

TSG-RAN Working Group 1 meeting #15  
Berlin, Germany  
August 22nd - 25<sup>th</sup> , 2000

**R1-00-0966**

**Agenda item:** Release 99 issues  
**Source:** Nokia, Vodafone Group  
**Title:** Clarification on RACH and CPCH subchannel definition  
**Document for:** Decision

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## **1. Introduction**

In the RAN WG1 #13 meeting there was a CR 25.214-096r3 [1] clarifying the RACH subchannel description because of an inconsistency between TS 25.211 and TS 25.214. However, this CR left the RACH access procedure in TS 25.214 somewhat misleading. This contribution clarifies the uplink RACH access procedure particularly with respect to RACH subchannels. The same clarifications are extended to the CPCH access procedure in TS 25.214.

## **2. References**

TSGR1#13(00)0787, "Correction to RACH subchannel definition", Nokia and Lucent Technologies

**CHANGE REQUEST**

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

**25.214 CR 122**

Current Version: **3.3.0**

GSM (AA.BB) or 3G (AA.BBB) specification number ↑

↑ CR number as allocated by MCC support team

For submission to: **TSG RAN #9** for approval  strategic  (for SMG use only)  
 list expected approval meeting # here ↑ For information  non-strategic

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: <ftp://ftp.3gpp.org/Information/CR-Form-v2.doc>

**Proposed change affects:** (U)SIM  ME  UTRAN / Radio  Core Network   
 (at least one should be marked with an X)

**Source:** **Nokia, Vodafone Group** **Date:** **Aug 22<sup>nd</sup> 2000**

**Subject:** **Clarification on RACH and CPCH subchannel definition**

**Work item:**

**Category:** F Correction  **Release:** Phase 2   
 A Corresponds to a correction in an earlier release  Release 96   
 B Addition of feature  Release 97   
 C Functional modification of feature  Release 98   
 D Editorial modification  Release 99   
 Release 00   
*(only one category shall be marked with an X)*

**Reason for change:** The description of RACH and access is not clear. Particularly, the selection of access slots within RACH sub-channels is made specific by this CR. CPCH access is clarified in the same fashion.

**Clauses affected:** **6.1, 6.1.1, 6.2**

**Other specs affected:** Other 3G core specifications  → List of CRs:  
 Other GSM core specifications  → List of CRs:  
 MS test specifications  → List of CRs:  
 BSS test specifications  → List of CRs:  
 O&M specifications  → List of CRs:

**Other comments:**

**Table 6: Updating of P1 and P2**

State of cell	P1 (DPCCH)	P2 (DPDCH)
non primary	Updated by the same way as specified in 5.2.1.2 or 5.2.1.3 in compressed mode	Switched off
primary		= P1

## 5.2.2 PDSCH

The PDSCH power control can be based on the following solutions, which are selectable, by the network:

- Inner-loop power control based on the power control commands sent by the UE on the uplink DPCCH.
- Slow power control.

## 5.2.3 AICH

The UE is informed about the relative transmit power of the AICH (measured as the power per transmitted acquisition indicator) compared to the primary CPICH transmit power by the higher layers.

## 5.2.4 PICH

The UE is informed about the relative transmit power of the PICH (measured as the power over the paging indicators) compared to the primary CPICH transmit power by the higher layers.

## 5.2.5 S-CCPCH

The TFCI and pilot fields may be offset relative to the power of the data field. The power offsets may vary in time.

## 5.2.6 CSICH

The UE is informed about the relative transmit power of the CSICH (measured as the power per transmitted status indicator) compared to the primary CPICH transmit power by the higher layers.

# Random access procedure

## 6.1 Physical random access procedure

The physical random access procedure described in this subclause is initiated upon request of a PHY-Data-REQ primitive from the MAC sublayer (cf. TS 25.321).

Before the physical random-access procedure can be initiated, Layer 1 shall receive the following information from the higher layers (RRC):

- The preamble scrambling code.
- The message length in time, either 10 or 20 ms.
- The AICH\_Transmission\_Timing parameter [0 or 1].
- The available signatures and RACH sub-channel groups for each Access Service Class (ASC), where a sub-channel group is defined as a group of some of the sub-channels defined in subclause 6.1.1.
- The power-ramping factor Power\_Ramp\_Step [integer > 0].

- The parameter Preamble\_Retrans\_Max [integer > 0].
- The initial preamble power Preamble\_Initial\_Power.
- The power offset  $\Delta P_{p-m} = P_{\text{message-control}} - P_{\text{preamble}}$ , measured in dB, between the power of the last transmitted preamble and the control part of the random-access message.
- The set of Transport Format parameters. This includes the power offset between the data part and the control part of the random-access message for each Transport Format.

Note that the above parameters may be updated from higher layers before each physical random access procedure is initiated.

At each initiation of the physical random access procedure, Layer 1 shall receive the following information from the higher layers (MAC):

- The Transport Format to be used for the PRACH message part.
- The ASC of the PRACH transmission.
- The data to be transmitted (Transport Block Set).

The physical random-access procedure shall be performed as follows:

- 1 Randomly select the RACH sub-channel group from the available ones for the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.
- 2 ~~For a time instant  $\tau$ , derive the available uplink access slots, in the next full access slot set, for the selected RACH sub-channel group with the help of subclauses 6.1.1. and 6.1.2. and the SFN of the first available P-CCPCH frame, that is time aligned with the 10 ms long period which contains start boundaries of all the downlink access slots corresponding to the uplink access slots in the selected RACH sub-channel group. Randomly select one uplink access slot from the first available set of uplink access slots corresponding to the selected RACH sub-channel group.~~ If there is no access slot available ~~in the selected set~~ then, randomly select one uplink access slot corresponding to the selected RACH sub-channel group from the next access slot ~~set available set of uplink access slots in the selected RACH sub-channel group~~. The random function shall be such that each of the allowed selections is chosen with equal probability.
- 3 Randomly select a signature from the available signatures for the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.
- 4 Set the Preamble Retransmission Counter to Preamble\_Retrans\_Max.
- 5 Set the preamble transmission power to Preamble\_Initial\_Power.
- 6 Transmit a preamble using the selected uplink access slot, signature, and preamble transmission power.
- 7 If no positive or negative acquisition indicator ( $AI \neq +1$  nor  $-1$ ) corresponding to the selected signature is detected in the downlink access slot corresponding to the selected uplink access slot:
  - 7.1 Select ~~the a new uplink access slot as~~ next available access slot, ~~i.e. next access slot~~ in the RACH sub-channel group ~~chosen used, as selected~~ in 1.
  - 7.2 Randomly selects a new signature from the available signatures within the given ASC. The random function shall be such that each of the allowed selections is chosen with equal probability.
  - 7.3 Increase the preamble transmission power by  $\Delta P_0 = \text{Power\_Ramp\_Step}$  [dB].
  - 7.4 Decrease the Preamble Retransmission Counter by one.
  - 7.5 If the Preamble Retransmission Counter > 0 then repeat from step 6. Otherwise pass L1 status ("No ack on AICH") to the higher layers (MAC) and exit the physical random access procedure.

- 8 If a negative acquisition indicator corresponding to the selected signature is detected in the downlink access slot corresponding to the selected uplink access slot, pass L1 status ("Nack on AICH received") to the higher layers (MAC) and exit the physical random access procedure.
- 9 Transmit the random access message three or four uplink access slots after the uplink access slot of the last transmitted preamble depending on the AICH transmission timing parameter. Transmission power of the control part of the random access message should be  $\Delta P_{p-m}$  [dB] higher than the power of the last transmitted preamble. Transmission power of the data part of the random access message is set according to subclause 5.1.1.2.
- 10 Pass L1 status "RACH message transmitted" to the higher layers and exit the physical random access procedure.

### 6.1.1 RACH sub-channels

A RACH sub-channel defines a sub-set of the total set of uplink access slots. There are a total of 12 RACH sub-channels. RACH sub-channel #i (i = 0, ..., 11) consists of the following uplink access slots:

- Uplink access slot ~~#i leading lagging~~ by  $\tau_{p-a}$  chips the downlink access slot #i contained within the 10 ms interval that is time aligned with P-CCPCH frames for which  $SFN \bmod 8 = 0$  or  $SFN \bmod 8 = 1$ .
- Every 12<sup>th</sup> access slot relative to this access slot.

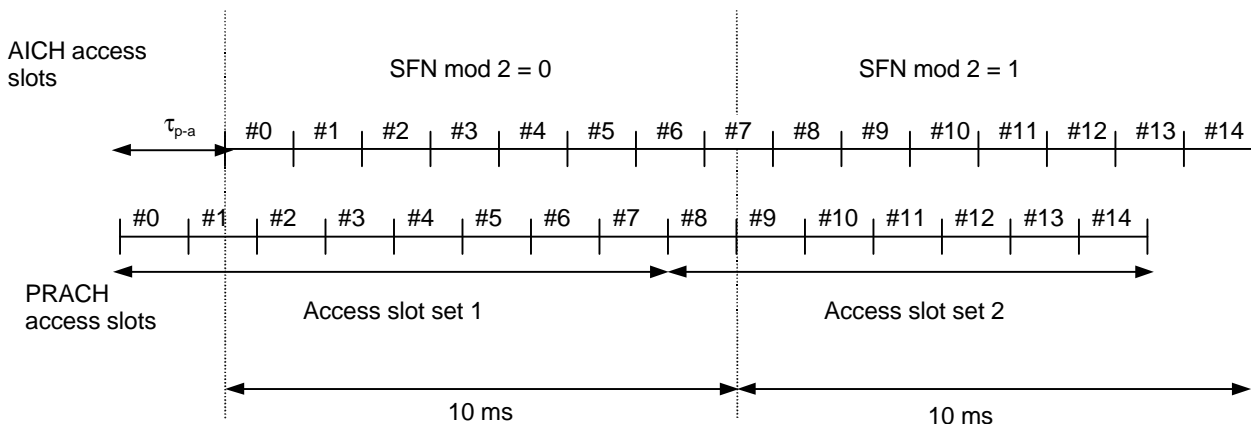
The access slots of different RACH sub-channels are also illustrated in Table 7.

**Table 7: The available uplink access slots for different RACH sub-channels**

SFN modulo 8 of corresponding P-CCPCH frame	Sub-channel number											
	0	1	2	3	4	5	6	7	8	9	10	11
0	0	1	2	3	4	5	6	7				
1	12	13	14						8	9	10	11
2				0	1	2	3	4	5	6	7	
3	9	10	11	12	13	14						8
4	6	7					0	1	2	3	4	5
5			8	9	10	11	12	13	14			
6	3	4	5	6	7					0	1	2
7						8	9	10	11	12	13	14

### 6.1.2 RACH access slot sets

The PRACH contains two sets of access slots as shown in Figure 2. Access slot set 1 contains PRACH slots 0 – 7 and starts  $\tau_{p-a}$  chips before the downlink P-CCPCH frame for which  $SFN \bmod 2 = 0$ . Access slot set 2 contains PRACH slots 8 - 14 and starts  $(\tau_{p-a} - 2560)$  chips before the downlink P-CCPCH frame for which  $SFN \bmod 2 = 1$ .



**Figure 2: PRACH access slot and downlink AICH relation ( $\tau_{p-a} = 7680$  chips)**

## 6.2 CPCH Access Procedures

For each CPCH physical channel in a CPCH set allocated to a cell the following physical layer parameters are included in the System Information message: L1 shall receive the following information from the higher layers (RRC).

- UL Access Preamble (AP) scrambling code.
- UL Access Preamble signature set.
- The Access preamble slot sub-channels group.
- AP- AICH preamble channelization code.
- UL Collision Detection(CD) preamble scrambling code.
- CD Preamble signature set.
- CD preamble slot sub-channels group.
- CD-AICH preamble channelization code.
- CPCH UL scrambling code.
- DPCCH DL channelization code.([512] chip).

NOTE: There may be some overlap between the AP signature set and CD signature set if they correspond to the same scrambling code.

The following physical layer parameters are received from the RRC layer:

- 1)  $N_{AP\_retrans\_max}$  = Maximum Number of allowed consecutive access attempts (retransmitted preambles) if there is no AICH response. This is a CPCH parameter and is equivalent to Preamble\_Retrans\_Max in RACH.
- 2)  $P_{RACH} = P_{CPCH}$  = Initial open loop power level for the first CPCH access preamble sent by the UE.
  - [RACH/CPCH parameter].
- 3)  $\Delta P_0$  = Power step size for each successive CPCH access preamble.
  - [RACH/CPCH parameter].
- 4)  $\Delta P_1$  = Power step size for each successive RACH/CPCH access preamble in case of negative AICH. A timer is set upon receipt of a negative AICH. This timer is used to determine the period after receipt of a negative AICH when  $\Delta P_1$  is used in place of  $\Delta P_0$ .
  - [RACH/CPCH parameter].
- 5)  $\Delta P_{p-m} = P_{message-control} - P_{cd}$ , measured in dB. This is the power offset between the transmit power of the CD preamble and the initial transmit power of the CPCH power control preamble (or the control part of the CPCH message part if the power control preamble length is 0 slots).
  - [CPCH parameter]
- 6)  $T_{cpch}$  = CPCH transmission timing parameter: This parameter is identical to PRACH/AICH transmission timing parameter.
  - [RACH/CPCH parameter].
- 7)  $L_{pc-preamble}$  = Length of power control preamble (0 or 8 slots).
  - [CPCH parameter].
- 8)  $N_{Start\_Message}$  = Number of frames for the transmission of Start of Message Indicator in DL-DPCCH for CPCH.
- 9) The set of Transport Format parameters. This includes a Transport Format to PCPCH mapping table.

L1 shall receive the following information from MAC prior to packet transmission:

- 1) Transport Format of the message part.
- 2) The data to be transmitted is delivered to L1 once every TTI until the data buffer is empty.

The overall CPCH -access procedure consists of two parts:

- 1) Upon receipt of a Status-REQ message from the MAC layer, the UE shall start monitoring the CSICH to determine the availability of the transport formats in the transport format subset included in the Status-REQ message. UTRAN transmits availability of each PCPCH or maximum available data rate with availability of each PCPCH over the CSICH in case CA is active. Upper layers will supply the UE with information to map the transport formats to the PCPCHs. The UE shall send a Status-CNF message to the MAC layer containing the transport format subset listing the transport formats of the requested subset which are currently indicated as "available".

The actual access procedure is then:

- 2) Upon receipt of the Access-REQ message from the MAC layer, which contains an identified transport format from the available ones, the following sequence of events occur. The use of step 2a or 2b depends on whether availability of each PCPCH or the Maximum available data rate along with the availability of each PCPCH is transmitted over CSICH. Note that in the first case, each access resource combination (AP signatures and access subchannel group) maps to each PCPCH resource and in the second case each access resource combination maps to each data rate.
  - 2a) (In case CA is not Active) The UE shall test the value(s) of the most recent transmission of the CSICH Status Indicator(s) corresponding to the PCPCH channel(s) for the identified transport format included in the Access-REQ message. If this indicates that no channel is 'available' the UE shall abort the access attempt and send a failure message to the MAC layer. The UE shall also retain the availability status of the each PCPCH for further verification in a later phase.
  - 2b) (In case CA is active) The CSICH Status Indicators indicate the maximum available data rate along with individual PCPCH availability. The UE shall test the value of the most recent transmission of the Status Indicator(s). If this indicates that the maximum available data rate is less than the requested data rate, the UE shall abort the access attempt and send a failure message to the MAC layer. The PHY provides the availability information to the MAC. The UE shall also retain the availability status of the each PCPCH for further channel assignment message verification in a later phase in case of success.
- 3) The UE sets the preamble transmit power to the value  $P_{\text{CPCH}}$  which is supplied by the MAC layer for initial power level for this CPCH access attempt.
- 4) The UE sets the AP Retransmission Counter to  $N_{\text{AP\_Retrans\_Max}}$ .
- 5a) In the case CA is not active, the uplink access slot and signature to be used for the CPCH-AP transmission are selected in the following steps:
  - a) The UE selects randomly one PCPCH from the set of available PCPCH channel(s) as indicated on the CSICH and supporting the identified transport format included in the Access-REQ message. The random function shall be such that each of the allowed selections is chosen with equal probability.
  - b) The UE randomly selects a CPCH-AP signature from the set of available signatures in the access resource combination corresponding to the selected PCPCH in step a). The random function shall be such that each of the allowed selections is chosen with equal probability.
  - c) ~~For a time instant  $\tau$ , Using the AP access slot sub-channel group of the access resource combination corresponding to selected PCPCH in step a), the UE derives the available CPCH-AP access slots with the help of subclauses 6.1.1. and 6.1.2, the SFN of the first available P-CCPCH frame that is time aligned with the 10 ms long period which contains start boundaries of all the downlink access slots corresponding to the uplink access slots in the selected AP access slot sub-channel group. The UE randomly selects one uplink access slot from the first available set of access slots corresponding to the selected AP access slot sub-channel group. If there is no access slot available in the selected set, then, the UE randomly selects one uplink access slot corresponding to the selected CPCH sub-channel group from the next access slot set of~~

~~available access slots corresponding to the selected AP access slot sub-channel group.~~ The random function shall be such that each of the allowed selections is chosen with equal probability.

- 5b) In the case CA is active, the uplink access slot and signature to be used for the CPCH-AP transmission are selected in the following steps:
- a) The UE randomly selects a CPCH-AP signature from the set of available signatures in the access resource combination corresponding to the transport format identified in the Access-REQ message. The random function shall be such that each of the allowed selections is chosen with equal probability.
  - b) ~~For a time instant  $\tau$ , U~~ Using the AP access slot sub-channel group of the access resource combination corresponding to the transport format identified in the Access-REQ message, the UE derives the available CPCH-AP access slots with the help of subclauses 6.1.1 and ~~6.1.2, the SFN of the first available P-CCPCH frame that is time aligned with the 10 ms long period which contains start boundaries of all the downlink access slots corresponding to the uplink access slots in the selected AP access slot sub-channel group. The UE randomly selects one uplink access slot from the first available set of uplink access slots corresponding to the selected AP access slot sub-channel group. If there is no access slot available in the selected set, then,~~ the UE randomly selects one uplink access slot corresponding to the selected CPCH sub-channel group from the next access slot set, available set of access slots corresponding to the selected AP access slot sub-channel group. The random function shall be such that each of the allowed selections is chosen with equal probability.
- 6) The UE transmits the AP using the selected uplink access slot and signature, and MAC supplied initial preamble transmission power. The following sequence of events occur based on whether availability of each PCPCH or the Maximum available data rate along with the availability of each PCPCH is transmitted over CSICH.
- 6a) (In case CA is not Active) The UE shall test the value of the most recent transmission of the Status Indicator corresponding to the identified CPCH transport channel immediately before AP transmission. If this indicates that the channel is 'not available' the UE shall abort the access attempt and send a failure message to the MAC layer. Otherwise the UE transmits the AP using the UE selected uplink signature and access slot, and the initial preamble transmission power from step 3, above.
- 6b) (In case CA is active) The Status Indicator indicates the maximum available data rate as well as the availability of each PCPCH. The UE shall test the value of the Status Indicator. If this indicates that the maximum available data rate is less than the requested data rate, the UE shall abort the access attempt and send a failure message to the MAC layer. Otherwise the UE shall transmit the AP using the UE selected uplink access slot, the MAC supplied signature and initial preamble transmission power from step 3, above.
- 7) If the UE does not detect the positive or negative acquisition indicator corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE shall test the value of the most recent transmission of the Status Indicator corresponding to the selected PCPCH immediately before AP transmission. If this indicates that the PCPCH is 'not available' the UE shall abort the access attempt and send a failure message to the MAC layer. Otherwise the following steps shall be executed:
- a) ~~Selects the new uplink next available~~ access slot ~~from the available access slot, i.e. next access slot~~ in the sub-channel group used. There must be a minimum distance of three or four (per Tpch parameter) access slots from the uplink access slot in which the last preamble was transmitted depending on the CPCH/AICH transmission timing parameter.
  - b) Increases the preamble transmission power with the specified offset  $\Delta P$ . Power offset  $\Delta P_0$  is used unless the negative AICH timer is running, in which case  $\Delta P_1$  is used instead.
  - c) Decrease the AP Retransmission Counter by one.
  - d) If the AP Retransmission Counter  $< 0$ , the UE aborts the access attempt and sends a failure message to the MAC layer.
- 8) If the UE detects the AP-AICH\_nak (negative acquisition indicator) corresponding to the selected signature in the downlink access slot corresponding to the selected uplink access slot, the UE aborts the access attempt and sends a failure message to the MAC layer. The UE sets the negative AICH timer to indicate use of  $\Delta P_1$  use as the preamble power offset until timer expiry.



- 9) Upon reception of AP-AICH\_ack with matching signature, the access segment ends and the contention resolution segment begins. In this segment, the UE randomly selects a CD signature from the CD signature set and also selects one CD access slot sub-channel from the CD sub-channel group supported in the cell and transmits a CD Preamble at the same power as the last AP, then waits for a CD/CA-ICH and the channel assignment (CA) (in case CA is active) message from the Node B. The slot selection procedure is as follows:
- a) The next available slot when the PRACH and PCPCH scrambling code are not shared. Furthermore, the PCPCH AP preamble scrambling code and CD Preamble scrambling codes are different.
  - b) When the PRACH and PCPCH AP preamble scrambling code and CD preamble scrambling code are shared, the UE randomly selects one of the available access slots in the next 12 access slots. Number of CD sub-channels will be greater than 2.
- 10) If the UE does not receive a CD/CA-ICH in the designated slot, the UE aborts the access attempt and sends a failure message to the MAC layer.
- 11) If the UE receives a CD/CA-ICH in the designated slot with a signature that does not match the signature used in the CD Preamble, the UE aborts the access attempt and sends a failure message to the MAC layer.
- 12a) (In case CA is not Active) If the UE receives a CDI from the CD/CA-ICH with a matching signature, the UE transmits the power control preamble  $\tau_{cd-p-pc-p}$  ms later as measured from initiation of the CD Preamble. The initial transmission power of the power control preamble shall be  $\Delta P_{p-m}$  [dB] higher than the power of the CD preamble. The inner loop power control in the power control preamble is described in sub clause 5.1.3.3. The transmission of the message portion of the burst starts immediately after the power control preamble. Power control in the message part is described in sub clause 5.1.3.2.
- 12b) (In case CA is active) If the UE receives a CDI from the CD/CA-ICH with a matching signature and CA message that points out to one of the PCPCH's (mapping rule is in [5]) that were indicated to be free by the last received CSICH broadcast, the UE transmits the power control preamble  $\tau_{cd-p-pc-p}$  ms later as measured from initiation of the CD Preamble. The initial transmission power of the power control preamble shall be  $\Delta P_{p-m}$  [dB] higher than the power of the CD preamble. The inner loop power control in the power control preamble is described in sub clause 5.1.3.3. The transmission of the message portion of the burst starts immediately after the power control preamble. Power control in the message part is described in sub clause 5.1.3.2. If the CA message received points out the channel that was indicated to be busy on the last status information transmission received on the CSICH, the UE shall abort the access attempt and send a failure message to the MAC layer.
- NOTE: If the  $L_{pc-preamble}$  parameter indicates a zero length preamble, then there is no power control preamble and the message portion of the burst starts  $\tau_{cd-p-pc-p}$  ms after the initiation of the CD Preamble. In this case the initial transmission power of the control part of the message part shall be  $\Delta P_{p-m}$  [dB] higher than the power of the CD preamble. Power control in the message part is described in sub clause 5.1.3.2
- 13) The UE shall test the value of Start of Message Indicator received from DL-DPCCH for CPCH during the first  $N_{Start\_Message}$  frames after Power Control preamble. Start of Message Indicator is a known sequence repeated on a frame by frame basis. The value of  $N_{Start\_Message}$  shall be provided by the higher layers.
- 14) If the UE does not detect Start of Message Indicator in the first  $N_{Start\_Message}$  frames of DL-DPCCH for CPCH after Power Control preamble, the UE aborts the access attempt and sends a failure message to the MAC layer. Otherwise, UE continuously transmits the packet data.
- 15) During CPCH Packet Data transmission, the UE and UTRAN perform inner-loop power control on both the CPCH UL and the DPCCH DL, as described in sub clause 5.1.3.
- 16) After the first  $N_{Start\_Message}$  frames after Power Control preamble, upon the detection of an Emergency Stop command sent by UTRAN, the UE halts CPCH UL transmission, aborts the access attempt and sends a failure message to the MAC layer.
- 17) If the UE detects loss of DPCCH DL during transmission of the power control preamble or the packet data, the UE halts CPCH UL transmission, aborts the access attempt and sends a failure message to the MAC layer.
- 18) The UE may send empty frames after the end of the packet to indicate the end of transmission. The number of the empty frames is set by higher layers.

