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To: RAN WG2, RAN WG4

Cc: RAN WG3

Source: RAN WG1

Title: Answer on liaison on power control preamble length

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RAN WG1 thanks RAN WG2 for their liaison R1-00-1413 (R2-00-2464) on power control preamble (PCP) length. RAN WG1 also thanks RAN WG4 for their involvement and feedback in the discussion.

Initially, RAN WG1 would like to explain the background for the proposal to increase the PCP length. It was pointed out in RAN WG1 that the data transmitted on the uplink before uplink synchronisation had been acquired would be lost. It was assumed that when setting up dedicated channels, the RRC Connection Setup Complete message would be transmitted at the very beginning on the uplink DPCH, and then this message would be lost. Since RLC AM mode is assumed to be used, this would lead retransmissions before that message was correctly received by UTRAN. Hence, RAN WG1 feared that not limiting how early the UE can transmit data on the uplink DPCH could lead to unnecessary delay, and waste of uplink resources. Some UE implementations would result in the first RRC message transmitted always being lost, an effect which RAN WG1 considered "ugly". As a solution to this identified problem, it was proposed to extend the PCP length, in order to ensure that at the end of the PCP (during which no DPDCH transmission is done) the uplink receiver was ready to receive the RLC AM data. Probably RAN WG2 should have the expertise to determine if the identified problem is "worth" solving.

When it comes to delivery of unacknowledged data, like speech frames, it may be of less importance that some initial data frames are lost while it is important to deliver data as soon as possible. For this case the use of a PCP must not necessarily lead to increased time before this data is delivered to the RNC. If no PCP is used, Node B can start to deliver data to the RNC at the very instant when uplink synchronisation is achieved (if we ignore the CFN/TTI restriction for the moment). When PCP is used, the start of delivery is at the time *max(uplink synchronisation achieved; end of PCP)*. Hence, only if the PCP length is set higher than the time needed for uplink synchronisation there would be additional delay. If it is essential that data is delivered as soon as possible, the PCP length could be set very short (even zero). However, the price one then has to pay is that acknowledged data will have to be retransmitted. The goal is of course to configure the PCP length as close to the actual synchronisation time as possible, so that there is no additional delay of unacknowledged data and at the same time acknowledged data is received correctly as soon as possible.

The extension of the PCP length parameter is proposed to provide some flexibility to adapt to the Node B searcher performance. The current assumption in RAN WG1 is that the detection of the uplink DPCCH may take longer than one radio frame, which is the current maximum preamble length defined in TS 25.331. There is no clear view currently on what synchronisation delays to consider. Thereby, RAN WG1 would like to kindly request some input from RAN WG4 to know what uplink synchronisation delay to consider, since that information is crucial to determine the exact value range for the PCP length parameter. As RAN WG2 mentioned in its LS, this is particularly critical in the case of hard handover. In the meantime, RAN WG1 suggests that the PCP length should be increased to 0 … 7 radio frames (3 bits), as this should be enough to take into account the worst cases of synchronisation delays. It should be noted however, that for some services it may be good to have a PCP length that is longer than the synchronisation time, in order to give the inner-loop power control time to converge to the optimum before transmitting the DPDCH data. One example is if the data packets contain very large amounts of bits, since that will require high power and a large part of uplink capacity, and hence it is important to start transmission at as low power as possible.

On the topic of power control preambles, RAN WG1 would like to ask RAN WG2 to change the current IE name in TS 25.331, "PC Preamble" to the more descriptive "Power control preamble length" or similar. Further, in TS 25.331 the unit of the value range is not given. As indicated by RAN WG1, the values should preferably be expressed as multiples of radio frames (although the current value 15 in the specifications means 15 slots, i.e. one radio frame).

RAN WG1 would also like to answer the questions in RAN WG2's liaison (original questions in italics).

1) How exactly is the overall DPCH setup delay impacted by the PCP length and the various cases of TTI settings of DCHs?

From the discussion in the introduction, it is clear that the definition of "DPCH setup delay" impacts the answer. If the setup delay is the time until the first message transmitted in RLC AM mode is correctly received, then the use of PCP should provide means of significantly lowering the setup delay. If the setup delay is the time until data is forwarded from Node B to the RNC, then the use of PCP would not lower the setup delay, but on the other hand not necessarily increase it either if the PCP length is configured correctly.

When PCP is used, transmission of $TrCH_i$ data will take place in the first radio frame after the PCP end with CFN mod $TTI_i/10 = 0$, where TTI_i is the TTI for $TrCH_i$. If the PCP length is configured correctly, the same radio frame is the first radio frame where transmission can be reliably done when no PCP is used.

2) The question was raised if the initial 40 ms period required for downlink DPCCH quality estimation in the UE (as described in R1-001274 CR 130r1 to 25.214 on radio link synchronisation) has impact on the uplink DPCH synchronisation.

For initial radio link setup, uplink transmission will not take place before downlink synchronisation has been acquired. This means that the time needed in the UE to find the downlink signal will impact the total DPCH setup delay.

3) The question was raised why the range of PCP length needs to be changed by this quite large amount, i.e. from 15 to up to 120 slots.

The required time to find uplink synchronisation will be very dependant on receiver implementation, cell radius, existence of propagation delay measurements on PRACH. Further, the synchronisation time is dependant on the channel conditions, signal-to-interference ratio, and the required detection probability and false-detection probability. It is believed that these issues had not been considered when selecting a maximum PCP length of 15 slots. It should be noted that *typical* values used in deployed systems for the parameter are expected to be lower than 120 slots (8 radio frames).

4) The PCP length is indicated in the RRC CONNECTION SETUP message to the UE and it can be indicated optionally in dedicated messages after connection setup. According to which criteria should the PCP length be set by RRC? Shall it be dependent only on searcher implementation in the Node B? Should the setting be made depending on service (e.g. short PCP length for conversational/speech, large for background packet data)?

The PCP length shall be configured to take searcher implementation, cell radius, existence of propagation delay measurements on PRACH, typical channel conditions and signal-to-interference values in the cell, and wanted detection and false-detection probabilities into account. Hence, it seems reasonable to assume that the PCP length should be configured according to cell characteristics. However, different services could use different SIR targets, which would impact the initial power used for transmission of the DPCCH. Since the time required to find synchronisation is depending on the received SIR, there could be benefits by also configuring the PCP length per service.

An additional proposed use of the PCP is to allow for the inner loop power control to converge to the optimum transmit power, based on the coarse initial open loop power estimate. Hence, there may be UE specific variance from the typical channel conditions (for example, due to UE speed), which will require different PCP lengths to allow correct convergence of power settings once synchronisation is achieved.

Hence, configuration of PCP length will probably be based both on cell characteristics, and UE and service specific requirements.

5) What exactly is the consequence of a setting of PCP length too short to obtain DPCH synchronisation reliably, considering the propagation conditions/delay? How do propagation conditions impact initial synchronisation delay?

If the PCP length is set too short, then uplink DPDCH transmission can take place before uplink synchronisation is acquired. The effect is then the same as if no PCP is used, where retransmissions because of loss of RLC AM data may occur.

As stated above, propagation conditions affecting channel delay profile, received SIR etc. will have an impact on the synchronisation time.

*6) If prior information about propagation delay would be available in the No*de B, would *it help to reduce DPCH synchronisat*ion delay or allow to adapt the *PCP length?*

Yes, the basic idea with providing propagation delay information to Node B is that the searcher time can be reduced, or that searcher implementation can be relaxed. Searching over the time corresponding to the full cell radius instead of in a more narrow window will always be more complex or take longer time. Hence, it is believed that the propagation delay measurement can be used to reduce the uplink synchronisation time. Therefore, depending on if that measurement is available to Node B or not, the optimal PCP length to use may be different.

7) If uplink DPDCH and DPCCH transmission would be started simultaneously, would it be feasible to reduce synchronisation delay by employing also the DPDCH in the searching procedure?

It may be possible to utilise also DPDCH energy in the searching process, although RAN WG1 has no clear view on if this brings any significant benefit on synchronisation time. However, also for this case, as long as uplink synchronisation is not found directly, the initial data transmitted on the DPDCH during the synchronisation process will be lost.

8) Should the name "power control preamble" be changed to e.g. "initial DPCH synchronisation preamble"?

It is recognised that "initial DPCH synchronisation preamble" may be a better name, although it is not seen as critical to change the name at this stage.

9) Does an increase of PCP length have an impact on the Iub interface?

RAN WG1 has not identified any impact on the Iub interface by changing the value range for the PCP length.