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Title: New power control ratio measurement for slow transmit power control

Document for: Discussion

1 Introduction

Slow transmit power control (STPC) is adopted as an alternative power control scheme. STPC can be used to transmit a large amount of downlink data with long breaks. In current slow transmit power control (STPC), UE measures power of serving cell by using CPICH [1] and power of neighboring cells. UE sends power control ratio (PCR) at least once in every T_{RINT} second [1].

Accurate power control ratio measurement is very important for the performance of slow transmit power control. But, the current PCR measurement has some limitation in reflecting real channel environment. In this paper, we propose a new PCR measurement method for the STPC.

2 Current STPC Scheme

2.1 Current PCR measurement for STPC

Following an order from the network and acknowledgement by the UE, ordinary fast closed-loop transmit power control can be stopped and a slow transmit power control mode can be entered. In this mode, downlink DPCCH/DPDCH transmit power is determined utilizing power control ratios reported from the UE. Uplink transmission is suspended when the UE does not have any information to send, and the transmission is resumed to send a power control ratio at least once in every T_{RINT} second. The UE calculates power control ratios in the following steps:

1. The UE measures the CPICH[1] power of the cell in which the UE is located, and sets the value to Q_1.

2. The UE measures CPICH powers received from neighbouring cells, and sets the values greater than Q_1/R_{SEARCH} to Q_i, where i = 2, 3,…, n.

[1] The reference [1] says that UE estimates power of cells by using PCCPCH. The CPICH was inserted during harmonization procedure. Therefore it is reasonable to measure PCR by using CPICH. We propose to replace PCCPCH with PCICH.

3. The UE sets the power control ratio to

$$(Q_1 + Q_2 + \ldots + Q_n)/Q_1 \quad (1)$$

All TPC bits in the uplink DPCCH are used to send power control ratios. One power control ratio is sent per frame, i.e. 32 TPC bits are used to carry the power control ratio. The bi-orthogonal (32,6) code is used for the encoding. Code word $(-1)^n C_{5,m}$ corresponds to (0,5m + 0,25n) dB where m = 0, 1, 2, …, 31 and n = 0, 1.

Following an order from the network, the slow transmit power control is stopped and ordinary fast closed-loop transmit power control is started. The parameters T_{RINT} and R_{SEARCH} are set using higher layer signaling.

2.2 The problem of current PCR measurement

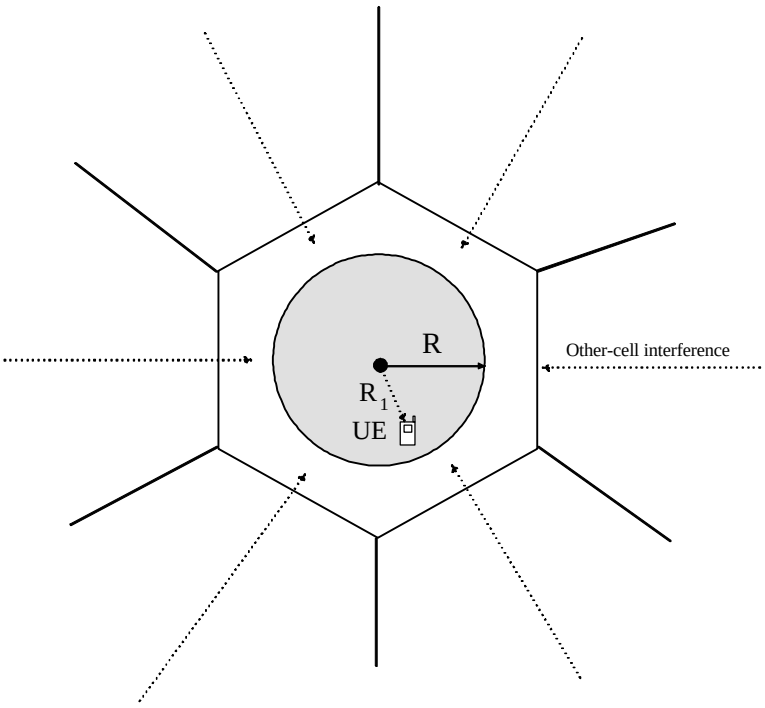

Figure 1. Cell environment

In current STPC scheme, UE measures PCR based on the CPICH power level of each cell. The PCR of the current scheme is given in equation (1). If UE is located within the shaded area of radius R as shown in Figure 1, it is almost impossible for the UE to acquire the CPICH of neighbor cells and to measure the power level CPICH of other cells accurately. Then, Q_1 value is dominant and the PCR value is almost 1.

The quality of downlink changes drastically as UE approaches UTRAN. But, the current PCR cannot reflect this. A simple PCR measurement result with current

PCR measurement is presented in Figure 2. If UE measures PCR with the current scheme, there exist area where UE can't estimate real channel status.
Another drawback of current PCR measurement scheme is that it cannot reflect the effect of multi-path. The signal-to-interference ratio (SIR) measured at UE changes for different multi-path profiles. Figure 3 shows the change of SIR with the multi-path profiles. It can be observed that quite different SIR's are measured for one-path and two-path channel conditions. But, the current PCR measurement scheme gives same SIR values for different multi-path profiles as shown in Figure 2.

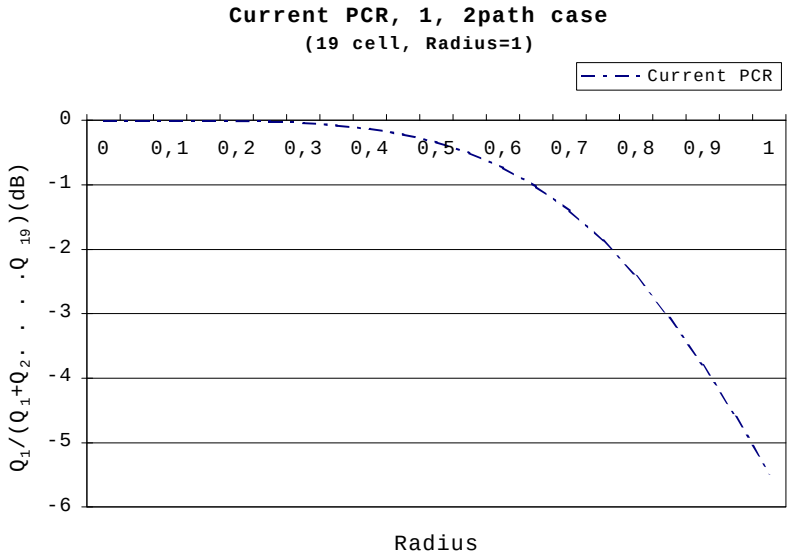

Figure 2. PCR with current method

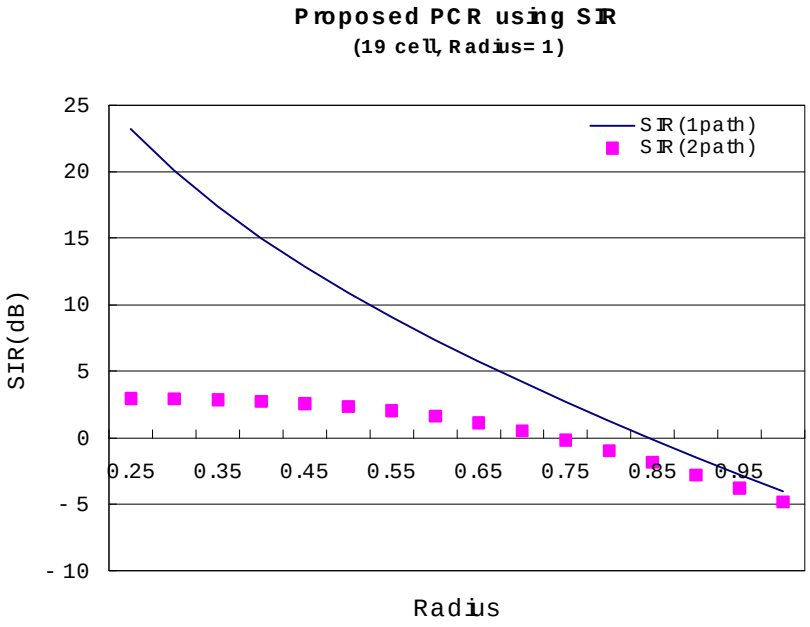

Figure 3. SIR versus distance from UTRAN

3. Proposed PCR measurement method

Downlink channel quality is dependent on path loss, multi-path profiles, interference from other cells, loading of cells and etc. For more efficient STPC, UE needs to estimate downlink channel quality more accurately. In this paper, we propose to use SIR value of CPICH measured at UE for PCR. UE measures SIR of CPICH for the PCR value and reports this value to UTRAN.
Figure 4 shows an example of UE receiver to measure the SIR of CPICH. Finger of UE estimates CPICH power level and interference level for each multi-path component. Then, UE combines CPICH power levels and interference levels measured at several fingers to give the received SIR of UE. SIR of UE can be calculated as

$$\text{SIR} = \frac{\sum Pilot(i)}{\sum Interference(i)} \qquad (2)$$

UE can average the SIR value to yield the final PCR for STPC. With this method, we can get the SIR value shown in Figure 4.
With this measurement method, UE can get the PCR for STPC more accurately and reflect the multi-path profiles and loading of cells.

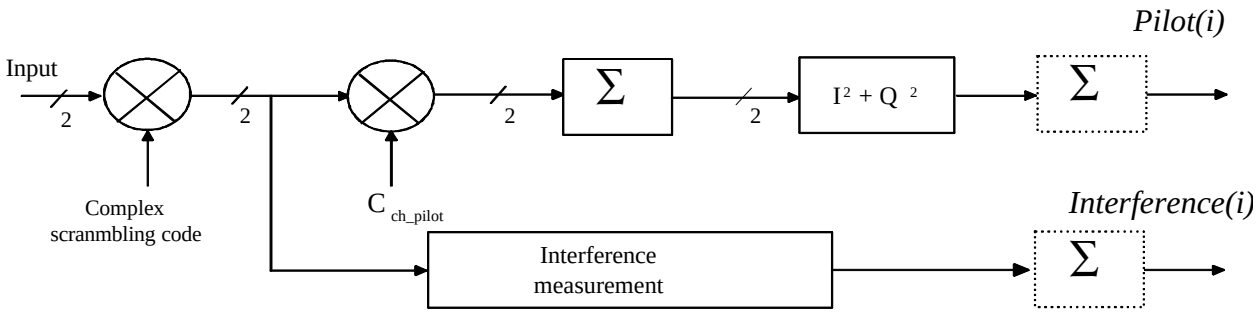

Figure 4. Block diagram of SIR measurement using CPICH

4 Conclusions

In this paper, we proposed a new PCR measurement for STPC. UE measures the SIR value of CPICH and sends the value to UTRAN. The SIR measurement method is more reasonable than current PCR and can reflect of multi-path profile and loading of cells. The performance of STPC can be improved with proposed PCR measurement.

References

[1] TS 25.214 V1.1.1 Physical layer procedures (FDD)

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