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Dynamic Adjustment of Power Offset between the uplink DPCCH and uplink DPDCH Based on the Estimation of Channel Fading-Rate

Author: Guoan Chen, Xiaohu Yu.
Addr: National Communication Research Lab. Southeast Univ. Nanjing (210096) China

1.Introduction

There are two types dedicated physical channels on the uplink, the uplink Dedicated Physical Date Channel (uplink DPDCH) and the uplink Dedicated Physical Control Channel (uplink DPCCH). The uplink DPDCH is used to carry dedicated data. There may be zero, one, or several uplink DPDCHs on each Layer 1 connection. The one and only one uplink DPCCH on each uplink Layer 1 connection is used to carry control information, which consists of known pilot bits to support channel estimation for coherent detection, transmit power-control (TPC) commands, and an optional transport-format indicator (TFI).

Data modulation for the uplink is dual-channel QPSK (see 5.3.1.1), where the uplink DPDCH and DPCCH are mapped to the I and Q branch respectively. The I and Q branch are then spread to the chip rate with two different channelisation codes Cd/Cc and subsequently complex scrambled by a mobile-station specific complex scrambling code Cscramb. For multi-code transmission, each additional uplink DPDCH may be transmitted on either the I or the Q branch. The DPCCH is always spread with a known channelisation code of length 256 (see 5.3.1.2.3.3), corresponding to the data rate 16kbit/s. The DPDCH may be spread with channelisation codes from spreading factor 32 to 256.

It is known that the effect of changing transmitting power and that of the spreading factor can be substituted for getting a required Eb/N0 in the same operating environment. The total power for transmitting data when smaller spreading factor is used, is almost the same as that when multi-code is adopted for a fixed data rate to a specific user. A name of ‘code-channel unit’ (CCU) is used in this report to represent the user data rate. The spreading factor of CCU is 256.

The power offset between the uplink DPCCH and uplink DPDCH CCU affect the performance severely because the power of DPCCH determines the accuracy of multi-path channel estimation. The DPCCH power must be sufficient enough to estimate the real-time value of multi-path fading channel accurately, even though only one DPDCH CCU is used. The ratio of DPCCH power over DPDCH power is varied according to how many CCUs were used, so reducing the average DPCCH can improve the efficiency of transmitting power especially when low data rate service were provided, and the system capacity can be enhanced.

This report describe the way to reduce the average DPCCH power based on the measurement of channel fading-rate without loss of receiver performance.

2. Unanimous viewpoint on DPDCH and DPCCH

On the TX-RX coherent detection link, there are two kinds unknown information to the receiver, the binary data signal and the complex value of multi-path fading channel. For a specific code channel, one information can be obtained if the other one is known. For example, on the DPCCH pilot channel the data is known (all 1s or 0s), so the value of fading channel may be estimated; and on the DPDCH data channel the value of fading channel is known (estimated from the DPCCH) so the data can be demodulated. Although the DPDCH and the DPCCH are used for different purpose, they have the same mechanism in the sense of transmitting. Therefor, just like the principle of voice activity, the power of pilot channel on DPCCH should be adjusted according to the real-time channel fading rate, because the fading channel may be viewed as a specific information rate. The pilot power can be reduced when the channel fading rate is small; on the other hand, the pilot power should be increased when the channel fading rate become larger.

3. The estimation of channel fading-rate

In order to realize the dynamic adjustment of the pilot channel power, the channel fading rate must be estimated firstly. The channel fading rate can be found by processing the estimated channel sequence from either the time domain or the frequency domain. The quantity of operating is small as the estimated channel sequence is on the rate of 1600 samples/second (chip rate 4096kbps and the spreading factor is 256). A simple channel fading-rate criterion which has been evaluated by the author is shown as following,

$$E = \frac{\sum_{k=1}^{N} | C_k - C_{k-1} |}{\sum_{k=1}^{N} | C_k |} \qquad (1)$$

where C_k is estimated channel sequence.

4. Comments

Although the power offset between the uplink DPCCH and uplink DPDCH can be monitored by the mobile station or base station independently, it is suggest that the uplink TPC contains the power offset information to help the base station to know the uplink offset as a state parameter. Which method to estimate the channel fading rate is used and how to adjust the offset should be added to the standard because they affect the system capacity and BER performance.

5. Conclusion

Dynamic adjustment of power offset between the uplink DPCCH and uplink DPDCH based on the estimation of channel fading-rate were proposed, the uplink capacity can be enhanced especially when the average data rate of service is small.