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TITLE : H.32X terminal and MPEG-2 Systems

PURPOSE : Discussion

## 1. INTRODUCTION

In the interest of service integration there is a desire within WPXV/1 to use MPEG-2 Systems syntax within the B-ISDN audio-visual terminal [1]. However MPEG-2 Systems may have overlapping functionality with that of the ATM layer and the ATM Adaptation Layer (AAL) of the B-ISDN Protocol Reference Model [2]. Work is therefore required to find a satisfactory distribution of functionality between MPEG-2 Systems in the Higher Layer, and an as yet unspecified AAL, that is suitable for real time, variable bit rate audio-visual services.

In this document

- an overview of the H.32X terminal is presented
- AAL functionality for an audio-visual terminal is proposed
- data flow in the H.32X terminal is illustrated by example
- MPEG-2 Systems functionality is identified, and
- some scenarios of MPEG 2 Systems, are presented.

## 2. H.32X AUDIO VISUAL TERMINAL

The H.32X audio visual system, and the relevant recommendations, are illustrated in Figure 1 [1].

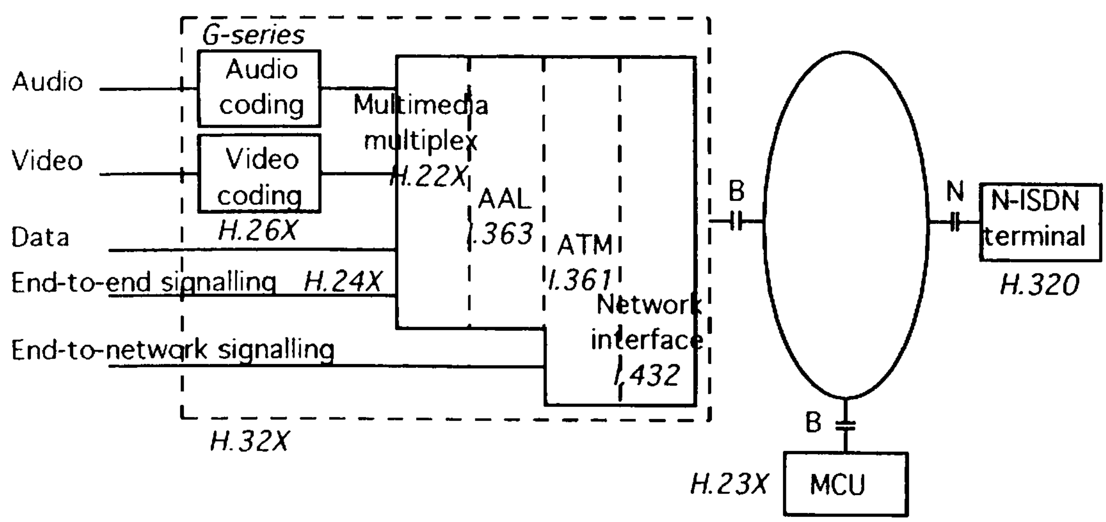



Figure 1. Audiovisual communication terminal and system configuration.

The issue to be addressed in this document is the distribution of functionality between H.22X and I.363 i.e. the ATM Adaptation Layer. MPEG-2 Systems is a candidate for H.22X.

## 3. AAL FOR REAL TIME AUDIO-VISUAL SERVICE

This section discusses nominal functions in an AAL for real time, variable bit rate audio-visual services, supposing that H.22X were not available. In this sense it is an AAL with full functionality.

Appendix 1 contains part of a formal definition of an AAL that satisfies requirements identified here.

### 3.1. Multiplexing

The attributes of media multiplexing at the

- user layer,
- CS sublayer
- SAR sublayer, and the
- ATM layer,

have been addressed in earlier work [3][4]. Table 1, Annex 6 of [5] summarises the characteristics of each layer multiplex. ATM layer, or virtual channel, multiplexing is viewed as the long term goal, when B-ISDN functionality can support such calls [6].

A multiplexing capacity within the terminal is therefore required to satisfy current requirements, and perhaps as an option in the longer term. A choice exists as to whether the multiplexing should be done within the AAL, or as a user multiplex.

*user multiplex* Table 1, Annex 6 of [5] lists the H.221 bit multiplex approach, or the MPEG System multiplex approach as suitable candidates for a user multiplex. The former places many media into one cell, which may not be desirable, while the latter cannot guarantee that different media will be in different cells, unless the user layer has complete knowledge about how data is handled within the AAL, including knowledge of payload sizes.

*AAL multiplex* a cell can be guaranteed to carry only one media. CS multiplexing is a packet based multiplex. SAR multiplexing is a segment based multiplex and for a reasonable multiplex capacity may have a large overhead.

Table 1 lists the different multiplex methods in terms of increasing multiplex delay.

| multiplex method | delay | layer |
|---|---|---|
| bit | none | User |
| segment | low | SAR, ATM |
| packet | depends on packet size | CS, User |

Table 1. Multiplex methods and delay

For the AAL described here CS sublayer multimedia multiplex is proposed.

### 3.2. Transfer of timing information

If AAL type 2 is to be generic, then like AAL type 1, it requires the optional capability to transfer information to enable regeneration of a clock at the receive terminal, which is locked to the send terminal. In the AAL proposed here, a field in the CS-PDU header is provided to transfer timing information. The field may not need to be included within every CS-PDU header. The actual mechanism of clock regeneration is not described here.

### 3.3. Error localisation

The AAL proposed here maps the data from one video slice to one AAL-SDU, and the data from one audio frame to one AAL-SDU i.e. an ATM cell payload carries data from only one video slice, or one audio frame. In this case the video slice header occurs at the start of the CS-PDU payload, and the trailing SAR-PDU payload may be only partially filled.

This mode of operation ensures that one error does not propagate beyond an interval of one video slice.

AAL-SDUs carrying data from more than one video slice may also need to be considered.

### 3.4. Delivery of errored AAL-SDUs

In AAL types 3/4 and 5 in Recommendation I.363 two peer-to-peer operational procedures, known as *assured* and *non-assured* operation are specified. These procedures relate to whether a corrupted AAL-SDU is delivered to the AAL user, or whether it is corrected by retransmission.

Retransmission is considered not to be an option for real time services.

For audio visual services an errored AAL-SDU *should* be delivered to the AAL user, provided information regarding error *location* can be determined within the AAL, and is made available to the AAL user. Information regarding the nature of the error may also be useful i.e. bit error or cell loss.

An option is whether data following the first error location should also be delivered. If an AAL-SDU carries data from more than one slice then resynchronisation can occur within the AAL-SDU. In this case data following an error should also be delivered.

### 3.5. Preservation of AAL-SDUs

Given the above requirements the following mechanisms are proposed,

*CS-PDU length field* required to indicate the length in octets of the user payload within the CS-PDU. Padding is proposed to fill out the CS-PDU to an integral number of SAR payload lengths.

*sequence number* a sequence number field in the SAR-PDU header is proposed to detect cell loss. The sequence number determines the position of the lost cell within the CS-PDU.

*segment type* to assist in reconstruction of the CS-PDU at the receiver a segment type field is proposed. The differences between two and three segment types, and the interaction with other error protection fields, needs to be considered.

*error detection* it is proposed to handle bit error detection over the whole CS-PDU.

There may be other mechanisms which can achieve the same functionality.

### 3.6. AAL-SDU inter arrival time and length

The following possibilities exist regarding the length of AAL-SDUs, and the time interval between consecutive AAL-SDU arrivals at the AAL-SAP,

*case A - fixed length, fixed interval*

This case corresponds to constant bit rate, which may be served by AAL type 1 or AAL type 2.

*case B - fixed length, variable interval*

This might represent the case where rate control is done outside the AAL and the delay through the AAL is constant. An AAL-SDU might correspond to an ATM cell payload.

*case C - variable length, fixed interval*

In this case the AAL may be able to assist in the timely delivery of AAL-SDUs at the receiver. Rate control of AAL-SDUs is required at the ATM-SAP.

*case D - variable length, variable interval*

The most general case.

In this AAL proposal case C is chosen as the mode of operation for AAL-SDUs at the AAL-SAP. This also serves case A mode.

### 3.7. Model for rate control

ITU-TSS Recommendation I.371 addresses traffic and congestion control in B-ISDN. The following summary can be made,

*Traffic parameter* qualitative or quantitative specification of a particular traffic aspect. Currently only peak cell rate is defined.

*Traffic descriptor* a list of *traffic parameters* which can be used to describe traffic characteristics of a source and an ATM connection.

*Traffic contract* defined at the TB reference point by the source traffic descriptor, the requested Quality Of Service, and the maximum cell delay variation tolerance allocated to the customer equipment.

*Connection Admission Control (CAC)* a set of actions taken by the network at call or connection set up, which ensure that sufficient network resources are available to support the call, or connection, at the required Quality Of Service (QOS), and to maintain the QoS of existing calls.

*Usage Parameter Control (UPC)* a set of actions taken by the network to monitor and control traffic during the call, so that the traffic contract agreed to at connection set up is not violated, and which validate virtual path and virtual channel identifier values.

With respect to traffic control, it is assumed that rate control at the sending terminal is preferable to UPC intervention of the traffic flow. The rate control algorithm at the sending terminal must therefore match the UPC algorithm, so that cell dropping by the UPC is avoided.

The peak cell rate is mandatory in any source traffic descriptor. Table 2 shows how peak cell rate is defined for a virtual path connection and a virtual channel connection.

| | |
|---|---|
| location | Physical Layer SAP |
| basic event | request to send ATM_PDU |
| definition | inverse of minimum interarrival time of two basic events |

Table 2. Peak cell rate definition for a VPC/VCC

It may be that the Physical Layer SAP is not accessible to the terminal.

On a terminal with a single AAL, and without ATM layer OAM flows, the above definition of peak cell rate can be applied at the ATM layer SAP, with the equivalent basic event being request to send ATM-SDUs.

If the ATM-SAP is used as the location for measurement of peak cell rate, and there are multiple AALs i.e. multiple virtual channels, and/or OAM cell flows, then the maximum tolerable cell delay variation specified in the traffic contract must take this into account.

Given the above, Figure 2 is proposed as a model for rate control of a variable bit rate codec. At the sender side a control algorithm determines the rate at which ATM-SDUs are delivered to the ATM-SAP. A second control algorithm is used as feedback to the video (and audio) coder. At the receiver AAL-SDUs are delivered to the AAL user with traffic characteristics as determined by offered AAL functionality.

### 3.8. CLP bit

At times of network congestion the network discards ATM cells with the CLP bit in the ATM header set to CLP=1, before cells with CLP=0, in order to protect the CLP=0 flow as long as possible. A connection utilising the CLP capability requests network capacity for the CLP=0 flow, and the aggregate CLP=0+1 flow. Possible UPC actions for non compliant cell flows include cell discard and cell tagging i.e. CLP=0 cells get moved to the CLP=1 flow.

In view of this the rate control model of Figure 2 may require modification to show rate control of the CLP=0 stream, and the aggregate CLP=0+1 stream.

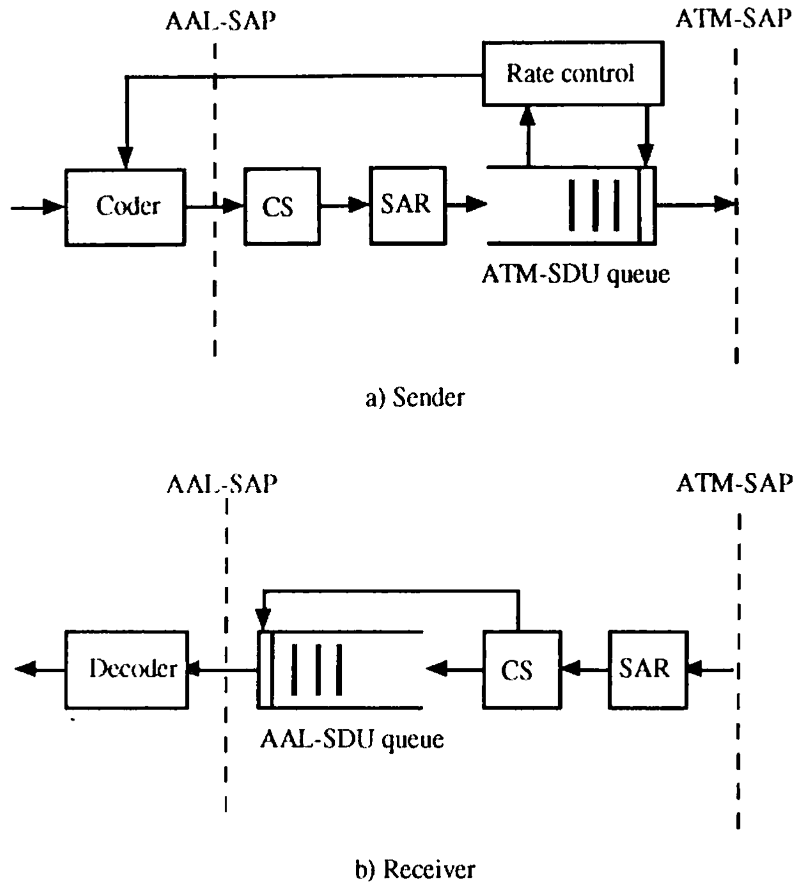



Figure 2. Proposed traffic control model.

## 4. H.32X TERMINAL EXAMPLE

Figure 3 illustrates by example, possible data flow at the send side of a H.32X terminal where H.22X is *not* used. The attempt is to show what data flow might look like, when free of constraints imposed by H.22X. The AAL of Appendix 1 provides all required functionality. (The exception is that of media synchronisation, which is assumed for the moment to be taken care of within the coders).

In Figure 3 a video coder produces two independent data streams, and an audio coder produces one. The horizontal direction shows time, while the vertical direction shows data flow for a particular slice interval. The strategy used is to map one video slice to one AAL-SDU. A packet of audio bits from the same period is also mapped to one AAL-SDU. The time between consecutive slices is fixed. Each SAR-PDU carries data from only one slice of only one medium.

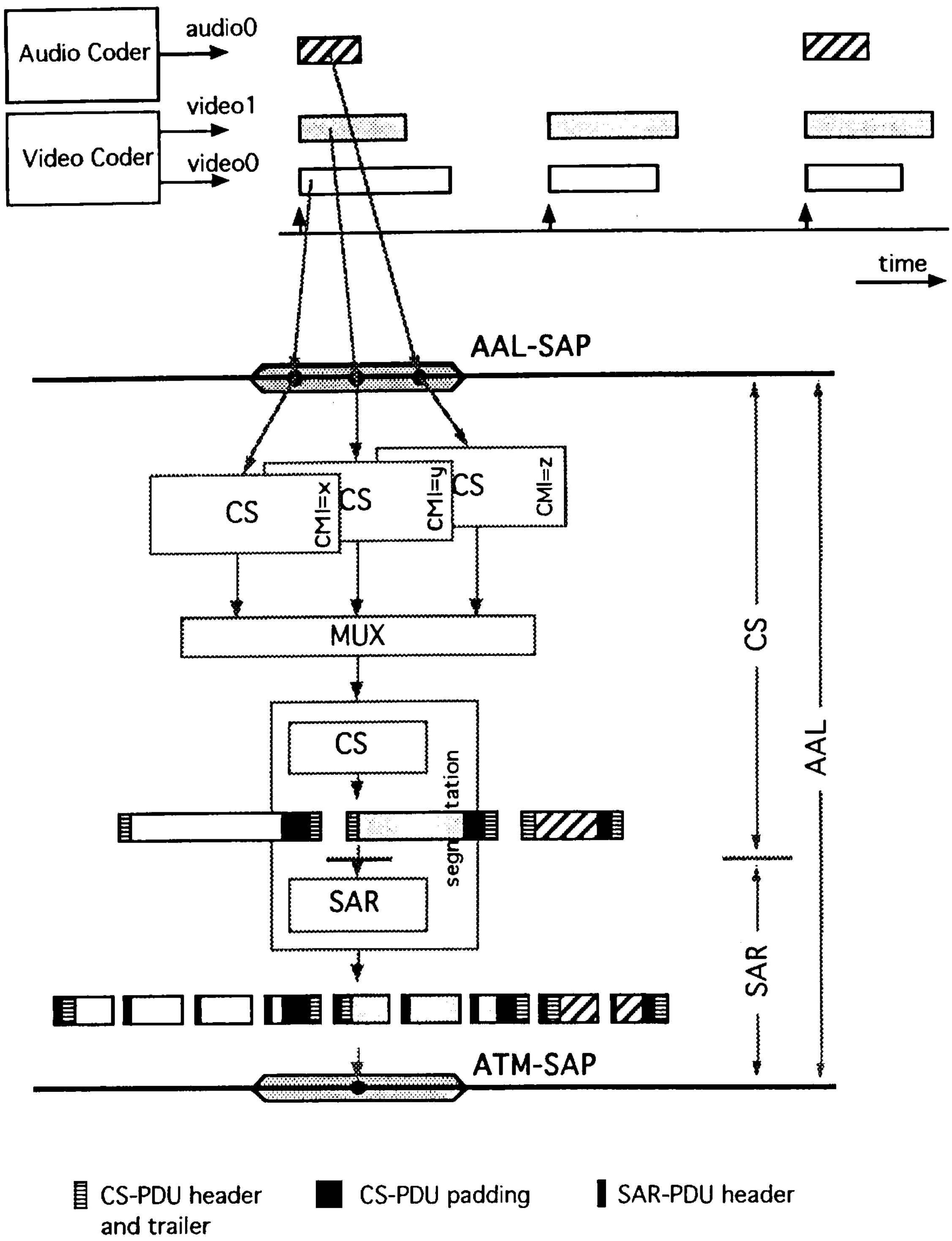



Figure 3. Illustration of data flow at sender side in H.32X terminal using AAL with full functionality.

## 5. MPEG-2 SYSTEMS FUNCTIONALITY

A summary of MPEG-2 Systems is presented here [7]. The structure of the Program Stream and the Transport Stream is shown in Figure 4. The Packetised Elementary Stream (PES) is a string of contiguous bytes from one elementary stream, be it MPEG coded video or audio, or user data, preceded by a packet header.

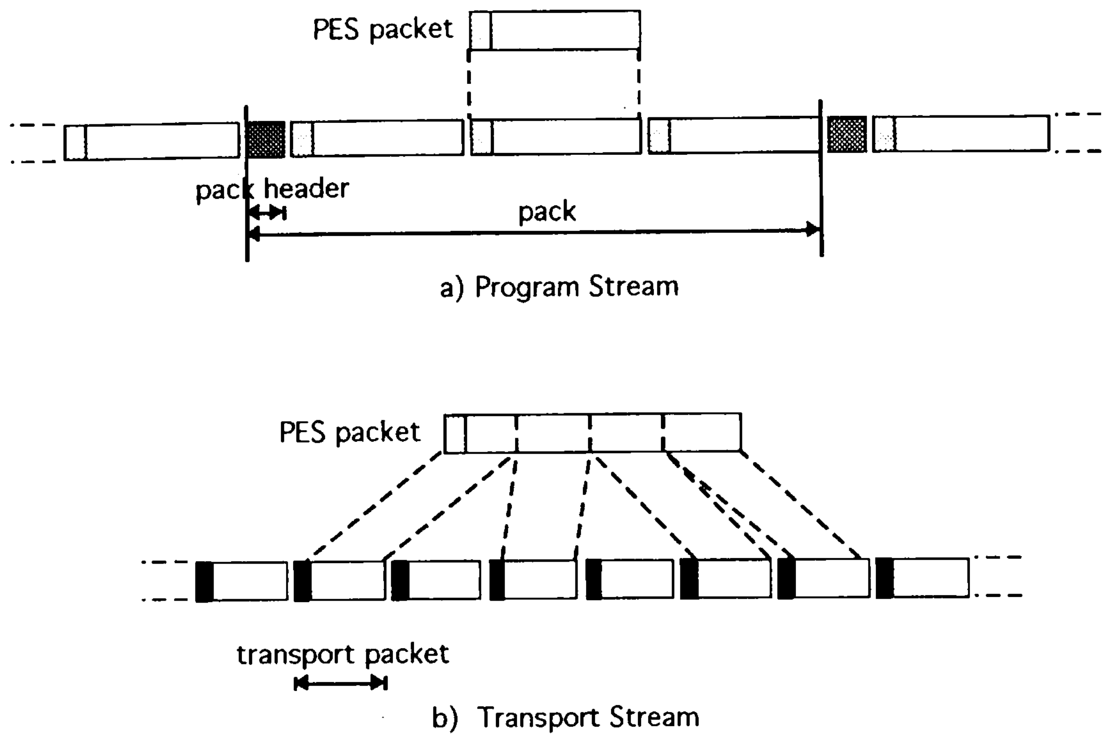



Figure 4. Structure of Program Stream and Transport Stream

It is noted that,

- the PES is used in both the Program Stream and Transport Stream.
- a fixed transport packet length is to be chosen at the New York meeting. It will be one of 132, 188, or 236 [8].

A summary of major functions and fields for the MPEG-2 System Packetised Elementary Stream, the Pack header, and the Transport Packet header is given in Table 3.

<u>Packetised Elementary Stream:</u>

- start code (24 bits)
- stream identification (8 bits)
- packet length
- scrambling
- packet continuity counter
- Elementary Stream Clock Reference
- Presentation Time Stamp
- Decoder time Stamp

<u>Pack header:</u>

- start code (32 bits)
- System Clock Reference
- mux rate
- system header:
  - global parameters

<u>Transport Packet header:</u>

- sync byte
- packet error indication
- PES start (segment type)
- priority
- packet identification (13 bits)
- scrambling
- continuity counter
- adaptation field:
  - adaptation field length
  - flags
  - Program Clock Reference

Table 3. Major functions and fields of MPEG-2 Systems syntax.

## 6. MPEG-2 SYSTEMS IN THE H.32X TERMINAL

The following sections attempt to represent data flow and the distribution of functions in the H.32X terminal, when the transport stream, the program stream, and the Packetised Elementary Stream, respectively are adopted as the basis of H.22X.

### 6.1. Transport stream

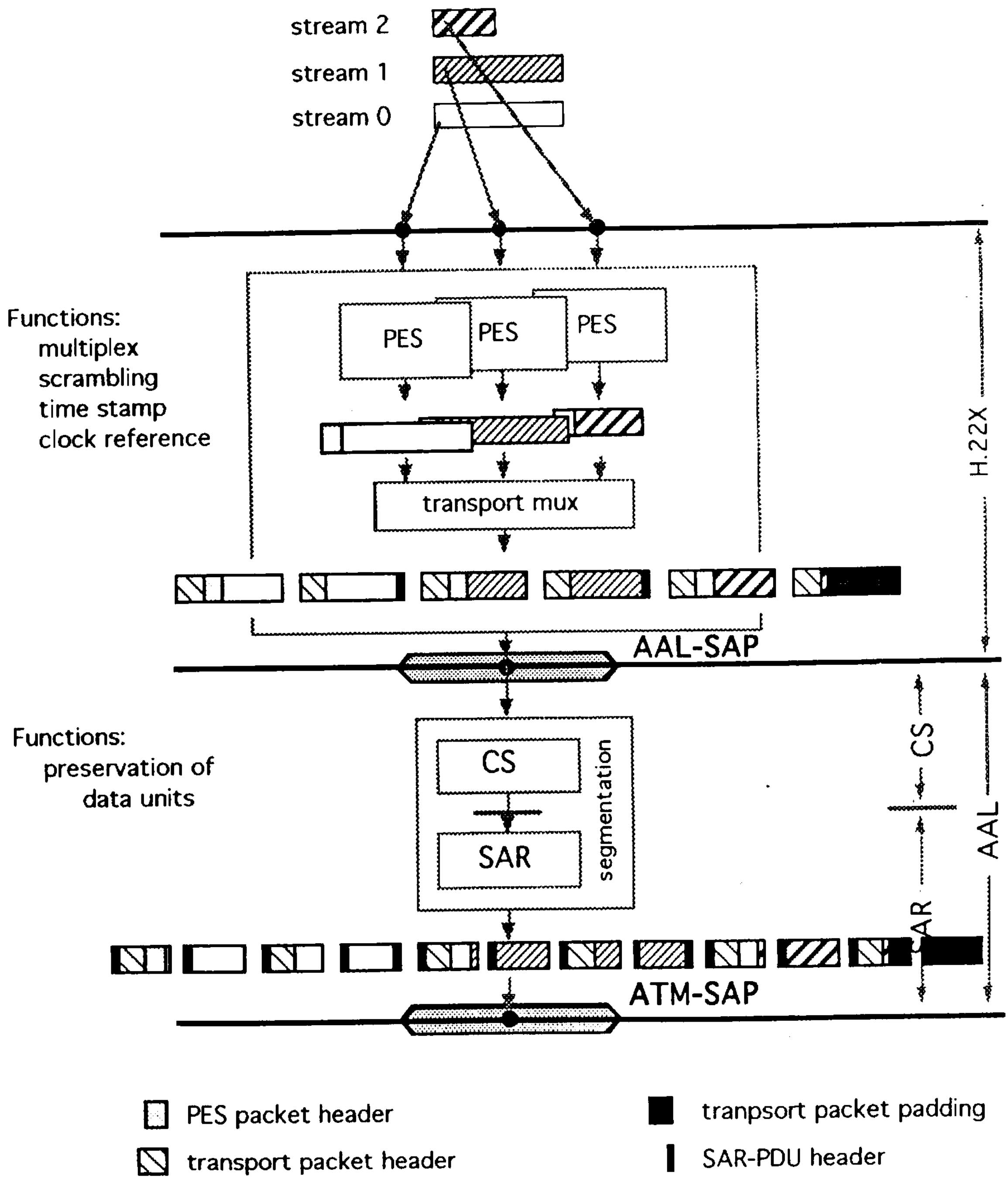



Figure 5. Representation of data flow using MPEG-2 Transport Stream in H.32X terminal.

### 6.2. Program Stream

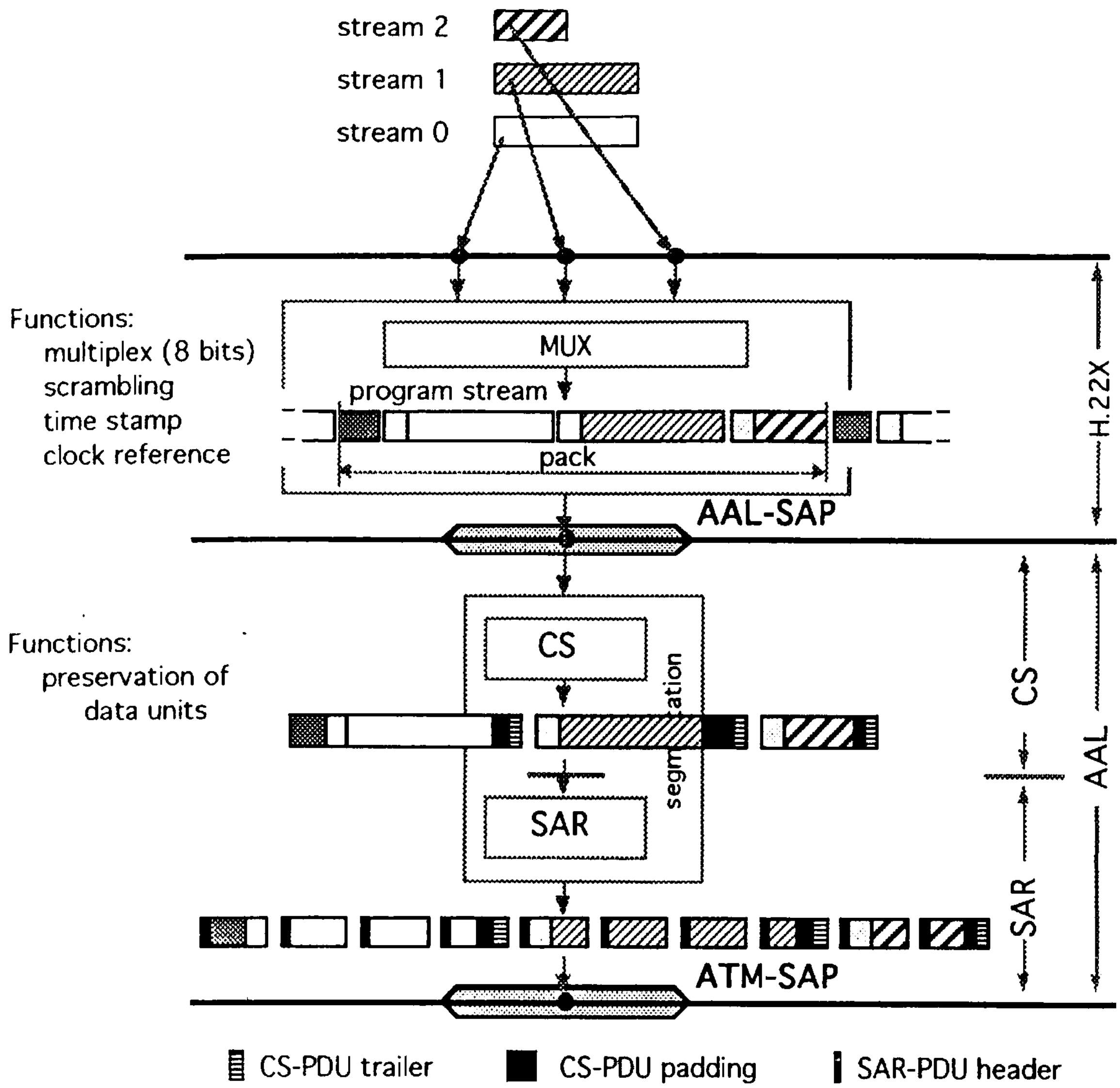



Figure 6. Representation of data flow using MPEG-2 Program Stream in H.32X terminal.

## 6.3. Packetised elementary stream

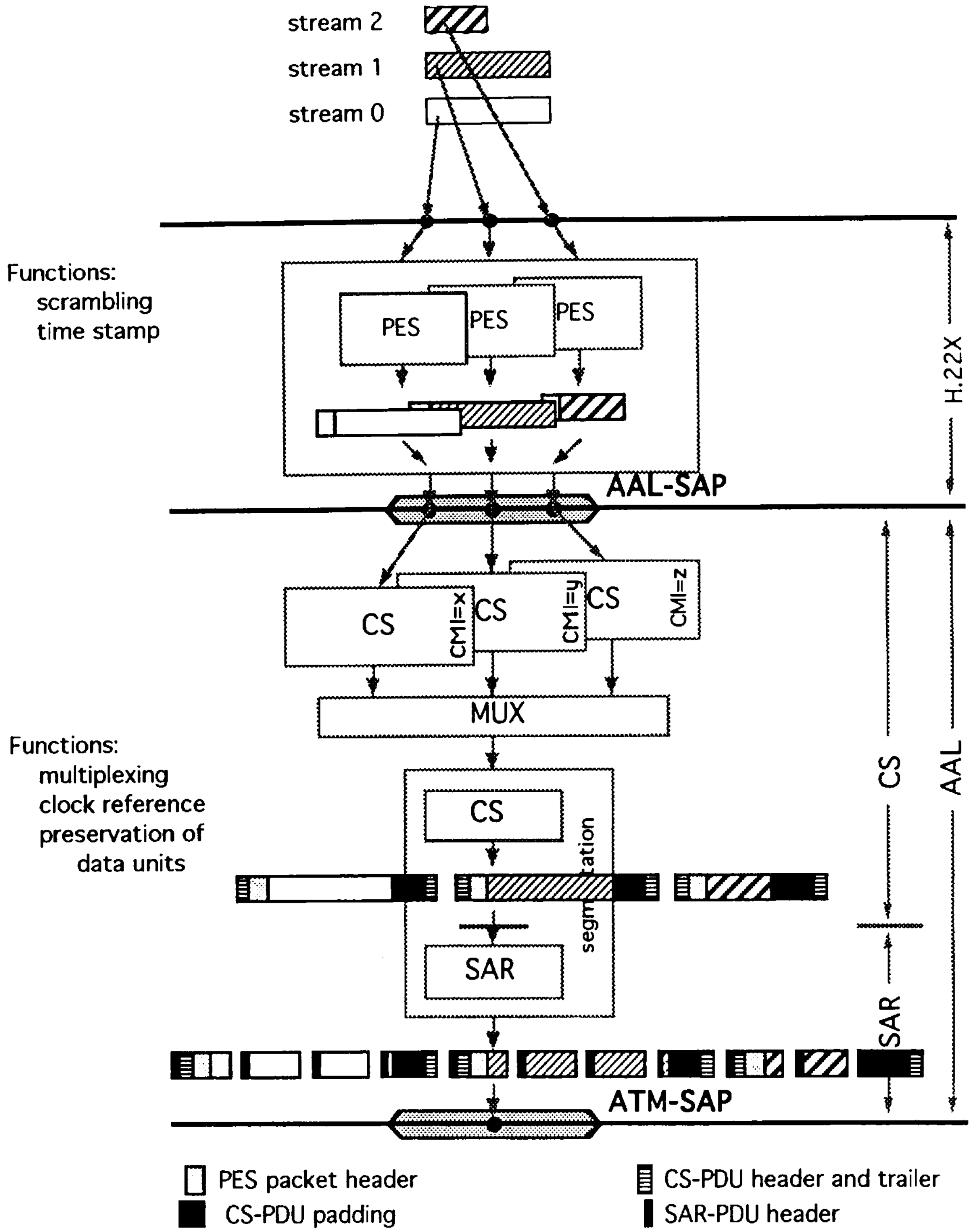



Figure 7. Representation of data flow using MPEG-2 Packetised Elementary Stream in H.32X terminal.

## 7. CONCLUSION

In this document the distribution of functions between H.22X and I.363 in the H.32X terminal have been examined. The four scenarios of a null H.22X, and use of the MPEG-2 Systems Transport Stream, Program Stream, and Packetised Elementary Stream as H.22X have been presented. No conclusion as to the optimum solution is drawn here.

A model for rate control is proposed.

Some modes of operation for an ATM Adaptation Layer for real time variable bit rate services have been discussed. In particular some specific instances of,

- error procedures as seen by the AAL user at the receiver,
- synchronisation between video structure and segmentation process, and
- AAL-SDU length and time interval between consecutive AAL-SDUs

have been discussed as possible modes of operation for a suitable AAL.

It is important to establish required AAL modes of operation before suitable mechanisms to support them are determined.

The following are identified as further work

- basis of H.22X
- additional AAL modes of operation for real time variable bit rate
- relevance of AAL type 1 to the H.32X terminal

## REFERENCES


[1] CCITT SGXV Experts Group for ATM Video Coding, "Workplan for Broadband Audiovisual Systems Recommendations", Document AVC-498, 19 May 1993.

[2] CCITT SGXV Experts Group for ATM Video Coding, "Report of the Eleventh Meeting in Sydney/Melbourne (March 27 - April 7, 1993)", Document AVC-496R, Annex 8, April 7 1993.

[3] CCITT SGXV Experts Group for ATM Video Coding, "Virtual Channels for Multimedia Support in the B-ISDN", Document AVC-39, May 1991.

[4] CCITT SGXV Experts Group for ATM Video Coding, "The ATM Adaptation Layer for Video Services in the B-ISDN", Document AVC-297, July 1992.

[5] CCITT SGXV Experts Group for ATM Video Coding, "Integrated Video Services (IVS) Baseline Document", Document AVC-448, February 1993.

[6] CCITT SGXV Experts Group for ATM Video Coding, "List of Open Issues", Document AVC-436, January 18, 1993.

[7] ISO MPEG, "MPEG 2 Systems Working Draft", 11 June 1993.

[8] ISO MPEG Systems Ad Hoc Meeting Agreements/Conclusions, Amsterdam, 12 June 1993.


# APPENDIX 1: AAL TYPE 2 PROPOSAL

## 1. INTRODUCTION

This appendix outlines an AAL type 2 for transport of multiple, variable bit rate, real time signals. The language and format of Recommendation I.363 is used.

## 2. SERVICES PROVIDED

The layer services provided by the AAL to the AAL user are:

- transfer of variable length service data units, where there is a fixed interval between consecutive data units, and timely delivery of them
- multiplexing of different information types
- transfer of timing information between source and destination
- delivery of errored service data units, with indication of error location and type.

### 2.1. Primitives at the AAL-SAP

At the AAL-SAP the following primitives are used between the AAL and the AAL user:

- AAL-UNITDATA-request (DATA [mandatory])

  Transfer of the AAL-SDU i.e. contents of the DATA parameter, from the local AAL entity to its peer entity, is requested. The length of the AAL-SDU is variable, and the time interval between two consecutive primitives is constant.

- AAL-UNITDATA-indication (DATA [mandatory] ERROR_LIST [optional])

  An AAL user is notified by the AAL that the AAL-SDU i.e contents of the DATA parameter, from its peer, is available. The length of the AAL-SDU may be variable and the time interval between two consecutive primitives should be constant.

Other cases of AAL-SDU length and consecutive AAL-SDU time intervals should be considered.

The parameters are defined as follows,

- DATA

  This parameter specifies the interface data exchanged between the AAL and the AAL user. DATA is an integral multiple of one octet.

- ERROR_LIST

  This parameter specifies a list of detected errors in the DATA parameter. An error list has the following syntax,

  *error_list:*
  *error*
  *error error_list*

  *error:*
  *error_location error_type*

  *error_location:*
  bit_pointer

  *error_type:*
  cell_loss
  bit_error

### 2.2. Primitives for the SAR sublayer of the AAL

These primitives model the exchange of information between the SAR sublayer and the CS.

SAR-UNITDATA-invoke (DATA [mandatory] SAR-LP [mandatory])

SAR-UNITDATA-signal (DATA [mandatory] MORE [mandatory])

The parameters are defined as follows,

- DATA

  This parameter specifies the interface data exchanged between the SAR and the CS. DATA is an integral multiple of 47 octets.

- SAR-LP

  This parameter indicates the loss priority for the associated SAR interface data. This parameter is mapped to the ATM layer's Submitted Loss Priority parameter at the sender side.

- MORE

  This parameter specifies at the receiver side whether the interface data is the trailing segment of the CS-PDU.

## 3. FUNCTIONS AND STRUCTURE

### 3.1. Functions of the SAR sublayer

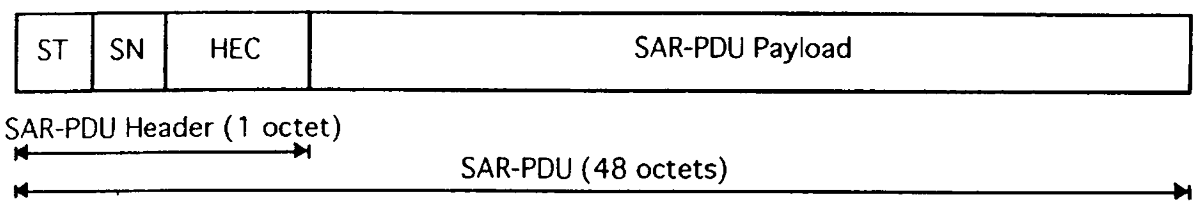
The SAR sublayer accepts variable length CS-PDUs which are integral multiples of 47 octets from the CS sublayer and generates SAR-PDUs of 48 octets in length. The SAR sublayer provides the following functions:

a) Preservation of SAR-SDU
   This function is provided by a segment type field.

b) Error detection
   This function is provided by a sequence number to detect loss or gain SAR-PDUs.

### 3.2. SAR-PDU structure

The structure of the SAR-PDU is shown in Figure 1.




ST: Segment Type
SN: Sequence Number
HEC: SAR-PDU Header Error Control

Figure 1. Structure of the SAR-PDU.

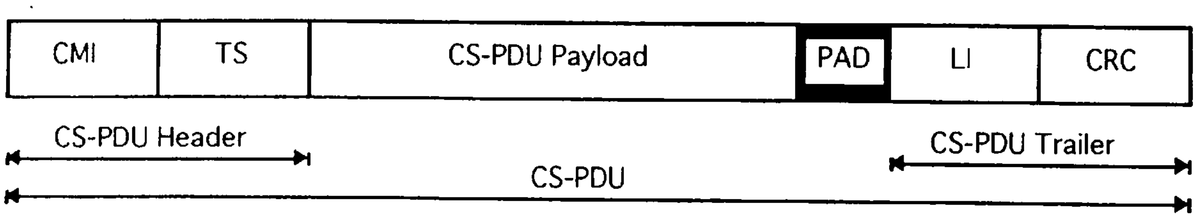
### 3.3. Functions of the CS sublayer

The functions provided by the CS sublayer include:

a) Preservation of AAL-SDUs
b) Multiplexing of AAL-SDUs from multiple connection end points
c) Source clock recovery at receiver
d) Preservation of consecutive AAL-SDU time interval.
d) Error detection and indication

### 3.4. CS-PDU structure

The structure of the CS-PDU is shown in Figure 2.




CMI: CS Multiplex Identifier
TS: Time Stamp
PAD: Padding
LI: Length Indicator of CS-PDU
CRC: Cyclic Redundancy Check

Figure 2. Structure of the CS-PDU.

## 4. FUNCTIONAL MODEL FOR THE AAL

Figure 3 and Figure 4 show functional models for the AAL described, for the sender side and receiver side respectively.

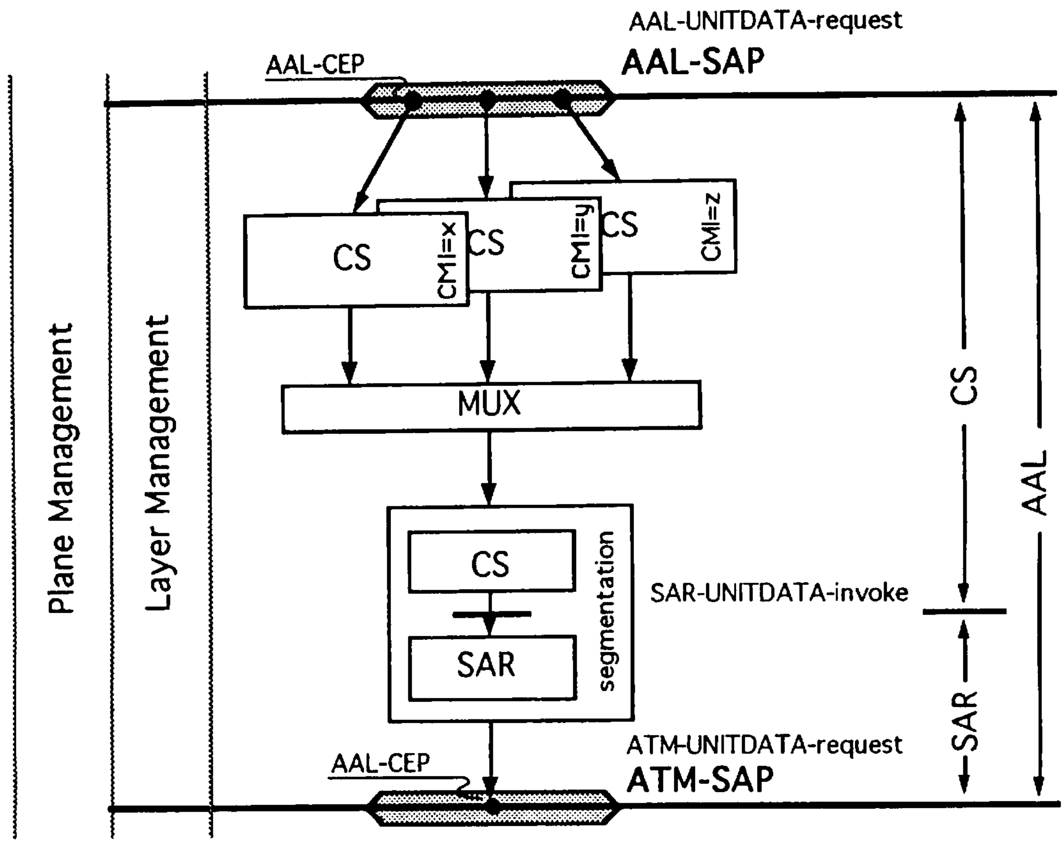



Figure 3. Functional model for the AAL (sender side).

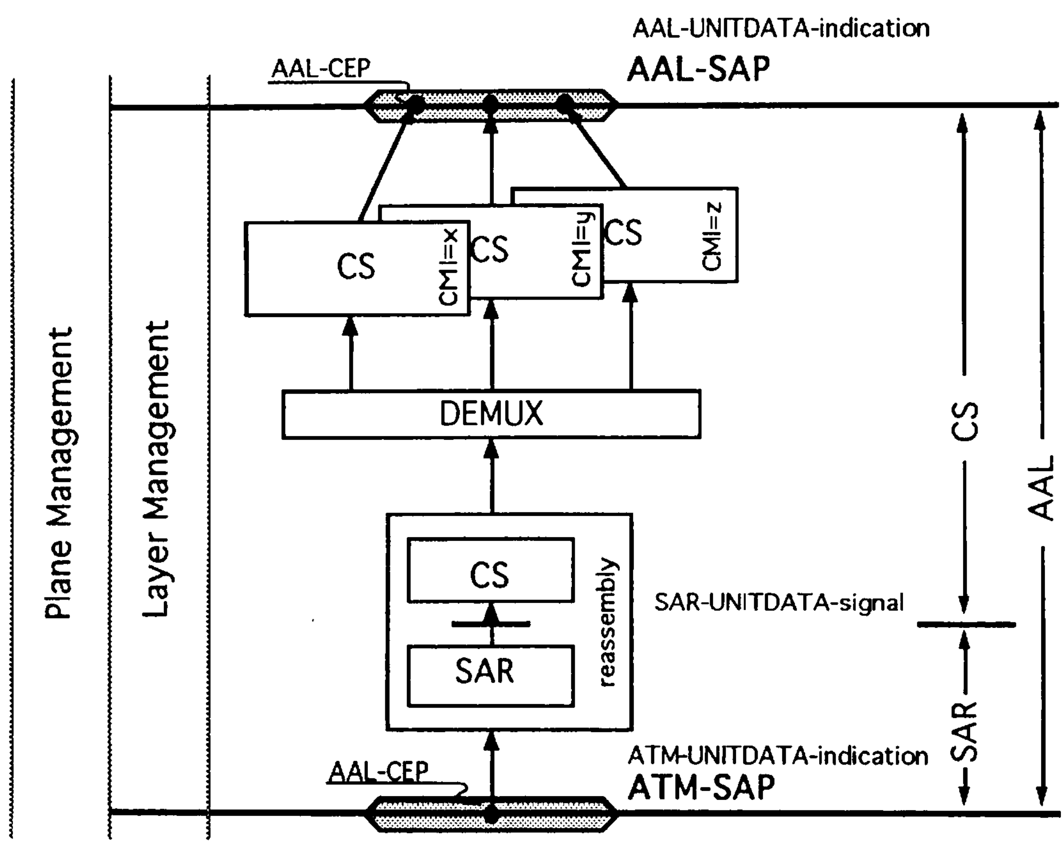



Figure 4. Functional model for the AAL (receiver side).