Figure 8 Access burst 2, GP denotes the guard period

]
ARIB:
[The Uplink Common Physical Channel carries RACH. There are two types of Uplink Common Physical Channel; a 32 ksps physical channel and a 128 ksps physical channel as described in section 7.3.1.2 (Figure 3.3.2-3 and Table 3.3.2-2).
]

9.3.2.3 Training sequences for access bursts

The training sequences, i.e. midambles, as described in section 0 are used for the uplink PRACH.

? [Editors Note : This training sequence is described as special scrambling codes (PSC) of option in ARIB.]

9.4 The physical synchronisation channel (PSCH)

? *[Editors Note : In ARIB, SCH is defined as part of Perch channel.]*

ETSI:

[The PSCH is similar to the FDD SCH. In order not to limit the UL/DL asymmetry the PSCH is mapped on two DL slots per frame only, as shown in Figure 9. The PSCH uses system-wide always the same two DL slots, which are slot 0 and slot 8.

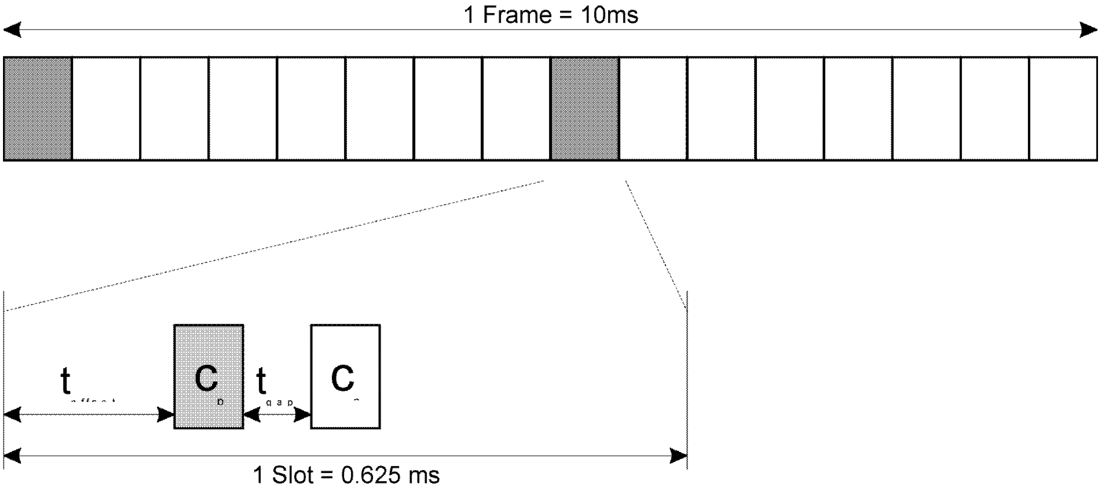

Figure 9 Scheme for Synchronisation channel SCH consisting of one primary sequence C_p and one secondary sequence C_s per used slot

As depicted in Figure 9, the PSCH consists of a primary and secondary code sequence. The used sequences C_p and C_s are the same as in FDD-Mode, see **[2]**.

The time offset t_{gap} is the time between the primary synchronisation code and the secondary synchronisation code. It provides enough time for calculations and a better interference distribution, since the codes do not superimpose. The exact value is to be determined.

Due to mobile to mobile interference, it is mandatory for public TDD systems to keep synchronisation between base stations. As a consequence of this, a capture effect concerning PSCH, see explanation below, can arise. The time offset t_{offset} enables the system to overcome the capture effect.

When searching for synchronisation engaging C_p a situation as outlined in Figure 10 may occur. The correlations, which are shown separately in the figure, superimpose at the mobile's receiver. The introduction of t_{offset} will ease the detection of cell 3. Since different cells use different time offsets, the time offset t_{offset} enables the receiver to detect even cells with low correlation peaks, as there is additional separation in time-domain. The cell's specific time offset t_{offset} is obtained by decoding the SCH.

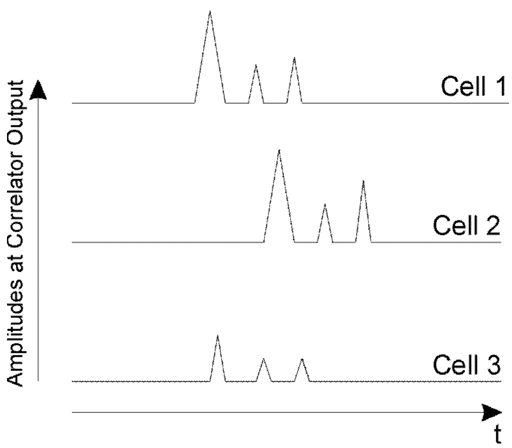

Figure 10 Sample for capturing effect whilst detecting synchronised Base Stations

]

10 Mapping of transport channels to physical channels

? *[Editors Note : There is difference of Transport and Physical channel configuration between ETSI and ARIB. Both are included in text.]*

ETSI:

[This section describes the way in which transport channels are mapped onto physical resources, see Figure 11. A description of the multiframe structure is given in section 8.3.

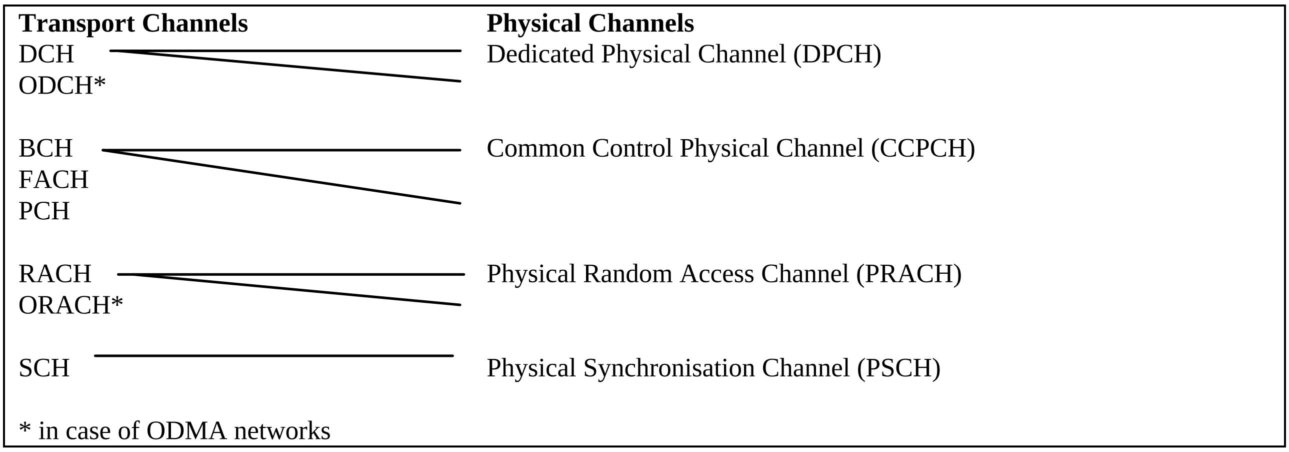

Figure 11 Transport channel to physical channel mapping

In the sequel, we use the terms physical channel and resource unit (RU); a physical channel is defined as the association of one code, one time slot and one frequency. A resource unit (RU) is that part of a physical channel allocated for one frame.

]

ARIB:

[Fig 3.2.1-5 shows the mapping relation between the transport and the physical channels.

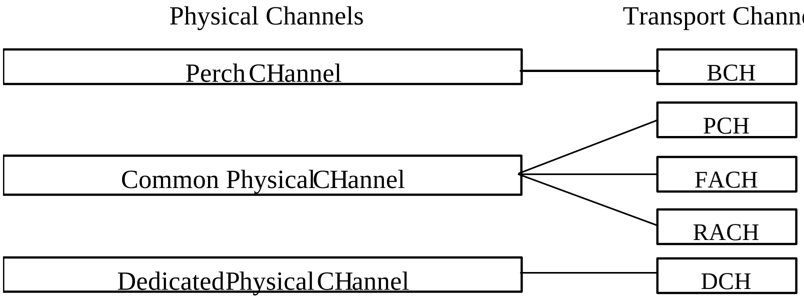

Fig. 3.2.1-5 Correspondence between Physical Channels and Transport Channels

]

10.1 Dedicated Transport Channels

? *[Editors Note : In ARIB, time slot allocation is described simply.]*

A dedicated transport channel is mapped onto one or more sets of slots and codes within a frame. An interleaving period is associated with each allocation. The frame is subdivided into slots that are available for uplink and downlink information transfer. Each set of slots and codes over an interleaving period maps to a data unit and a data unit can correspond to one or more FEC code blocks and one or more RLC protocol data units dependent from the service being supported. The mapping is illustrated by the following diagram (Figure 12):

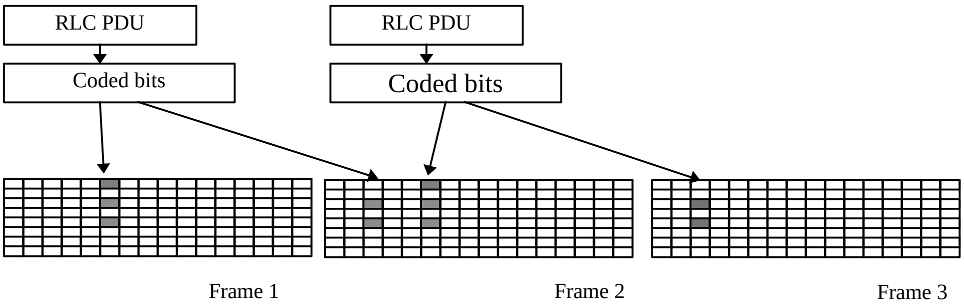

Figure 12 Mapping of PDU onto the physical bearer

For NRT packet data services an allocation is made only for a relatively short period of time. In general, for RT services an allocation is made for a certain time period and a release procedure is necessary to release the resource. For the efficient use of resources the slot/ code set allocated to a radio bearer may be changed from time to time and the resources allocated to a VBR service may increase or decrease along with the changes in the data rate. Traffic channels are power controlled.

ETSI:

An ODCH is also mapped onto one or more sets of slots and codes within a TDD frame as shown in Figure 5. The actual transmission mode (i.e. combination of slots, codes, TX power, interleaving depth etc.) chosen for a relay link will be negotiated between nodes prior to transmission. Several of these transmission mode parameters can be adapted during transmission due to changes in propagation and data traffic.

? *[Editors Note : There is no ODCH in ARIB.]*

10.2 Common Transport Channels

10.2.1 The Broadcast Channel (BCH)

? *[Editors Note : In ARIB, BCH is mapped onto Perch Channel. SCH is defined as a part of Perch channel and has fixed structure.]*

ETSI:

[

The BCH is mapped on one or several RU per frame. The secondary SCH indicates in which timeslot and code group a mobile can find the BCH. If the BCH uses more than one RU, the secondary SCH comprises a pointer to the whole BCH mapping scheme or only to the primary BCH RU and this comprises a pointer to secondary BCH RU. The BCH has a reference power level. The RU allocated by BCH can be shared with other common control channels, e.g. PCH or FACH, according to a multi-frame structure.

]

ARIB:

[

- BCH is mapped to the perch channel.
- A radio unit of BCH consists of 2 radio frames, thus one Layer 3 message consists of 2 * n radio frames. The Layer 3 message to be transmitted by BCH shall not cross over superframes.
- BCH transmits the information below generated at BTS.
  - SFN (System Frame Number)
- In the radio units of BCH that do not have Layer 3 information, dummy (all zero) shall be transmitted.]

10.2.2 The Paging Channel (PCH)

? *[Editors Note : In ARIB, the mapping of PCH is almost the same as FDD and described in detail in FDD. In ETSI, the grouping scheme is not described.]*

ETSI:

[

The PCH can be mapped onto any combination of time slots and codes so that capacity can be matched to requirements. The location of the PCH is indicated on the BCH. The PCH has to allow an efficient DRX. It is always transmitted at a reference power level.

]

ARIB:

[

- PCH is divided into several groups in one superframe, and layer 3 information is transmitted in each group.
- There shall be 288 groups per one Common Physical Channel.
- Each group of PCH shall have information amount worth 4 time slots, and consists of totally 6 information parts: 2 parts for indicating whether there are terminating calls (PI part) and 4 parts for destination user ID number (MUI part).
- In each group, 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 this pattern by 4 slots each, multiple 288 groups of PCH are allocated on one Common Physical Channel.
- The PCH of Group 1 are allocated so that the head symbol of superframe becomes the head symbol of the PI part of Group 1 PCH. Consequently, the PCHs of each group of Groups 2, 3, ... up to 288 are allocated within the radio frames for PCH sequentially.

The mapping method is shown in Fig.3.3.1-1. The channel is only transmitted on the assigned time slots.

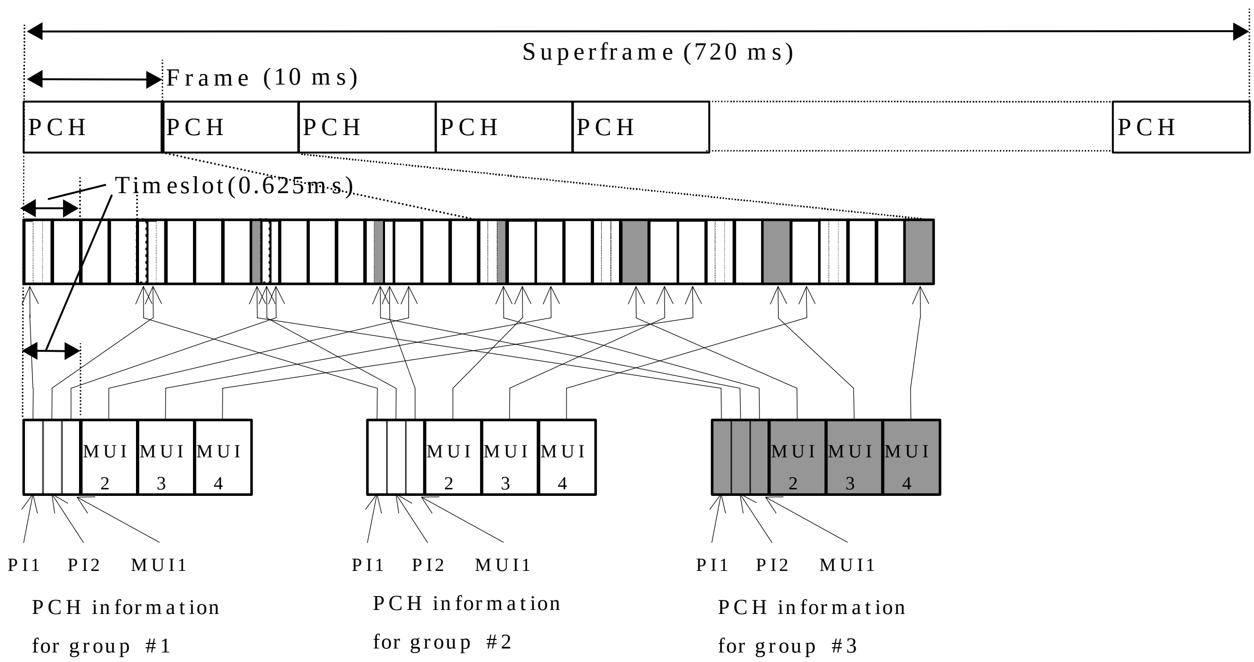

Fig. 3.3.1-1 PCH Mapping Method (example)

]

10.2.3 The Forward Channel (FACH)

? *[Editors Note : In ARIB, the mapping of FACH is the same as FDD, but the figure of old concept remains. Therefore, the figure in TDD is not shown and the description and figure of FDD is shown in this text.]*

ETSI:

[

The FACH can be mapped onto any combination of downlink resource units. The location of the FACH is indicated on the BCH and both, capacity and location can be changed, if required. FACH may or may not be power controlled.

]

ARIB:

[

Fig. 3.2.1-7 shows mapping method of FACH.

- There are two transport formats, FACH-S and FACH-L for FACH transmission. Which transport format to use is determined by MAC sub-layer depending on the amount of information to be transmitted on FACH.

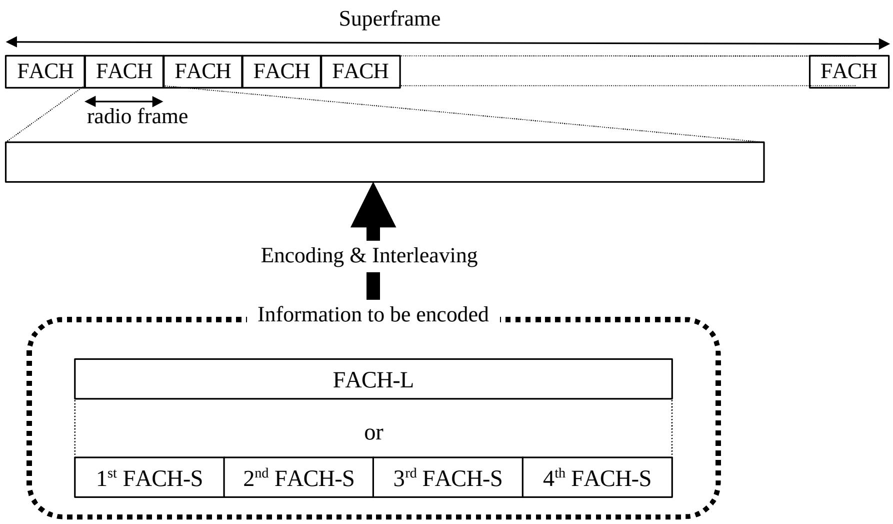

Fig. 3.2.1-7 FACH Mapping Method

]

10.2.4 The Random Access Channel (RACH)

? *[Editors Note : In ARIB, the mapping of RACH is almost the same as FDD.]*

ETSI:

[

The RACH has an interleaving period of one frame and each transmission occupies only one burst. To accommodate RACH a single uplink slot is subdivided into two sub-slots each capable of supporting independent transmissions of one burst. The same slot may be used for RACH by more than one cell. Multiple transmissions using different codes may be received in parallel. If needed more than one slot may be administrated for the RACH. The location of slots allocated to RACH is indicated on the BCH. The RACH uses open loop power control.

]

ARIB:

[This is the same as FDD mode. However, the channel is only transmitted on the assigned time slots. In this method, RACH-S=32kps, RACH-L= 128ksps. There are maximal of 8 types of timing offsets available.]

10.2.5 The Synchronisation Channel (SCH)

The SCH is mapped onto the PSCH as described in section The physical synchronisation channel (PSCH).

? *[Editors Note : In ARIB, SCH is defined as a part of Perch channel.]*

10.2.6 Common Transport Channels for ODMA networks

? *[Editors Note : In ARIB, there is no ODMA networks and ORACH.]*

The ORACH is used to transfer short probes or short protocol data units (PDU) between one or more nodes for routing and resource allocation control.

To limit the transmission time of short probe PDUs on the ORACH then this data should be transmitted as one burst on one resource unit (RU). That is, one probe burst should be transmitted on one 625 μs timeslot (which as described in section Frame structure would be configured as an ORACH slot).

Since the ORACH is a common control channel used to transfer probes between one or more nodes a common fixed spreading factor should be adopted.

10.3 Multiframe structure

? *[Editors Note : In ARIB, there is no concept of multiframe structure.]*

A strong requirement for the multiframe structure comes from the realization of low cost dual mode FDD-TDD terminals and from the GSM compatibility of the UTRA proposal. In this respect the superframe and multiframe structure for FDD and TDD mode have to be compatible and harmonised with GSM.
Thus in the proposed structure a multiframe is composed by 72 frames each of length 10 ms. So the multiframe period is 720 ms.
All frames in the traffic channel multiframes are used to carry both user data and dedicated signalling. The TDD multiframe matches exactly a FDD multiframe ensuring the compatibility of both modes.

11

12 History

Document history		
v0.0.1	1999-01-29	Document created based on the documents UMTS (xx.09) V 1.2.0 and ARIB Volume 3 Ver.1.0
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