ITU-T Telecommunication Standardization Sector
Study Group 15
Experts Group for Video Coding and Systems
in ATM and Other Network Environments
(Rapporteur's Group on Part of Q.2/15)

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SOURCE : Japan
TITLE : Multimedia multiplex and AAL for high quality videoconferencing
PURPOSE : Discussion

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1. Introduction

Network adaptation (multimedia multiplex and AAL) for variable bitrate real time communication has been discussed and 'PES + AAL3/4 SAR' has been proposed as a reference model [1]. This document also discusses multimedia multiplex and AAL. However, it is not clear yet whether PES is the most suitable for our purpose. Here we use 'elementary stream segment' as a general notion. It is out of the current scope that the elementary stream segment may or may not be equal to PES packet. The discussion points are the following;

- What are constraints on the elementary stream segment?
- What is the difference between reference AAL and other AALs in performance?

The network adaptation performance should be evaluated in terms of [2];

- delay
- packing efficiency
- error resilience
- timing recovery
- implementation

This document addresses the first three items. The latter two items need separate consideration.

2. Constraint on elementary stream segments for real time communication

2.1 Maximum interval between two consecutive segments

If all segments are of constant length and the information generation is variable, there is no guarantee that the time to make a segment is shorter than the permissible delay. It is true even if segment length is ATM cell size (as in 'pipelining mode' [1]). Therefore some constraints are necessary for real time communication.

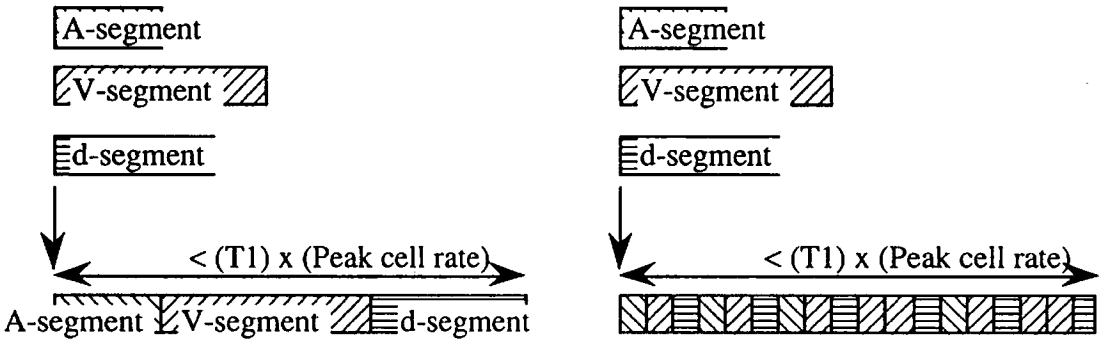
One approach is to put the constraint on minimum information generation rate and keep the segment to be of constant length. The other approach is to put the constraint on maximum interval time between two consecutive segments and allow variable length for the segment. If video is the only medium to be transmitted, the former approach is easy to realize because video algorithm has bitrate control mechanism. However, other media may not be able to control minimum information generation rate. Therefore the latter approach is favorable for generic standard.

We assume that multimedia multiplexing is done within a maximum interval time. Then we call the maximum interval time as multiplexing interval time (T1).

2.2 Maximum segment length

Segment transmission should be completed before the following segment starts to be transmitted. Therefore, maximum segment length should be restricted. In general it is (T1) x (peak cell rate). However, it may vary depending on UPC. Furthermore, if multimedia segments are transferred using one VC, sum of segment length should be restricted. This restriction does not depend on the multiplexing method as shown in Fig.

1. If video structure, for example slice, is aligned to the segment, information generation is limited by the segment length. In this case, we should declare peak rate a several times higher than average rate. On the other hand, if video structure is not aligned to the segment, information generation is not limited by the segment length. Buffering is neccasary before AAL and then delay occurs in this case.



(a) Packet (segment) based multiplex (b) Cell based multiplex

Fig. 1 Packet (segment) based multiplex and cell based multiplex

3. Evaluation for several AALs

3.1 System configuration

Elementary coded data is segmented and multiplexed in H.22X and transferred via AAL/ATM as shown in Fig. 2.

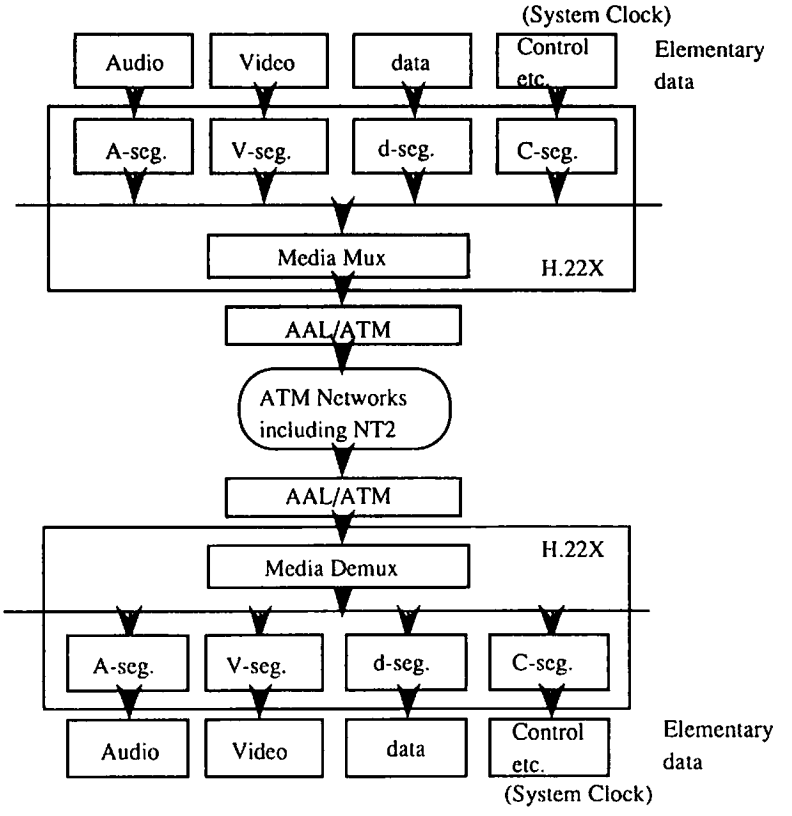


Fig. 2 System configuration

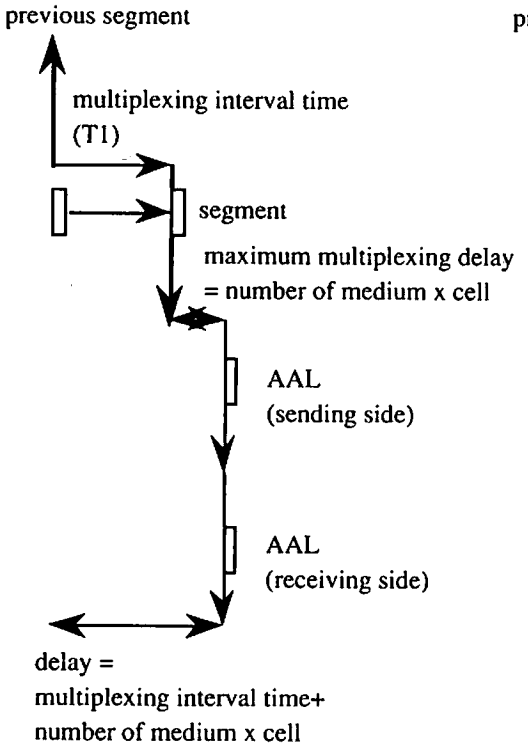
3.2 Delay caused by multimedia multiplex and AAL

Delay caused by multimedia multiplex and AAL is minimum when cell based multiplex and pipelining AAL are used (reference model). It becomes maximum when packet based multiplex and stored/forward AAL are used. Fig. 3 shows maximum delay in both cases.

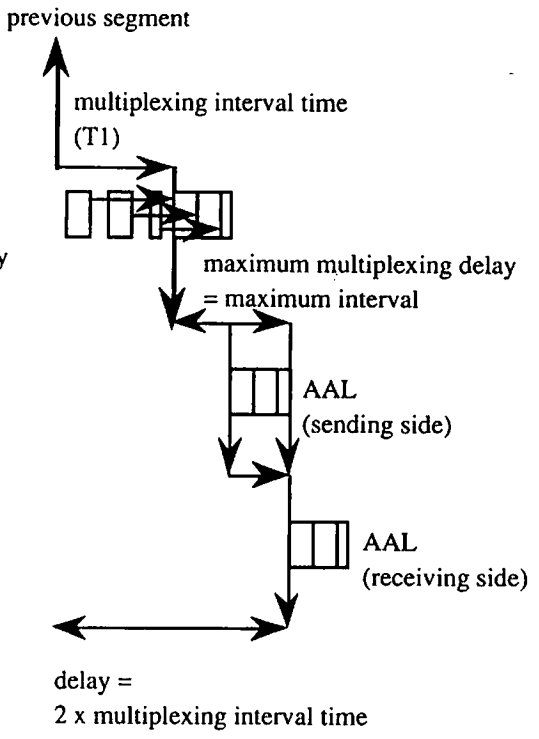
In the reference model maximum delay occurs when the information generation is too small to fill the cell. On the other hand, in packet based multiplex and stored/forward AAL maximum delay occurs when the information generation is maximum.
The difference is only a multiplexing interval T1. If T1 is 3 msec, it may not be significant compared to the total system delay.

Therefore delay is not a key point for selecting the multiplex and AAL when we put constraints on multiplexing interval and segment length.

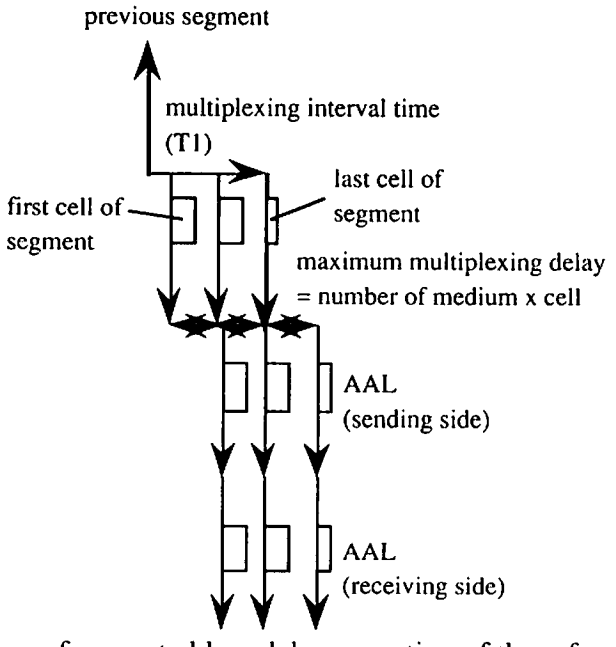
Note; This conclusion is different from that of AVC-585. It is because variable segment length is considered in this document.



(a) maximum delay in the reference model



(b) maximum delay in packet multiplex and AAL5



ref. expected low delay operation of the reference model

Fig. 3 Maximum delay

3.3 Difference between several AALs

Depending on the network QOS several cases can be considered.

3.3.1 Variable length is supported by AAL function

a) Error detection is necessary while correction is not necessary

- Reference model ; AAL 3/4 SAR

Error detection is done cell by cell. Therefore, all cells without error can be used. On the other hand transmission efficiency is low (appro. 91.7%=44/48).

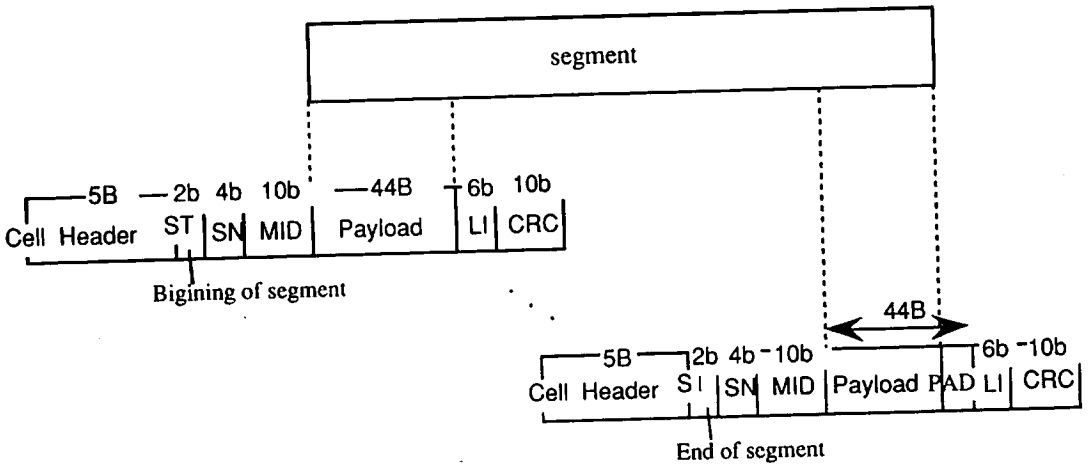


Fig. 4-1 Reference model ; AAL 3/4 SAR

- AAL 5

Error detection is done packet by packet. Therefore, a whole segment will be lost when an error occurs in the packet. Transmission efficiency is high. (appro. 99.5%=1875/(1875+8) when segment length is 1875 byte for bitrate of 5Mbps and multiplexing interval of 3 msec.)

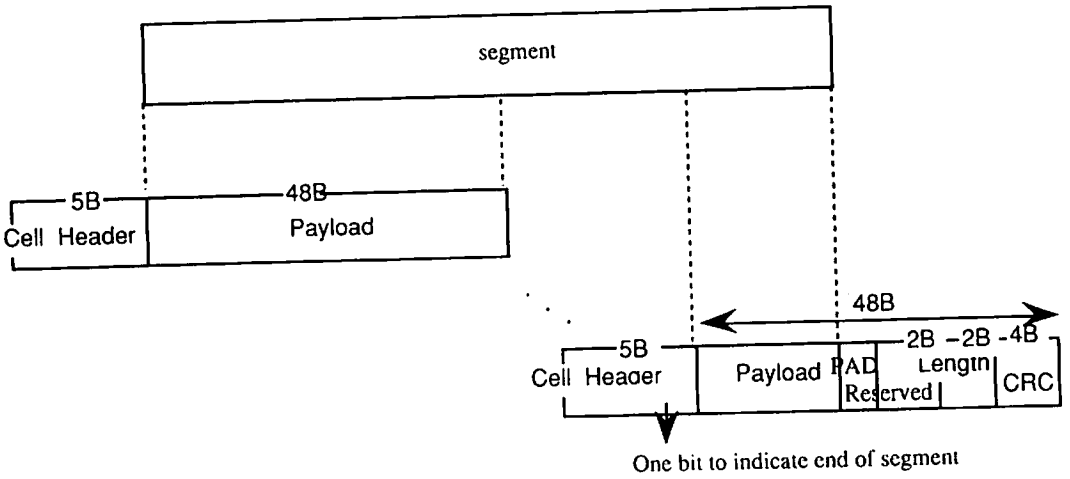


Fig. 4-2 AAL5

Discussion point; Which is favorable for our purpose? Stronger resilience or higher transmission efficiency? If bit error ratio is very low, for example once in

every 30 minutes, we should use AAL 5.

b) Bit error correction is necessary
- FEC for each cell costs too high. As a practical solution, 4 byte RS (Reed Solomon) for each 4 cell Segment is divided into 4 cells. One bit in ATM header is used to indicate the end of 4 cells. Transmission efficiency is higher than reference model (appro. 95.8% = 184/192). However, two stage mux/demux is necessary for this mechanism.

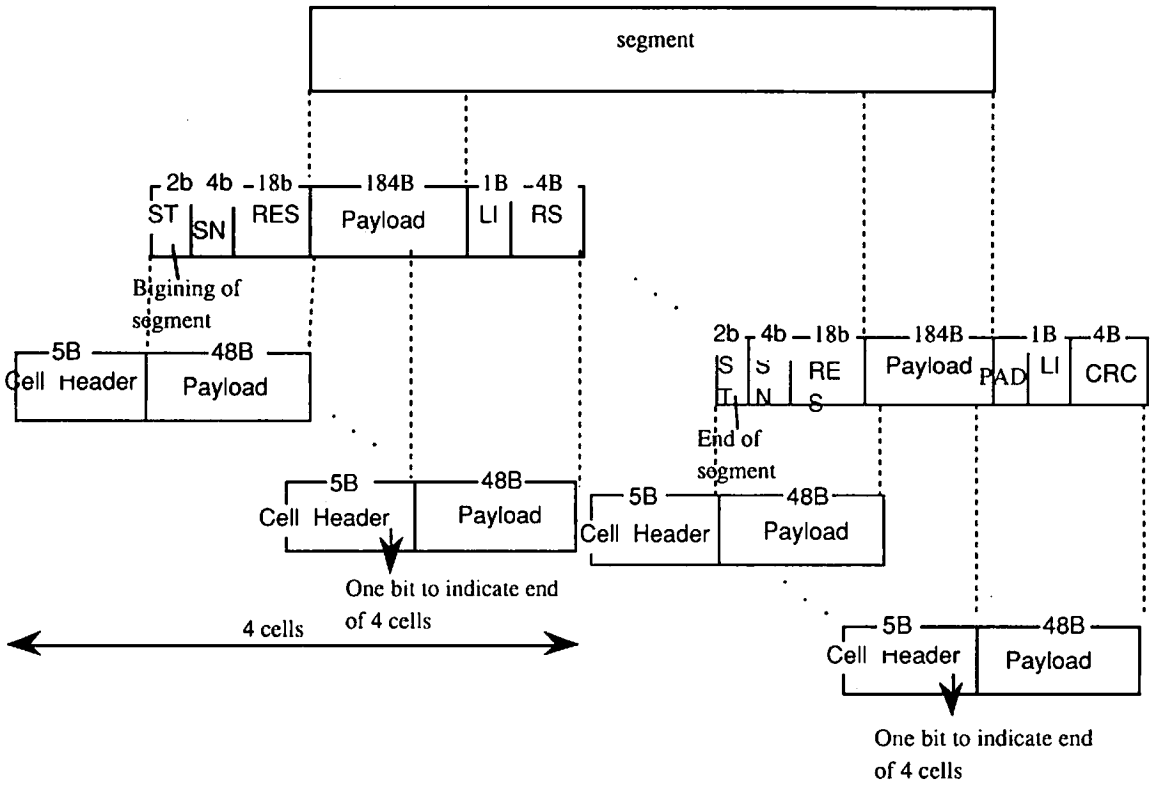


Fig. 4-3 New bit error correction AAL

Discussion point ; Is bit error correction necessary?

c) Cell loss correction is necessary
- Cell interleaving matrix
In this case, variable bitrate operation defined in this document is not adequate.

3.3.2 Variable length is supported by upper layer (H.22X) function but not AAL
a) Error detection is necessary while correction is not necessary
b) Bit error correction is necessary
- New AAL that is similar to AAL 1 [3]
Use new AAL that is similar to AAL 1. Only difference from AAL 1 is that cell interval time is not constant. Bit error detection or/and bit error correction is done by the upper layer. Details are for further study.

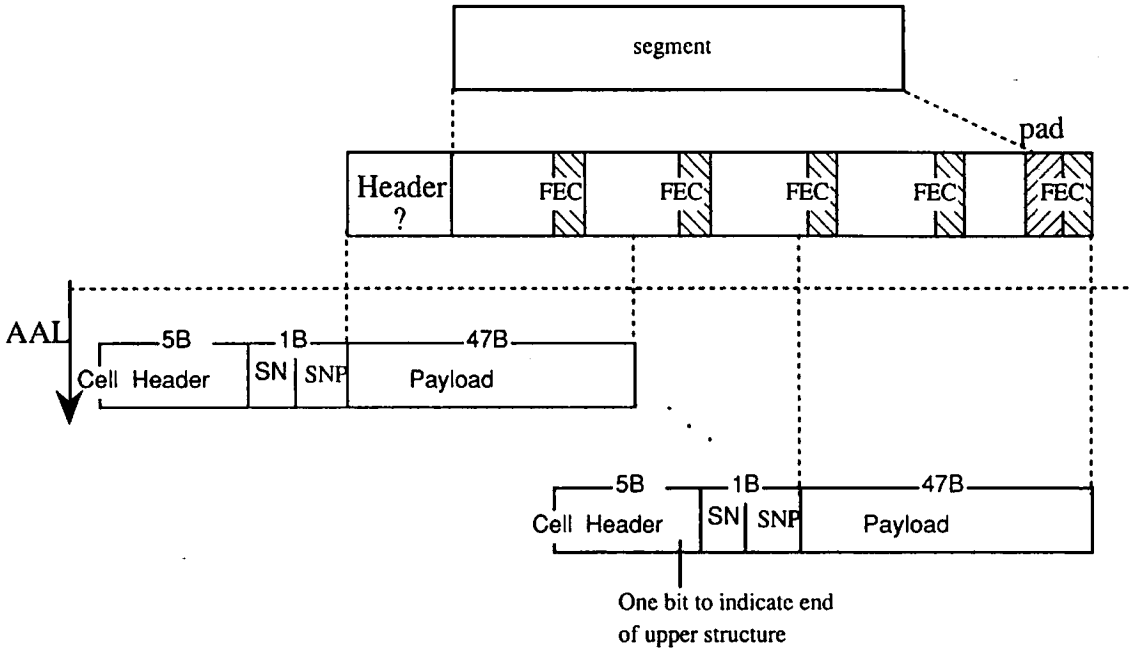


Fig. 5-1 Bit error detection/correction by upper layer

c) Cell loss correction is necessary
- New AAL that is similar to AAL 1 cell interleaving [4]
  Use new AAL that is similar to AAL 1 cell interleaving matrix. Only difference from AAL 1 is that interval time between the cell interleaving matrices is not constant. Padding bytes to the segment are used to fill the interleaving matrix by the upper layer. Details are for further study.

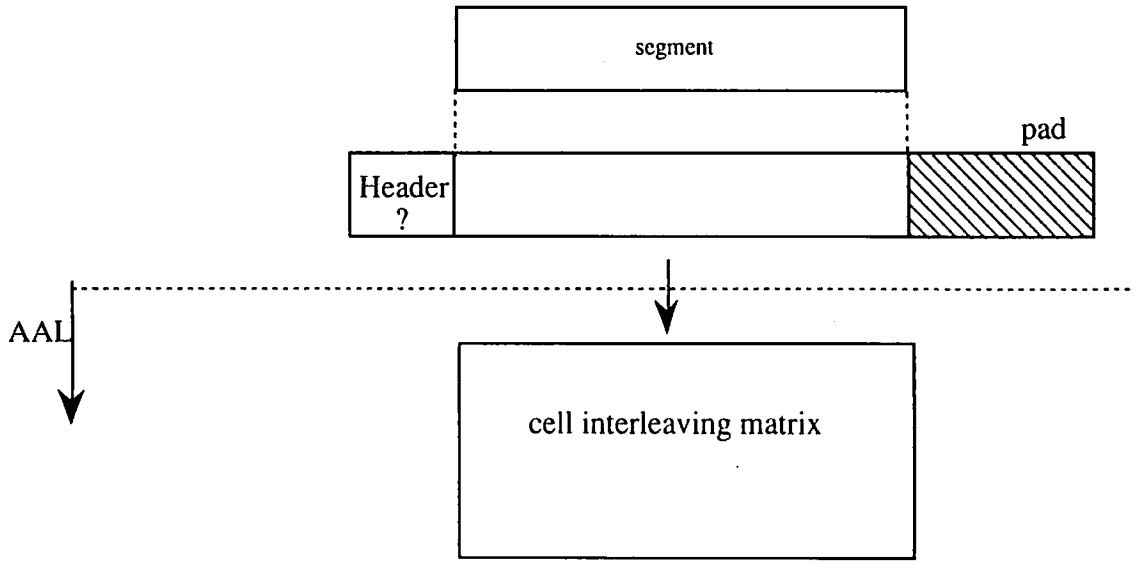


Fig. 5-2 Cell loss correction by cell interleaving matrix

4. Conclusion

Constraint on multiplexing interval time, that means maximum interval between two consecutive segment for one medium, is necessary for generic variable bitrate real time transmission. The delay difference between packet (segment) multiplexing and cell multiplexing is the same as multiplexing interval. Therefore If we choose adequate maximum multiplexing time we need not worry about multiplexing method from a view point of delay. Several AALs are compared based on transmission efficiency and error resilience. If we can accept 3msec information discard when an error occurs, we can save 8% transmission loss by using AAL type 5. Further discussion is necessary.

References

[1] AVC-585 ATM network adaptation performance parameters (S. Dunstan) Nov. 1993, Daejeon

[2] AVC-598R REPORT OF THE FOURTEENTH EXPERTS GROUP MEETING IN DAEJEON AND SEOUL(RAPPORTEUR), clause 7.2 Nov. 1993

[3] AVC-608 Terminal Specifications for High Quality Videoconferencing (Japan), Section 4 and 6, Mar. 1994, Paris

[4] AVC-616 Cell loss correction method with low processing delay (Japan), Mar. 1994, Paris