TSG-RAN Working Group 1 meeting No. 7 *TSGR1#7(99)b38*
August 30-September 3, Hanover, Germany

Agenda Item: **Ad hoc 14**

Source: **Philips**

Title: **Status information for CPCH**

Document for: **Discussion**

Summary

This document proposes a method for providing CPCH status information on the downlink.

Background

The current proposal for CPCH [1,2,3] is illustrated in Figure 1. It includes an initial access phase with power ramping of RACH-like preamble signatures and acknowledgment via an AICH (Acquisition Indicator Channel). A maximum of one access attempt per access slot is given a positive acknowledgement. The initial access is followed by a contention resolution phase where the UE randomly selects from another set of preamble signatures with a different scrambling code. The network would normally respond (on an AICH-like channel) to the transmission received with greatest power, thus granting permission to send the packet. The acknowledgements for the contention and resolution phases can be distinguished by different channelization codes. Thus if more than one UE selected the same initial preamble, the probability of selecting the same signatures in the contention resolution phase is reduced in proportion to the number of available signatures.

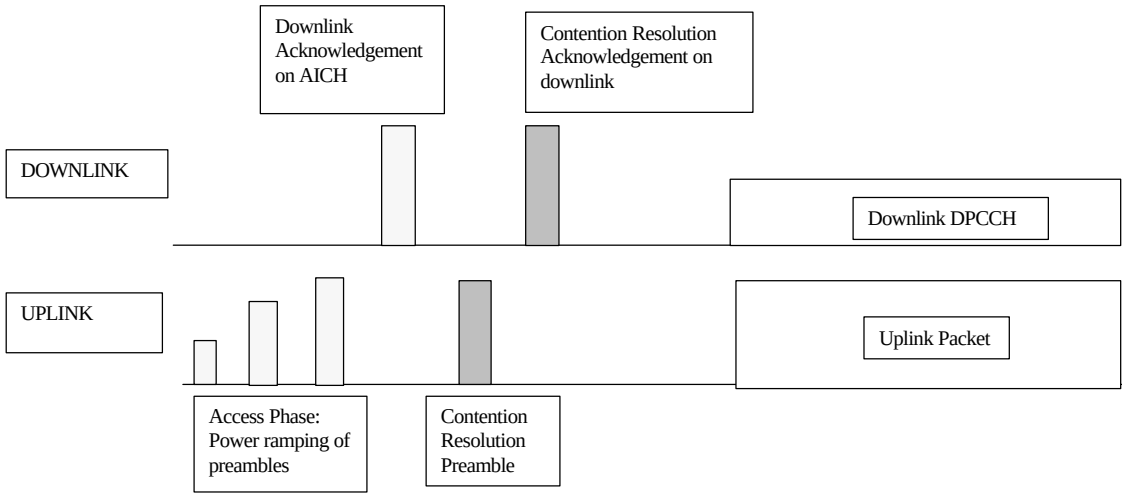

Figure 1: Basic CPCH scheme

In the current CPCH proposal the access phase preambles are each mapped to one of a limited number of specific downlink spreading codes (for DPCCH) and uplink scrambling codes (with associated data rates). Therefore it is likely that UE's will spend significant time waiting for a given resource to become available, particularly with high traffic loading. Not only will this lead to transmission delays, but also significant numbers of failed access attempts on the uplink. This problem is made worse because the UE selects a specific signature for the access phase, which corresponds to a specific downlink DPCCH. If this is not available, the UE cannot be allocated another DPCCH, even if one is free, and the UE will need to make another access attempt.

Therefore it is highly beneficial if a UE can determine what CPCH resources are available (if any) before attempting to send a packet and also to help in selecting an appropriate signature.

It has already been suggested in 3GPP RAN WG1 that the UE could monitor activity on the AICH in order to determine which CPCH channels are free (or likely to be free). This requires that the UE monitors the AICH for an extended period before packet transmission. There have also been doubts raised as to the reliability of status information derived in this way. However, a small error rate in determination of CPCH status may not be a serious problem, since the main impact would be additional delay on a only few access attempts.

What is needed is a reasonably reliable indication of CPCH status, which has low overhead on the downlink and requires minimal activity by the UE. Therefore we propose that the CPCH status is regularly broadcast in some way.

Clearly, a major concern is the amount of status information to be sent. One factor is the rate of update of the status. If this rate is too low, then this will add packet transmission delay. If it is too high, then the overhead on the downlink could be significant. Another factor is the number of bits to be sent. For 16 CPCH channels, 16 bits would be needed to indicate the status of each channel.

Discussion

First we consider the delay in packet transmission, from the moment it is available at the UE to the moment it is successfully received. A realistic average value for this delay is estimated in [4]. For transmission of status information with an interval of T, the average packet delay would be about 68+T/2 ms.

Transmitting status information every frame would give a value for T/2 of 5ms, which would contribute less than 7% of the total delay. This calculation does not include delays due to contention for CPCH resource, back-off periods, or packet transmission errors, which will significantly increase the average delay, particularly under high load conditions. Therefore CPCH status sent once per frame seems reasonable from a delay point of view, and it could probably be sent less frequently without a major impact.

Now we consider the number of bits required for the status information. Some possible approaches are discussed:

- If up to 16 CPCH channels are to be supported, then 16 bits of status information would be needed per frame to show individually which of these is currently in use.
- If channel assignment is carried out at the end of collision resolution [e.g. as proposed in 5], then it will be sufficient to indicate whether resource at a particular bit rate is available. If there are six possible bit rates (in kbps) of 60, 120, 240, 480, 960 and 1920, then six bits would be needed.

- The set of bit rates supported at any one time could be limited (e.g. to two or three bit rates). This set could be updated as necessary.
- A further improvement is possible, using the same set of bit rates (including zero) but only indicating the maximum bit rate available [as proposed in 6]. Then three bits are sufficient, assuming that any bit rate below the maximum can be supported.

It should be noted that the BER on the status information could be quite high (e.g. up to 1%) without significant impact on CPCH performance.

Now we consider the method of broadcasting CPCH status. Some possibilities include:

- Broadcast on BCH. This is not satisfactory because of the coding overhead and the need to update the information rapidly from Layer 1.
- Direct indication of status on AICH, or AICH-like channel. The duty cycle of the CPCH status information is 100%, whereas the AICH is designed for signals with low duty cycle.
- Broadcast on Paging Indicator Channel (PICH) see [7], or a PICH-like channel. Since the PICH is designed for continuous transmission, it seems suitable for sending CPCH status. Some options for sending the CPCH status bits are: (a) using some of the Page Indicators (b) using the unused bit positions in Figure 2 or (c) by defining another physical channel which has the same channelisation code as the PICH , but only occupies the space left by the unused bits.

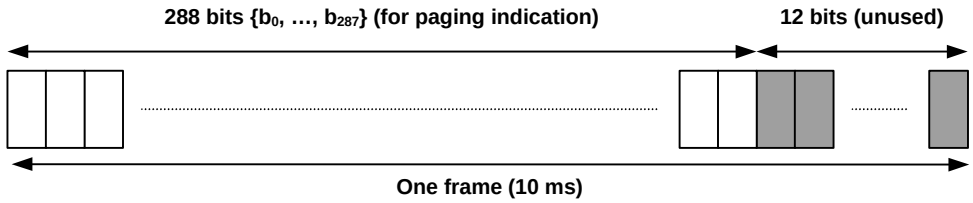

Figure 2: Frame structure of PICH (stolen from [7])

If the CPCH is broadcast using the "PICH" method, then it would probably be useful to allow a power offset between the Page Indicators and the CPCH status bits. As with the PICH, repetition coding could be used if fewer than 12 bits are needed for CPCH status. If more than 12 bits were needed, then the broadcast interval could be extended (e.g. over 2 frames).

Proposal

The following are proposed from the options reviewed above:

- CPCH status is broadcast every frame.
- Either:
  1. The maximum available bit rate for CPCH packets is indicated with a 3-bit status word (in conjunction with CPCH code assignment as proposed in [5] or [6]).

  Or:

  2. The maximum number of bit rates in CPCH is limited to three (at any one time) and the availability of each is indicated with a single bit flag in a 3 bit status word.
- The 3-bit CPCH status word is transmitted using the (currently) unused bits in the PICH, with 4 times repetition coding.
- The PICH is modified to support CPCH status (according to Figure 3).

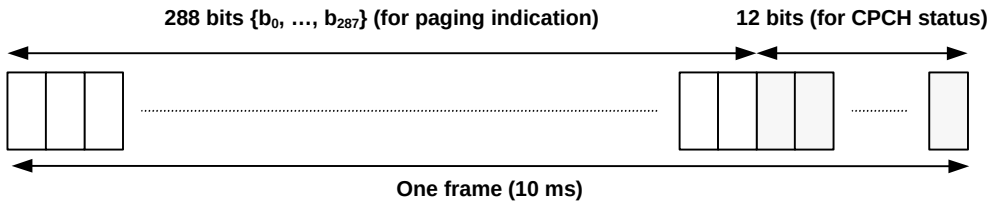

Figure 3: Modified frame structure of PICH

Recommendation

It is recommended that the proposals made here are adopted as working assumptions for CPCH, and that provision is made in the design of the PICH for transmission of CPCH status.

References

1. TSGR1#7(99)A72, “Proposed CPCH-related insertions into 25.213 (Resubmission)”, Adhoc 14
2. TSGR1#7(99)A73, “Proposed CPCH-related insertions into 25.214 (Resubmission)”, Adhoc 14
3. TSGR1#7(99)A74, “Proposed CPCH-related insertions into 25.211 (Resubmission)”, Adhoc 14
4. TSGR1#7(99)b36, “Performance of CPCH”, Philips
5. TSGR1#6(99)906, “Enhanced CPCH procedure”, Samsung
6. TSGR1#7(99)b37, “Enhanced CPCH with status monitoring and code assignment”, Philips
7. TSGR1#6(99)848, “Updated text proposal for Paging Structure”, Ericsson