ITU-T Telecommunication Standardization Sector
Study Group 15
Experts Group for Video Coding and Systems
in ATM and Other Network Environments

Document AVC-631R
25 March 1994

Source: RAPPORTEUR (Sakae OKUBO)
Title: REPORT OF THE JOINT MEETING WITH SG13 AAL 1&2 GROUP IN GENEVA (14 March 1994) AND LIAISON STATEMENT FROM SG13
Purpose: Report

This document contains the following outcome from the SG13 meeting in March 1994.

Source	S. Okubo, K. Yamazaki
Title	Draft report of the joint meeting OS SG13 AAL Type 1&2 Group and SG15 Experts Group for ATM Video Coding

Source	Q.6 (AAL 1&2)/SG13
Title	Proposed Liaison to SG15 (ATM Video Coding), SG9 and ISO/IEC MPEG (for information)
Subject:	Video signal transport in ATM networks
Attachments	1) Correction method for delay sensitive services
	2) Status Report on AAL 1&2 (AAL Types 1 and 2) for video signal transpor

TD 36 (P) (Rev.)

ANNEX-3 (Rev.)
to AAL1&2 Report

SOURCE: S. Okubo (Rapporteur Q.2/SG15 for ATM video coding) and K.Yamazaki (Rapporteur Q.6/SG13 for AAL1&2)

TITLE: Draft report of the joint meeting of SG13 AAL Type 1&2 Group and SG15 Experts Group for ATM Video Coding

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Note: This document was reviewed by SG13 AAL1&2 Group and SG15 ATM Video Coding Experts Group.

1. Introduction

SG13 AAL1&2 Group and SG15 ATM Video Coding Experts Group met on 14 March, taking an opportunity of SG13 meeting for 7-18 in Geneva and of SG15 experts meeting for 16-25 in Paris, under the joint chairmanship of Mr. S. Okubo and Mr. K. Yamazaki. Two groups exchanged views and considerations on various aspects of AAL support for audiovisual applications. Status reports of the two groups, TD.27(Rev.) of SG13 and TD.32 of SG15, were used as a basis for discussions along with several working documents each addressing a specific item. This document highlights key topics discussed during the meeting, particularly addressing open issues to be studied further in detail by the two groups.

2. AAL1 for CBR services

Two functions of AAL1 were reviewed, i.e., source clock frequency recovery and error correction method utilizing the short interleaver with diagonal reading, since the two functions are key items to support CBR video applications, and to assess the support of real-time VBR applications. A work plan and some views of SG9 were also presented (TD.29 and TD.30) by J-Y. Cochennec (France), Rapporteur for Q.31/SG9, on a CBR application of digital video distribution over an ATM network. SG9 has a plan to further investigate AAL1 functions for the transport of MPEG-2 CBR Transport Stream.

With respect to AAL1 support for a CBR video application, the following were recognized:

- H.320 utilizes synchronous circuit transport, hence does not require the SRTS or adaptive clock method of AAL1 which is used for asynchronous circuit transport.
- SG9 is studying the use of the adaptive clock method of AAL1 for distributive video signal transport.

- H.320 can utilize the short interleaver method for correcting lost cells and errored octets in an ATM network.
- The short interleaver at present does not support Structured Data Transfer (SDT) method, e.g., 6/24/30-octet delineation in 384/1536/1920 kbit/s transport. Although H.320 does not need to rely on the SDT method because of its self-contained delineation mechanism (H.221), it may be desirable to have SDT in the short interleaver method. SG13 will continue the study on the support of SDT in the short interleaver method.
- It was also noted that octet delineation is always possible by AAL1.

There was presented a closed form of the short interleaver matrix, but questions were raised on value and applicability of the matrix for VBR applications from the AAL1&2 group.

3. AAL2 for a real-time VBR application

(1) Timing issues or distinction between CBR and real-time VBR

Although AAL2 is defined in I.362 as AAL for class B services, it is still unclear on exact implications of "real-time VBR". The following were noted by SG13 from ATM networking viewpoints:

- In CBR, the bandwidth is assured and Cell Delay Variation (CDV) is controlled within the network. AAL1 can remove the effect of CDV at its receiver operation and can pass constant bit/octet stream at its service access boundary to a higher layer.
- It is uncertain on how much CDV is introduced for a real-time VBR application, and on whether AAL2 can remove such effect of CDV at the receiver.
- SG13 cannot give values of CDV for real-time VBR services at present. An objective value of CDV for real-time VBR services may also differ from that for CBR services.
- It should also be noted that interworking with existing N-ISDN and leased line network can be possible only by CBR services of an ATM network.

A couple of ideas were expressed during discussions as working assumptions, i.e., the use of "some" constant information between the transmitter and the receiver so that the receiver can remove the effect of CDV by utilizing such a constant nature. These ideas need to be examined by both SG15 and SG13.

With respect to the support of MPEG-2 Transport Stream (TS), a concern was raised on whether time stamp method of MPEG-2 TS is good enough in a VBR application, considering CDV introduced within an ATM network. MPEG-2 TS assumes no jitter for its underlying layer, to which AAL1/CBR service will be able to meet by constant bit stream provided at AAL1 service boundary. It needs to be studied how to support MPEG-2 in VBR services.

It was also recognized that required jitter performance depends on a specific application and on a bit-rate. As an example, very low bit-rate video applications may be more jitter tolerant. A frequency spectrum of jitter performance also needs to be assessed, since low frequency jitter will not cause any problem in general for the majority of applications.

(2) Error correction/detection issues

SG13 noted that background bit error characteristics of an ATM network will be almost equivalent to those in existing networks, by assuming that an ATM network utilizes transmission facilities whose performance has already been studied for existing services. G.826 specifies parameters and objective values of such bit error characteristics, which will give a good starting point for studies in SG15.

At present, SG13 can not give any specific value on Cell Loss Ratio (CLR) provided by the network. An objective value of CLR for real-time VBR services may differ from that for CBR services. Such a value may also be time-dependent, e.g., 10^{-a} for two hours and 10^{-b} for more than 24 hours. The following qualitative aspects were, however, obtained by AAL1&2 Group, which may be useful for SG15:

- One possible method for supporting correction of both cell losses and bit errors is the use of FEC and octet interleaving as specified in AAL1. Those methods may require a cell-by-cell AAL header such as sequence numbering, in order to detect the exact positions of lost cells and octets in an interleaving matrix.
- It should be noted that correction of lost cells will be achieved more efficiently in AAL compared to higher layers.

(3) Resource management issues

Status of study in Q.8/SG13 (resource management) was presented by Mr. J.P. Coudreuse, Rapporteur for Q.8/SG13. Key points to be noted are:

- Only peak cell rate (PCR) is currently defined as a parameter of traffic control and ATM network resource management.
- PCR is the upper limit or the ceiling of input traffic to an ATM network. So, under this PCR constraint, a user can generate any bit-stream, e.g., CBR and VBR (regardless of real-time or non real-time).
- It is under study how to support VBR-based traffic control and resource management.

(4) Performance requirement

It was understood by the two groups that performance requirements for timing and error correction/detection depend on a specific application (e.g., interactive video conference, distribution of digital TV program, video on a screen of workstation, etc.,) with a specific bit-rate to be used. Therefore, it is desirable and necessary to study further in detail with respect to a specific application and bit-rate. Contributions to SG15 (AVC-609, 611, 613) address these issues.

SG15 also noted several concerns on how to support H.262 and MPEG-2 (AVC-606, 616, 617, 618, 619). SG13 noted that although it is desirable to have only one AAL for all video applications in real-time VBR services, including both interactive and distributive applications, it may be necessary to have more than one AAL due to different performance requirement.

(5) Work plan

Both SG15 and SG13 noted schedule of Recommendations as summarized below:

- SG15 will produce a frozen text of H.22X at its March 1995 meeting.
- SG13 will produce a frozen text of I.363.x at its July 1995 meeting.

Since the next SG13 meeting is scheduled in November 1994 and there is no interim activity until such a meeting, all results of SG15 discussions will be input to SG13 November 1994 meeting.

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ANNEX-6
to AAL1&2 Report

SOURCE : Q.6 (AAL1&2) / SG13

TITLE : Proposed Liaison to SG 15 (ATM Video Group), SG9 and ISO/IEC MPEG (for information)

SUBJECT : Video signal transport in ATM networks

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This is to inform you that SG13 received positive confirmation from both SG15 and SG9 on error correction method for delay sensitive services (a short interleaver method), whose description was sent by SG13 at the July 1993 meeting. It was also noted that the both SG15 and SG9 agreed to use the same binary primitive polynomial of RS code, i.e., $x^8+x^7+x^2+x+1$, for error correction methods for both loss and delay sensitive services. The revised text on the description of the short interleaver method is attached to this Liaison. Also attached to this Liaison is a status report on the AAL1&2 support for video signal transport in ATM networks, which is an updated version on the issues being discussed, and summary of study status from network viewpoints.

Attachment-1: Appendix-2 to ANNEX-1 of the AAL1&2 report.
Attachment-2: ANNEX-5 to the AAL1&2 report

2.5.2.4.2 Correction method for delay sensitive services

a) Characteristics of the method

The method combines FEC using Reed-Solomon codes and octet interleaving of data. The size of the interleaver is 16 cells, the interleaving matrix has 8 rows and 94 columns. The method utilizes Reed-Solomon (94, 88) codes. The erasure mode is used for the correction of dummy octets corresponding to cell loss locations. Reed-Solomon codes to be used are built over Galois Field (256), and the generator polynomial is given by :

$$\prod_{i=0}^{5}(x-\alpha^{i+k}),$$

where α is a root of the binary primitive polynomial $x^8+x^7+x^2+x+1$, and κ is the base exponent of the generator polynomial with $\kappa=120$.

A diagonal interleaving mechanism is used to decrease the processing delay of the method. In the interleaver, the writing mode and the reading mode are alternate. The process in the interleaver is continuous, i.e., only one interleaver is necessary at each end. See Figure X1/I.363.x for structure of the short interleaver matrix.

	88 octets	6 octets
1	data	FEC
2		
8		

FIGURE X1/I.363.x
Structure of the short interleaver matrix

b) Operation at the transmitting end

RS codes for a row are calculated prior to writing in the interleaver. The writing order in the interleaver is horizontal. The reading order is diagonal. The process is operated octet by octet. Let a (i,j) be a coefficient (i.e. an octet) in the matrix, where i is the row number and j the column number. Then the sequence of coefficients to be read out of the matrix diagonally is as follows :

... , a (i+1,j-1) , a (i,j) , a (i-1,j+1) , ...

The format and organization of the interleaver is given in Figure X2/I.363.x.

writing order ⟶

A1	A2	A3	...	A93	A94	A95
B1	B2	B3	...	B93	B94	B95
C1	C2	C3	...	C93	C94	C95
D1	D2	D3	...			
E1	E2	E3	...			
F1	F2	F3	...			
G1	G2	G3	...	G93	G94	G95
H1	H2	H3	...	H93	H94	H95

FIGURE X2/I.363.x
Format and organization of the short interleaver matrix

For a correct reading order of the diagonal mechanism, a virtual column is added (Number. 95). It is used only for counting, it does not contain any information and it is not transmitted. It is mentioned in "parentheses" in the following sequences only to permit a good understanding of the reading order. Examples of 47 octets sequences that are read out of the interleaver are given hereafter :

...
seq. k : (B95), A1,H2,G3, ... , A9, H.10, ... , A17, ... , A25, ... , A33, ... , A41, ... , C47.
seq. k+1 : B48, A49, H50, ... , B56, ... , B64, ... , B72, ... , B80, ... , B88, ... , D94.
seq. k+2 : (C95), B1, A2, H3, G4, ... , B9, ... , B17, ... , B25, ... , B33, ... , B41, ... , D47.
seq. k+3 : C48, B49, A50, ... , C56, ... , C64, ... , C72, ... , C80, ... , C88, ... , E94.
seq. k+4 : (D95), C1, B2, ... , C9, ... , C17, ... , C25, ... , C33, ... , C41, ... , E47.
...

Operation at the beginning of the communication

At the beginning of the communication, the reading of the interleaver begins, before it is completely filled up. The reading process begins as soon as the first octet has been written in the interleaver. As a result, in the first SAR-PDUs of the communication, only some octets carry valid information. Other octets contain dummy information as they correspond to positions in the interleaver which have not yet been filled. The communication begins as follows (X : dummy octets) :

1st SAR-PDU : A1, X ... X, A9, X ... X, A17, X ... X, A25, X ... X, A33, X ... X, A41, X ... X.
2nd SAR-PDU : X, A49, X ... X, A57, X ... X, A65, X ... X, A73, X ... X, A81, X ... X, A89, X ... X.
3rd SAR-PDU : B1, A2, X ... X, B9, A10, X ... X, B17, A18, X ... X, B25, A26, X ... X, B33, A34, X ... X, B41, A42, X ... X.

The first SAR-PDU to be completed with valid octets is number 15.

Operation at the end of the communication

At the end of the communication, the transmitting interleaver is read out until it gets completely empty. Some data of the transmitting interleaver will be transmitted twice, which has no action in the receiving interleaver where they will be stored a second time in positions that have already been read out, and which will be interpreted as dummy positions.

c) Operation in the receiving end

The mechanism in the receiving interleaver is the inverse of that of the transmitting interleaver, i.e. the writing order is diagonal and the reading order is horizontal. For the reading, the rule is the following : when the interleaver has been filled up with 14 SAR-PDUs, then the reading process is started for the first row.

d) Delineation of the interleaver

~~For the delineation of the 16 cell interleaver, the CSI could be used. However~~, As the process is continuous in the interleaver, there is no real start of the interleaver. Only the even or odd value of the sequence number is necessary in the receiving CS to know if the corresponding SAR-PDU begins respectively with a coefficient numbered 1 or with a coefficient numbered 48.

e) Performance

Correction capabilities of this method are:

- one cell loss occurrence in the group of 16 cells
- 3 errored octets in a row of 94 octets.

The overhead of the method is 6.38 %.

Processing delay imposed by this method is as follows:

The following calculation of the processing delay takes into account both the transmitting and the receiving ends. Let D be the processing delay corresponding to a horizontal/ vertical processed interleaver. Due to the diagonal mechanism, for a given row of the interleaver, the distribution of the delay is following :

- for the first octet of the interleaver the delay is approx. null in the transmitter and approx. D in the receiver
- for the last octet of the interleaver the delay is approx. D in the transmitter and approx. null in the receiver.

As a result, for a given octet the total delay is D. Examples of values are given for the total processing delay. Processing delays are: 14.7 ms for 384 kbit/s, 3.67 ms for 1536 kbit/s, 2.93 ms for 1920 kbit/s.

ANNEX-5
to AAL1&2 Report

Status Report on AAL1&2 (AAL Types 1 and 2) for video signal transport

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1. Introduction

Studies have been carried out between SG13, SG15 ATM Video Coding Experts Group and SG9 (formerly CMTT) on AAL1&2 for video signal transport through Liaison documents and the IVS (Integrated Video Services) Baseline Document. This document is an updated version on the issues being discussed, and summarizes the status of study from network viewpoints.

2. AAL1

2.1 Error protection

In the March 1993 version of I.363, SG13 specifies the method of correcting lost cells and bit errors in a cell payload, namely the long interleaver method, for distributive services according to requirement by SG9. At its July 1993 meeting, SG13 also developed an error correction method for delay sensitive services, namely the short interleaver method, based on Liaison documents from SG15 and SG9. These two methods are summarized below:

(1) Long interleaver method

- 128-cell interleaving matrix with (128, 124) RS code, and vertical reading at the transmitter.
- Error correction: 4 cell loss within 128 cells, 2 cell loss and 1 errored octet in each row of 128 octets, 2 errored octets in each row if there is no cell loss.
- Delay including both ends at AAL1-SAP: 2x124 cells, i.e., 2.65 ms (34 Mbit/s) and 2.01 ms (45 Mbit/s).

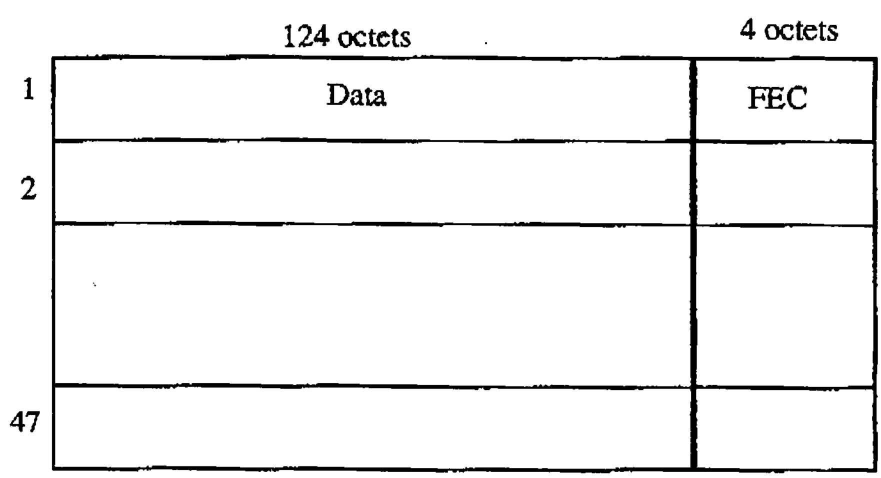


Fig. 1 Long interleaver method with vertical reading

(2) Short interleaver method

- 16-cell interleaving matrix with (94, 88) RS code, and diagonal reading at the transmitter.
- Error correction: 1 cell loss within 16 cells, or 3 errored octets in each row of 94 octets.
- Delay including both ends at AAL1-SAP: 14.7 ms (384 kbit/s), 3.67 ms (1536 kbit/s), 2.93 ms (1920 kbit/s).

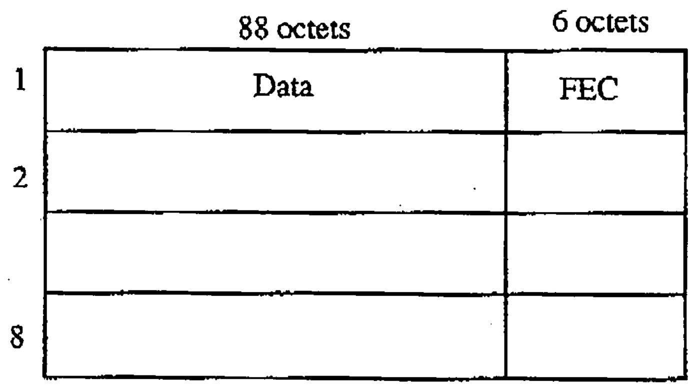
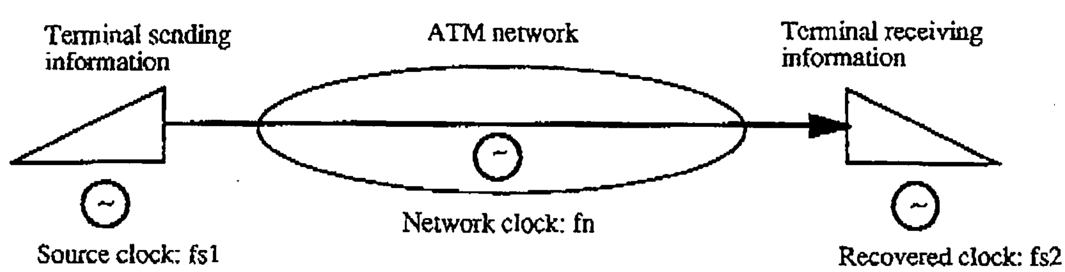


Fig. 2 Short interleaver method with diagonal reading

2.2 Source clock frequency recovery for asynchronous circuit transport

The term asynchronous, when applied to a CBR service, means that the bit clock of the CBR source at the ingress AAL1-SAP is not locked to a network clock. Recommendation I.363 specifies two methods whereby this source clock frequency can be recovered at the egress AAL1-SAP. The two methods are SRTS and adaptive clock.

The SRTS method, however, itself requires that a common network clock be available at the sending and receiving AAL1 entities. SG 13 is studying the issue of extending the SRTS method to a plesiochronous environment, i.e., an exact common clock is not available at both ends, and where CPE does not know the exact clock situation between two ends. Such a case is typical in international networks and a network comprising public and private networks.



Note: Source clock frequency recovery makes fs2 equal to fs1, where fs1/fs2 is not frequency locked to fn.

Fig. 3 Source clock frequency recovery of AAL1

3. Support of MPEG-2 signal transport over ATM network

It was reported that SG9 has a plan to study transport of MPEG-2 signals over an ATM network for digital TV distribution services, according to requirements from ITU-R SG 10 and

11. The AAL1&2 group has the following consensus:

- when MPEG-2 Transport Stream (TS) is supported by CBR services of an ATM network for digital TV distribution services, it is adequate to use AAL1 with/without a long or short interleaver method depending on error protection and delay requirements. The exact method of source clock frequency recovery of the AAL1 to be used also needs to be assessed.

- when MPEG-2 is supported by VBR services, the group wishes to have as much communality between H.262/H.22X and MPEG-2 as possible. TS may not be appropriate due to its redundancy with ATM functionality. A collaborative study with SG9 and SG15 (ATM Video Group) will be taken.

4. AAL2

4.1 Functions of H.22X

Fig. 4 depicts possible protocol stack of AAL2 and higher layers. AAL2 referred to hereinafter is AAL to support class B services, as defined in I.362. It is assumed that H.22X will support the following functions:

- Audiovisual multiplexing, i.e., multiplexing video, voice and data in terms of H.32X system aspects.
- Synchronization between higher layers, e.g., between video and voice.

In addition, support of CPE-to-CPE (in-channel) signalling (i.e., H.24X) may be provided by H.22X.

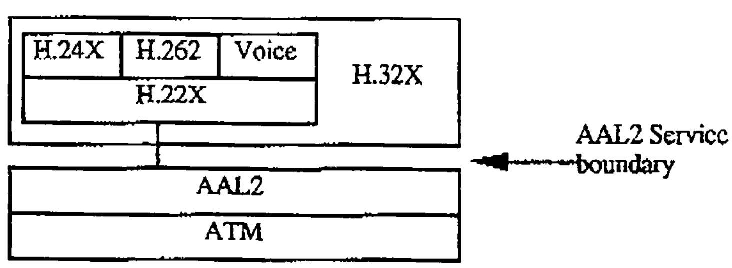


Fig. 4 Protocol stack of AAL2 and higher layers

4.2 Objectives of AAL2

The objectives of AAL2 are:

- to support interactive video/audiovisual applications, e.g., H.32X, in VBR services,
- to support distributive video applications in VBR services (ffs), and
- to maintain future expandability to support other possible applications.

4.3 Functions of AAL2

The following paragraph gives candidate functions and considerations regarding AAL2.

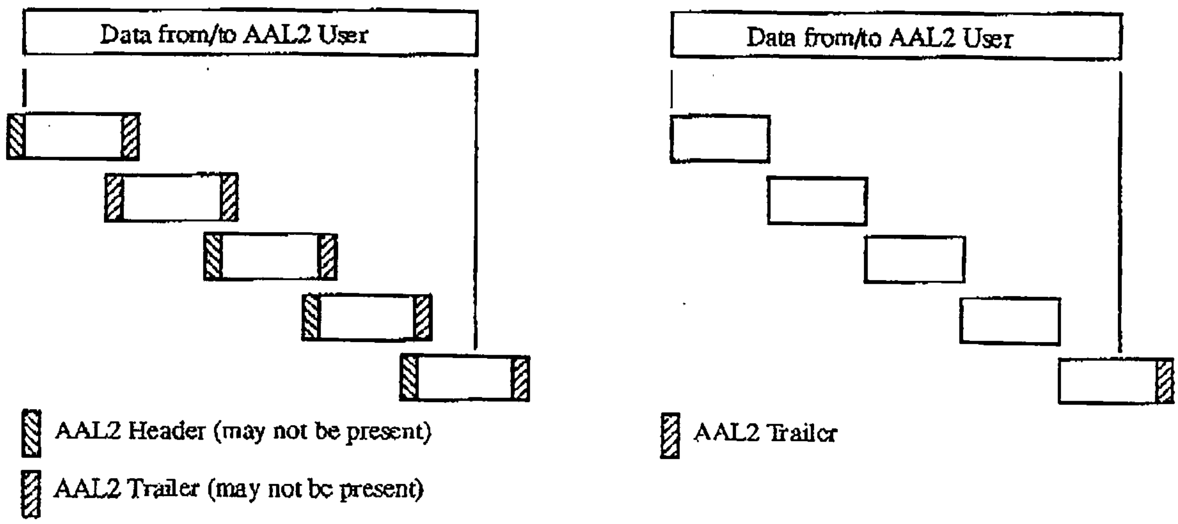
(1) Framing of H.22X data: cell-by-cell or packet with trailer

Since data exchanged between H.22X and AAL2 is variable length, AAL2 supports framing of such data. There are two alternatives for framing methods:

- cell-by-cell approach like AAL1, 3/4, and
- variable packet with trailer like AAL5.

When the packet method is adopted, protocol overhead will be reduced compared to the cell-by-cell method. It is anticipated, however, that in the packet method, a delay variation is introduced at the receiver due to variable waiting time, i.e., the receiver needs the whole packet for its trailer operation, and then passes the valid packet to H.22X.

In the following items (2) and (3), the two methods are further compared in terms of error protection functions and ATM user-to-user indication.



(1) Cell-by-cell method

(2) Variable packet method

Fig. 5 Two methods of framing AAL2 user data

(2) Error protection: detection only or detection/correction

The need for an error protection function in AAL2 and the required performance should be addressed. The error protection capability of AAL1 can be used for assessing this issue in AAL2, which is described in section 2.1 of this document. Will AAL2 have to support:

- detection of cell losses?
- detection of bit errors of the cell payload?
- correction of cell losses?
- correction of bit errors of the cell payload?

SG13 needs answers from SG15 on this issue. Performance requirements of error protection capabilities also need to be clarified. Such performance requirements may depend on a specific application with a specific bit-rate, for example:

- 30 minutes error free for video conference with 1.5 - 10 Mbit/s?
- Two or three hours error free for video program transmission with 10 - 20 Mbit/s?
- Others?

One possible method for supporting correction of both cell losses and bit errors is the use of FEC and octet interleaving as specified in AAL1. Those methods may require a cell-by-cell AAL2 header such as sequence numbering, e.g., to detect positions of lost cells/octets in an interleaving matrix. It should be noted that correction of lost cells will be achieved more efficiently in AAL, as compared to higher layers.

(3) Handling of ATM user-to-user indication

An AAL2 user is able to use two information streams on a cell basis by using the ATM user-to-user indication in the cell header. Moreover, each information stream may be utilized with a cell-by-cell based cell loss priority. Use of the ATM user-to-user indication is not possible when an AAL5-like method is adopted.

(4) Handling of Cell Loss Priority

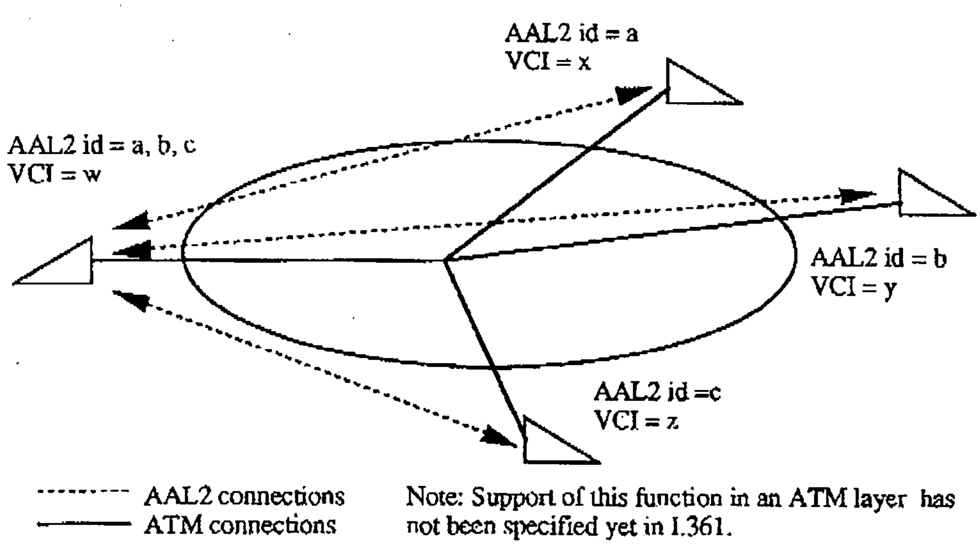
This function will allow an AAL2 user to use cell-by-cell based CLP. AAL2 should support mapping of this information between the AAL2 user and the ATM layer.

(5) Timing/synchronization issues

A study should be directed to clarify timing/synchronization issues in VBR services with real-time constraints. Issues to be addressed include: 1) what timing relationship should be supported between a transmitter and receiver at AAL2-SAP? and 2) can the effect of cell delay variation be removed at the receiver side of AAL2-SAP?

(6) Multiplexing of information

Although H.22X will provide for multimedia multiplexing of audio-visual services, support of multiplexing in AAL2 needs to be examined as possible advancement for future standardization. One possible use of AAL2 multiplexing is to support multipoint-to-multipoint connections as depicted below.



Note: Support of this function in an ATM layer has not been specified yet in I.361.

Fig. 6 An example of multipoint-to-multipoint configuration over AAL2/ATM
