Telecommunication Standardization Sector
Study Group 15
Experts Group for ATM Video Coding
(Rapporteur's Group on part of Q.2/15)

Document AVC-459
April 1993

SOURCE : JAPAN
TITLE : A Study of Forward Error Correction Method in AAL Type1
PURPOSE : Discussion

----

1. Introduction

As a cell loss protection method for unidirectional video services in the ATM network, the Reed-Solomon(128,124) code combined with octet interleaver is defined in Recommendation I.363 (See Annex 1). This method has a capability of correcting 4 cell losses in the block of 128 cells, but requires an additional delay for correction processing. The liaison statement from SWP XVIII/8-3 pointed out that in order to support H.320 terminals in B-ISDN, this delay may be unacceptable for low speed services (Ref. AVC-447 page 2).

Moreover, a protection method against bit error in ATM cells is awaiting study at the previous Rome meeting (Ref. AVC-443R Section 7.1.3).

In this document, a forward error correction method in AAL Type1 against cell losses and bit errors with low processing delay is studied.

2. A study of protection method with low delay

An error correction processing delay is depend on a size of error correction matrix for cell loss protection. For example, when the transmission rate of SAR-PDU(i.e. 48 bytes) is 384kbit/sec, the processing delay of a matrix whose size is N cells will be N msec. Considering an acceptable delay, it is desirable that the value of N is several tens.

Since the Sequence Number(SN) for cell loss detection of AAL type 1 is numbered modulo 8, so it is preferable that N is a multiple of 8 (See Annex 2). To indicate the first cell of error correction matrix, CS Indication(CSI) bit can be used. Another method to detect the first cell of the matrix is a reservation of synchronization bits at SAR-PDU payload.

From the above consideration, the protection method against cell losses and bit errors in cell is described with the following condition.

A size of error correction matrix : 48(bytes) * 16 (cells) i.e. $N=16$

Forward Error Correction Code : Reed-Solomon (48,44) code (See Annex 3)

Procedure :

(1) In the transmitting CS, 4 bytes error protecting code, RS(48,44), is computed over 44 bytes of information field. This information field consists of 43 bytes of data from the CS layer and one byte SAR-PDU header (See Figure 1). The RS(48,44) code is able to correct up to 2 random errored symbols(bytes) or 4 erasures in the FEC frame (i.e. 48 bytes). An erasure is an errored byte whose location in the FEC frame is known.

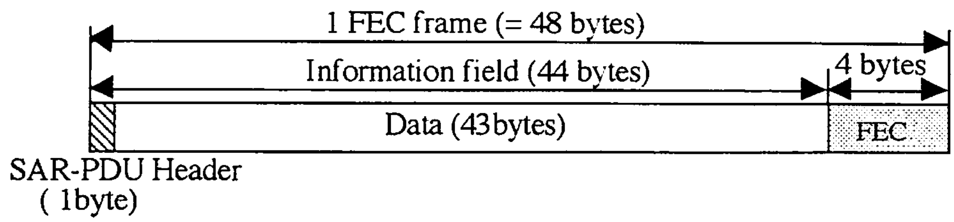


Figure 1 FEC framing for RS(48,44) code

(2) Next, the error correction matrix is made up of 16 FEC frames and each FEC frame is divided into 16 sectors. The sector whose length is 3 bytes is numbered from $1 to $16. To make a protection against a cell loss, a SAR-PDU is organized from one sector of each FEC frame (See Figure 2). By this process, the loss of one SAR-PDU implies 3 erasures in the FEC frames, therefore this loss is correctable. The first sector which includes the SAR-PDU header always placed the head of the SAR-PDU.

Note) Considering the capability of RS(48,44) code, it is possible that an error correction matrix is made up of 12 FEC frames. In this case, each FEC frame will be divided into 12 sectors whose length is 4 bytes.

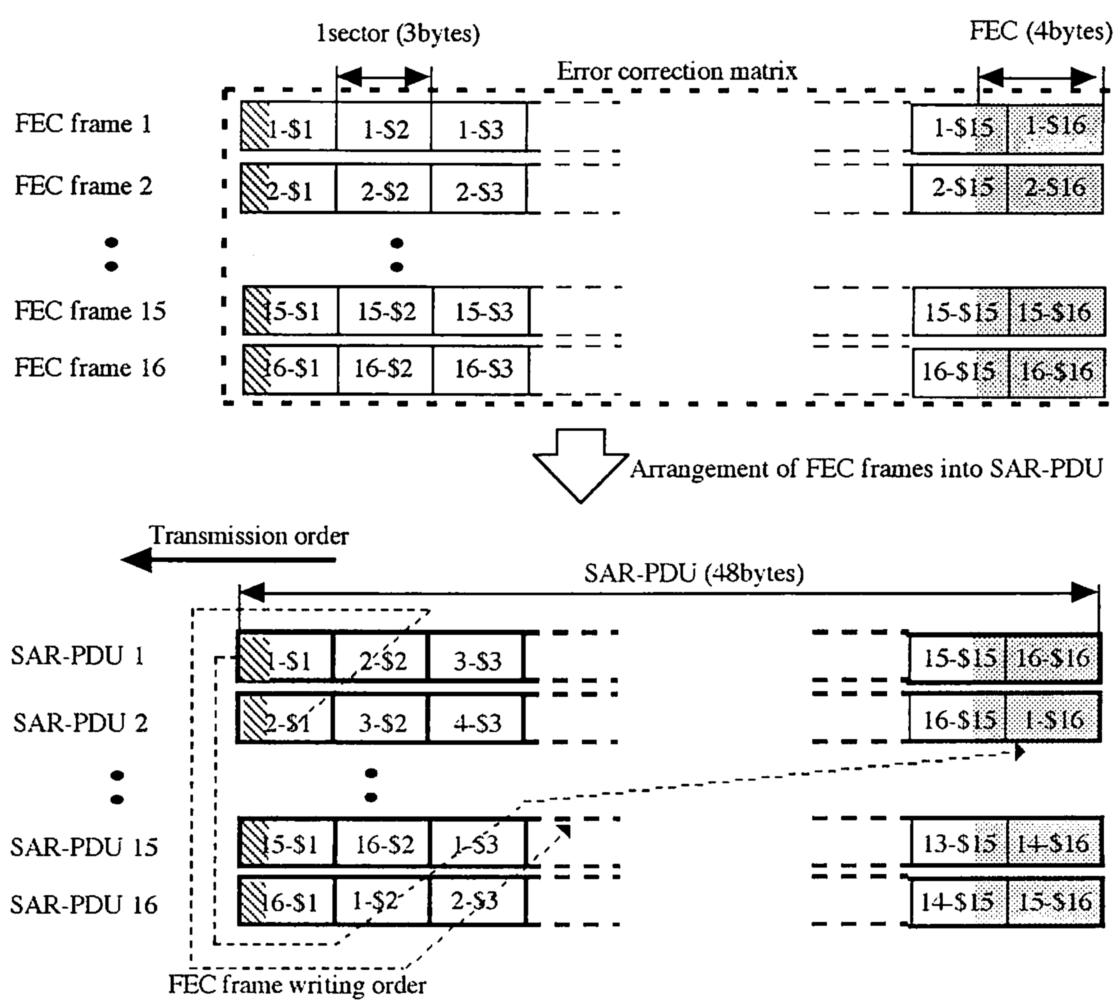


Figure 2 Arrangement of FEC frames into SAR-PDUs

3. Performance

The capability of error correction and transmission efficiency of this method are listed on table 1. It is noted that this correction method can perform against either cell loss or random bytes errors.

Table 1 Capability of Error Correction and Efficiency

Error Correction Code	Correctable error (either-or)		Efficiency
	cell loss(es) within 16cells	random bytes errors within 48 bytes	
RS(48,44)	1 cell	2 bytes	91.5 %
RS(48,42)	2 cells	3 bytes	87.2 %
RS(48,40)	2 cells	4 bytes	83.0 %

cf.) I.363 method can correct either 4 cell losses within 128 cells or 2 bytes errors within 128 bytes. The efficiency of I.363 method is 96.9 %.

The size of error correction matrixes is 48(bytes)*16(cells)*2(transmitting and receiving side), i.e. 1536 bytes, therefore the sum of processing delay will be calculated as table 2.

Table 2 Error Correction Processing delay
(Sum of transmitting and receiving side)

Bit rate (SAR-PDU rate)	Processing delay of this method	Processing delay of I.363 method
5M bit/sec	2.4 msec	9.6 msec
1M bit/sec	12 msec	48 msec
384k bit/sec	32 msec	128 msec

4. Conclusion

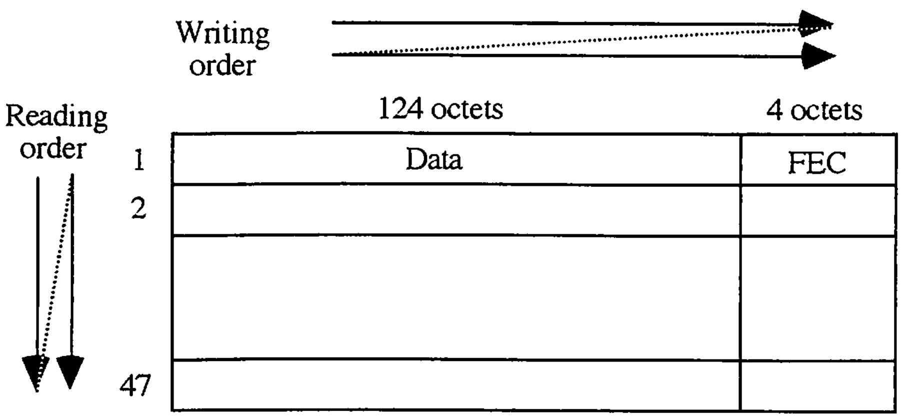
A forward error correction method in AAL Type 1 is studied. By this method, it is able to correct either cell loss or random bytes errors within cells with acceptable delay for low speed services. If cell losses may not occur in bursts at low bit rate, this method will be useful.

Moreover, shorter delay or higher efficiency will be achievable by using lower correctable FEC code.

END.

Annex 1 to AVC-459

Figure of the format of interleave matrix from Recommendation I.363.



Annex 2 to AVC-459

AAL Type 1 Format (Ref. CCITT SGXVIII-R103-E 'INTEGRATED VIDEO SERVICES (IVS) BASELINE DOCUMENT' July 1992)

	SN field (4bits)		SNP field (4bits)		AAL user information field (47 octets)	
Cell header (ATM layer)	CSI (1)	SN count (3)	CRC (3)	Even parity (1)	P field (8bits) (if necessary)	

Annex 3 to AVC-459

The generator polynomial of the Reed Solomon(48,44) code is given by

$$G(x) = \prod_{i=0}^{3} (X + \alpha^i)$$

where α is a root of the binary primitive polynomial

$$g(x) = x^8 + x^4 + x^3 + x^2 + 1.$$

The minimum distance of RS(48,44) code is 5.