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Source:	**Panasonic**
Title:	**Text Proposal for HARQ complexity evaluation section of TR25.848**
Agenda Item:	**AH24 (HSDPA)**
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1. Introduction

This document proposes HARQ complexity evaluation content for the TR25.848. The simulation analysis for this contribution is presented in R1-01-0205. [1]

2. Text Proposal

7.2.2 Complexity Evaluation <UE and RNS impacts>
7.2.2.1 N-channel stop-and-wait H-ARQ

7.2.2.2 Separated Systematic and Parity information Mapping (SSPM) for HARQ with partial IR (type-III HARQ)
7.2.2.2.1 Introduction
When type-III HARQ is employed, SSPM can reduce UE's buffer size without performance degradation. SSPM is explained as follows.

      ✍ NodeB maps systematic information and parity information on separated symbols
      ✍ UE combines all packets' systematic symbols before turbo decoding

A complexity evaluation with using of SSPM is presented in this section.
7.2.2.2.2 Description of SSPM
✍ Node B maps systematic information and parity information on separated symbols

Fig. 1 shows the sender structure of type-III HARQ using SSPM. Fig. 2 shows the packet format of type-III HARQ using SSPM. Systematic bits set S is sent in each retransmission and Parity bits set Podd and Peven are sent alternately in each packet. In this figure Podd and Peven are selected as different parity information for rate 1/2 turbo code. When rate 3/4 turbo code is used, six different types of parity information are generated and sent on each retransmission.

One symbol for systematic bits includes systematic bits only. One symbol for parity bits includes parity bits only. No symbol includes systematic bits and parity bits simultaneously. Systematic bits and parity bits are mapped on symbols separately with this procedure.
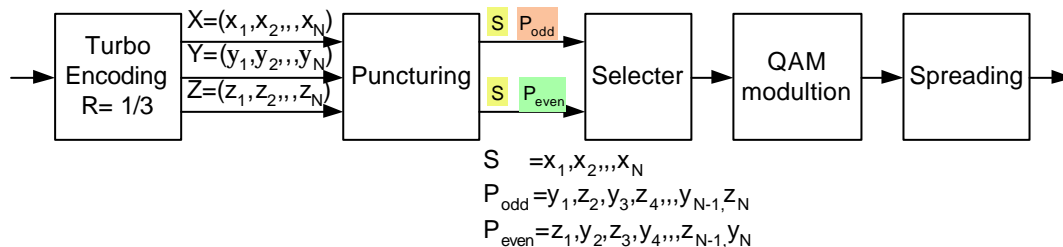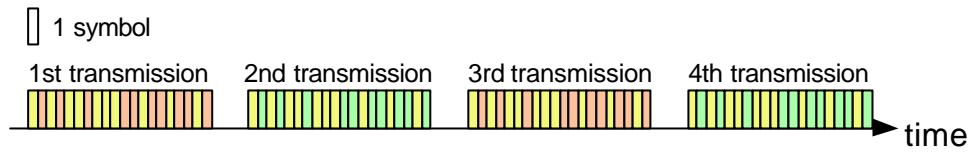

$$S = x_1, x_2, \ldots, x_N$$
$$P_{odd} = y_1, z_2, y_3, z_4, \ldots, y_{N-1}, z_N$$
$$P_{even} = z_1, y_2, z_3, y_4, \ldots, z_{N-1}, y_N$$

Fig. 1 Sender structure of type-III HARQ using SSPM(R=1/2)

⎕ 1 symbol

| 1st transmission | 2nd transmission | 3rd transmission | 4th transmission |

→ time

One symbol includes systematic bits only or parity bits only.
No symbol includes systematic bits and parity bits simultaneously.

Fig. 2 Packet format of type-III HARQ using SSPM (R=1/2)

✍ A combination of bit interleaver and symbol interleaver can be employed for SSPM

In order to achieve the same performance as the conventional bit interleaver used for conventional mapping method, the combination of bit interleaver and symbol interleaver can be adapted for SSPM.

The interleaving function can be employed as the following two steps. The first function is to employ bit interleaver for systematic information and parity information respectively. The second function is to employ symbol interleaver for systematic infromation and parity information simalteneously. The interleaver pattern of release-99 second interleaver can be applied for both bit interleaver and symbol interleaver. An example of the interleaver structure is shown in Fig. 3 and the interleaving pattern is shown in Fig. 4 . In this example only one interleaver pattern is used for both bit interleaver and symbol interleaver respectively. The simulation results show that the usage of this interleaver pattern can achieve good performance. However it seems thre is room for further refinement.
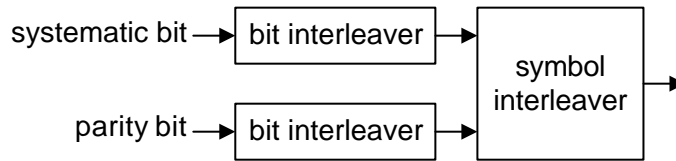
systematic bit → bit interleaver → ⎯⎯⎯⎯⎯→ symbol interleaver →

parity bit → bit interleaver → ⎯⎯⎯⎯⎯→

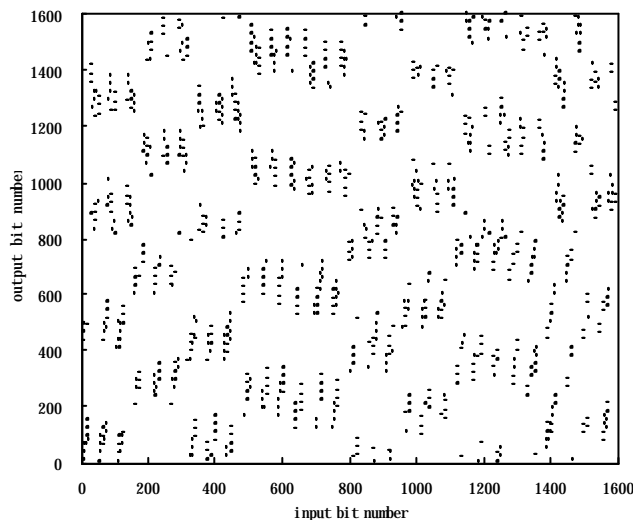**Fig. 3 An example of combined interleaver structure for SSPM**

Fig. 4 An example of the interleaving pattern for SSPM (16QAM R=1/2)

✍ Symbol combining of systematic information at UE can reduce the UE's buffer

When SSPM is used, receiver can combine every packet's systematic symbols before turbo decoding. Receiver also combines plural received Podd packet symbols and Peven packet symbols respectively before turbo decoding. Log-likelihood ratio (LLR) of each bit is calculated after the symbol combination. The buffer size for systematic information of the proposed scheme is only the size of one packet symbols. Therefore SSPM can reduce the receiver's buffer size
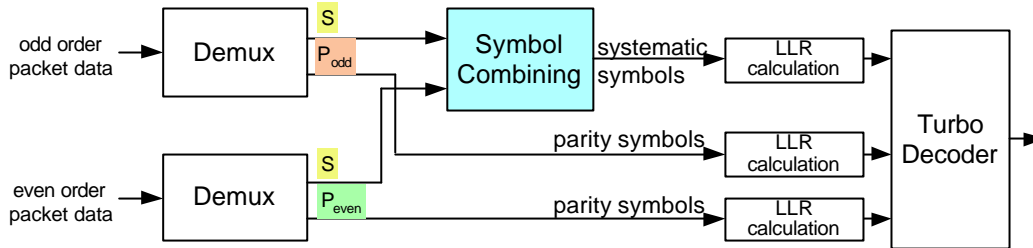

Fig. 5 Receiver structure of type-III HARQ using SSPM (R=1/2)

7.2.2.2.3 Buffer size comparison at UE

$$Buffer_{conventional} \; ? \; (N_{systematic} \; ? \; N_{parity}) \; ? \; N_{type} \tag{1}$$

$$Buffer_{SSPM} \; ? \; N_{systematic} \; ? \; N_{parity} \; ? \; N_{type} \tag{2}$$

$Buffer_{conventional}$ buffer size of conventional type-III HARQ receiver

$Buffer_{SSPM}$ buffer size of type-III HARQ receiver using SSPM

$N_{systematic}$ number of systematic symbols in one HS-DSCH packet

N_{parity} number of parity symbols in one HS-DSCH packet

N_{type} number of different type of packet in type-III HARQ retransmission

Conventional receiver has to store each retransmission packet, the buffer size is the number shown in equation (1), while proposed scheme has to prepare only the size of one packet regarding systematic symbols. So proposed scheme can reduce receiver's buffer.

Table. 1 Buffer size comparison(SF = 32, 1 code)

Code rate in each retransmission unit	$N_{systematic}$	N_{parity}	N_{type}	$Buffer_{conventional}$	$Buffer_{SSPM}$
1/2	200	200	2	800symbols	600symbols
3/4	300	100	6	2400symbols	900symbols

7.2.2.2.4 Conclusion
A complexity evaluation with using of SSPM for type-III HARQ is presented in this section. The use of SSPM can reduce UE's buffer size when 16QAM or higher-level modulation is used.

7.2.2.2.5 References
[1] R1-01-0031, Panasonic "Proposal of bit mapping for type-III HARQ" Boston, USA, January 15-18, 2001