Agenda Item:

Source: Panasonic

Title: Detail Description of Variable Rate Packet Transmission in S1.14

Document for:

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Summary:

This contribution describes the modified concept of the access control for mult-rate and/or multi-code packet data transmission. This concept is described as "3.2.6.10.3. Access Control for Multi-rate and/or Multi-code Packet Data Transmission" in ARIB Volume 3. However, it is not described in 3GPP RAN S1.14. In this contribution, the basic concept and key features such as channel estimation and data rate control method are clarified. We would like the proposed text to be added to 3GPP RAN S1.14.

1 Introduction

In CDMA systems, increasing the transmit power improves the transmission quality when signal-to-interference power ratio (SIR) becomes worse due to channel fluctuation. However, such transmit power control increases the interference with other mobile and base stations. Such a problem appears especially when a mobile station suffers from slow fading and/or shadowing, or is located at the fringe of a cell. This contribution describes the variable rate transmission according to the channel conditions. When the transmit power becomes higher than a certain value, that is, the channel conditions are bad, transmit power is reduced in order to avoid excess interference by selecting lower data rate. Such variable rate transmission can be applied to packet data services because some transmission delay is allowed.
In this contribution, we clarify the basic concept and key features such as channel estimation and data rate control method.

2 Access Control for Packet Data Transmission

According to the channel conditions, parts of channel structure is changed in order to avoid excess interference as well as to maximize the throughput performance.
On the down-link, the data rate and transmit power are reduced when excess transmit power is required due to bad channel conditions. This can avoid excess interference with other mobile stations. The number of transport blocks to be transmitted, channel coding and interleaving are controlloed according to the channel conditions, and burst transmission with variable length is employed. TFCI is updated frame by frame.
On the up-link, the data rate and transmit power are reduced when the transmit power of mobile station is not enough to achieve the required quality. This can improve the throughput performance though the data rate is low. In addition to three functions for the down-link, rate matching is also controlled and continuous transmission due to dynamic rate matching is employed. TFCI is updated frame by frame. Spreading factor is NOT controlled on both links.

3 Proposed Text

x.x Access Control for Multi-rate and/or Multi-code Packet Data Transmission

x.x.1 Down-link

The base station monitors the down-link traffic condition, and determines the initial data rate for down-link by Layer-2, 3 negotiation. During a call, the base station estimates the channel conditions of particular mobile station, which is obtained by averaging the transmit power over several frames (or one frame), and controls the data rate according to the channel conditions. Figure Xa shows the data rate control flow. If the averaged transmit power for a mobile station (P_{ave}) becomes higher than the allowable power (P_{max}), that is, the channel conditions are bad, the base station reduces the data rate (R_n) and transmit power (P_{tx}) in order to avoid excess interference with other mobile stations. On the other hand, if the transmit power becomes lower than the allowable power, the base station recovers higher data rate and transmit power within limited data rate and transmit power in order to clean out the buffered transport blocks as soon as possible. The allowable power is determined according to the system environment such as traffic condition.

Figure Xb shows the channel structure on the down-link. The data rate controller determines the data rate and the number of transport blocks to be transmitted according to the averaged transmit power, and select the corresponding TFCI for each mobile station. The buffer retains the transport blocks which are not transmitted at current frame when lower data rate is selected. Rate matching pattern is always the same for any data rate (static rate matching). Therefore burst transmission with variable length is employed for lower data rate.

x.x.2 Up-link

The mobile station determines the initial data rate for up-link by Layer-2, 3 negotiation. During a call, the base station estimates the channel conditions, which is obtained by averaging the transmit power over several frames (or one frame), and controls the data rate according to the channel conditions. If the averaged transmit power becomes higher than the allowable power, that is, the channel conditions are bad, the mobile station reduces the data rate and transmit power in order to maximize the throughput within limited transmit power. On the other hand, if the transmit power becomes lower than the allowable power, the mobile station recovers higher data rate and transmit power within limited data rate and transmit power in order to clean out the buffered transport blocks as soon as possible. The allowable power is determined according to the maximum transmit power of mobile station.

Figure Xc shows the channel structure on the up-link. The data rate controller determines the data rate and the number of transport blocks to be transmitted according to the averaged transmit power, and select the corresponding TFCI. The buffer retains the transport blocks which are not transmitted at current frame when lower data rate is selected. Rate matching pettern is not the same for each data rate (dynamic rate matching) so that continuous transmission is employed even for lower data rate.
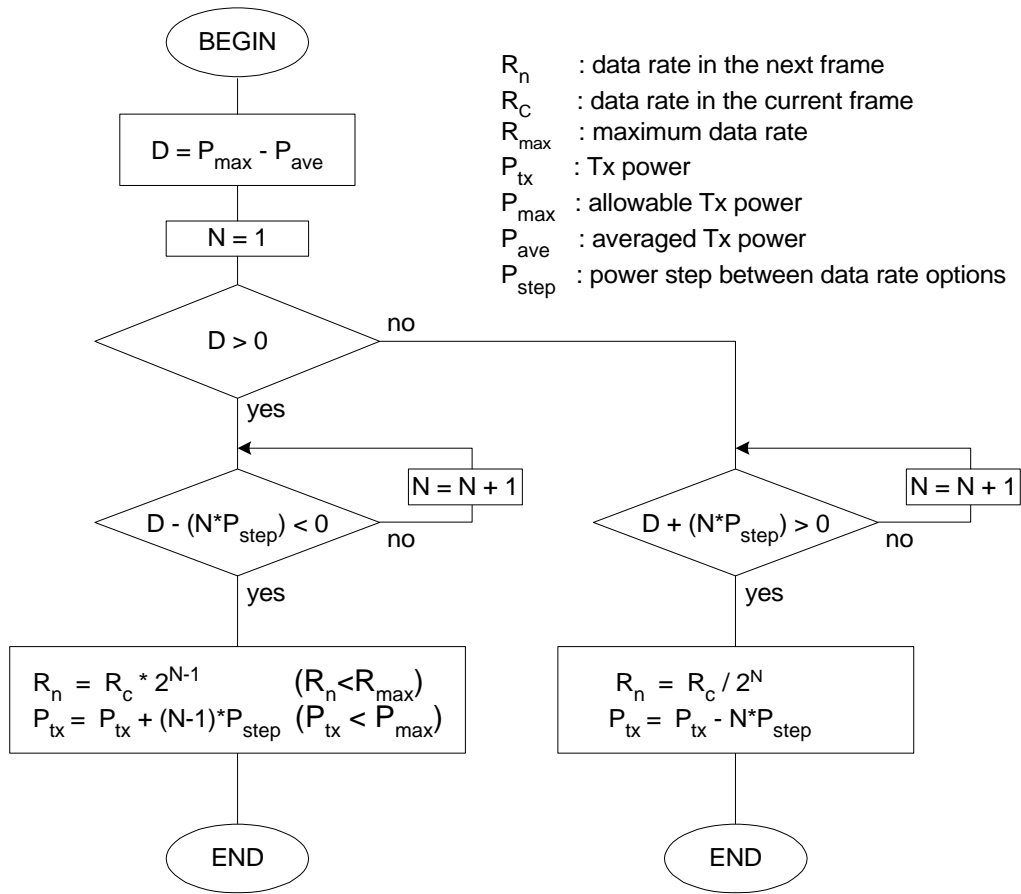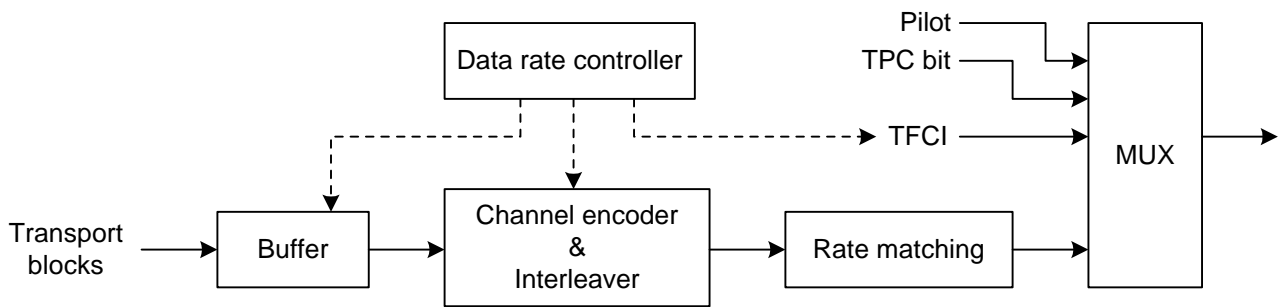
BEGIN

$D = P_{max} - P_{ave}$

$N = 1$

R_n : data rate in the next frame
R_C : data rate in the current frame
R_{max} : maximum data rate
P_{tx} : Tx power
P_{max} : allowable Tx power
P_{ave} : averaged Tx power
P_{step} : power step between data rate options

$D > 0$ no

yes

$D - (N*P_{step}) < 0$ $N = N + 1$

no

yes

$R_n = R_c * 2^{N-1}$ $(R_n < R_{max})$
$P_{tx} = P_{tx} + (N-1)*P_{step}$ $(P_{tx} < P_{max})$

END

$D + (N*P_{step}) > 0$ $N = N + 1$

no

yes

$R_n = R_c / 2^N$
$P_{tx} = P_{tx} - N*P_{step}$

END

Fig-Xa   Data rate control flow

Data rate controller

Pilot
TPC bit
TFCI

MUX

Transport blocks → Buffer → Channel encoder & Interleaver → Rate matching → MUX →

Fig-Xb   Channel structure on the down-link

Data rate controller

Pilot
TPC bit
TFCI

MUX

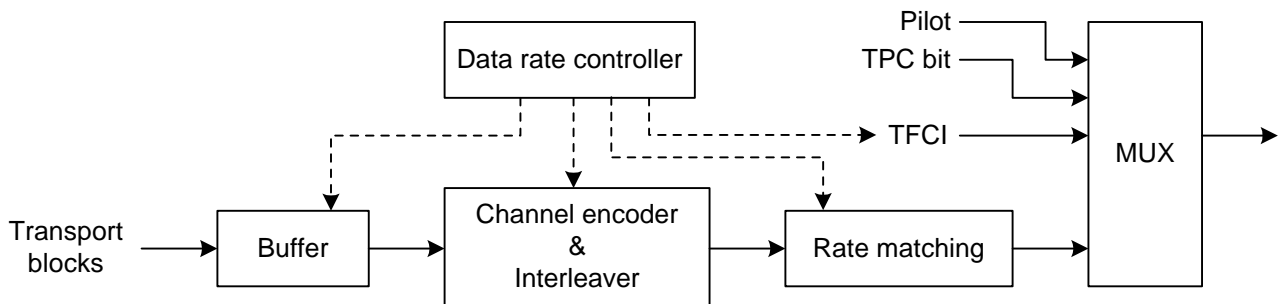Transport blocks → Buffer → Channel encoder & Interleaver → Rate matching → MUX →

Fig-Xc   Channel structure on the up-link

4 Conclusion

In this contribution, we described the modified concept of the access control for mult-rate and/or multi-code packet data transmission. Data rate and transmit power are controlled in order to avoid excess interference as well as to maximize the throughput. At the present time, spreading factor is NOT controlled. It will be for further study.