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Agenda item: **6.7**
Source: **Golden Bridge Technology**
Title: **Firm Handover over CPCH**
Document for: **Information and Discussion**

Abstract: This document addresses the cell edge issue with CPCH and random access channels. The Firm handover solution utilizes the macro-diversity at the cell edge during the Access Preamble part of the transmission. During the data transmission, the data is transmitted to one cell only. So, the scheme has the advantages of the soft and hard handover, i.e., diversity gain and simplicity.

Common Packet Channel Handover
UE-Based-Firm Handover

This contribution discusses a handover scheme, which is optimum for bursty traffic and is for the use of W-CDMA-based Common Packet and Control Channel (CPCH and RACH).

The UE has one controlling cell when there is no other candidate cells (with Eb/I0 within delta dB of the controlling cell). When the latter occurs, the UE enters a Firm or Firmer Packet Handover State, which is an UE-Based-Firm-Handover with UE-based-macro-selection diversity. This is for Uplink transmissions since CPCH/RACH is in the uplink direction. The use of the word firm distinguishes the process from soft which implies some kind of selection diversity or combining diversity of the continuous or bursty in the infrastructure. In this method, we propose an UE-based-macro-diversity-selection of the preambles in the firm-firmer Handover State. The bursty packets are only sent through one cell. However, as long as there are 2 or more cells in the candidate set, the UE stays in the firm-firmer handover state which implies possible transmission through any of the cells in the set. When the UE exits that state, it communicates through once cell only.

Abstract

The UEs on the cell edge (same Base Node or various Base Nodes) which could constitute up to 30% of the overall mobiles could experience long delays, cause cell capacity degradation (uncontrolled faded transmission to the adjacent cell) and throughput decline in RACH and CPCH if they employ a simple hard handover method. We propose a new handover technique for bursty traffic, which is UE-based-Firm-handover. We call it Firm Handover since uplink macro-selection-diversity is employed in a DTX manner and the data is transmitted via one base station only. Also, the selection is made in the UE rather than the infrastructure during the preamble transmission. The message part is only sent to one cell.

Problem Statement

The UEs at the cell edge that opt to communicate through RACH/CPCH with 2 or more candidate cells (with Ec/I0 within Δ dB of the controlling cell) will potentially adversely impact the capacity of the candidate cell since the transmitted Packet will be independently Rayleigh faded towards the candidate cells. This problem exists for both RACH and CPCH schemes. This problem is more pronounced for indoor and pedestrian environments. Note that with RACH and OLPC, this effect degrades the capacity significantly. The same is true for CPCH with CLPC. As a slowly faded packet at high data rate could potentially degrade capacity unless its data rate is decreased. This contribution outlines another solution to this problem, which is employment of Firm Handover.

RACH problems (OLPC)

Here is a list of potential problems with UEs in the cell edge transmitting to a single base station:

1. Long delays at the cell edge
2. Negative capacity impact since 30% of the mobiles at cell edge transmit to potentially two cells at uncontrolled levels.
3. The overall negative capacity impact is less pronounced at low data rates such as 32 kbps as compared to 64/144/384 kbps.

CPCH problems (CLPC):

In indoor and pedestrian environments, the cell edge mobiles could be received in one of the cells at Δ dB higher than the other could which translates into Δ+ dB degradation in capacity. Note that 30% of the mobiles are potentially at the cell edges. At high data rates (CPCH), this effect is more pronounced.

The packet data users employing CPCH might potentially experience longer delays at the cell edge if the Firm Handover scheme is not employed.

Solutions:

Solution A:

The UEs are continuously measuring the RSSI from the neighbor list. When an RSSI of BS in the neighbor list is Δ dB below the received RSSI from the current base, then it will be in the active set. When the UE has a packet to transmit via CPCH, it will alternate preamble transmissions between the two base nodes in the active set and wait for the AICH from the Base Nodes. After the receipt of the AICH, the UE will transmit the Collision Detection code and start transmission if it receives the right CD code from the Base Node. This solution applies to the Firm handover between two cells belonging to different Base Nodes. We call this solution the Ping-Pong method.

Solution B:

The mobiles at the cell edge transmit the common preamble and wait for the AICH, upon receipt of the AICH from one of the Base Nodes; the UE transmits another set of preambles for collision detection and resolution purposes. At the end of this process, the UE will transmit the packet to the best cell, i.e., and the cell that has transmitted the AICH message. This solution is suited for Firmer Handover between two cells belonging to the same Base Node. We call this solution the common-preamble method. The Ping-Pong method refers to sending the distinct preambles to each cell alternately and waiting for the AICH from the corresponding cell.

Both solutions insure that the UE is communicating through the base which requires less transmit power and the packet will not negatively impact the other cell since the preamble was not even detected in that cell.

Gains:

The shadow fading margin that has been selected due to handover gains can be maintained without incurring long packet delays for the cell-edge-mobiles.

Negative impact on CPCH/RACH throughput is contained.

Negative impact on cell capacity is contained.

0,0

.... The preamble for the second Base Station (Base Station 1) is transmitted at powers $P_{0,1}$, $P_{1,1}$, $P_{2,1}$ .... . In this case, only Base Station 0 acknowledges the reception of UE-Preamble0. The UE then undergoes through the Collision Detection/Collision Resolution CD/CR process, the transmission of the UE-CLPC-Preamble, and the transmission of the data information. Ways to enable preamble transmissions to more than two Base Stations can be easily derived from the above procedure. It is understood from Fig. 1, that the reception of the last UE-Preamble0 at Base Station 0 was received stronger than the last UE-Preamble1 at Base Station1. Therefore, the Base Station that possessed the better Uplink Channel was chosen. A UE could also have the choice of responding to the first Base Station that acknowledges a preamble reception. This could be for the case when the information transmission delay needs to be minimized.

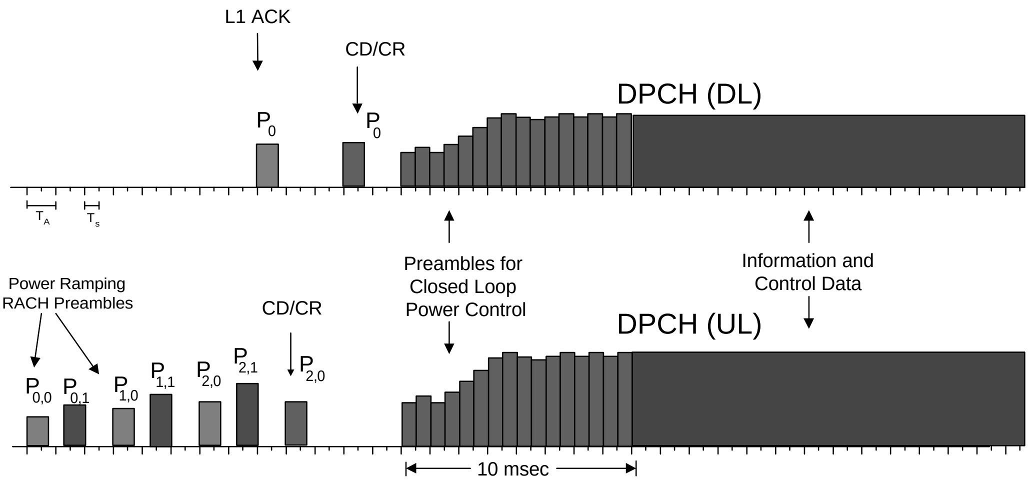

FIG 1. Common Packet Channel (CPCH) Timing Diagram with its Associated Downlink Dedicated Physical Channel.

In Fig. 2, both Base Station 0 and Base Station 1 acknowledged their corresponding UE-Preamble reception. However, the UE underwent the CD/CR process for Base Station 0 without waiting for the reception of the Base Station 1 acknowledgement. The remaining process is the same as before with the UE being in link with base Station 0.

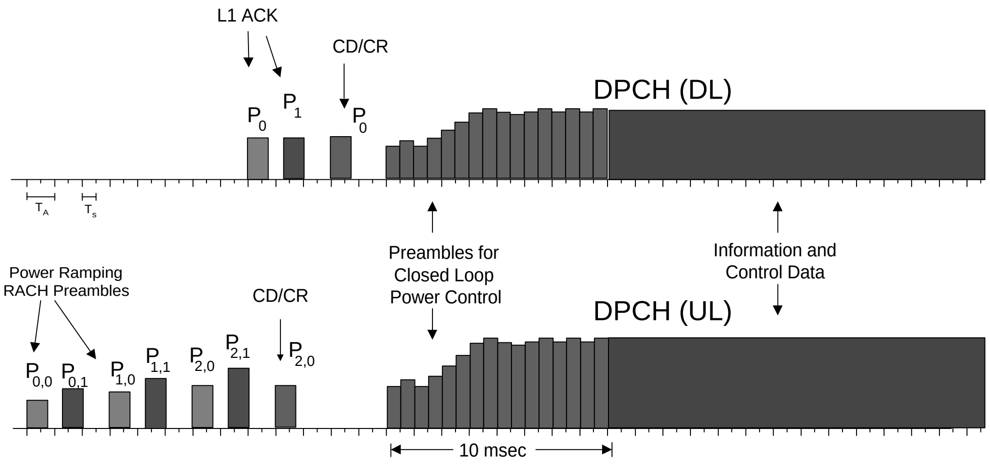

FIG 2. Common Packet Channel (CPCH) Timing Diagram with its Associated Downlink Dedicated Physical Channel.

In Fig. 3, the UE awaits for the possible reception of both acknowledgements before deciding which Base Station to transmit the CD/CR preamble signal. This allows the UE to select the Base Station that is being received the strongest. This does not necessarily guarantee that the Base Station selected is the one with the better Uplink channel. Statistically, however, the one being received strongest by the UE, is the most likely one to have the better Uplink channel.

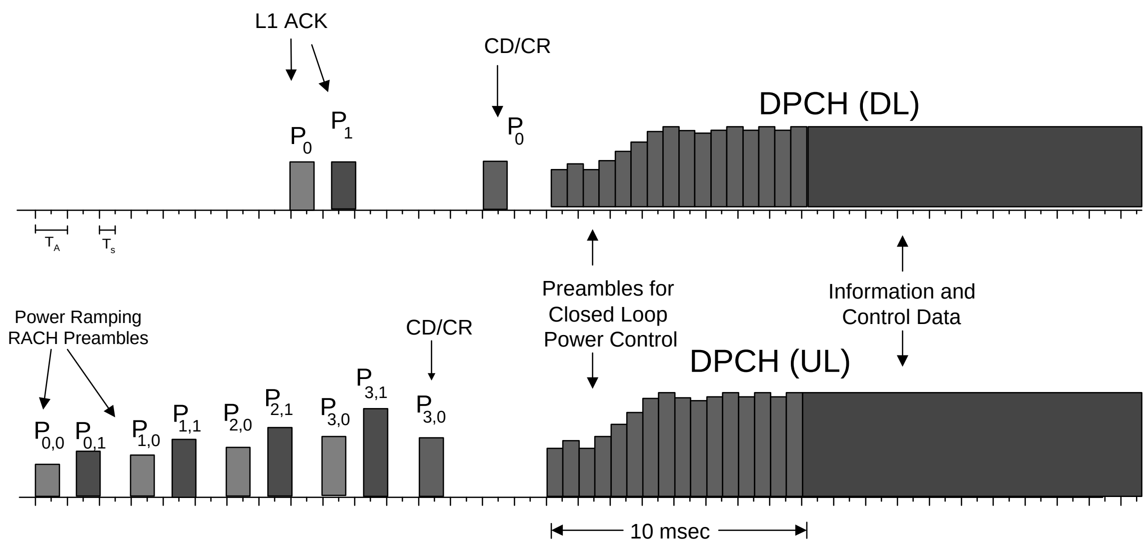

FIG 3. Common Packet Channel (CPCH) Timing Diagram with its Associated Downlink Dedicated Physical Channel.

CPCH Operation Using a Common Preamble (Firmer Handover)

When the UE is in a region at about the same distance from two or more cells belonging to the same Base Node, the power being received at the UE from the cells, is not a clear indication of which cell is best receiving the UE. A mechanism is needed so that the best receiving cell is being used for communication most of the time. In certain cases, the UE could transmit an UE-Preamble that is common to two or more cells. These cells form a Common-Preamble-Cell-Group. All cells in the Common-Preamble-Cell-Group are receiving the common UE-Preamble. In the following discussion, we limit our discussion to **two cells** that belong to the same Base Node. These two cells belong to the **Common-Preamble-Cell-Group**.

The set of Common Preambles is sent to the UEs by UTRAN via the Common Channels. This information can also be sent to the UE during the registration process.

The UE is monitoring the RSSI received from the cells in the neighbor list. When the active set contain the cells that belong to the same Base Node, then the UE will use the Common-Preamble between these two cells to access CPCH.

At the onset of the transmission from the UE, all cells in the Common-Preamble-Cell-Group will be tuned to receiving this common UE-Preamble. At some point, one or more cells from the Common-Preamble-Cell-Group will detect the UE-Preamble and send it over their downlink channel a L1 Acknowledgement (L1 ACK). As shown in Figure 4, two cells from the Common-Preamble-Cell-Group acknowledged the common UE-Preamble transmission. The UE, knowing the timing of the L1 Acknowledgement for all cells in the Common-Preamble-Cell-Group, can determine if and how many cells have acknowledged. Measuring the relative powers of the L1 Acknowledgement signals, the UE then sends a Collision Detection / Collision Resolution-Preamble (CD/CR-Preamble) to a single. That is, the UE will send a CD/CR-Preamble, which can only be detected, by the selected cell in the Common-Preamble-Cell-Group. The cell that receives the CD/CR-Preamble will respond back with the same CD/CR-Preamble. The different CD/CR-Preamble code structures are known to all the cells in the Common-Preamble-Cell-Group through some negotiation carried out beforehand between the UE and the Base Node in the Common-Preamble-Cell-Group. The CD/CR-Preamble serves the purpose of detecting the possibility of more than a single common UE-Preamble transmission from different Remote Stations. With the UE picking at random a CD/CR-preamble from a set a possible CD/CD-Preambles, unless the same CD/CR-preambles is reflected back from the selected Base Station, the UE will refrain from, at least temporarily, completing its intended transmission. At a predetermined time instant, both the UE and the selected-cell start transmitting Closed Loop Power Control Preambles (CLPC-Preambles). The Base Station sends a BS-CLPC-Preamble and the UE an UE-CLPC-Preamble. These preambles will serve for closed loop power controlling both the UE and the Cell before the transmission of the actual information and control data.

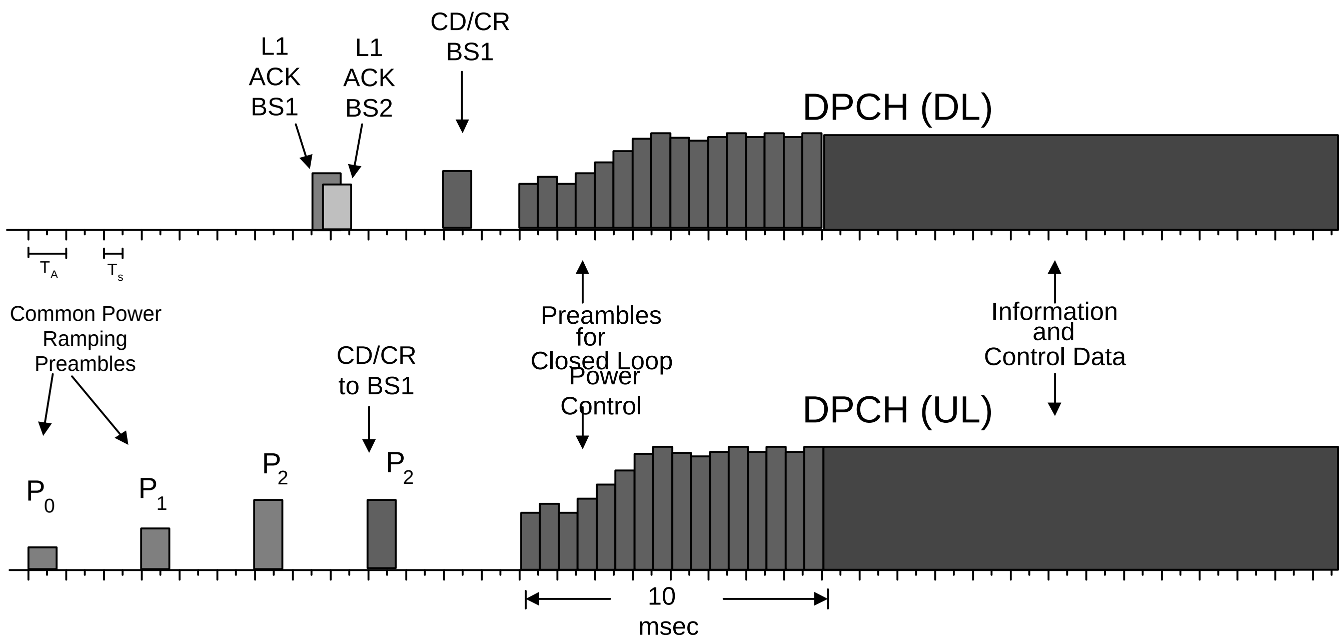

FIG 4. Common Packet Channel (CPCH) Timing Diagram with its

Associated Downlink Dedicated Physical Channel.

Common Preamble for two or more Base Stations.