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Study Group 15
Experts Group for ATM Video Coding
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CODING OF MOVING PICTURES AND ASSOCIATED AUDIO

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SOURCE : JAPAN
TITLE : Consideration on the diagonal interleaving method for cell loss correction
PURPOSE : Proposal

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1. Introduction

To support H.320 terminals in B-ISDN, the cell loss protection method for AAL type 1 was discussed at the last Boston meeting, and the liaison statement(Annex 6 to AVC-553R) was sent to SG13. According to the SG13's response on our liaison, the AAL1/2 group of Q.6/SG13 has produced the correction method that utilizes a short interleaver with diagonal processing and Reed-Solomon code(See AVC-557). This method introduces our general idea of diagonal reading of the correction matrix.

In this document, the SG 13's method is reviewed and the closed form of error correction matrix is proposed for variable bit-rate services. Moreover, RS(192,188) code with byte interleaver is also proposed to SG 13 as the cell loss protection method for MPEG 2 Transport packet transmission by AAL type 1.

2. Review of Diagonal interleaving method

The method of SG 13 is based on the diagonal reading of the transmitting interleaver and Reed-Solomon(94,88) code. The size of the interleaver is 16 cells, the matrix has 8 rows and 94 columns. This method can correct either one cell loss within 16 cells or 3 bytes errors in a row of 94 bytes.

In the liaison statement from SG15, RS(48,44) or RS(47,43) code was selected in order that the correction process is carried out on cell basis. Although it is more complicated procedure, when the random error is relatively high, RS(94,88) code is preferable than RS(48,44) code. In the figure of Annex 1, the correction capability against random byte error is shown.

Regarding the implementation aspect, hardware size of RS(94,88) encoder/decoder is larger than that of RS(48,44). Now, there is the LSI device which supports the RS(94,88) code, it may be implemented without increasing the complexity. The binary primitive polynomial of this LSI is $g(x) = x^8 + x^7 + x^2 + x + 1$, and this is the same as that of the long interleaving method i.e. error correction method for unidirectional video services by using RS(128,124) code. Therefore, the use of the binary primitive polynomial suggested by CMTT/3 will be acceptable to have the common polynomial for error correction methods.

To minimize the processing delay, the reading of the interleaver begins **before** a whole data has been written in the interleaver. The process in the interleaver is continuous, i.e. the interleaver is constructed by the ring buffer. Figure 1 shows the diagonal interleaving method with the ring buffer. For example, after writing the 94 bytes of the 'A' row's data, the cell of seq. # k is immediately read out. Owing to use this mechanism, the processing delay will be 14.7 msec for 384 kbit/sec, 3.67 ms for 1536 kbit/sec. However, the disadvantage of this method is the necessity of the dummy data transmission at the beginning and the end of the communication.

3. Extension for variable bit rate services

In the case of variable bit rate(VBR) services like as AAL type 2, the diagonal interleaving method with ring buffer is inappropriate to the stop-go data transmission. Whenever the data are transmitted, the dummy data transmissions are needed for the ring buffer method.

From above reason, for the VBR services we propose a double-buffer method i.e. the interleaver is constructed by the double-buffer. In the contrast with the ring buffer method, the reading of the interleaver begins **after** a whole data has been stored in the interleaver. Figure 2 shows the diagonal interleaving method with double-buffer. The processing delay, both in the transmitting and the receiving AALs, is the twice of that of the ring buffer method.

Moreover, the advantage of the proposed method is an easy multiplexing of multi-media data in unit of 16 cells.

4. Cell loss correction method for MPEG 2 Transport Stream(TS) transmission

At the New York meeting, MPEG Systems has defined the transport packet which has the fix length of 188 bytes. The packet length decision is based on the assumption that there should be alignment between the start of a Transport packet and the ATM cell payload. The use of RS(94,88) code is possible to correct the cell loss with low processing delay, however, the transport packet and cell are not aligned(Refer to the case 1 in AVC-568).

To achieve the alignment and cell loss protection, the combination method of byte interleaver and RS(192,188) code can be applied. The byte interleaver is organized as a matrix of 47 rows and 192 columns(See Figure 3). A Transport packet with additional 4 bytes FEC (i.e. 192 bytes) is horizontally written in the transmitting interleaver and 47 bytes cell payload for AAL type 1 is vertically read out. This method can correct either 4 cell losses within 192 cells or 2 bytes random errors in a row of 192 bytes. For the sensitive system against the error detection, 16-bit CRC, calculated using the same polynomial of the HDLC system i.e. $x^{16}+x^{12}+x^{5}+1$, and 2-byte FEC can be applied.

For synchronization of the interleave matrix, PTI(user to user indication) or CSI(CS indicator) bit can be used.

5. Conclusion

The diagonal interleaving method suggested from SG 13 will be acceptable for the constant bit-rate and delay sensitive services.

To avoid unnecessary dummy data transmission for variable bit-rate services, the proposed double-buffer method should be also described in the Recommendation.

For MPEG2 Transport packet transmission, the cell loss correction method by using RS(192,188) code with byte interleaver (as described in section 2.5.2.4.1 of Rec. I.363) is proposed to SG 13 to achieve the alignment between Transport packet and cell payload.

END.

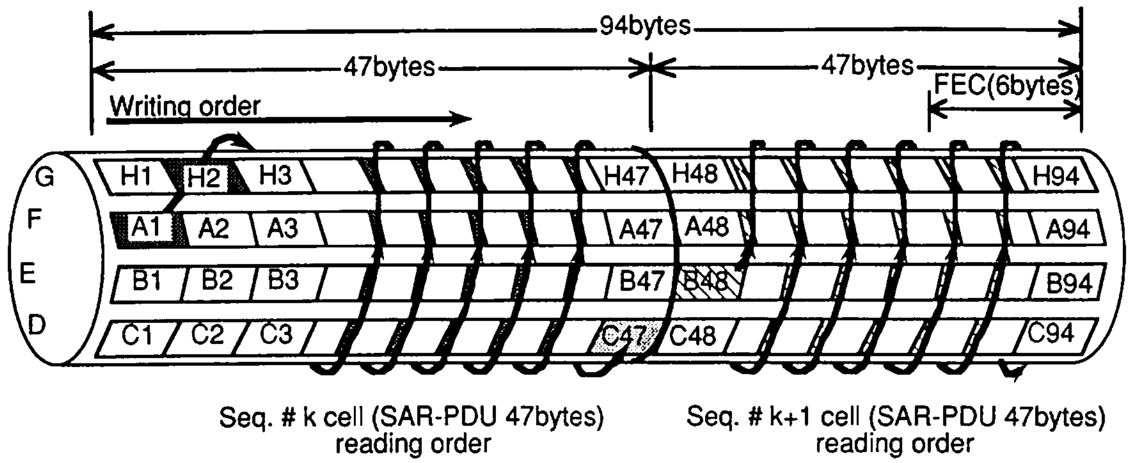

Figure 1. Diagonal interleaving method with ring buffer

(Reading of the cell begins as soon as the first row has been written in the buffer.)

Processing delay at 384kbit/sec

88(bytes)x8(frame)x1(receiving side)x8(bit/byte)/ 384(kbit/sec)=14.7msec

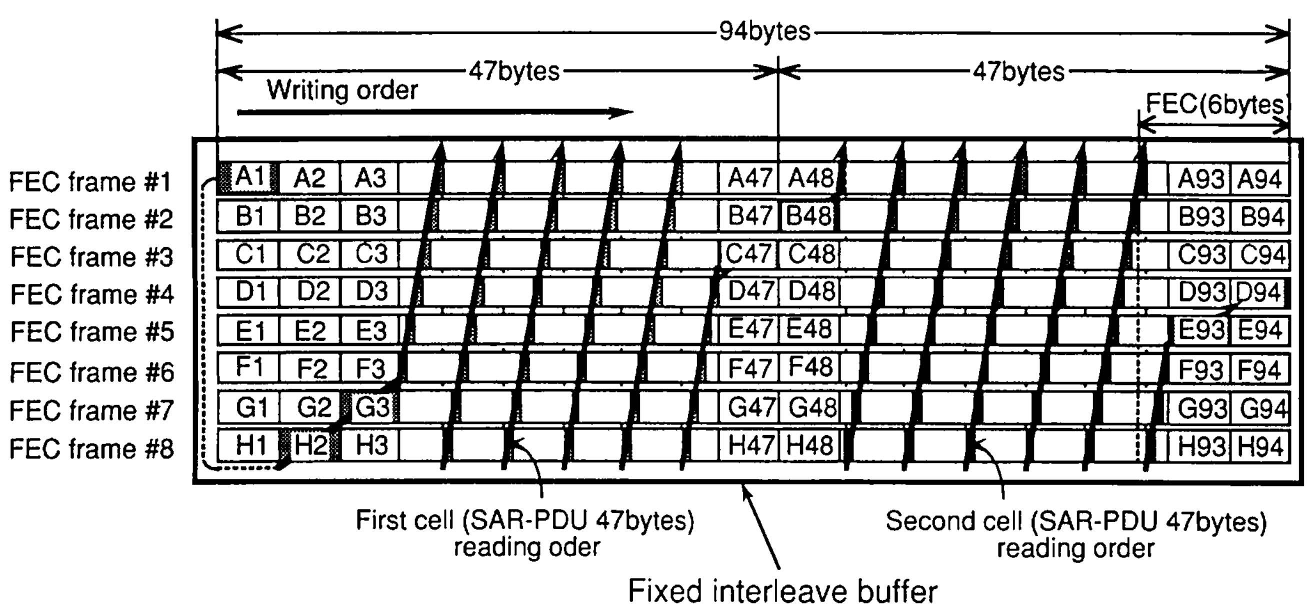

Figure 2. Diagonal interleaving method with double-buffer

(Reading of the first cell begins after a whole data has been written in the buffer.)

Processing delay at 384kbit/sec

88(bytes)x8(frame)x2(both sides)x8(bit/byte)/ 384(kbit/sec)=29.4msec

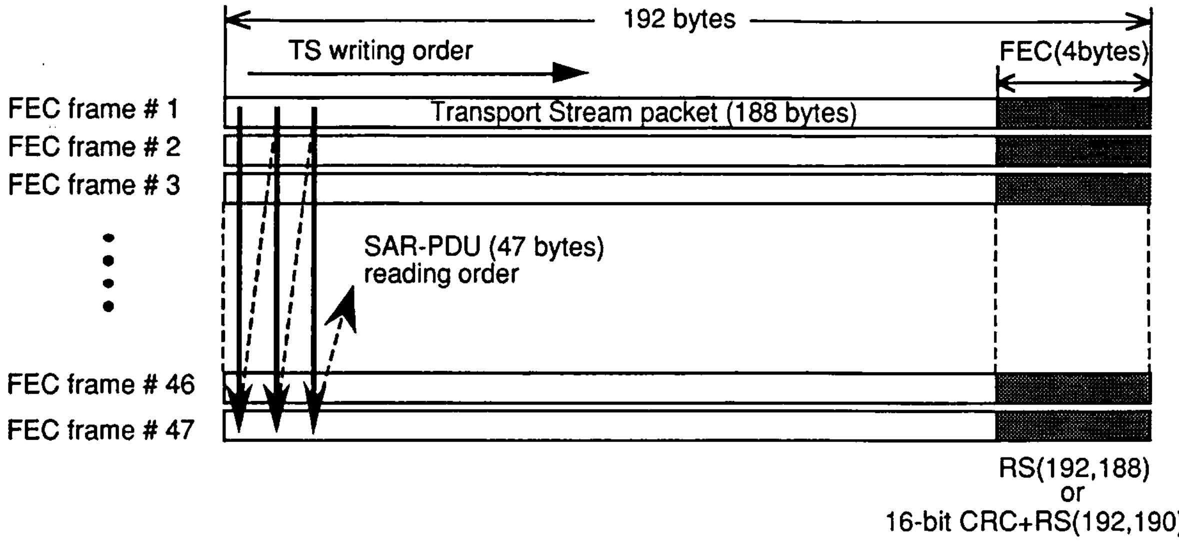

Figure 3. Interleave matrix for Transport Stream transmission

Processing delay for 10Mbit/sec

188(bytes)x47(frames)x2(both sides)x8(bit/byte)/10(Mbit/sec)=14.1msec

Annex 1 to AVC-569

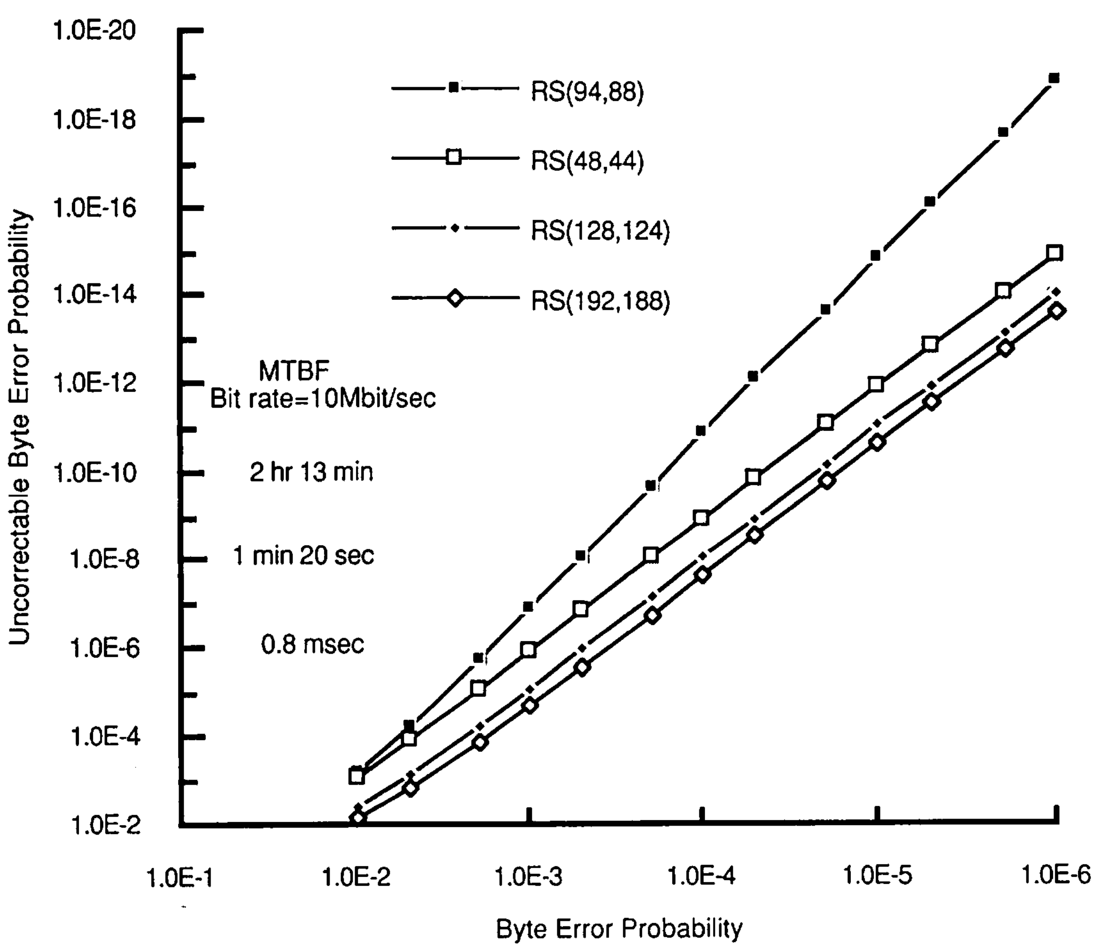

Figure Correction performance for random byte error