Telecommunications Standardisation sector
Study Group 15
Experts Group for Video Coding and Systems
in ATM and Other Network environments

Document AVC - 686
Version 1
1-4 November 1994, Singapore

Source: BT (Author: Mike Nilsson, Dave Beaumont, Geoff Morrison)
Title: An AAL for class B services
Purpose: Proposal

1. Introduction

The following describes the requirements for an AAL for class B services, that is, ones that have Variable Bit Rate (VBR) and are delay sensitive; and offers a proposal for such an AAL. The existing placeholder for such an AAL within I.363 is called AAL 2.

This document has been presented to the ATM Forum, ISO MPEG (via e-mail) and ETSI NA5, and will be presented to SG13 Q6 in November.

This proposal conforms to the prefered Class B AAL development agreed by the ETSI NA5 meeting in Stockholm on 3-7 October 1994 (i.e. an AAL Type 2 dervived from AAL Type 1).

2. Requirements of class B services

This section describes the requirements for class B services, that is, ones that are VBR but delay sensitive.

- Means should be provided for bit error and cell loss detection and correction.
- Transmission is likely to be subject to cell delay variation (CDV) that is undesirable to many applications. Means should be provided to either correct for CDV or pass CDV information to the next higher (application) layer.
- The possibility to convey structure information would be desirable in some applications, for example, in MPEG applications, to indicate the start of a MPEG transport packet.

3. Existing AALs

Two AALs have been identified as possibly being of use for class B services: AAL1 and AAL5. This section describes the capabilities of these AALs.

3.1. AAL1

This AAL is intended for real time, delay sensitive, constant bit rate services.

Indication of lost data is achieved by use of sequence count and sequence number protection in the segmentation and reassembly sub-layer. Also interleaving and FEC, which provides the capability of cell loss and bit error detection and correction, is possible, with the start of the interleave matrix indicated by the CSI bit. This can not be used if structured data is used.

The transfer of timing information for delivery of constant bit rate services is achieved through the use of SRTS conveyed in the CSI bit, in cells with odd sequence number.

Structure information is conveyed by use of the CSI bit, in cells with even sequence number, which is used to indicate the presence of the pointer in the SAR-PDU payload, which indicates the start of a data unit.

3.2. AAL5

This AAL is intended for non real time, delay insensitive, variable bit rate, data services.

This AAL provides the capability for transmission of long packets with a length indicator and CRC check at the end. These provide error protection and detection.

Means are also available to allow the transmission of long packets to be aborted before transmission is complete.

The efficiency of the AAL, in terms of bit usage, is improved when long packets are used.

4. An AAL for class B services

This section proposes an AAL for class B services. MPEG applications are referred to in this proposal solely to illustrate its principles when applied to an existing application. However, it is a specific feature of this proposal that it can support application bitstreams that do not have the same functionality as MPEG bitstreams.

4.1. Dependence on the application layer

Good design practice suggests that the definition of the AAL should be made independently of considerations for any particular potential application. For example considering the MPEG application, there is no specific need to fit exactly an integer number of transport packets into an AAL 'unit'.

Also, the AAL should not modify the application layer data. For example again in the MPEG application, the MPEG transport sync byte should never be removed at the input to the network to make room for AAL information, and then be replaced at the receive side.

4.2. Similarity with existing AALs

The description above of AAL1 and AAL5, when considered with the requirements of class B services, suggests that AAL1 is much closer to what is needed for class B services than AAL5.

The main difference between what AAL1 provides and what class B services need is that SRTS has no direct use, but some method of measuring CDV is needed. Also, the FEC and interleaver may be inappropriate for class B services: when the bit rate is temporarily low, the interleaving matrix may be partially full and cause significant amounts of delay.

An AAL for class B services could therefore be created from AAL1 by replacing the SRTS mechanism with a mechanism for measuring CDV. This would also aid the drafting of the standard as most of the text already exists in I.363 and perhaps would also allow hardware to be shared for AAL1 and the class B AAL.

Class A services, that is, ones that have constant bit rate, are a special case of class B services. Therefore, the class B AAL should also support, or be capable of supporting, class A services. An AAL derived from AAL1 will inherit this capability.

4.3. Measurement of CDV

CDV does not need to be assessed with infinite precision. The required accuracy of CDV estimates depends on the application, but an accuracy of about 1us is expected to be sufficient in most cases. For the MPEG application, the accuracy should be sufficient to support adaptation to the Real Time Interface [1][2].

CDV can be measured by sending samples of a clock at the input of the network to the output of the network, where a similar clock is present. The difference between the receiver clock and the received clock sample is a measure of the CDV. This mechanism is well known.

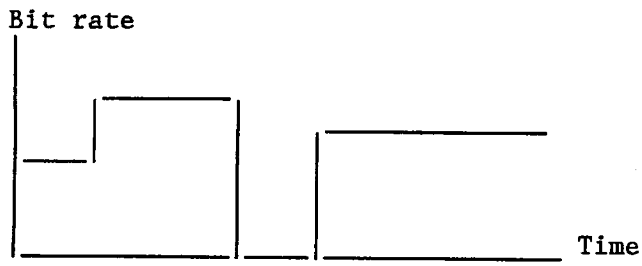
Such clock samples, or time stamps, could be samples of a counter clocked at a frequency that is available to both transmitter and receiver. If a network clock that is common to both transmitter and receiver exists, then this frequency could be a derivative of that clock, divided down to a frequency consistent with the accuracy requirements of the CDV estimate.

If a common network clock does not exist, then independent network clocks could be used. Although it is recognised that this is not perfect, independent clocks should exist that are sufficiently accurate to meet the accuracy requirements of the CDV estimate: clocks should be available that are accurate to 1 part in 10^11. The concept of Timebase Recovery as defined in [3] is what is required in this case: independent clocks at transmitter and receiver drive counters, CDV is estimated from the difference between receiver clock and received counter value, and clock frequency differences are taken into account by occasional step changes to the receiver counter.

CDV accuracy of 1us suggests a sample clock at about 1MHz. The maximum CDV is expected to be of the order of 1ms, so a counter that goes to just over 1000 is about right. Time stamps encoded as 14 bit samples of a 1MHz clock (or thereabouts) should be satisfactory.

The cell delay variation can only be deduced for cells carrying the timestamp. In practice, it may not be possible to encode a timestamp for a cell containing a particular piece of information, such as a MPEG clock reference; also, cell delay variation may be needed for every cell.

It would be possible to deduce the cell delay variation for every cell provided that information is known about the rate at which cells are put into the network [4]. It is probably valid to assume that all variable bit rate services will enter the network at piecewise constant bit rate, where the rate can change frequently and can be zero. Piecewise cell rate could be carried by the AAL. Piecewise constant bit rate is illustrated below.



Example profile to illustrate piecewise constant bit rate

4.4. Class B AAL proposal

This AAL proposal for class B services is exactly the same as the definition of AAL1 except for the following.

No SRTS information is conveyed in the CSI bit of cells with sequence number equal to 1, 3, 5 or 7.

For cells with sequence number equal to 1, 3, 5 or 7, when the CSI bit is zero, the 47 octets of the SAR-PDU payload are filled with user information.

For cells with sequence number equal to 1, when the CSI bit is one, the first two octets of the SAR-PDU payload contain the time stamp field, and the remaining 45 octets are filled with user information.

The first two bits of the time stamp field are reserved for future use. The remaining 14 bits contain a sample of a counter, Ct, driven by a clock, fnx, where fnx = fn / x, and fn is the network clock frequency, e.g. 155.52MHz, and x is an integer that is a power of two. Note: this is the same mechanism as used in AAL1 for SRTS, except that in this case the full timestamp is transmitted, while in AAL1 only the residual part is transmitted. When fn = 155.52 MHz, and x = 128, fnx = 1.22 MHz, and the counter will wrap around to zero after 13.48 ms.

For cells with sequence number equal to 3, when the CSI bit is one, the first two octets of the SAR-PDU payload contain the cell rate field, and the remaining 45 octets are filled with user information. Note: the error on the estimate of the value of the counter, Ct, for a cell without an explicit timestamp is proportional to the percentage error on the encoded value of cell rate and to the time since the last timestamp was received. The coding of the cell rate field should therefore be defined on a logarithmic scale, so that the percentage error due to coding of the actual value into a finite length field is independent of the magnitude of the cell rate. This also allows a large range of cell rates to be encoded in a 16 bit field.

For cells with sequence number equal to 5, when the CSI bit is one, the first two octets of the SAR-PDU payload are reserved for future use, and the remaining 45 octets are filled with user information.

For cells with sequence number equal to 7, the 47 octets are filled with user information. When the CSI bit is one in a cell with sequence number equal to 7, the next cell with sequence number equal to zero is the first of an FEC interleave matrix.

AAL primitives are the same as for AAL1, except that the sentences 'The length of the AAL-SDU is constant and the time interval between two consecutive primitives is constant' should be removed. In addition, another parameter should be associated with the primitives at the receiver to indicate the relative delay of the SDU compared to the average delay. This parameter will indicate the jitter imposed on the SDU if this has not already been removed at the adaptation layer.

4.5. Class B AAL proposal alternatives

It may not be necessary to allow a time stamp to be deduced for every cell, and so the cell rate field may not be necessary.

No proposal was made for bit error correction. It is assumed that this will either be provided by FEC and interleaving, which is primarily intended for cell loss recovery, or be provided at the application layer. However, if it is considered necessary, it could be achieved at the AAL by use of a Reed-Solomon error correcting code, with the start of the error correcting frame being indicated using the CSI bit when the sequence number is equal to 5.

4.6. Class B AAL aspects for further study

The practicality of transmitting timestamps and cell rate and using FEC and interleaving at the same time has not been fully investigated yet, and is a subject for further study

5. Conclusion

The requirements of class B services have been described, as have the capabilities of the existing AALs, 1 and 5.

It was found that AAL1 was very close to satisfying the requirements of class B services, and with slight modifications would provide the definition of an AAL for these services.

An actual proposal for an AAL for class B services, based on the current definition of AAL1, was made. Such an AAL definition could be drafted quickly using the text for AAL1 and would provide the possibility of sharing hardware between this new AAL and AAL1.

The proposed AAL has the following features:

- it maintains the existing AAL1 cell delineation of one byte header and 47 bytes of payload;
- the CSI bits used for SRTS are reused to carry generic timestamps and cell rate indicators;
- it provides the capability of FEC with interleaving for cell loss and bit error correction and
- maintains the capability of SDT.

6. References

[1] WG 11 N0741, 'Description of requirements for MPEG-2 extensions', Part 9, 'Extension for Real Time Interface for Systems Decoders'.
[2] WG11 N0785, 'First Working Draft MPEG2 part 9 (RTI)'
[3] 'Support for Real Time Services in the AAL', Guido Franceschini, CSELT
[4] 'MPEG 94/253, 'Faster timing recovery in the presence of cell delay jitter', Barry Haskell, Amy Reibman, AT&T

End of Document