TSG-RAN Working Group1 meeting #16 TSGR1#16(00)1243

Pusan, South Korea, 10th – 13th October 2000

Agenda Item: AH99
Source: Siemens AG
Title: Clarification of RACH behaviour at maximum and minimum power
Document for: Decision

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1. Introduction

The behaviour of the UE had not been specified clearly for the case that the power would exceed the capability of the UE. Note that both the maximu m power of the UE (or the maximum allowed power in the cell) can be exceeded and the minimum power (the latter is allowed to be lower than the minimum required UE output power, but in any case there will be a minimum power of the implementation). For power control this problem had been addressed in several contributions ([1], [2], [3]) and an additional section (5.1.2.5.1) had been introduced in TS 25.214 [4], to handle this case [1]. However, the behaviour for the RACH has not been specified yet. It is proposed to also clarify this section in line with the changes for power control [1].

2. Proposed Changes

Several parameters for the RACH procedure are supplied by higher layers, in particular by RRC. However, some of those parameters are called differently in the RRC specification [5]. It is proposed to align the nomenclature, mostly this is merely a question whether or not to use underscores.

The changes proposed are similar to the changes introduced by [1], in particular, if a transmission would be done at a power exceeding the maximum allowed power (which in turn is the lower of the maximum output power of the UE power class and the maximum allowed UL TX power indicated for the cell) then the power is reduced to the maximum allowed power. As the preamble does not contain DPDCH plus DPCCH, no sophisticated scaling is necessary in this case, it is enough to set the power. However it will become necessary to avoid an excessive number of preamble transmissions, all at an insufficient power level, so an optional escape mechanism is included.

For the minimum power, as specified in TS 25.101: "UE Radio transmission and Reception (FDD)", it would be undesirable to impose that the UE transmits at exactly this power, because potentially the UE may be able to transmit at an even lower power. Therefore it is proposed to allow the UE a transmission between the computed power level and the limit set in TS 25.101. No further requirements are proposed, in order not to constrain unnecessarily the implementation of the UE and in order not to deter manufacturers from implementing this option.

3. Notes

The handling of the power for the RACH message part as described in section 6.1 step 9 references section 5.1.1.2. which ultimately references the new section 5.1.2.5.1, where the additional scaling has already been included by the above mentioned previously agreed CR [1], so there is no need for extra clarifications.

The section CPICH procedure is functionally very similar to the RACH procedure, however the description is somewhat different. Similar clarifications may be relevant for that section, however it could first be investigated by the CPICH proponents whether the difference in description is intentional or accidental. Therefore this CR only takes care to propagate changes in nomenclature from the RACH description to the CPICH description.

For TDD there is no RACH power ramping defined for layer1, therefore no clarifications are necessary in the TDD WG1 specifications.

4. References

[1] Philips; "Clarification of power control at maximum and minimum power"; TSG-RAN Working Group 1 meeting #15; Tdoc R1-00-1103; Berlin, Germany; August 22nd – 25th, 2000;

[2] Siemens "Correction of ? formula in the case of transmission at power limits"; TSG-RAN Working Group 1 meeting #15; Tdoc R1-00-1055; Berlin, Germany; August 22nd – 25th, 2000

[3] Siemens "Clarification of power control at maximum and minimum power"; TSG-RAN Working Group 1 meeting #15; Tdoc R1-00-1056; Berlin, Germany; August 22nd – 25th, 2000

[4] 3GPP TSG RAN WG1; 3G TS 25.214 V3.4.0-DRAFT (2000-09)

[5] 3GPP TSG RAN W2; 3GPP TS 25.331 V3.4.1 (2000-09)

3GPP TSG RAN WG1#13
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e.g. for 3GPP use the format TP-99xxx
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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	136	Current Version:	3.4.0

GSM (AA.BB) or 3G (AA.BBB) specification number ? *? CR number as allocated by MCC support team*

For submission to:	RAN #10	for approval	X	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: *(at least one should be marked with an X)* (U)SIM [ ] ME [X] UTRAN / Radio [ ] Core Network [ ]

Source: Siemens AG **Date:** 10.10.2000

Subject: Clarification of RACH behaviour at maximum and minimum power

Work item:

Category: *(only one category shall be marked with an X)*

F	Correction	X	**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	X
				Release 00	

Reason for change: The behaviour of the UE is not specified clearly for the case that the power would exceed the capability of the UE during the RACH preamble transmission. A similar handling as proposed in section (5.1.2.5.1) for power control is proposed. Additionally the nomenclature is aligned with the RRC specification.

Clauses affected: 6.1, 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:

6 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. [9]).

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~~Power Ramp Step [integer > 0].
- The parameter ~~Preamble_Retrans_Max~~Preamble Retrans Max [integer > 0].
- The initial preamble power Preamble_Initial_Power.
- The Power offset $P_{p\text{-}m}$ ~~power offset ? $P_{p\text{-}m}$~~ = $P_{message\text{-}control} - P_{preamble}$, 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 ~~e~~ 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 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. If there is no access slot available in the selected set, randomly select one uplink access slot corresponding to the selected RACH sub-channel group from the next access slot set. 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~~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. In the case that the preamble transmission power would exceed the maximum allowed value, the UE shall transmit with the maximum allowed power. In the case that the preamble transmission power would be below the minimum

level required in [7], then the UE shall transmit with a power, which is at or below the required minimum power specified in [7]. The UE transmit power shall not be lower than the preamble transmission power.

7 If no positive or negative acquisition indicator (AI ? +1 nor –1) corresponding to the selected signature is detected in the downlinkaccess slot corresponding to the selected uplink access slot:

7.1 Select the next available access slot in the RACH sub-channel group chosen 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 ? P_0 = ~~Power_Ramp_Step~~Power Ramp Step [dB]. If the preamble transmission power exceeds the maximum UE transmit power by 6dB, the UE may pass L1 status ("No ack on AICH") to the higher layers (MAC) and exit the physical random access procedure.

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 $P_{p\text{-}m}$ ~~? $P_{p\text{-}m}$~~ [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 by $?_{p\text{-}a}$ chips the downlink access slot #i contained within the 10 ms interval that is time aligned with P-CCPCH frames for which SFN mod 8 = 0 or SFN mod 8 = 1.
- Every 12^{th} 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 $?_{p\text{-}a}$ chips before the downlink P-CCPCH frame for which SFN mod 2 = 0. Access slot set 2 contains PRACH slots 8 - 14 and starts ($?_{p\text{-}a}$ –2560) chips before the downlink P-CCPCH frame for which SFN mod 2 = 1.

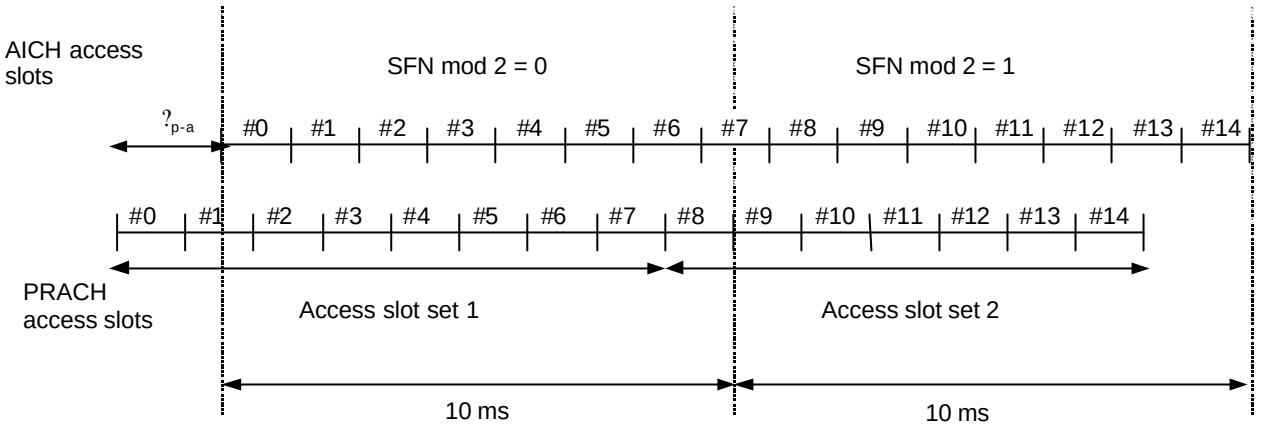

Figure 2: PRACH access slot and downlink AICH relation (?$_{p-a}$ = 7680 chips)

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 = Maximu m 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~~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) ? P_0 = Power step size for each successive CPCH access preamble.

   - [RACH/CPCH parameter].

4) ? 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 ? P_1 is used in place of ? P_0.

   - [RACH/CPCH parameter].

5) ? $P_{p\text{-}m} = P_{message\text{-}control} - P_{cd}$, 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) $L_{pc\text{-}preamble}$ = 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 $P_{CPCH\_}$ 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_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) 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. If there is no access slot available in the selected set, the UE randomly selects one uplink access slot corresponding to the selected CPCH sub-channel group from the next access slot set. 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) 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. If there is no access slot available in the selected set, the UE randomly selects one uplink access slot corresponding to the selected CPCH sub-channel group from the next access slot set. 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) Select the next available access slot in the sub-channel group used. There must be a minimum distance of three or four (per Tcpch 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 ? P. Power offset ? P_0 s is used unless the negative AICH timer is running, in which case ? 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 ? 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 ? $_{cd\text{-}p\text{-}pc\text{-}p}$ ms later as measured from initiation of the CD Preamble. The initial transmission power of the power control preamble shall be ? $P_{p\text{-}m}$ [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 ? $_{cd\text{-}p\text{-}pc\text{-}p}$ ms later as measured from initiation of the CD Preamble. The initial transmission power of the power control preamble shall be ? $P_{p\text{-}m}$ [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 $L_{pc\text{-}preamble}$ parameter indicates a zero length preamble, then there is no power control preamble and the message portion of the burst starts ? $_{cd\text{-}p\text{-}pc\text{-}p}$ 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 ? $P_{p\text{-}m}$ [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.