Type II Hybrid ARQ Scheme based on QoS and LDPC Code

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***Abstract*— In order to improve channel throughput while at the same time satisfying Quality of Service (QoS) under various channel conditions, an efficient hybrid ARQ type II scheme is proposed. In the proposed scheme, the optimum redundancy size for every transmission is calculated to maximize the throughput using QoS parameters, the performance of LDPC code and channel conditions. The proposed scheme, together with such benefits as QoS support, provides a way of achieving higher throughput in wireless communication systems.**

I. Introduction

A dynamic and efficient usage of radio resources is a fundamental aspect of post-3G systems. In order to improve the channel efficiency, adaptive modulation (AM) according to the feedback channel information is used by changing modulation schemes, such as BPSK, QAM, and 16QAM. However, incorrect channel estimations or the difficulties in channel estimation lead to packet errors. There are two kinds of technique used for error control: FEC (Forward Error Correction) and ARQ (Automatic Repeat reQuest). By combining these two schemes, there are two kinds of different HARQ (Hybrid ARQ) methods as follows [1]:

- *Type I Hybrid ARQ :* The cyclic redundancy code (CRC) is added to an original data and the data is encoded with FEC.
- *Type II Hybrid ARQ :* The type II HARQ is a so-called Incremental Redundancy ARQ scheme. This means that erroneous packets at receivers are not discarded, but are combined with incremental redundancy information provided by the transmitter, and a higher coding gain is achieved as the number of retransmissions increases.

In [2], a type II hybrid ARQ scheme using punctured convolutional coding was proposed. Also, in [3], a new type II hybrid ARQ scheme was proposed by selective combining. However, the size of the redundancy information is the same for every retransmission in these papers, and no progress is made based on the size of the redundancy information, considering the packet QoS and channel conditions.

II. Proposed Scheme

We propose an efficient type II HARQ scheme that maximizes channel throughput, considering both QoS support and implementation. Here, we consider an allowed packet delay and outage probability, in view of supporting QoS.

In general, adaptive channel coding schemes based on a channel estimation are used to maximize channel throughput via the feedback channel information transmitted by receivers. However, in fast time-variant channel environments, the channel estimation is imperfect, and an incorrect channel estimation induces the degradation of throughput. So, in a type II HARQ scheme, minimizing the size of additional redundancy according to QoS and channel conditions makes it possible for throughput to be maximized via a code rate that adapts to channel conditions. The size of an initial transmission or retransmission is determined by the maximum number of allowed data retransmissions and a required packet outage probability. In order to satisfy QoS, the smaller is the required outage probability, the greater is the redundancy. In addition, the greater is the maximum number of data retransmissions, the smaller is the redundancy. The optimum size is given in section III in order to transmit within the allowed packet delay while at the same time satisfying the packet outage probability.

Fig. 1 shows a flowchart of the proposed scheme. When a packet arrives, the number of maximum data transmissions, Nr, is determined by the allowed packet delay, the scheduling algorithms used in the transmitter and the round trip time for ACK/NACK responses. Following that, the transmission sizes, $R_1, R_2, ..., R_{N_r}$ for initial transmission and retransmissions, are determined optimally according to channel conditions and channel coding performances. Here, by restricting the redundancy size within a multiple of the minimum data transmission unit, the complexity of scheduling and data transmissions is reduced. When an opportunity for transmitting the packet arises, the data for initial transmission, with size R_1, is transmitted. If a NACK is received from the receiver, data of size R_2 is transmitted. Data of sizes $R_3, R_4, ..., R_{N_r}$ are sequentially transmitted when the respective NACKs are received from the receiver.

III. Mathematical Modeling

We define the following variables to calculate the optimum redundancy sizes for all the retransmission times.

- κ : size of information bit
- n : size of information bit + parity bit