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CPCH channel assignment modification for improved reliability

Introduction.

- In the last WG1 the Channel Assignment with CPCH was discussed in terms of reliability with the CA message decoding. In connection with this it was shown the error rate for correct CD and incorrect CA message can be in the order of 1 % in the presented simulation cases. This contribution proposes a functional modification of the CA access procedure which would make the problem less acute and still retain the advantages of CA scheme. Proposed solution

Evaluation Criteria for a CA modification

When considering the alternatives how to improve the CA reliability, the following criteria were considered for evaluation the alternatives:

- It is not desired to increase downlink TX power for such non-power control channels, thus 10 dB increase in the CA channel TX power (etc.) should be avoided.
- Considering the late event of finalising the items also it is not desired to define new physical channel structures to approach the problem and the cross WG changes should be minimised.
- The benefits of CA should be retained to maximum extent
- The course of "normal" CPCH transmission after access procedure should be protected by on the other hand reducing the collisions probability and on the other hand not making the successful communication too sensitive for disconnecting after the transmission has started already.
- The Node B should not be forced to have complicated assignment collision detection methods for the case when two UE may end up on the same channel. Such a methods have high complexity and have requirements that are far more complicated than the normal searcher operations in terms of seracher windows etc. This need suffucient low error propability.

Proposed solution

The following is proposed to alleviate the CA reliability problem:

- Instead of sending the maximum available data rate as currently proposed with CA, UTRAN shall send always the availability of the existing CPCH channels, as with UE channel selection method.
- When decoding the CA message, UE shall consider both CA and status monitoring signalling and accept a CA message for a given channel only if the channel was indicated to be free by the status monitoring.

This will achieve roughly 1% to the power of two error probability if the events are assumed to be independent due to the time separation, thus 0.01 % error probability for the worst case could reduce the cases when two (or more, thus not ver likely) users can end up using the same CPCH channel.

The proposed solution can also simplify the CPCH operation, as only one status monitoring approach is needed. No new channels need to be detected by the UE or transmitted by the Node B.

Changes needed

The proposed solution would need changes in two specification documents (at least). The Annex 1 shows the needed changes in 25.214 on top of the draft CR on channel assignment prepared by Philips and GBT (AND IS NOT ACTUAL CR as changes are only against proposed CR shown underlined) and intends to show the additions to the CPCH access procedure. The other affected specification is 25.303 in WG2 for which the changes need to be done to earlier approved CR in WG2 (25.303 CR 022r1which approval assumes naturally that CA is approved in WG1 as well for release -99). The changes for 25.303 are presented in a separate paper for WG2, which will be presented subject to the CA decisions to WG1.

Annex: 1.CHANGES IN 25.214 PROPOSED CPCH PROCEDURE FROM THE INCLUSIONS OF CA WITH THE PROPOSED MODIFICATION

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:

- 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.
- CPCH UL channelization code. (variable, data rate dependant)
- DPCCH DL channelization code

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 are access, collision detection/resolution and CPCH data transmission parameters:

Power ramp-up, Access and Timing parameters (Physical layer parameters)

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) ΔP_0 = Power step size for each successive CPCH access preamble.

   [RACH/CPCH parameter]
4) ΔP_1 = Power step size for each successive RACH/CPCH access preamble in case of negative AICH. A timer ish set upon receipt of a negative AICH. This timer is used to determine the period after receipt of a negative AICH when ΔP_1 is used in place of ΔP_0.

[RACH/CPCH parameter]

5) T_{cpch} = CPCH transmission timing parameter: This parameter is identical to PRACH/AICH transmission timing parameter.

[RACH/CPCH parameter]

6) $L_{pc\text{-}preamble}$ = Length of power control preamble (0 or 8 slots)

[CPCH parameter]

The CPCH -access procedure in the physical layer is:

1. Upon receipt of a Status-REQ message from the MAC layer, the UE shall receive 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 channel over the CSICH. 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'.

2) Upon receipt of an Access-REQ message from the MAC layer, the UE shall test the value(s) of the most recent transmission of the Status Indicator(s) corresponding to the channel(s) for the identified tranport 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.

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 (value TBD).

5) The UE randomly selects a CPCH-AP signature from the set of signatures for the transport format identified in the Access-REQ message. The random function is TBD.

6) Using the AP access slot subchannel group for the selected AP signature, the UE derives the available CPCH-AP access slots in the next two frames, defined by SFN and SFN+1 with the help of SFN and table 7 in section 6.1. The UE randomly selects one access slot from the available access slots in the next frame, defined by SFN, if there is one available. If there is no access slot available in the next frame, defined by SFN then, randomly selects one access slot from the available access slots in the following frame, defined by SFN+1. Random function is TBD

7) . 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 tranmission. 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.

8) 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 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 following steps shall be executed:

   a) Selects the next uplink access slot from among the access slots in the CPCH-AP sub-channel group for the selected AP signature, as described in step 6, above. 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 ΔP . Power offset ΔP_0 s is used unless the negative AICH timer is running, in which case ΔP_1 is used instead..

c) Decrease the Preamble Retransmission Counter by one.

d) If the Preamble Retransmission Counter < 0, the UE aborts the access attempt and sends a failure message to the MAC layer.

9) 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 ΔP_1 use as the preamble power offset until timer expiry

10) 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, then waits for a CD-ICH and the channel assignment (CA) (in case CA is active) message from the Node B.

11) If the UE does not receive a CD-ICH in the designated slot, the UE aborts the access attempt and sends a failure message to the MAC layer.

12) If the UE receives a CD-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.

13) If the UE receives a CD-ICH with a matching signature and CA message that points out to one of the channels that were indicated to be free by the last received CSICH broadcast, the UE transmits the power control preamble $\tau_{cd\text{-}p\text{-}pc\text{-}p}$ ms later as measured from initiation of the CD Preamble. . The transmission of the message portion of the burst starts immediately after the power control preamble. NOTE: If the $L_{pc\text{-}preamble}$ parameter indicates a zero length preamble, then there is not power control preamble and the message portion of the burst starts $\tau_{cd\text{-}p\text{-}pc\text{-}p}$ ms after the initiation of the CD Preamble. If the CA message received points out ot the channel that was indicated to be busy on the last status information transmission received on the CSICH, the UE shall abort the access attemp and send a failure message to the MAC layer.

14) During CPCH Packet Data transmission, the UE and UTRAN perform inner-loop power control on both the CPCH UL and the DPCCH DL.

15) 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.

16) If the UE completes the transmission of the packet data, the UE sends a success message to the MAC layer.