3GPP-RAN Working Group 1 meeting #2 **TSGR1#2(99)026**
Yokohama, Japan 22 - 25 February 1999

Agenda Item: 5

Source: Golden Bridge Technology, Inc.

Title: Uplink Common Packet Channel

Document for: Proposed draft text for Uplink Common Packet Channel

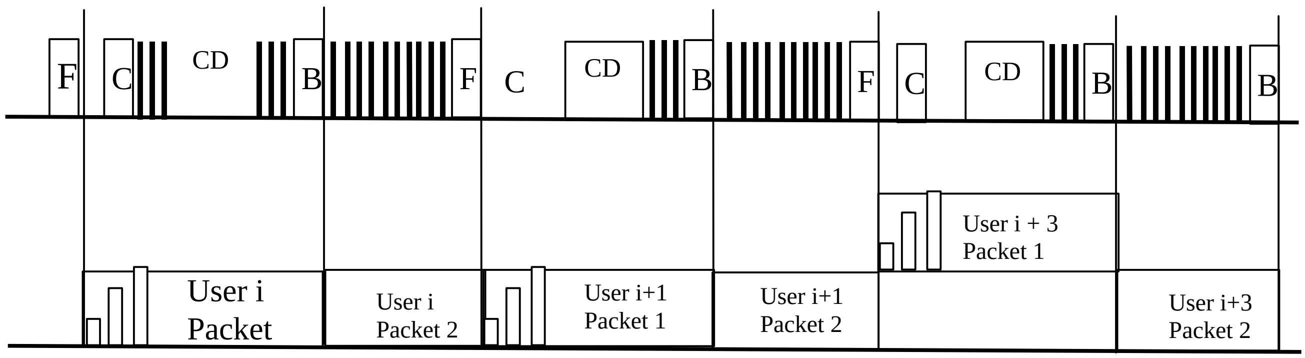
1. Common Packet Channels

1.1. Overview of Common Packet Channel (CPCH) Operation and the DSMA/CDMA-CD Protocol

The packet data mechanism described here is a method that shall be used to transfer packet switched based multimedia and messaging services. Some of the services are as follows:

Simple Messaging Service: SMS
Switched Data Service: SD
Medium Multi-Media Service: MMM
High Multi-Media Service: HMM
High Interactive Multi-Media Service: HIMM

The Common Packet Channel (CPCH) mechanism is perceived to be used for all data rates: 8kbps, 16 kbps, 32 kbps, 64 kbps, 144 kbps, 384 kbps and 2.048 Mbps. There is a corresponding Common Control Channel to the CPCH in each direction.
The main goal of introducing this mechanism is to create the ability to transfer data in a packet transfer mode rather than circuit transfer mode. **Figure 1** illustrates two different mechanisms that could be used to transfer circuit switched data and packet switched based data:



F = Free
C = L1 ack
B = Busy
CD = Collision Detection

Figure 1 *WP-CDMA Collision detection protocol*

1.1.1. Service Provision

The base station shall transmit the available type of services through the BCCH. It is also possible to use the CCCH to transmit the type of services.

1. The BCCH transmits the available data rates for UDD services. Each data rate corresponds to a set of short sequences.
2. The mobile will request the minimum QoS with the Base Station through the RACH upon service initiation (initiation of a packet service session).
3. The base will assign the mobile a priority level based on the required QoS through BCCH
4. Radio link Quality and the loading condition will be continously monitored by the Base Station. Adjustments to the QoS will be signaled through BCCH
5. DL service provision is TBD.

1.1.2. Data Rates

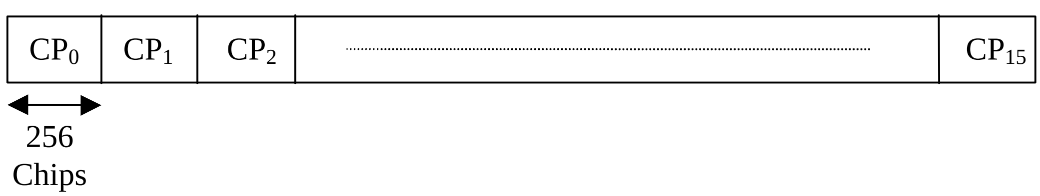
There are seven type of data rates available for the UDD service:8 kbps, 16 kbps, 32 kbps, 64 kbps, 144 kbps, 384 kbps and 2048 kbps. Each derived type is distinguished by different short signature sequences. There can be n short sequences in the base station and n/7 sequence per data rate.

1.1.3. Slot, Burst and Frame Structure of the UL Common Packet Channel

Each burst consists of a preamble and a data portion. The first preamble is sent at an initial constant power level. The preamble is modulated by 16 different possible sequences. Once the preamble is sent, the MS waits for an L1 ACK response. If there is no response within .25 ms, it will try again increasing the preamble power level. The preamble duration is approximately 1 ms (4096 chips = 256 chips x 16).

Once the mobile captures the channel through the preamble power ramp up process, it will hold the channel until it sends all of its packets.

The UL CPCH burst consists of a long preamble followed by data similar to the RACH design as illustrated in **Figures 2-3**. The data portion shall be a multiple of TBD ms. The base station shall transmit power control bits in the opposite direction as soon as it receives the data. The preamble part is shown in **Figure 2**, and the entire burst along with preamble ramp up is shown in **Figure 3:**



P_0 P_1 P_2 ….. P_{15}: Preamble sequence
C: Orthogonal gold code of length 256 Chips

***Figure** 2 Structure of the CPCH Burst Preamble Part*

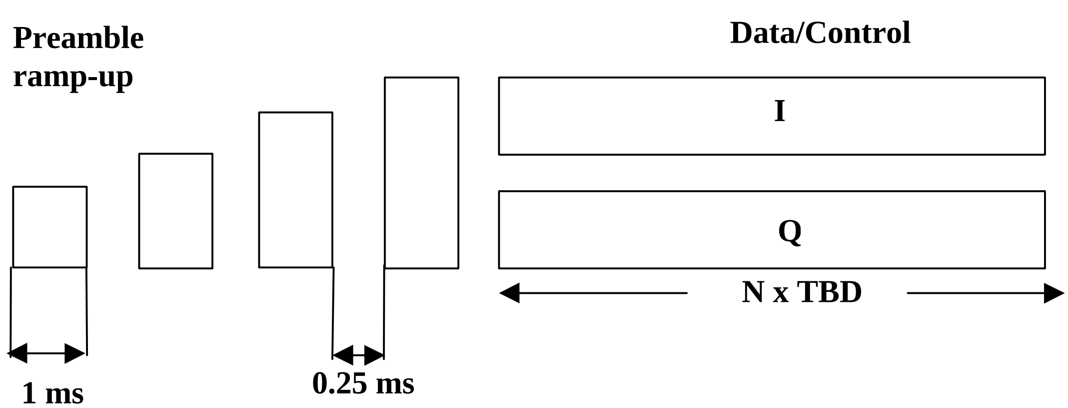


***Figure 3** CPCH UL Burst Structure*

Source: Excerpts from harmonized WP-CDMA RTT as submitted on 8 January 1999 by WP-CDMA Committee (TR46.1/TlPl.5) to the ITU.

Figure 4 illustrates the slot structure associated with the UL Common Packet Channel. As can be seen, the data modulation is BPSK and the data and control are I/Q multiplexed. The first slot has the additional collision detection field. The use of MS ID, service type field per frame are under study. There shall be a CRC field per slot for ARQ on a block per block basis.

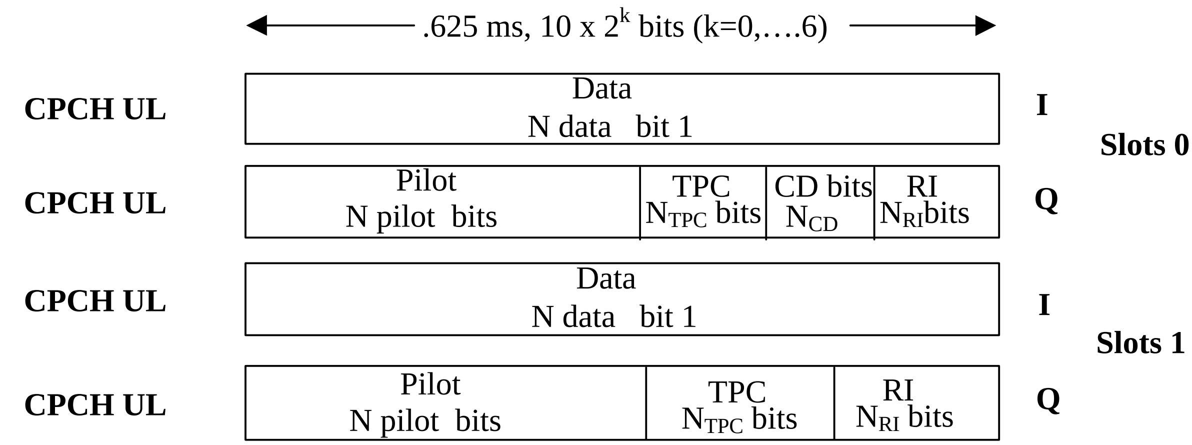


***Figure 4** CPCH UL Slot Structure*

Figure 5 illustrates the frame structure associated with UL-CPCH when the frame length is 10 ms.

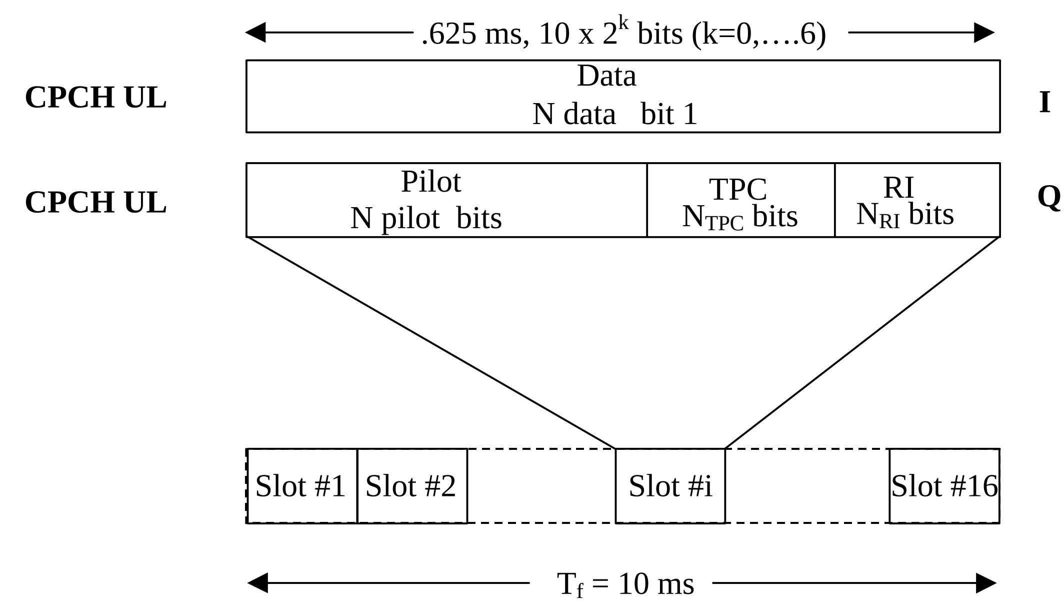


***Figure 5** CPCH UL Frame Structure*

1.1.3.1. Multicode Transmission

For multicode transmission in uplink, each additional UL DPDCH may be transmitted on either I or Q branch, sharing a single common DPCCH. Each DPDCH branch shall use its own channelization code, multiple DPDCH's on different branches may share a common scrambling code. When multiple radio links are allocated for one MS, pilot aired coherent detection and transmit power control shall be performed using the same DPDCCH.

1.1.3.2. Preamble Ramp up Mechanism and Closed Loop Power Control (CLPC)

There are three features in the operation of the CPCH, which are crucial to fast access and have the least negative impact on capacity. The first feature is the preamble ramp up mechanism. The second feature is the fast L1 ACK mechanism and the third is the Closed Loop Power Control.

Figure 6 illustrates the impact of using Open Loop Power Control on the Common Packet Channel.

The Common Control Channel in the downlink shall bear the signaling related to Power Control, L1 ACK, DSMA/CDMA-CD protocol related signaling and ARQ signaling. The structure of the DL Common Control Channel is explained in a separate contribution.

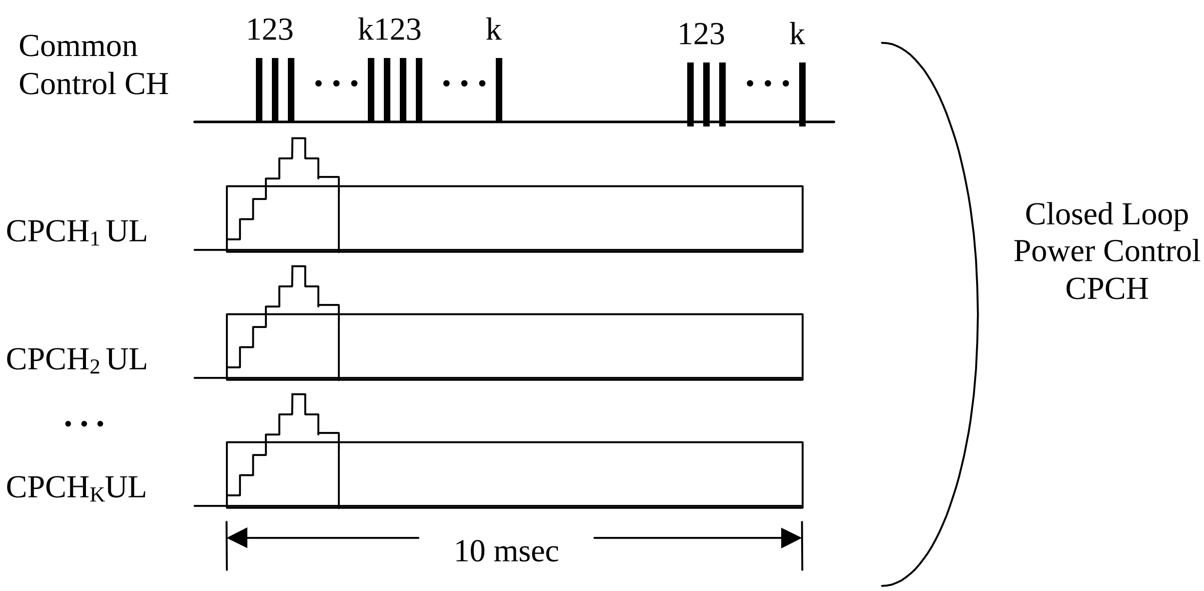


Figure 6 *CLPC on Common Packet Channel*

The signaling protocol and requirements for achieving Closed Loop Power Control is outlined here and is shown in **Figure 7**:

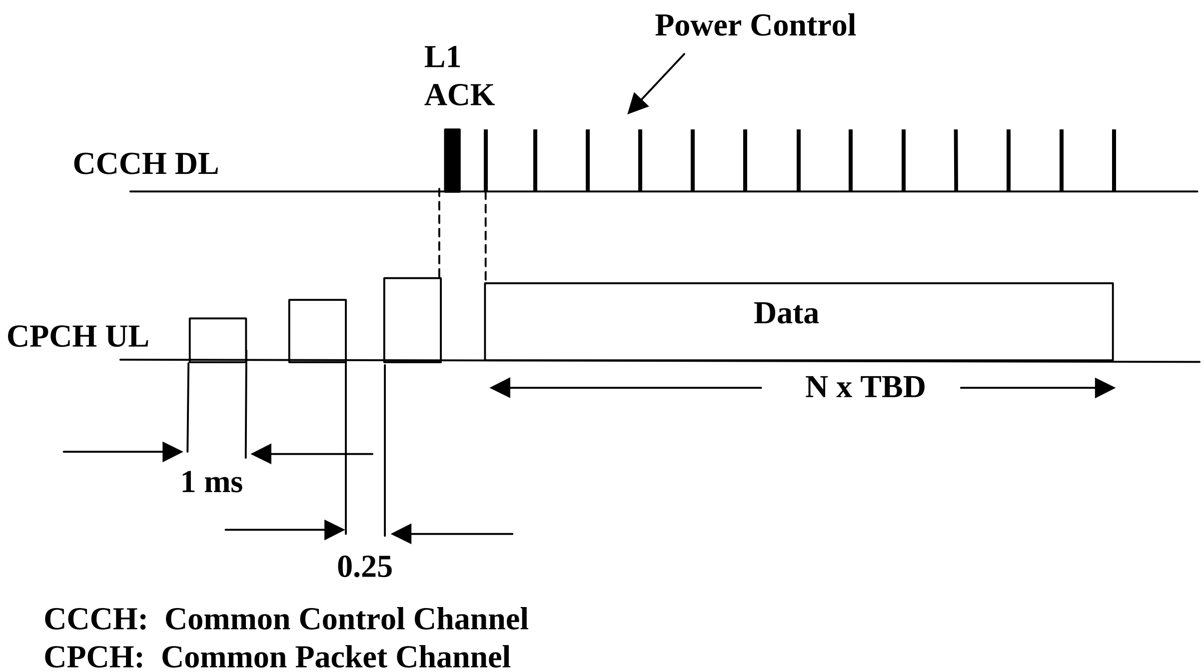


Figure 7 *Signaling Procedure and Requirements for Achieving CLPC*

1. The Mobile transmits a constant power level preamble. The initial transmission power level will be TBD dB below the open loop power estimate. The mobile stops transmission after 4096 chips (1 ms).
2. The MS waits for 0.25 ms to receive a L1 ACK from the base station. If there is no response within the 0.25 ms. The next preamble is transmitted at a higher power level after TBD ms.
3. When the mobile receives the L1 ACK (Busy Signal), it shall send the data at the start of the next mini-slot. Note that there are eight 1.25 ms mini-slots per 10 ms slot. The DSMA/CDMA CD related slot and mini-slot structure is explained in section 4.6.
4. The BS shall transmit the power control bits as soon as it receives the data. The power control bits are sent through the DL Common Control Channel.

1.1.3.4 Collision Detection with Low Feedback Delay (2 ms)

Each basic 10 ms slot can be further subdivided into N_{ss}= eight sub-slots for lowering the probability of collision. These 1.25 ms subslots are the DSMA/CDMA CD slots.

One of M (TBD) Scrambling codes which were assigned by the Base Station shall be picked randomly by various users at any moment that they wish to transmit and capture the mini-slot. Once the base detects the 1 ms preamble and determines the preamble sequence, it will generate an L1 ACK within the 0.25 ms guard time between the transmission of the preamble and the data part of the CPCH burst.

When the same preamble sequence and mini-slot is picked up by the another mobile, there will be a collision. In case of a collision (which means usage of the same scrambling sequence and mini-slot by two users) the BS will send a collision message immediately after it detects the collision state. Both MS stop transmission and will retry based on a TBD back-off scheme.

There are two collision avoidance mechanisms as shown in **Figure 8:**

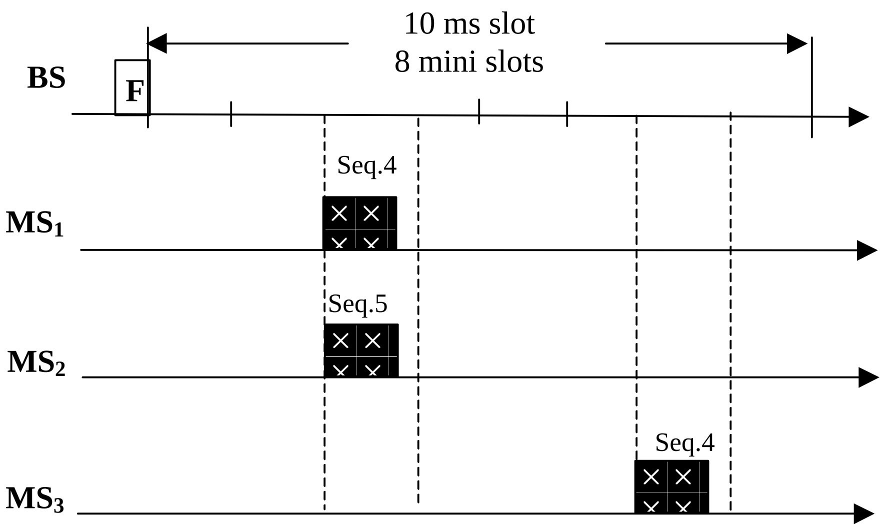


Figure 8 *Collision avoidance hooks in the DSMA/CDMA-CD protocol*

1. Each mobile shall pick one of eight mini-slots to transmit its message.
2. Each mobile shall randomly choose one of L preamble sequences for its transmission (M preamble sequences per data rate: 8 kbps, 16 kbps, 32 kbps, 64 kbps, 144 kbps, 384 kbps and 2.048 Mbps service). M varies with the data rate.

There is a collision detection mechanism, in case any two mobiles collide. There will be a Collision Detection (CD) field which follows the Pilot and the TPC in the UL direction.

The coding on the xxx symbols is TBD. The CD field shall not be interleaved, so that there is no long delay associated with collision detection or resolution using this scheme. The CD field shall be the temporary mobile ID and the base shall mirror it back immediately after demodulation and detection through the DL Common Control Channel. The insertion of the CD field will decrease the feedback delay to less than 2 ms in case of collision.

So, if two mobiles have data to send at the same time, there is a 1/32 probability that the two pick the same preamble sequence if L=4. Referring to Figure 11, it can be seen that as the two mobiles that have picked the same mini-slot, but different preamble sequences are not colliding. Also, two mobiles could potentially pick two different mini-slots and the same preamble sequences and yet not collide.

Figure 9 captures the collision aspects of the DSMA/CDMA-CD of Random Access Protocol. The figure illustrates the operation of CLPC and Collision Detection and the Collision Feedback Delay Cycle.

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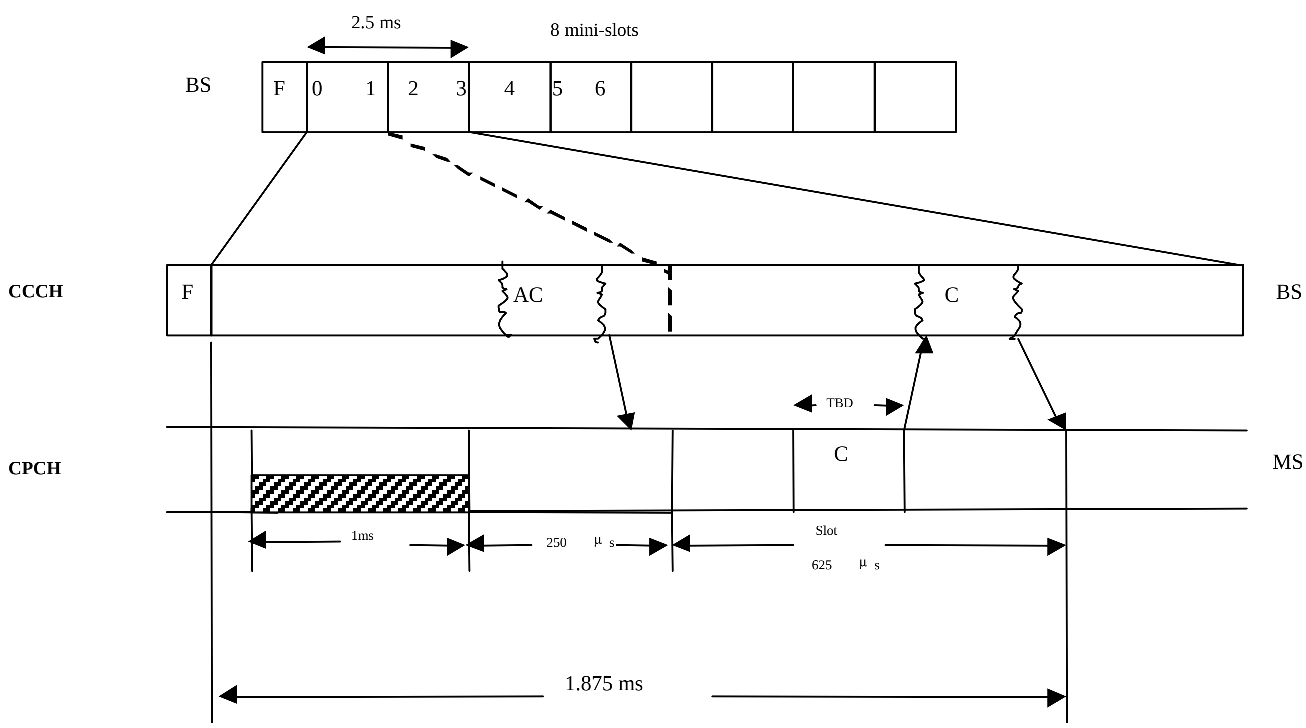

Figure 9 *Collision Feedback Delay Cycle DSMA/CDMA-CD*

1.1.3.5. Retransmission Protocol for Common Packet Channel

1. Each 10 ms portion of a data burst contain 16 blocks. Each block has a separate CRC field. Re-transmission can be performed on a block by block basis through the use of ACK and NAK, which goes over the CCCH in the DL direction.
2. If the MS is not successful in its first try, it will back-off and retransmit the message at a later time (TBD).

Figure 10 illustrates the ARQ mechanism and the retransmission protocol for the Common Packet Channel:

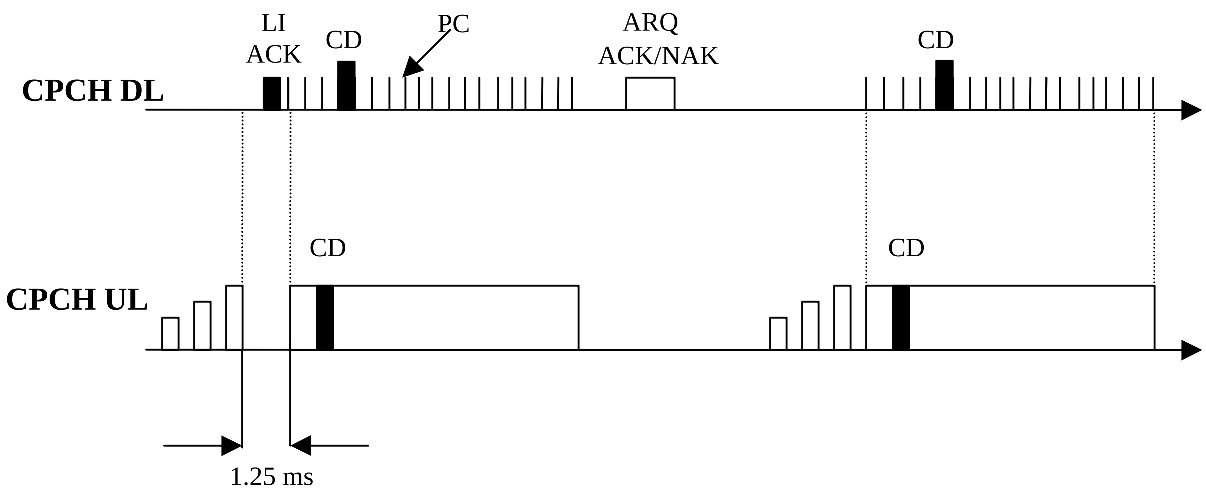

Figure 10 *ARQ Mechanism*