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SOURCE : Japan
TITLE : Relation between MPEG-2 transport mux and ATM/AAL and possible candidates for AAL
PURPOSE : Information and Discussion
Relevant sub-group: System

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1. Introduction

This document discusses the relation between MPEG 2 transport mux and AAL, and also discusses some possible candidates for AAL. We assume here that bit error ratio is sufficiently low, thus only bit error detection is necessary.
Specific discussion points are as follows;

1. Is a mechanism necessary to send some control information associated with pure video bitstream?
2. Is it fatal if other cells (or bits) constituting a packet are also lost when a cell loss occurs?
3. Is PES packet adequate for audiovisual communication?
4. Is it adequate to use TS Packet in ATM environment?

2.MPEG 2 Transport Mux [1]

In MPEG 2 transport mux, video and audio elementary streams are packetised and Packet Headers are added. These packets are called PES (Packetised Elementary Stream) Packets. PES packet header is similar to that of MPEG 1 systems packet header. Then PES packet is segmented into TS (Transport Stream) packets. PES packet length may be variable and relatively long, for example several or several tens kByte. On the other hand, TS packet length is fixed and relatively short (Note).

Note; MPEG Systems Ad Hoc will recommend a single normative transport packet length among three options (132, 188 & 236 Byte) at the New York Meeting [2].
(Annex 1 shows possible AALs to carry the TS packet.)

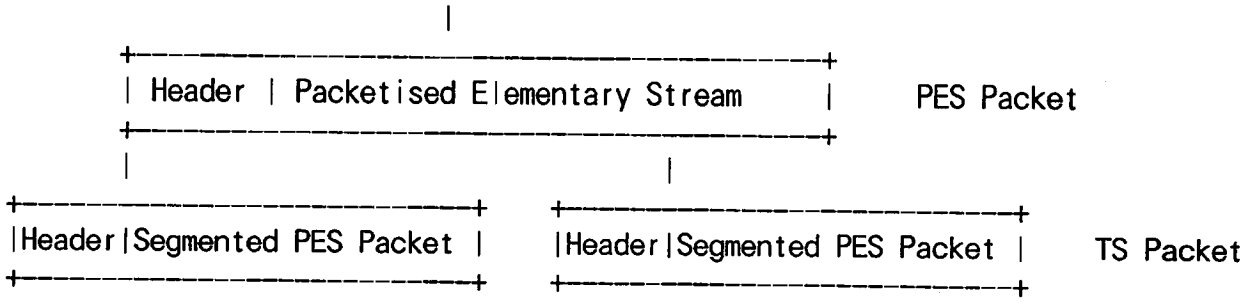


Table 1 PES Packet Header

name	status	bits	purpose
1) packet_start_code_prefix	(mandatory)	24	; PES packet synchronization
2) stream_id	(mandatory)	8	; elementary stream identification

3) Packet Length	(mandatory)	16	; demarcation
4) scrambling_control_flags	(option)	2	; scrambling indication
5) vital_data_flag	(option)	2	; priority
6) packet_continuity_counter	(option)	8	; packet loss detection
7) elementary_SCR	(option)	32	; Clock Reference for each elementary stream
8) ES_rate	(option)	22	; required decoder resource indication
9) STD_buffer_scale,size	(option)	1,13	; required decoder resource indication
10) PTS&DTS	(option)	32,32	; video and audio synchronization, recovery of video and audio source clocks

Table 2 TS Packet Header

name	status	bits	purpose
1) sync_byte	(mandatory)	8	; TS packet synchronization
2) packet_error_detection	(mandatory)	1	; error indication
3) PES_start	(mandatory)	1	; PES packet header indication
4) priority	(mandatory)	1	; priority
5) PID	(mandatory)	13	; multiple channels support
6) scrambling_control_field	(mandatory)	2	; scrambling indication
7) adaptation_field_flag	(mandatory)	2	; contents of TS packet
8) continuity_counter	(mandatory)	4	; packet loss detection

The use of the 2 bit adaptation_field_flag is as follow ;

0 0	Reserved
0 1	Payload only
1 0	Adaptation Header only
1 1	Adaptation Header & Payload

3. Requirement for video transmission in audiovisual communications

In this section we would like to discuss the requirements for video transmission in audiovisual communication.

[Discussion Point 1]

Is a mechanism is necessary to send some control information associated with pure video bitstream?

[Opinion]

We believe that some mechanism is necessary, because high quality audiovisual communication may require PTS&DTS and scrambling indication.

[Discussion Point 2]

Is it fatal if other cells (or bits) constituting a packet are also lost when a cell loss occurs?

[Opinion]

When cell loss rate is low, it is not always fatal. It depends on the required video transmission quality.

4. Relation between TS mux and audiovisual communication

4.1 Consideration of TS mux

(1) PES packet

If some mechanism is required to send control information associated with pure video bitstream [Discussion Point 1], commonality between MPEG 2 systems and systems for audiovisual

communications is preferable for video service integration.

[Discussion Point 3]

Is PES packet adequate for audiovisual communication?

[Opinion]

Demerits of using PES packet may be the following two points;

- PES packet may include some redundant data for audiovisual communication.
- PES packet may increase the transmission delay.

However, the overhead of PES packet is small and PES Packet header can be easily created by software. Delay is controllable by choosing the PES packet length.

On the other hand, if all video services use PES Packet, PES Packet can work as an interchange unit for different video services. It may be preferable for video service integration.

(2) TS packet

Mr. Dunstan shows two scenarios to transmit PES packets [3] .

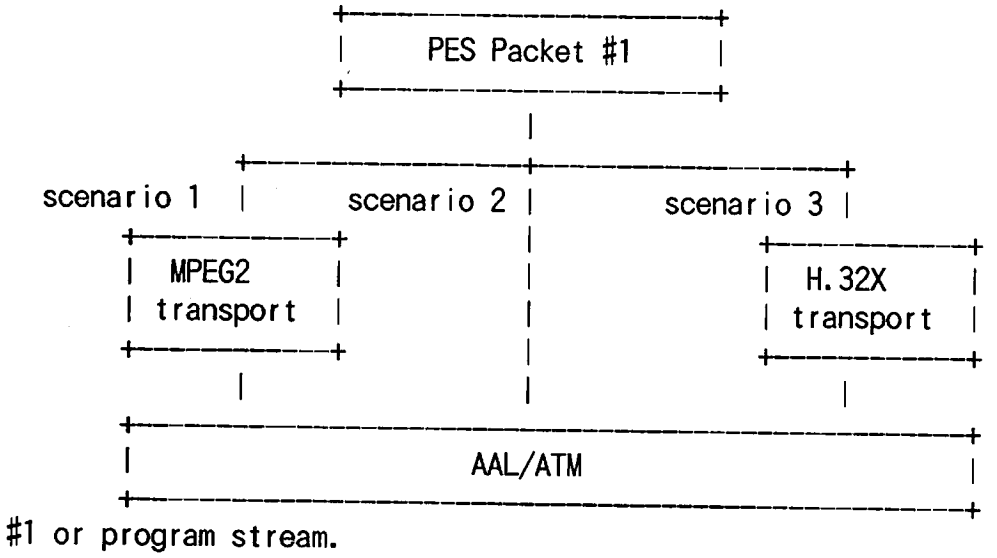
1) TS packet serves some purpose in a H.32x terminal; use of ATM/AAL as a bearer service i.e. bit pipe for TS packet.
2) TS packet serves no purpose in a H.32x terminal; then AAL takes place of TS packet.

We would like to add the third scenario;

3) H.32X transport mux takes place of TS packet; use ATM/AAL as a bearer service i.e. bit pipe for H.32X transport packet.

The difference between TS Packet and H.32X transport packet is

- H.32X transport packet supports variable length.
- H.32X transport packet length or number of packets per second should be restricted for the purpose that it can be supported by software.



#1 or program stream.

[Discussion Point 4]

Is it adequate to use TS Packet in ATM environment?

[Opinion]

Mr. Dunstan pointed out that scenario 1 is at the moment a bad idea[4]. There are two problems to use TS packet.

- It represents two stages of segmentation, one from the PES layer to transport packets, and a second from transport packets to ATM cell payloads. Moreover, TS packet length and cell payload length

are too close. It means that two stages hardware is necessary.

- TS packet can not support variable length. On the other hand, PES packet length may not always be multiple of TS Packet payload length (e.g. retrieval service) Thus last PES packet may include padding Bytes. When a TS packet containing the PES Packet header is lost, there is no method to remove these padding Bytes.

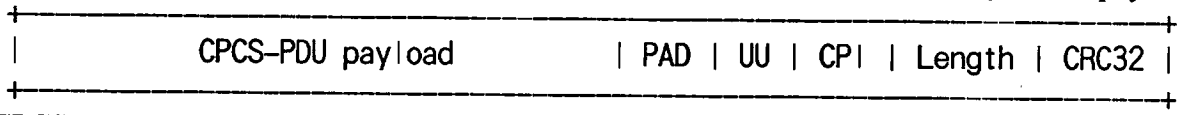
On the other hand, whole PES packet loss may sometimes causes serious problems. Then scenario 3, defining H.32X transport layer may be a possible candidate. If H.32X transport packet is supported by software, it may not be the problem even if two stage segmentation is involved.

4.2 Possible candidate AALs for audiovisual communication

We would like to discuss scenario 2 and scenario 3. Scenario 2 and 3 require AAL to transmit variable length data. There are two choices against occurrence of transmission error;

1) to discard whole PES packet (scenario 2) or H.32X transport packet (scenario 3)
   -> AAL type 5
   When QOS is low, PES packet or H.32X transport packet should be shorter.

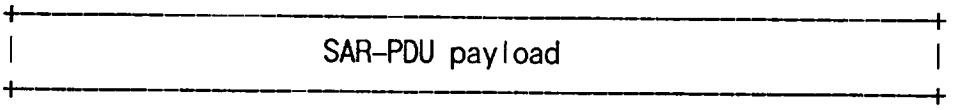
CPCS (Common Part Convergence Sublayer) -PDU length is multiple of 48 Byte (cell payload).



CPCS-PDU payload; PES packet or H.32X transport packet in our case

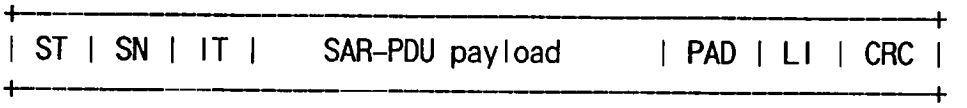
PAD	; Padding	(0-47 Byte)
UU	; User-to-User Indication	(1 Byte)
CPI	; Common Part Indicator	(1 Byte)
Length	; Length of PES packet or H.32X transport packet	(2 Byte)
CRC32	; Cyclic Redundancy Check	(4 byte)

One bit user to user indication in ATM header allows to identify the end of CPCS-PDU.



SAR-PDU payload; segmented CS-PDU (48Byte)

2) to discard only errored cells and pass all other cells to video decoder.
   -> Old AAL type 2
   Correctness of payload is checked cell by cell.



ST	; beginning, continuation and end of H.32X transport packet	(2 bits)
SN	; detection	(4 bits)
IT	; information type	(2 bits)

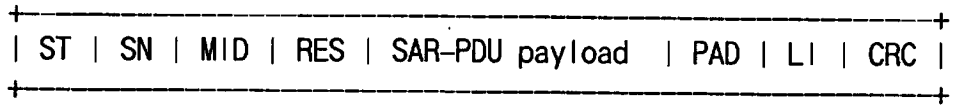
SAR-PDU payload; segmented PES packet or H.32X transport packet in our case (<45 byte)

PAD	; Padding	(0-43 Byte)
LI	;Length of segmented PES packet or H.32X transport packet	(6 bits)
CRC	; Cyclic Redundancy Check	(10 bits)

For multimedia communication via one VC, media identification is necessary. IT in old AAL

type 2 is only 2 bits long and insufficient for audiovisual communications where more than 4 media are likely to be involved. AAL type 4 SAR is one possible candidate.

-> AAL Type 4 SAR modified



ST ; beginning, continuation and end of PES packet or H.32X transport packet (2 bits)

SN ; cell loss detection (4 bits)

MID ; Media Identifier (? bits)

10 bits in original but audiovisual communication may not require 10 bits.
MID has the same functionality with stream_id in PES packet, but this redundancy is justified if video service integration is take into consideration.

RES ; Reserved

not included in the original AAL type 4 SAR. Total of MID and RES should be 10 bits.

SAR-PDU payload; segmented PES packet or H.32X transport packet in our case (<44 byte)

PAD ; Padding (0-43 Byte)

LI ; Length of segmented PES packet or H.32X transport packet (6 bits)

CRC ; Cyclic Redundancy Check (10 bits)

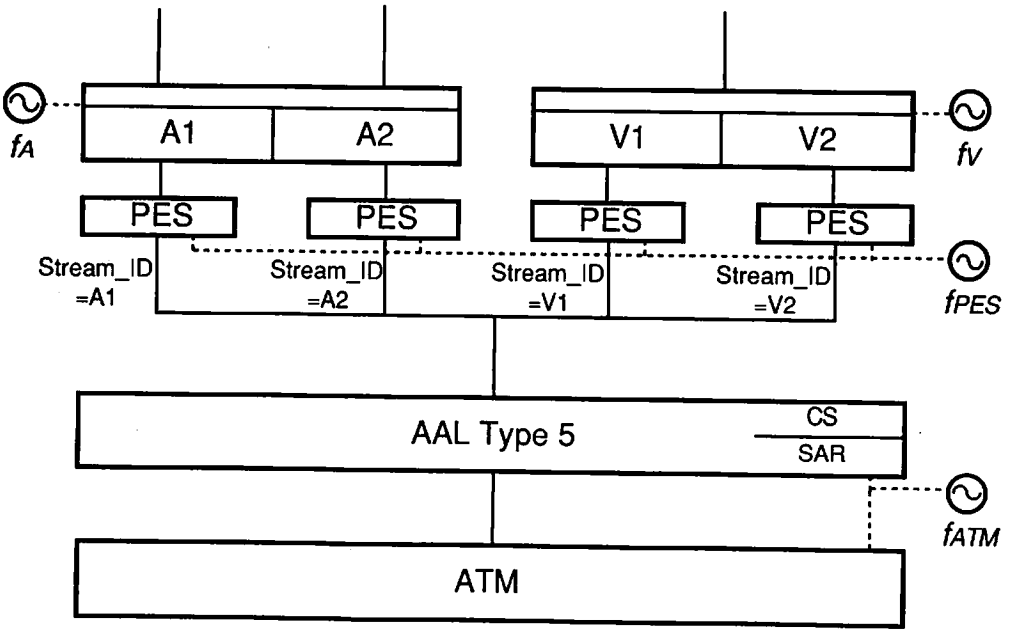
5. Implication for audiovisual communication

a) scenario a ; (scenario 2 + AAL type 5)

1) Respective elementary streams are segmented into PES packets.
2) PES packets are transferred by using AAL type 5.
3) A whole PES packet is lost when transmission error occurs.
5) Upper layer can detect loss of data when the sequence number becomes discontinuous.

Characteristics;

Suitable when QOS is high and bit rate is high.



b) scenario b ; (scenario 3 +AAL type 5)

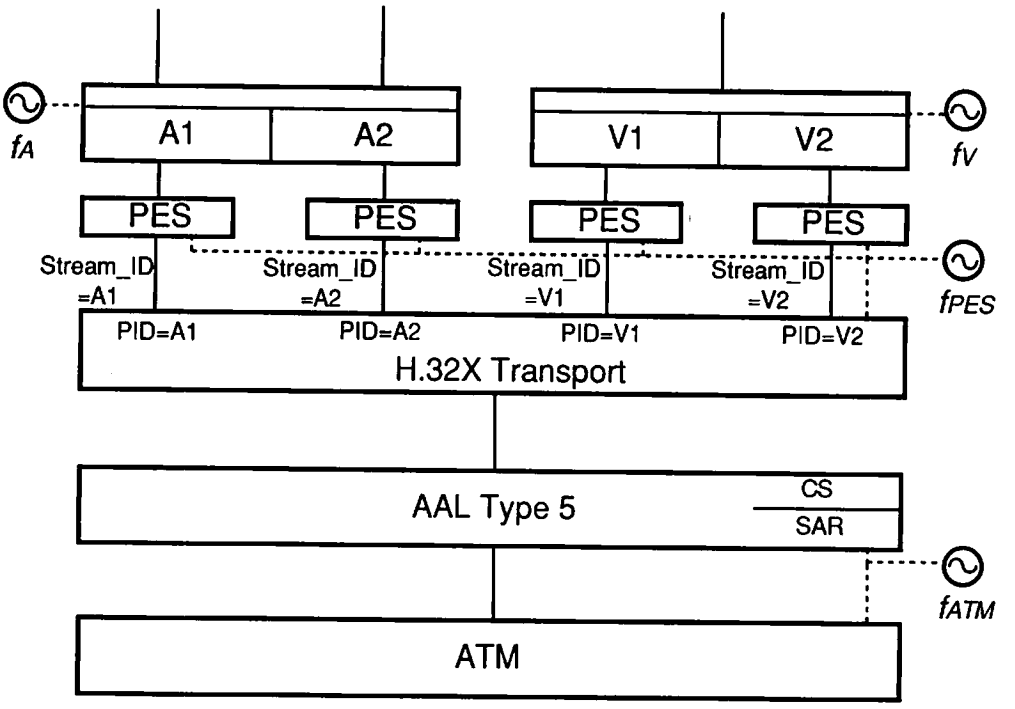
1) Respective elementary streams are segmented into PES packets.
2) PES packet is re-segmented into H.32X transport packets.
Note; Mandatory fields for H.32X transport Packet Header are shown in Table 3.

Table 3 An example of H.32X transport Packet Header

name	status	bits	purpose
1) PID	(mandatory)	?	; multiple channels support
PID has the same functionality with stream_id in PES packet, but this redundancy is justified if video service integration is take into consideration.			
2) PES_start	(mandatory)	1	; PES packet header indication
3) continuity_counter	(mandatory)	4	; packet loss detection

3) H.32X transport packets (scenario 3) are transferred by using AAL type 5.
4) A whole H.32X transport packet is lost when transmission error occurs.
5) Upper layer can detect loss of data when the sequence number becomes discontinuous.
Characteristics;

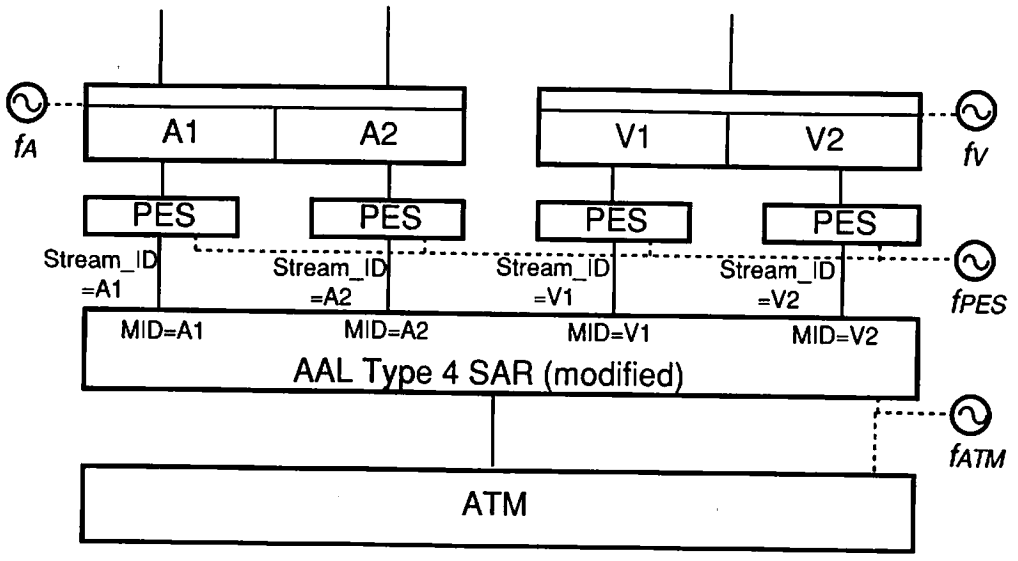
When high transmission efficiency is necessary, H.32X transport packet should be long. On the other hand, when shorter packetising delay and higher cell loss resilience are necessary, H.32X transport packet should be short. This scenario can be adaptable for different QOS.



c) scenario c ; (scenario 2 + (modified) AAL type 4)
1) PES packets are transferred by using AAL type 4 SAR modified.
2) AAL detects cell losses by sequence number and also detects bit errors by CRC.
3) Upper layer can be notified loss of data by indication of AAL.
Characteristics;

Decoder can use data cell by cell. Then, transmission delay is short and propagation of cell loss effect is limited in one cell. On the other hand, usable cell payload is shorter than 44 Byte and transmission efficiency is always lower than scenario a.

This scenario is suitable when QOS is low and communication is delay sensitive.



6. Communication procedures

One example of procedure for broadband multimedia communication via one VC is shown in Annex 2. It should be noted that AAL is designated as a part of outband signaling.

7. Conclusion

The relation between MPEG 2 TS mux and ATM/AAL is discussed. Several discussion points are listed up. Use of PES packet may be preferable for video service integration. On the other hand, use of TS packet may not be good idea because it requires two stage segmentation by using hardware. To adapt different QOS, the idea of H.32X transport packet may be a good solution. The differences between TS packet and H.32X transport packet is that H.32X transport packet;

- can support variable length and can support different QOS.
- can be implemented by software.

Three scenarios are shown.

- PES packet is directly transferred by using AAL type 5.
  suitable for high QOS.
- PES packet is segmented into H.32X transport packets which are transferred by using AAL type 5.
  adaptable for different QOS.
- PES packet is transferred by using (modified) AAL type 4 SAR.
  suitable for low QOS.

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[1] MPEG 2 Systems Working Draft, Page 32, 11 June 1993.

[2] Joseph B. Stampleman; 'MPEG Systems Ad Hoc Meeting, Amsterdam ', MPEG systems group e-mail, Mon., 14 June 93.

[3] S. Dunstan; 'AAL and MPEG Systems proposal', MPEG systems group e-mail, Tue, 11 May 93.

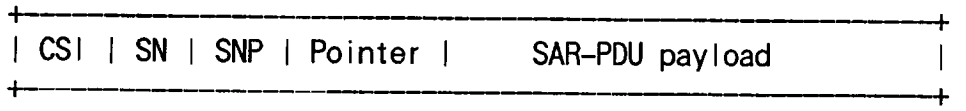
[4] S. Dunstan; 'MPEG 2 Systems and ATM/AAL', MPEG systems group e-mail, Wed, 9 June 93.

[5] Japan; 'Relation between MPEG-2 transport mux and ATM/AAL', Document AVC-464, 23 March 93.

Annex1; Possible candidates for AAL to carry TS packet

1. TS packet is asynchronous to cell

TS mux is assumed for constant bit rate. AAL type 1 may be the solution. Pointer can be used to indicate the position of TS packet start.

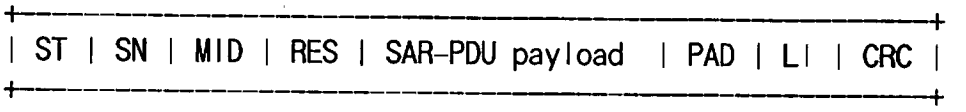


CSI ; existence of pointer	(1 bits)
SN ; cell loss detection	(3 bits)
SNP ; sequence number protection	(4 bits)
Pointer; indication of structure (option)	(8 bits)
SAR-PDU payload; segmented TS packet	(46 or 47 Byte)

2. TS packet is synchronous to cell

(1) TS packet length is 132 Byte.

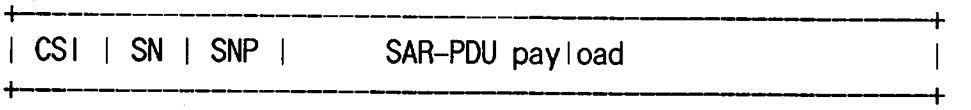
AAL type 4 SAR may be suitable. (same situation with scenario c)



ST ; beginning, continuation and end of TS packet	(2 bits)
SN ; cell loss detection	(4 bits)
MID ; Media Identification	(? bits)
RES ; Reserved	
SAR-PDU payload; segmented TS packet	(<45 byte)
PAD ; Padding, in this case always 0	(0-43 Byte)
LI ; Length of TS packet	(6 bits)
CRC ; Cyclic Redundancy Check	(10 bits)

(2) TS packet length is 188 Byte. (There is another solution. see (3).)

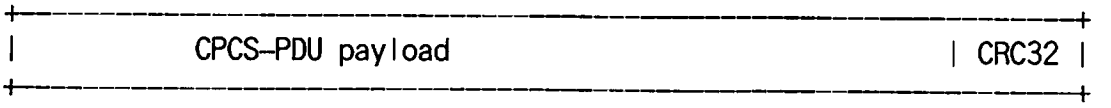
CSI in SAR header or one bit user to user indication in ATM header is used to indicate the end of CPCS-PDU. This AAL is similar to AAL type 1.



CSI ; end of TS packet	(1 bits)
SN ; cell loss detection	(4 bits)
SNP ; sequence number protection	(4 bits)
SAR-PDU payload; segmented TS packet	(47Byte×4 cells=188 Byte.)

(3) TS packet length is 188 or 236 Byte.

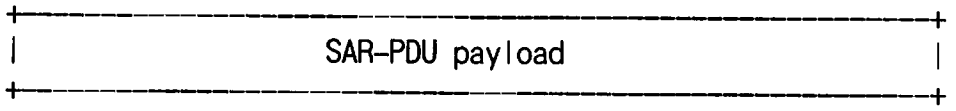
The following AAL may be suitable. This AAL is similar to AAL type 5 but has no functionality to support variable length.



CPCS-PDU payload; TS packet	(48Byte×4 cells−4Byte= 188 Byte , 48Byte×5 cells−4Byte=236 byte)

CRC32 ; Cyclic Redundancy Check (4 byte)

One bit user to user indication in ATM header allows to identify the end of CPCS-PDU.



SAR-PDU payload; segmented CS-PDU (48Byte)

Annex 2; Procedure for multimedia communication via one VC

1) call setup
   calling side calls as follows;
      HLC ; H.32X terminal
      AAL ; type 5 or modified type 4 SAR
      Bit rate ; bitrate in range of H.32X standardization.
      QOS ; required QOS.
   called side or network may change bitrate and/or QOS when there are not sufficient resources.
   Default or minimum bitrate should be standardized.
2) Audio communication starts
      Audio communication starts with default audio algorithm and multiplexing identification (scenario a; stream_id, scenario b; PID, scenario c; MID).
      These default should be standardized by H.32X.
3) Negotiation starts
      multiplexing identification for negotiation should be standardized by H.32X.
      By using this multiplexing identification, algorithm, bitrate and other parameters are negotiated.
      If bitrate change is necessary as a result of negotiation, signaling should be done.
4) Multimedia communication starts
5) When user wants to change media and/or bitrate, negotiation is repeated.