I.363 : B-ISDN ATM ADAPTATION LAYER (AAL) SPECIFICATION

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1 Introduction

The ATM Adaptation Layer (AAL) enhances the service provided by the ATM layer to support functions required by the next higher layer. The AAL performs functions required by the user, control and management planes and supports the mapping between the ATM layer and the next higher layer. The functions performed in the AAL depend upon the higher layer requirements.

The AAL supports multiple protocols to fit the needs of the different AAL service users. The service provided by the AAL to the higher layer and the functions performed are specified in this Recommendation.

Details of the data unit naming convention used in this Recommendation can be found in Annex A.

1.1 Scope of the Recommendation

This Recommendation describes the interactions between the AAL and the next higher layer, and the AAL and the ATM layer, as well as AAL peer-to-peer operations. This Recommendation is based on the classification and the AAL functional organization described in Recommendation I.362.

Different combinations of SAR (Segmentation and Reassembly) sublayers and CS (Convergence Sublayer) provide different Service Access Points (SAPs) to the layer above the AAL. In some applications the SAR and/or CS may be empty.

1.2 Information flow across the ATM-AAL boundary

The AAL receives from the ATM layer the information in the form of a 48 octet ATM Service Data Unit (ATM-SDU). The AAL passes to the ATM layer information in the form of a 48 octet ATM-SDU. See Recommendation I.361 for description of primitives provided by the ATM layer.

2 AAL type 1

2.1 Service provided by AAL type 1

2.1.1 Definitions

The layer services provided by AAL type 1 to the AAL user are:

- transfer of service data units with a constant source bit rate and the delivery of them with the same bit rate;
- transfer of timing information between source and destination;
- transfer of structure information between source and destination;
- indication of lost or errored information which is not recovered by AAL type 1, if needed.

2.1.2 Primitives

2.1.2.1 General

At the AAL-SAP, the following primitives will be used between the AAL type 1 and the AAL user:

- From an AAL user to the AAL,
  AAL-UNITDATA-REQUEST;

- From the AAL to an AAL user,
  AAL-UNITDATA-INDICATION.

An AAL-UNITDATA-REQUEST primitive at the local AAL-SAP results in an AAL-UNITDATA-INDICATION primitive at its peer AAL- SAP.

2.1.2.2 Definition of primitives

2.1.2.2.1 AAL-UNITDATA-REQUEST

AAL-UNITDATA-REQUEST (DATA [mandatory],
STRUCTURE [optional])

The AAL-UNITDATA-REQUEST primitive requests the transfer of the AAL-SDU, i.e., contents of the DATA parameter, from the local AAL entity to its peer entity. The length of the AAL-SDU is constant and the time interval between two consecutive primitives is constant. These two constants are a function of the AAL service provided to the AAL user.

2.1.2.2.2 AAL-UNITDATA-INDICATION

AAL-UNITDATA-INDICATION (DATA [mandatory],
STRUCTURE [optional],
STATUS [optional])

An AAL user is notified by the AAL that the AAL-SDU, i.e., contents of the DATA parameter, from its peer are available. The length of the AAL-SDU should be constant and the time interval between two consecutive primitives should be constant. These two constants are a function of the AAL service provided to the AAL user.

2.1.2.3 Definition of parameters

2.1.2.3.1 STRUCTURE parameter

The STRUCTURE parameter can be used when the user data stream to be transferred to the peer AAL entity is organized into groups of bits. The length of the structured block is fixed for each instance of the AAL service. The length is an integer multiple of 8 bits. An example of the use of this parameter is to support circuit mode bearer services of the 64 kbit/s based ISDN. The two values of the STRUCTURE parameter are:

START, and
CONTINUATION.

The value START is used when the DATA is the first part of a structured block which can be composed of consecutive DATA. In other cases, the STRUCTURE parameter is set to CONTINUATION. The use of the STRUCTURE parameter depends on the type of AAL service provided. The use of this parameter is agreed prior to or at the connection establishment between the AAL user and the AAL.

2.1.2.3.2 STATUS parameter

The STATUS parameter identifies that the DATA is judged to be non-errored or errored. The STATUS parameter has two values:

VALID, and
INVALID.

The INVALID status could also imply that the DATA is a dummy value. The use of the STATUS parameter and the choice of dummy value depend on the type of AAL service provided. The use of this parameter is agreed prior to or at the connection establishment between the AAL user and the AAL.

2.2 Interaction with the management and control planes

2.2.1 Management plane

The following indications may be passed from the user plane to the management plane:

- errors in the transmission of user information;
- lost or misinserted cells (further study is required on whether it is necessary to distinguish between lost and misinserted cells for management purposes);
- cells with errored AAL Protocol Control Information (AAL-PCI) (further study is required to determine if this indication is necessary for layer services supported by this AAL type);
- loss of timing and synchronization;
- buffer underflow and overflow.

2.2.2 Control Plane

For further study.

2.3 Functions of AAL type 1

The following functions may be performed in the AAL type 1 in order to enhance the ATM layer service:

a) segmentation and reassembly of user information;
b) handling of cell delay variation;

c) handling of cell payload assembly delay;
d) handling of lost and misinserted cells;
e) source clock frequency recovery at the receiver;
f) recovery of the source data structure at the receiver;
g) monitoring of AAL-PCI for bit errors;
h) handling of AAL-PCI bit errors;
i) monitoring of user information field for bit errors and possible corrective action.

Other functions are for further study.

Note - For some AAL users, the end-to-end QOS may be monitored. This may be achieved by calculating a CRC for the CS-PDU payload, carried in one or more cells, and transmitting the CRC results in the CS-PDU or by the use of OAM cells. Further study is required.

2.4 Segmentation and Reassembly (SAR) sublayer

2.4.1 Functions of the SAR sublayer

The SAR sublayer functions are performed on an ATM-SDU basis.

a) Mapping between CS-PDU and SAR-PDU

The SAR sublayer at the transmitting end accepts a 47 octet block of data from the CS, and then prepends a one octet SAR-PDU header to each block to form the SAR-PDU.

The SAR sublayer at the receiving end receives the 48 octet block of data from the ATM layer, and then separates the SAR-PDU header. The 47 octet block of SAR-PDU payload is passed to the CS.

b) Existence of CS function

The SAR sublayer has the capability to indicate the existence of a CS function. Associated with each 47 octet SAR-PDU payload, it receives this indication from the CS and conveys it to the peer CS entity. The use of this indication is optional.

c) Sequence numbering

Associated with each SAR-PDU payload, the SAR sublayer receives a sequence number value from the CS. At the receiving end, it passes the sequence number value to the CS. The CS may use these sequence number values to detect lost or misinserted SAR-PDU payloads (corresponding to lost or misinserted ATM cells).

d) Error protection

The SAR sublayer protects the sequence number value and the CS indication against bit errors. It informs the receiving CS when the sequence number value and the CS indication are errored and can not be corrected.

Note - For certain applications such as speech, some SAR functions may not be needed. This item is for further study.

2.4.2 SAR protocol

The SAR-PDU header together with the 47 octets of the SAR-PDU payload comprises the 48 octet ATM-SDU (cell information field). The size and positions of the fields in the SAR-PDU are given in Figure 1/I.363.

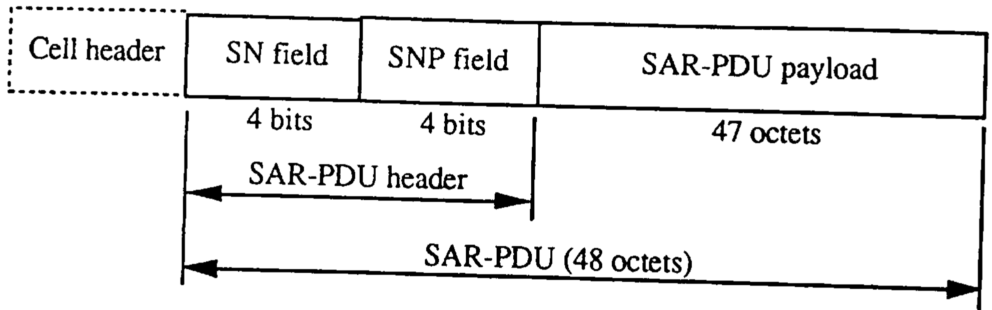


FIGURE 1/I.363
SAR-PDU format of AAL type 1

2.4.2.1 Sequence Number (SN) field

The SN field is divided into two subfields as shown in Figure 1-A/I.363. The sequence count field carries the sequence count value provided by the CS. The CSI bit carries the CS indication provided by the CS. The default value of the CSI bit is "0".

The least significant bit of the sequence count value is right justified in the sequence count field.

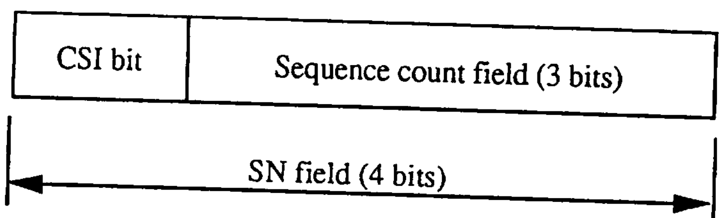


FIGURE 1-A/I.363
SN field format

2.4.2.2 Sequence Number Protection (SNP) field

The SNP field provides error detection and correction capabilities over the SAR-PDU header. The format of this field is given in Figure 1-B/I.363. A two step approach is used for the protection:

1) The SN field is protected by a 3 bit CRC code;
2) The resulting 7 bit codeword is protected by an even parity check bit.

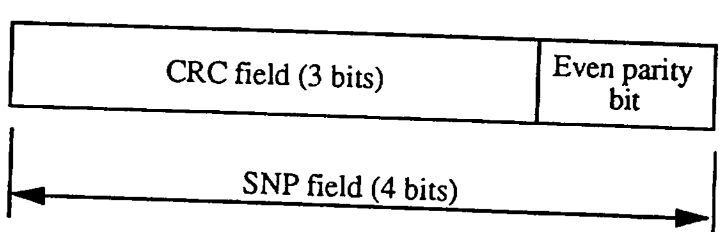


FIGURE 1-B/I.363
SNP field format

The receiver is capable of either single-bit error correction or multiple-bit error detection.

a) Operations at transmitting end

The transmitter computes the CRC value across the first 4 bits of the SAR-PDU header and inserts the result in the CRC field.

The notation used to describe the CRC is based on the property of cyclic codes. The elements of an n-element codeword are thus the coefficients of a polynomial of order n-1. In this application, these coefficients can have the value 0 or 1 and the polynomial operations are performed using modulo 2 operations. For example a code vector such as 1011 can be represented by the polynomial $P(x)=x^3+x+1$. The polynomial representing the content of the SN field is generated using the first bit of the SN field as the coefficient of the highest order term.

The CRC field consists of three bits. It shall contain the remainder of the division (modulo 2) by the generator polynomial x^3+x+1 of the product x^3 multiplied by the content of the SN field.

After completing the above operations, the transmitter inserts the even parity bit.

b) Operations at receiving end

The receiver has two different modes of operation : correction mode and detection mode. These modes are related as shown in Figure 1-C/I.363. The default mode is the correction mode, which provides for single-bit error correction. At initialization, the receiver is set up in this default mode.

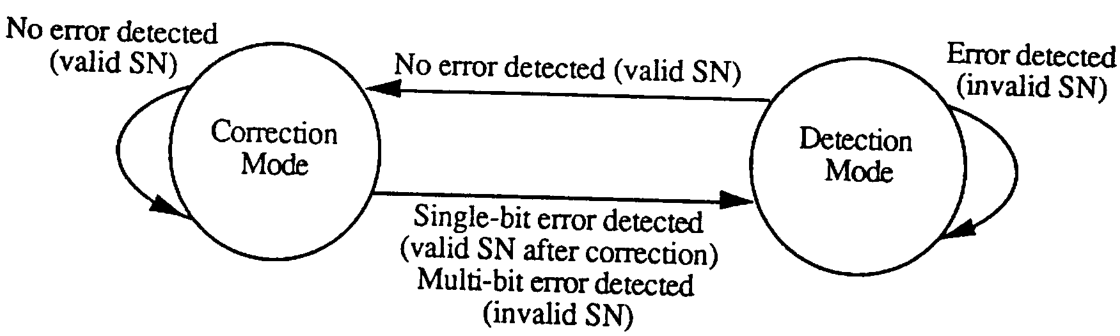


FIGURE 1-C/I.363
SNP : receiver modes of operation

The receiver examines each SAR-PDU header by checking the CRC bits and even parity bit. If a header error is detected, the action taken depends on the state of the receiver. In the "Correction Mode", only single-bit errors can be corrected and the receiver switches to "Detection Mode". In "Detection Mode", all SAR-PDU headers with detected errors are declared to have an invalid SN; however, when a SAR-PDU header is examined and found not to be in error, the receiver switches to "Correction Mode".

Tables 1/I.363 and 2/I.363 give the detailed operations of the receiver in the "Correction Mode" and "Detection Mode", respectively. The operation is based on the combined validity of the CRC and parity check bit.

The receiver conveys the sequence number count and the CS indication to the CS together with SN check status (valid or invalid).

TABLE 1/I.363
Operations in Correction Mode

CRC syndrome	Parity	Action on current SN +SNP	Reaction for next SN+SNP
Zero	No violation	No corrective action. Declare SN valid.	Continue in Correction Mode
Non-zero	Violation	Single bit correction based on syndrome. Declare SN valid.	Switch to Detection Mode
Zero	Violation	Correct parity bit. Declare SN valid.	Switch to Detection mode
Non-zero	No Violation	No corrective action : multi-bit errors are uncorrectable. Declare SN invalid.	Switch to Detection mode

TABLE 2/I.363
Operations in Detection Mode

CRC syndrome	Parity	Action on current SN +SNP	Reaction for next SN+SNP
Zero	No violation	No corrective action. Declare SN valid.	Switch to Correction Mode
Non-zero	Violation	No corrective action. Declare SN invalid.	Continue in Detection Mode
Zero	Violation	No corrective action. Declare SN invalid.	Continue in Detection mode
Non-zero	No violation	No corrective action. Declare SN invalid.	Continue in Detection mode

2.5 Convergence Sublayer (CS)

2.5.1 Functions of the CS

The CS may include the following functions. For performing some of these functions, the CS will need a clock. This clock may be derived from the S_B or T_B interface.

a) Handling of cell delay variation is performed at this sublayer for delivery of AAL-SDUs to an AAL user at a constant bit rate.

b) Processing of sequence count may be performed at this sublayer. The sequence count value and its error check status provided by the SAR sublayer can be used by the CS to detect cell loss and misinsertion. Further handling of lost and misinserted cells is also performed in this sublayer.

c) The CS can utilize the CS indication provided by the SAR sublayer to support CS functions for some AAL users.

d) For AAL users requiring recovery of source clock frequency at the destination end, the AAL can provide a mechanism for a timing information transfer.

e) For some AAL users, this sublayer provides the transfer of structure information between source and destination.

f) For video and high quality audio signal transport, forward error correction may be performed to protect against bit errors. This may be combined with interleaving of AAL user bits (e.g., octet interleaving) to give more secure protection against errors.

g) The CS may generate reports giving the status of end-to-end performance as deduced by the AAL. The performance measures in these reports could be based on:

- events of lost and misinserted cells,
- buffer underflow and overflow,
- bit error events.

The following paragraphs identify the functions of the CS for individual layer services of AAL type 1.

2.5.1.1 Functions of the CS for circuit transport

The following functions support both asynchronous and synchronous circuit transport . Asynchronous circuit transport will provide transport of signals from constant bit rate sources whose clocks are not frequency-locked to a network clock. Examples are Recommendation G.702 signals at 1.544, 2.048, 6.312, 8.448, 32.064, 44.736 and 34.368 Mbit/s. Synchronous circuit transport will provide transport of signals from constant bit rate sources whose clocks are frequency-locked to a network clock. Examples are signals at 64, 384, 1536 and 1920 kbit/s as described in Recommendation I.231.

Note - Another possible example of synchronous circuit transport is conveyance of SDH signals described in Recommendation G.709.

a) Handling of AAL user information

The length of the AAL-SDU is one bit, when asynchronous circuit transport utilizes the Synchronous Residual Time Stamp (SRTS) method described in § 2.5.2.2.1.

For those AAL users which require transfer of structured data, e.g. 8 kHz structured data for circuit mode bearer services of the 64 kbit/s based ISDN, the STRUCTURE parameter option of the primitives defined in § 2.1.2 will be used. The CS uses the Structured Data Transfer (SDT) method described in § 2.5.2.3.

b) Handling of cell delay variation

A buffer is used to support this function. The size of this buffer is dependent upon specifications provided in Recommendation I.35B.

In the event of buffer underflow, it may be necessary for the CS to maintain bit count integrity by inserting the appropriate number of dummy bits. In the event of buffer overflow, it may be necessary for the CS to maintain bit count integrity by dropping the appropriate number of bits.

When Recommendation G.702 1.544 Mbit/s and 2.048 Mbit/s signals are being transported, the inserted dummy bits shall be all "1"s.

c) Handling of lost and misinserted cells

The sequence count values are further processed at this sublayer to detect lost and misinserted cells. Detected misinserted cells are discarded. The CS procedure to be used for sequence count processing is described in § 2.5.2.1.

In order to maintain the bit count integrity of the AAL user information, it may be necessary to compensate for lost cells detected by buffer underflow and sequence count processing by inserting the appropriate number of dummy SAR-PDU payloads. The content of this dummy SAR-PDU payload depends on the AAL service being provided. For example, this dummy SAR-PDU payload is all "1"s for Recommendation G.702 1.544 Mbit/s and 2.048 Mbit/s signals.

d) Handling of timing relation

This function is required for delivery of AAL-SDUs to an AAL user at a constant bit rate.

The handling of timing relation for asynchronous circuit transport is referred to as source clock frequency recovery. Recovered source clock should have satisfactory jitter performance. For example, the jitter performance for Recommendation G.702 signals is specified in Recommendations G.823 and G.824, for which the CS procedure to be used (the SRTS method) is described in § 2.5.2.2.1.

2.5.1.2 Functions of the CS for video signal transport

The following functions support transport of video signals for interactive and distributive services.

a) Handling of AAL user information

The length of the AAL-SDU is one octet, when utilizing the correction method described in § 2.5.2.4.1.

For those AAL users which require transfer of structured data, the STRUCTURE parameter option of primitives defined in § 2.1.2 will be used. The CS uses the SDT method described in § 2.5.2.3.

As an option, the STATUS parameter defined in § 2.1.2 will be passed to the AAL user to facilitate further picture processing, e.g. error concealment.

b) Handling of cell delay variation

A buffer is used to support this function. The size of this buffer is dependent upon specifications provided in Recommendation I.35B.

In the event of buffer underflow, it may be necessary for the CS to maintain bit count integrity by inserting the appropriate number of dummy bits. In the event of buffer overflow, it may be necessary for the CS to maintain bit count integrity by dropping the appropriate number of bits.

c) Handling of lost and misinserted cells

The sequence count values are further processed at this sublayer to detect lost and misinserted cells. Detected misinserted cells are discarded. The CS procedure to be used for sequence count processing is described in § 2.5.2.1.

In order to maintain the bit count integrity of the AAL user information, it may be necessary to compensate for lost cells detected by buffer underflow and sequence count processing by inserting the appropriate number of dummy SAR-PDU payloads. The content of this dummy SAR-PDU payload depends on the AAL service being provided.

Information in lost cells may be recovered by the mechanism described in e).

d) Handling of timing relation

This function is required for delivery of AAL-SDUs to an AAL user at a constant bit rate.

Some AAL users may require source clock frequency recovery, e.g., recovery at the receiving end of camera clock frequency which is not locked to the network clock. The exact method is for further study.

e) Correction of bit errors and lost cells

This is an optional function provided for those AAL users requiring bit error and cell loss performance better than that provided by the ATM layer. Examples are unidirectional video services for contribution and distribution. This function may be performed with the CS procedure described in § 2.5.2.4.1.

2.5.1.3 Functions of the CS for voice-band signal transport

The following functions support transport of voice-band signals, e.g. 64 kbit/s A-law and μ-law coded Recommendation G.711 signals, and 64 kbit/s Recommendation G.722 signals;

a) Handling of AAL user information

The length of the AAL-SDU is one octet.

b) Handling of cell delay variation

A buffer is used to support this function. The size of this buffer is dependent upon specifications provided in Recommendation I.35B.

c) Handling of lost and misinserted cells

The detection of lost and misinserted cells, if needed, may be provided by processing the sequence count values. The monitoring of the buffer fill level can also provide an indication of lost and misinserted cells. Detected misinserted cells are discarded.

Handling of lost cells and buffer underflow is for further study.

Note - For transporting signals of speech and 3.1 kHz audio bearer services as specified in 64 kbit/s ISDN, the need for A/μ-law conversion is identified. This conversion function is outside the scope of this Recommendation.

2.5.1.4 Functions of the CS for high quality audio signal transport

The capabilities of AAL type 1 are in principle applicable for transfer of high quality audio signals.

2.5.2 CS protocol

The following sections describe CS procedures to be provided for implementing CS functions. The use of each procedure depends on the required CS functions and is given in § 2.5.1.1 through to 2.5.1.4.

2.5.2.1 Sequence count operations

2.5.2.1.1 Sequence count operations at the transmitting end

At the transmitting end, the CS provides the SAR with a sequence count value and a CS indication associated with each SAR-PDU payload. The count value starts with 0, is incremented sequentially and is numbered modulo 8.

2.5.2.1.2 Sequence count operations at the receiving end

At the receiving end, the CS receives from the SAR the following information associated with each SAR-PDU payload:

- sequence count,
- CS indication,
- check status of the sequence count and CS indication.

The use of sequence count values and CS indications will be specified on a service specific basis. See § 2.4.2 for details about the check status processing.

The CS processing at the receiving end may identify lost or misinserted SAR-PDU payloads. This will be useful for many CBR services.

CS processing may identify the following conditions:

- SAR-PDU payload sequence normal (i.e. in correct sequence),
- SAR-PDU payload loss,
- SAR-PDU payload misinsertion.

Processing of sequence count values may provide additional information to related entities within the CS, as required. Some examples are:

- location of lost SAR-PDU payload in the incoming SAR-PDU stream,
- number of consecutive SAR-PDU payloads lost,
- identification of misinserted SAR-PDU payload.

Note - Processing of sequence count values may be subject to performance specifications. The performance specifications will be applied on a service specific basis.

2.5.2.2 Source clock frequency recovery method

2.5.2.2.1 Synchronous Residual Time Stamp (SRTS) method

a) General

The Synchronous Residual Time Stamp (SRTS) method uses the Residual Time Stamp (RTS) to measure and convey information about the frequency difference between a common reference clock derived from the network and a service clock. The same derived network clock is assumed to be available at both the transmitter and the receiver. If the common network reference clock is unavailable (e.g., when working between different networks which are not synchronized), then the asynchronous clock recovery method will be in a mode of operation associated with "Plesiochronous network operation" which is described in paragraph e). The SRTS method is capable of meeting the jitter specifications of the 2.048 Mbit/s hierarchy in Recommendation G.823 and the 1.544 Mbit/s hierarchy in Recommendation G.824.

The following is a description of the SRTS method. The description uses the notation below;

fs --- service clock frequency,
fn --- network clock frequency, e.g. 155.52 MHz,
fnx -- derived network clock frequency, fnx=fn/x, where x is an integer to be defined later,
N ---- period of RTS in cycles of the service clock of frequency fs,
T ---- period of the RTS in seconds,
M(Mnom, Mmax, Mmin) ---- number of fnx cycles within a (nominal, maximum, minimum) RTS period,
Mq --- largest integer smaller than or equal to M.

The SRTS concept is illustrated in Figure 1-D/I.363. In a fixed duration T measured by N service clock cycles, the number of derived network clock cycles Mq is obtained at the transmitter. If Mq is transmitted to the receiver, the service clock of the source can be reconstructed by the receiver, since it has the necessary information: fnx, Mq and N. However, Mq is actually made up of a nominal part and a residual part. The nominal part Mnom corresponds to the nominal number of fnx cycles in T seconds and is fixed for the service. The residual part conveys the frequency difference information as well as the effect of the quantization and thus can vary. Since the nominal part is a constant, it can be assumed that the nominal part of Mq is available at the receiver. Only the residual part of Mq is transmitted to the receiver.

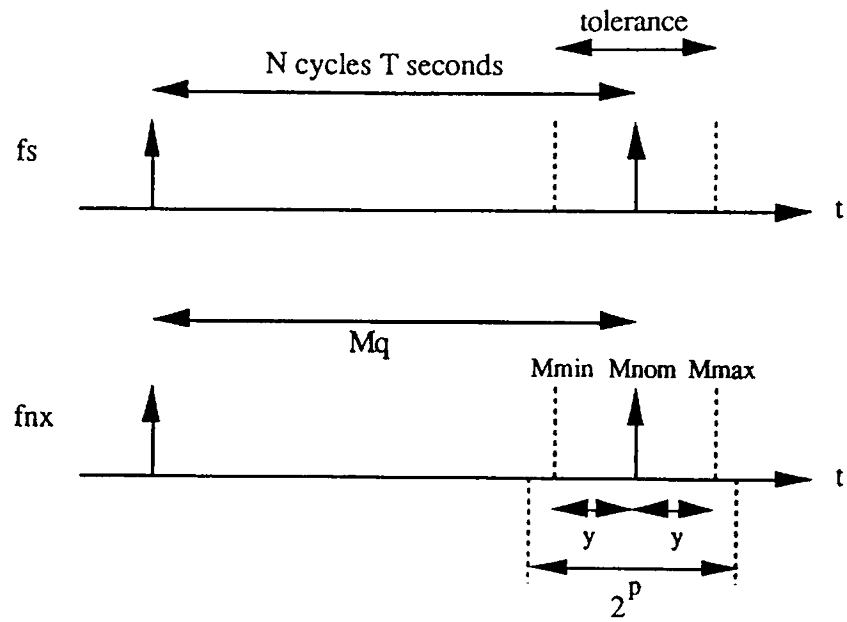


FIGURE 1-D/I.363
The concept of Synchronous Residual Time Stamp (SRTS)

A simple way of representing the residual part of Mq is by means of the RTS, whose generation is shown in Figure 1-E/I.363. Counter Ct is a P-bit counter which is continuously clocked by the derived network clock. The output of counter Ct is sampled every N service clock cycles. This P-bit sample is the Residual Time Stamp.

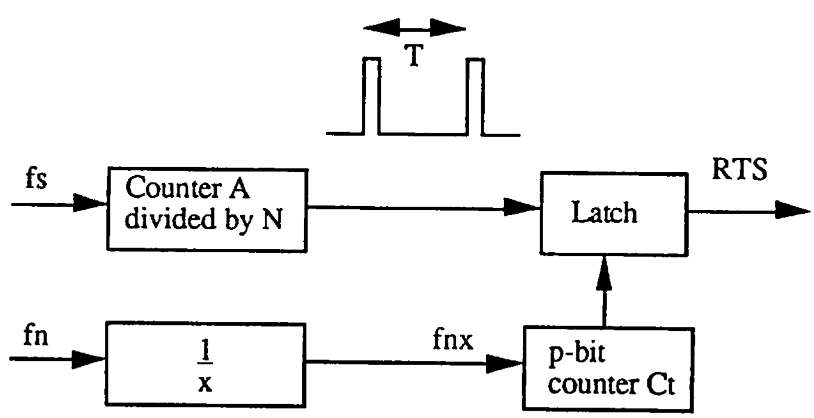


FIGURE 1-E/I.363
Generation of Residual Time Stamp (RTS)

With a knowledge of the RTS and the nominal part of Mq at the receiver, Mq is completely specified. Mq is used to produce a reference timing signal for a Phase-Locked Loop to obtain the service clock.

b) Choice of parameter

The minimum size of the RTS required to unambiguously represent the residual part of Mq is a function of N, the ratio fnx/fs, and the service clock tolerance, ± e. Let y be the difference between Mnom and the maximum or minimum value of M (denoted as Mmax, Mmin). The difference y is given by

$y = N * fnx / fs * e.$

In order that Mq can be unambiguously identified, the following conditions must be satisfied (see Figure 1-D/I.363);

$2^{(p-1)} > [y],$

where [y] denotes the smallest integer larger than or equal to y.

The following parameter values are used for the asynchronous circuit transport of Recommendation G.702 signals:

N = 3008 (total number of bits in eight SAR-PDU payloads),
$1 < fnx/fs \leq 2$,
Tolerance = $200 * 10^{-6}$
Size of RTS = 4 bits

The introduction of any AAL convergence sublayer overhead into the SAR-PDU payload will reduce the amount of payload available for the transport of AAL user data. This will reduce the number of service clock cycles over which the RTS period is specified, since the RTS period is defined over a fixed number of SAR-PDU payloads. The RTS period parameter, N, can be adjusted to accommodate such cases. For example, if four octets of CS overhead are required from every eight SAR-PDU payloads, then N would be reduced from 3008 to 2976. However, the CS overhead has to be allocated so that the RTS period always remains a constant number of service clock cycles. Therefore, the CS overhead must reduce the user data transport capacity by a constant amount over the fixed number of SAR-PDU payloads for which the RTS period is defined. See § 2.5.2.3.2 for an example.

c) Network clocks

For an SDH network, a 155.520 MHz network clock (fn) is available from which the following clocks can be derived:

$155.520 \text{ MHz} * 2^{-k}$, k=0,1,,,,11

As an example, to support service rates of 64 kbit/s the fnx will be $155.520 \text{ MHz} * 2^{-11}$ (i.e. 75.9375 kHz).

This set of derived network clocks can accommodate all service rates ranging from 64 kbit/s up to the full capacity of the STM-1 payload. The derived network clock to be used for a given service rate is uniquely specified, since the frequency ratio is constrained by $1 < fnx/fs \leq 2$.

Administrations/RPOAs may use existing network clocks to support national service in a non-SDH ATM network.

d) Transport of the RTS

The 4-bit RTS is transmitted in the serial bit stream provided by the CSI bit in successive SAR-PDU headers. The modulo 8 sequence count provides a frame structure over 8 bits in this serial bit stream. Four bits of the framed 8 bits are allocated for the RTS and the remaining 4 bits are available for other uses. If the four bits available for other uses are not utilized, they are set to 0. The SAR-PDU headers with the odd sequence count values of 1, 3, 5 and 7 are used for RTS transport. The MSB of the RTS is placed in the CSI bit of the SAR-PDU header with the sequence count of 1.

e) Plesiochronous network operation

The issue about the accommodation of plesiochronous operation (i.e. when a common reference clock is not available from the network) needs to be addressed. This scenario must be accommodated in such a way that the recovered clock satisfies the jitter requirements specified in Recommendations G.823 and G.824 for Recommendation G.702 signals. However, the detailed method of dealing with plesiochronous operation is not standardized.

2.5.2.2.2 Adaptive clock method

The following is a general description of the method. The receiver writes the received information into a buffer and then reads it with a local clock. The fill level of the buffer is used to control the frequency of the local clock. The control is performed by continuously measuring the fill level around its medium position, and by using this measure to drive the Phased-Locked Loop providing the local clock. The fill level of the buffer may be maintained between two limits in order to prevent buffer overflow and underflow.

2.5.2.3 Structured data transfer (SDT) method

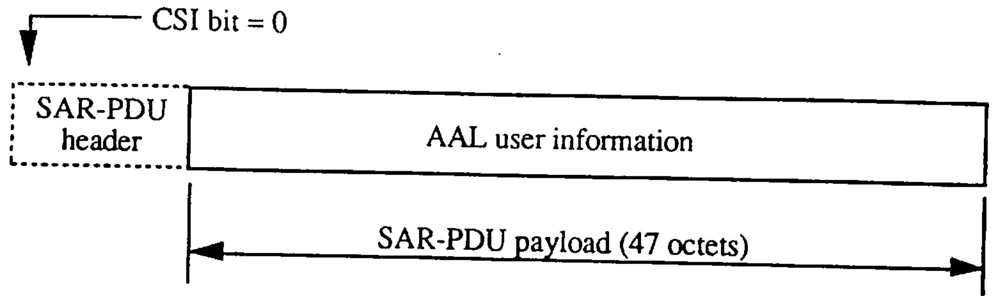
2.5.2.3.1 SDT without use of SRTS

The CS procedure for structured data transfer uses a pointer to delineate the structure boundaries. The procedure supports any fixed, octet-based structure. In particular, it supports 8 kHz based structures used in circuit-mode services of Recommendation I.231.

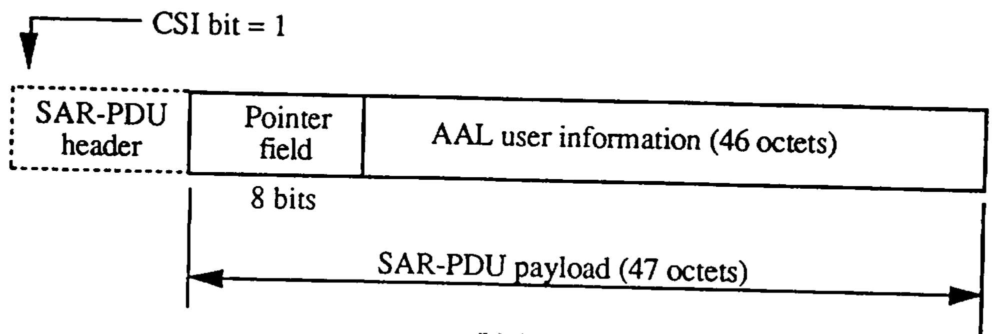
The procedure description given here is intended for data transfer which does not use the SRTS method (see § 2.5.2.2.1) for recovery of the user clock. However, since the SDT method and the SRTS method use the CS indication in alternating SAR-PDU payloads, it is possible to use the two procedures simultaneously to support both structured data transfer and SRTS clock recovery. This combined use is described in the next section.

The STRUCTURE parameter in the AAL-UNITDATA-REQUEST and AAL-UNITDATA-INDICATION primitives is used to convey structure information between the AAL and the AAL user. See § 2.1.2 for definition of primitives and parameters.

The 47-octet SAR-PDU payload used by the CS has two formats, called non-P and P format, as shown in Figure 1-F/I.363.



(a) Non-P format



(b) P format

FIGURE 1-F/I.363
Format of SAR-PDU payload for structured data transfer method

a) Operations of the non-P format

In the non-P format, the entire CS-PDU is filled with user information.

b) Operations of the P format

In the P format, the first octet of the SAR-PDU payload is the pointer field. The remainder is filled with user information. This format may be used only if the sequence count value in the SAR-PDU header is 0, 2, 4 or 6.

The format of the pointer field is shown in Figure 1-G/I.363.

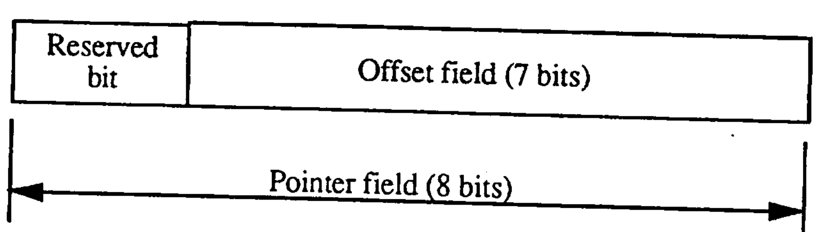


FIGURE 1-G/I.363
Pointer field format

The pointer field contains the binary value of the offset, measured in octets, between the end of the pointer field and the first start of the structured block in the 93 octet payload consisting of the remaining 46-octets of this SAR-PDU payload and the 47-octets of the next SAR-PDU payload. This offset ranges between 0 and 92 inclusive. Moreover, the offset value 93 is used to indicate that the end of the 93 octet payload coincides with the end of a structured block whose start does not lie in the 93 octet payload.

The binary value of the offset is inserted right justified in the offset field, i.e., the least significant bit of the offset is transmitted last. The first bit of the pointer field is reserved for future standardization and is not used for the offset; this bit is set to 0.

The pointer should be used as often as necessary to ensure that the structure recovery is robust. The frequency of pointer utilization is an item for further study.

Note - The receiving CS must know the payload size of a lost or misinserted SAR-PDU payload in order to maintain correct bit count and correct block delineation. When such a SAR-PDU has an even sequence count value, the number of octets to be inserted/deleted is 46 or 47 depending on the presence of the pointer field. There is a need to specify a method which assists the CS in determining whether the pointer field is present. A possible method is to require the transmitting CS to use the pointer field in a systematic manner (e.g., periodically). The exact method is for further study.

The first structured block to be transmitted after the AAL connection is established uses the P format with sequence count value in the SAR-PDU header equal to 0 and with the first octet of the structured data placed in the second octet of the SAR-PDU payload.

Partially filled cells

The SAR-PDU payload may be filled only partially with user data in order to reduce the cell payload assembly delay. In this case, the number of leading octets utilized for user information (excluding pointer field) in each SAR-PDU payload is a constant which is determined by the allowable cell payload assembly delay. The remainder of the SAR-PDU payload consists of dummy octets. The value of the dummy octet is for further study.

The offset value in the pointer field includes all octets of the SAR-PDU payload regardless of whether the octets are utilized for user data or consist of dummy data.

2.5.2.3.2 SDT with use of SRTS

The CS procedure for supporting structured data transfer together with SRTS clock recovery is basically a simple combination of the CS procedures of § 2.5.2.2.1 and § 2.5.2.3.1.

The 47-octet SAR-PDU payload uses the two formats shown in Figure 1-F/I.363.

a) Operations of the non-P format

The non-P format is used if the sequence count value within the SAR-PDU header is 1, 3, 5 or 7. The CS indication bits carry the RTS value as described in § 2.5.2.2.1. The 47-octets of the SAR-PDU payload are filled with user information.

b) Operations of the P format

The P format is used if the sequence count value within the SAR-PDU header is 0, 2, 4 or 6. The first octet of the SAR-PDU payload is the pointer field and the remainder is filled with user information.

If pointer action is not needed for delineating a structured block contained in this SAR-

PDU payload or in the next SAR-PDU payload, then the seven bits denoting the offset are set to the dummy value of all ones. The CS indication is set to 1 because the pointer field is present.

If pointer action is needed for delineation, the offset and pointer operation are as described in § 2.5.2.3.1.

The first structured block to be transmitted after the AAL connection is established uses the P format with sequence count value in the SAR-PDU header equal to 0 and with the first octet of the structured data placed in the second octet of the SAR-PDU payload.

2.5.2.4 Correction method for bit errors and lost cells

Other methods are for further study.

2.5.2.4.1 Correction method for bit errors and cell losses for unidirectional video services

This correction method combines Forward Error Correction (FEC) and octet interleaving, from which a CS-PDU structure is defined. FEC uses the Reed-Solomon (128,124) code which is able to correct up to 2 errored symbols (octets) or 4 erasures in the block of 128 octets. An erasure is an errored octet whose location in the block is known. The specific polynomials to be used for Reed-Solomon code are for further study. In the transmitting CS, the 4 octet Reed-Solomon code is appended to 124 octets of incoming data from the upper layer. The resulting 128 octet long blocks are then forwarded to the octet interleaver. See Figure 1-H/I.363 for format of the interleave matrix.

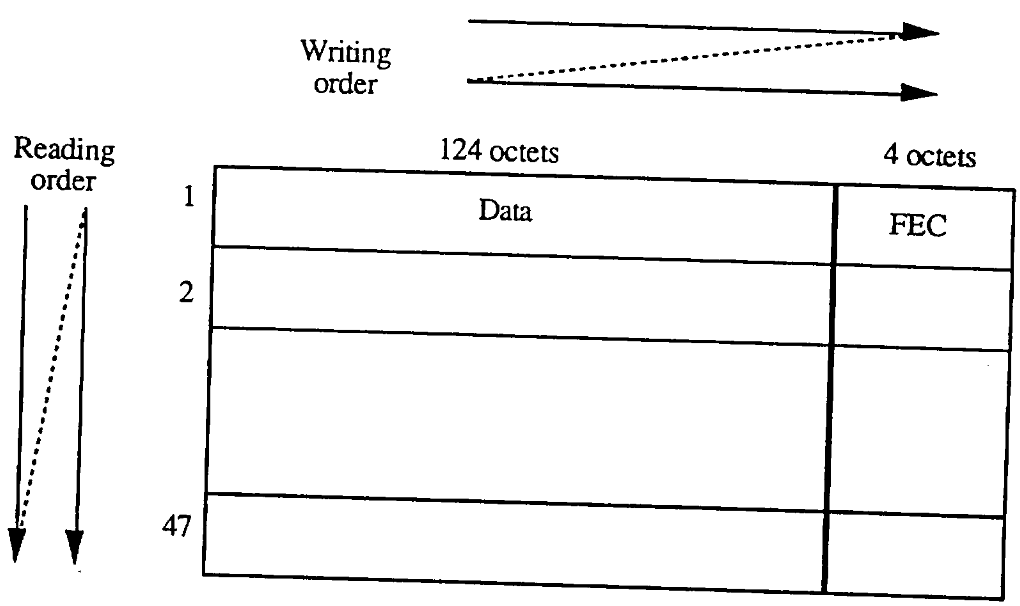


FIGURE 1-H/I.363
Format of the interleave matrix

The octet interleaver is organized as a matrix of 128 columns and 47 rows. The interleaver is used as follows; at the input, incoming 128 octet long blocks are stored row by row (one block corresponding to one row); at the output, octets are read out column by column. The matrix has 128 x 47 = 6016 octets, corresponding to 128 SAR-PDU payloads. These 128 SAR-PDU payloads constitute one CS-PDU.

In this process, the loss of one SAR-PDU payload in the matrix implies one erasure to correct in each row of the matrix. Erasures correspond to dummy cell payloads inserted in the cell flow when a cell loss has been detected. Misinserted cells which have been detected are merely discarded in the CS.

For the synchronization of the CS-PDU, the CS indicator bit of the SAR-PDU header is set to 1 for the first SAR-PDU payload of the CS-PDU. This use of the CS indication bit precludes the use of the SDT method as specified in § 2.5.2.3.

Within any CS-PDU matrix, this method can perform the following corrections:

- 4 cell losses ; or
- 2 cell losses and 1 errored octet in each row; or
- 2 errored octets in each row if there is no cell loss.

The overhead of this method is 3.1%, and the delay is 128 cells.

3 AAL type 2

3.1 Service provided by AAL type 2

3.1.1 Definitions

The layer services provided by AAL type 2 to the AAL user may include:

- transfer of service data units with a variable source bit rate;
- transfer of timing information between source and destination;
- indication of lost or errored information which is not recovered by AAL type 2, if needed.

3.1.2 Primitives

For further study.

3.2 Interaction with the management and control planes

3.2.1 Management plane

The following indications may be passed from the user plane to the management plane:

- errors in the transmission of user information;
- lost or misinserted cells (further study is required on whether it is necessary to distinguish between lost and misinserted cells for management purposes);
- cells with errored AAL Protocol Control Information (AAL-PCI) (further study is required to determine if this indication is necessary for layer services supported by this AAL type);
- loss of timing and synchronization;
- buffer underflow and overflow.

3.2.2 Control Plane

For further study.

3.3 Functions of AAL type 2

The following functions may be performed in the AAL type 2 in order to enhance the

ATM layer service:

a) segmentation and reassembly of user information;
b) handling of cell delay variation;
c) handling of lost and misinserted cells;
d) source clock frequency recovery at the receiver;
e) recovery of the source data structure at the receiver;
f) monitoring of AAL-PCI for bit errors;
g) handling of AAL-PCI bit errors;
h) monitoring of user information field for bit errors and possible corrective action

Other functions are for further study.

3.4 Segmentation and Reassembly (SAR) sublayer

3.4.1 Functions of the SAR sublayer

For further study.

The SAR sublayer functions are performed on an ATM-SDU basis. As the SAR accepts variable length CS-PDUs from the convergence sublayer, the SAR-PDUs may need to be partially filled.

3.4.2 SAR protocol

For further study.

[Note to Secretariat : The Figure 2/I.363 has been deleted.]

3.5 Convergence Sublayer (CS)

3.5.1 Functions of the CS

For further study.

3.5.2 CS protocol

For further study.