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INTERNATIONAL TELECOMMUNICATION UNION

CCITT **I.363**

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

OVERALL NETWORK ASPECTS AND FUNCTIONS, ISDN USER-NETWORK INTERFACES

B-ISDN ATM ADAPTATION LAYER (AAL) SPECIFICATION

Recommendation I.363

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Geneva, 1991

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FOREWORD

permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation I.363 was prepared by Study Group XVIII and was approved under the Resolution No. 2 procedure on the 5th of April 1991.

CCITT NOTES

1)
indicate both a telecommunication Administration and a recognized private operating agency.

2) A list of abbreviations used in this Recommendation can be found in Annex B.

Preamble to B-ISDN Recommendations

In 1990, CCITT SG XVIII approved a first set of Recommendations on B-ISDN. These are:

I.113 - Vocabulary of terms for broadband aspects of ISDN

I.121 — Broadband aspects of ISDN

I.150 — B-ISDN asynchronous transfer mode functional characteristics

I.211 — B-ISDN service aspects

I.311 — B-ISDN general network aspects

I.321 — B-ISDN Protocol Reference Model and its application

I.327 — B-ISDN functional architecture

I.361 — B-ISDN ATM Layer specification

I.362 — B-ISDN ATM Adaptation Layer (AAL) functional description

I.363 — B-ISDN ATM Adaptation Layer (AAL) specification

I.413 — B-ISDN user-network interface

I.432 — B-ISDN user-network interface — Physical Layer specification

I.610 — Operation and maintenance principles of B-ISDN access

These Recommendations address general B-ISDN aspects as well as specific service- and network-oriented issues, the fundamental characteristics of the asynchronous transfer mode (ATM), a first set of relevant ATM oriented parameters and their application at the user-network interface as well as impact on operation and maintenance of the B-ISDN access. They are an integral part of the well established I-Series Recommendations. The set of Recommendations are intended to serve as a consolidated basis for ongoing work relative to B-ISDN both within CCITT and in other organizations. They may also be used as a first basis towards the development of network elements.

CCITT will continue to further develop and complete these Recommendations in areas where there are unresolved issues and develop additional Recommendations on B-ISDN in the I-Series and other series in the future.

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B-ISDN ATM ADAPTATION LAYER (AAL) SPECIFICATION

1 Introduction

The ATM adaptation layer (AAL) enhances the service[1]) 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 this 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) 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.

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1)

The term “service” in this Recommendation is used in two different meanings. In one case, it is used in the sense of a Layer service and in the other case in the sense of a telecommunication service, e.g. Voice service, Data service.

2 AAL type 1

2.1 *Service provided by AAL type 1*

2.1.1 *Definitions*

The services provided by AAL type 1 to the higher layer 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;

— indication of lost or errored information which is not recovered by AAL type 1.

2.1.2 *Primitives*

For further study.

2.2 *Interaction with the management and control planes*

2.2.1 *Management plane*

The following indications may be passed from AAL type 1 in 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);

— cells with errored AAL protocol control information (AAL-PCI) (further study is required to determine if this indication is necessary for services supported by this AAL type);

— loss of timing/synchronization.

2.2.2 *Control plane*

For further study.

2.3 *Functions in AAL type 1*

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

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) monitoring of AAL-PCI for bit errors;

f) handling of AAL-PCI bit errors;

g) monitoring of user information field for bit errors and possible corrective action (the use of this function for voice service is for further study);

h) other service specific functions are for further study.

The allocation of these functions to the CS or SAR is for further study.

Note — For circuit emulation a need has been identified to monitor the end-to-end QOS. This may be achieved by calculating a CRC for the CS-PDU payload, carried in one or more cells, and transmitting the result in the CS-PDU or by the use of an OAM cell. Further study is required.

2.3.1 *Segmentation and reassembly sublayer*

2.3.1.1 *Functions of the SAR sublayer*

The definitions of these functions are for further study.

The SAR functions are performed on a ATM-SDU basis.

2.3.1.2 *SAR-PDU structure and coding*

See Figure 1/I.363.

Figure 1/I.363 = 11 cm

2.3.2 *Convergence sublayer*

2.3.2.1 *Functions of the CS*

The CS may include the following functions:

a) For high quality audio and video forward error correction may be performed to protect against bit errors. This may be combined with bit interleaving to give more secure protection against errors.

b) For some services, this sublayer provides the clock recovery capability for the receiver e.g. by monitoring the buffer filling. This requires no specific field in the CS-PDU.

c) For services requiring explicit time indication, this may be provided by means of a time stamp pattern inserted in the CS-PDU. Other mechanisms may be used to provide this function.

d) Further sequence number processing may be performed at this sublayer. The handling of lost and misinserted cells is also performed in this sublayer.

2.3.2.2 *CS-PDU structure and coding*

For further study.

3 AAL type 2

3.1 *Service provided by AAL type 2*

3.1.1 *Definitions*

The services provided by AAL type 2 to the higher layer 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.

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 AAL type 2 in the user plane to the management plane:

— errors in the transmission of user information;

— loss of timing/synchronization;

— lost or misinserted cells (further study is required on whether it is necessary to distinguish between lost and misinserted cells);

— cells with errored AAL-PCI (further study is required to determine if this indication is necessary for all services supported by this AAL type).

3.2.2 *Control plane*

For further study.

3.3 *Functions in AAL type 2*

The following functions may be performed in the AAL type 2 in order to enhance the service provided by the ATM layer:

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) monitoring of AAL-PCI for bit errors;

f) handling of AAL-PCI bit errors;

g) monitoring of user information field for bit errors and possible corrective action (the use of this function for voice service is for further study).

The allocation of these functions to the CS or SAR is for further study. Other service specific functions are for further study.

3.3.1 *Segmentation and reassembly sublayer*

3.3.1.1 *Functions of the SAR*

For further study.

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

3.3.1.2 *SAR-PDU structure and coding*

The SAR-PDU structure and coding requires urgent further study.

Examples of SAR functions and a SAR-PDU structure that are for further study are given below:
Figure 2/I.363 = 14 cm

3.3.2 *Convergence sublayer*

3.3.2.1 *Functions of the CS*

The functions to be performed are for further study.

The convergence sublayer may perform the following functions:

a) Clock recovery for variable bit rate audio and video services by means of the insertion of a time stamp or real time synchronization word in the CS-PDU. Other mechanisms may be used to provide this function.

b) Sequence number processing may be performed to detect the loss or misinsertion of ATM-SDUs. The handling of lost and misinserted ATM-SDUs is also performed in this sublayer.

c) For audio and video services forward error correction may be performed.

3.3.2.2 *CS-PDU structure and coding*

For further study.

4 AAL type 3

4.1 *Service provided by AAL type 3*

The need for the following modes of service and operational procedures in this AAL type requires further study.

Two modes of service are defined: message and streaming.

a) *Message mode service:* This service provides the transport of a single AAL service data unit (AAL-SDU) in one (or, optionally more than one) convergence sublayer protocol data units (CS-PDUs);

b) *Streaming mode service:* This service provides the transport of one or more fixed size AAL service data units (SDU1-SDUn) in one convergence sublayer PDU (CS-PDU). The AAL-SDU may be as small as one octet, and is always delivered as a unit, because it is the atomic unit of data recognized by the application.

Both modes of service may offer the following peer-to-peer operational procedures:

— *Assured operations:* Every assured AAL-SDU is delivered with exactly the data content that the user sent. The assured service is provided by retransmission of missing or corrupted CS-PDUs. Flow control is provided as a mandatory feature. The assured operation may be restricted to point-to-point ATM layer connections.

— *Non-assured operations:* Integral AAL-SDUs may be lost or corrupted. Lost and corrupted AAL-SDUs will not be corrected by retransmission. An optional feature may be provided to allow corrupted AAL-SDUs to be delivered to the user (i.e.

optional error discard). Flow control may be provided as an option on point-to-point ATM layer connections. However, no flow control is provided on point-to-multipoint ATM layer connections.

These procedures are for further study.

4.1.1 *Definitions*

For further study.

4.1.2 *Primitives*

For further study.

4.2 *Interaction with the management and control planes*

4.2.1 *Management plane*

For further study.

4.2.2 *Control plane*

For further study.

4.3 *Functions in AAL type 3*

4.3.1 *Segmentation and reassembly sublayer (SAR)*

4.3.1.1 *Functions of the SAR sublayer*

The SAR sublayer functions are performed on an ATM-SDU basis. The SAR sublayer accepts variable length CS-PDUs from the convergence sublayer, and generates SAR-PDUs containing up to 44 octets of CS-PDU data.

The SAR sublayer functions may provide the means for the transfer of multiple variable length CS-PDUs concurrently over a single ATM layer connection between AAL entities.

a) *Preservation of CS-PDU*

This function preserves each CS-PDU by providing for a segment type indication and a SAR-PDU payload fill indication. The SAR-PDU payload fill indication identifies the number of octets of CS-PDU information contained within the SAR-PDU payload. The Segment Type indication identifies a SAR-PDU as being a Beginning of Message (BOM), Continuation of Message (COM), End of Message (EOM), or Single Segment Message (SSM).

b) *Error Detection*

This function provides the means to detect:

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—

The presence of either type of error may be indicated to the CS.

c) *Multiplexing/demultiplexing*

This function provides for multiplexing/demultiplexing of multiple CS-PDUs

concurrently from multiple AAL connections over a single ATM layer connection.

The necessity of this function for AAL type 3 requires further study.

4.3.1.2 *SAR-PDU structure and coding*

The SAR sublayer functions require a 2 octet SAR-PDU header and a 2 octet SAR-PDU trailer. The
SAR-PDU header and trailer together with the 44 octets of SAR-PDU payload comprise the 48 octet ATM-SDU
(cell payload). The sizes and positions of the fields are given in Figure 3/I.363.

Figure 3/I.363 = 9 cm

The coding of SAR-PDU conforms to the coding conventions specified in § 2.1 of Recommendation I.361.

a) *Segment type field*

The association between the encoding and the meaning of the segment type field is shown in Table 1/I.363.

µTABLE 1/I.363

Coding of segment type

Encoding	Segment type
MSB	
LSB	
BOM	
1	
0	
COM	
0	
0	
EOM	
0	
1	
SSM	
1	
1	

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b) *Sequence number field*

Four bits are allocated to the sequence number field allowing the stream of SAR-PDUs of a CS-PDU to be numbered modulo 16.

Each SAR-PDU belonging to the same AAL connection will have its sequence

number incremented by one relative to its previous sequence number.

c) *Reserved field*

This field is reserved for future use, e.g. for multiplexing. The need for multiplexing and other possible functions is for further study.

If this field is used for multiplexing, then it may be used to multiplex multiple user sessions on a single ATM layer connection of a given quality of service (QOS). The following restrictions may apply:

—
must have identical QOS characteristics;

—
field will be on a user-to-user basis;

—
will be administered as a single entity.

d) *SAR-PDU payload field*

The CS-PDU information is left justified within the SAR-PDU payload field. Any part of the SAR-PDU payload that does not contain CS-PDU information is coded as zero.

e) *Length indication field*

The length indication field is binary encoded with the number of octets from the CS-PDU that are included in the SAR-PDU payload field. This field may have a value less than or equal to 44.

f) *CRC field*

The CRC field is filled with the value of a CRC calculation which is performed over the entire contents of the SAR-PDU, including the SAR-PDU header, SAR-PDU payload, and LI field of the SAR-PDU trailer. The CRC-10 generating polynomial is:

$$G(x) = 1 + x + x4 + x5 + x9 + x10$$

The result of the CRC calculation is placed with the least significant bit right justified in the CRC field.

4.3.2 *Convergence sublayer (CS)*

4.3.2.1 *Function of CS*

For further study.

4.3.2.2 *CS structure and coding*

For further study.

5 AAL type 4

5.1 *Service provided by the AAL type 4*

AAL type 4 provides the capabilities to transfer the AAL-SDU for one AAL user to one or more AAL users through the ATM network.

Two modes of service are defined: message and streaming.

a) **message mode service:**

This service provides the transport of a single AAL service data unit (AAL-SDU) in one (or, optionally more than one) convergence sublayer protocol data units (CS-PDUs);

b) **streaming mode service:**

This service provides the transport of one or more fixed size AAL service data units (SDU1-SDUn) in one convergence sublayer PDU (CS-PDUs). The AAL-SDU may be as small as one octet, and is always delivered as a unit, because it is the atomic unit of data recognized by the application.

The application of these modes to a particular service is service dependent and requires further study.

Both modes of service may offer the following peer-to-peer operational procedures:

— *Assured operations:* Every assured AAL-SDU is delivered with exactly the data content that the user sent. The assured service is provided by retransmission of missing or corrupted CS-PDUs. Flow control is provided as a mandatory feature. The assured operation may be restricted to point-to-point ATM layer connections. Assured operation may not be necessary in a connectionless environment.

— *Non-assured operations:* Integral AAL-SDUs may be lost or corrupted. Lost and corrupted AAL-SDUs will not be corrected by retransmission. An optional feature may be provided to allow corrupted AAL-SDUs to be delivered to the user (i.e. optional error discard). Flow control may be provided as an option on point-to-point ATM layer connections. However, no flow control is provided on point-to-multipoint ATM layer connections.

These procedures are for further study.

5.1.1 *Definitions for AAL type 4*

The AAL type 4 provides the capabilities to transfer the AAL-SDU from one AAL-SAP to one or more AAL-SAPs through the ATM network (see Figure 4a/I.363 and 4b/I.363). The AAL-users will have the capability to select a given AAL-SAP associated with the QOS required, to transport that AAL-SDU (for example, delay, loss sensitive QOS).

Figure 4/I.363 (a and b) = 16,5 cm

AAL type 4 makes use of the service provided by the underlying ATM layer (see Figure 5/I.363). Multiple AAL connections may be associated with a single ATM layer connection, allowing cell multiplexing at the AAL. The AAL user selects the QOS provided in the AAL by the choice of the AAL-SAP used for data transfer.

Figure 5/I.363 = 5,6 cm

5.1.2 *Primitives*

At each AAL-SAP, the primitives provided by AAL type 4 will include the following primitives to the AAL-user:

a) *Primitives*

AAL-UNITDATA-request (AAL-SAP-ID[1]), DATA): The AAL-UNITDATA-request primitive requests the transfer of an AAL-SDU from the local AAL-entity to a single peer AAL-entity, or multiple peer AAL-entities.

AAL-UNITDATA-indication (AAL-SAP-ID1), DATA, RECEPTION-STATUS)

The AAL-UNITDATA-indication primitive indicates the delivery of an AAL-SDU from the AAL layer to the AAL service user entity.

Other primitives are for further study.

b) *Parameters*

The DATA parameter specifies the AAL-SDU to be exchanged between the AAL service provider and the AAL service user entity across the AAL-SAP.

The AAL-SAP IDentifier parameter specifies the AAL connection. This parameter has local significance allowing the AAL user to select one specific AAL connection.

The RECEPTION STATUS parameter indicates the success or failure of reception of the AAL-SDU. The type of failure will be indicated.

Other parameters are for further study.

5.2 *Interaction with the management and control planes*

5.2.1 *Management plane*

For further study.

5.2.2 *Control plane*

For further study

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1) The need for this parameter is for further study.

5.3 *Functions in AAL type 4*

5.3.1 *Segmentation and reassembly sublayer (SAR)*

5.3.1.1 *Functions of the SAR sublayer*

The SAR sublayer functions are performed on an ATM-SDU basis. The SAR sublayer accepts variable length CS-PDUs from the CS and generates SAR-PDUs containing up to 44 octets of CS-PDU data.

The SAR sublayer functions will provide the means for the transfer of multiple variable length CS-PDUs concurrently over a single ATM layer connection between AAL entities.

a) *Preservation of CS-PDU*

This function preserves each CS-PDU by providing for a segment type indication and a SAR-PDU payload fill indication. The SAR-PDU payload fill indication identifies the number of octets of CS-PDU information contained within the SAR-PDU payload. The segment type indication identifies a
SAR-PDU as being a beginning of message (BOM), continuation of message (COM), end of message (EOM), or single segment message (SSM).

b) *Error detection*

This function provides the means to detect:

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—

The presence of either type of error may be indicated to the CS.

c) *Multiplexing/demultiplexing*

This function provides for the multiplexing and demultiplexing of multiple CS-PDUs concurrently over a single ATM connection using the multiplexing identification (MID) field.

5.3.1.2 *SAR structure and coding*

The SAR sublayer functions require a 2 octet SAR-PDU Header and a 2 octet SAR-PDU Trailer. The
SAR-PDU header and trailer together with the 44 octets of SAR-PDU payload comprise the 48 octet ATM-SDU
(cell payload). The sizes and positions of fields are given in Figure 6/I.363.
Figure 6/I.363 = 9 cm

The coding of SAR-PDU conforms to the coding conventions specified in § 2.1 of I.361.

a) *Segment type field*

The association between the encoding and the meaning of the segment type field is shown in the Table 2/I.363.

µTABLE 2/I.363

Coding of segment type

Encoding Segment type MSB LSB
BOM 1 0
COM 0 0
EOM 0 1
SSM 1 1

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b) *Sequence number field*

Four bits are allocated to the sequence number field allowing the stream of SAR-

PDUs of a CS-PDU to be numbered modulo 16.

Each SAR-PDU, associated with a given MID value, will have its sequence number incremented by one relative to its previous sequence number.

c) *Multiplexing identification (MID) field*

All SAR-PDUs of a given CS-PDU will have the same MID. The MID field is used to identify SAR-PDUs belonging to a particular CS-PDU. The MID field assists in the interleaving of ATM-SDUs from different CS-PDUs and reassembly of these CS-PDUs.

d) *SAR-PDU payload*

The CS-PDU information within the SAR-PDU payload is left justified within the field. Any part of the SAR-PDU payload that does not contain CS-PDU information is coded as all zeros.

e) *Length indication field*

The length indication field is binary coded with the number of octets from the CS-PDU that are included in the SAR-PDU. This field may have a value less than or equal to 44.

f) *CRC field*

The CRC field is filled with the value of a CRC calculation which is performed over the entire contents of the SAR-PDU, including the SAR-PDU Header, SAR-PDU payload, and LI field of the SAR-PDU Trailer. The CRC-10 generating polynomial is:

$$G(x) = 1 + x + x4 + x5 + x9 + x10$$

The result of the CRC calculation is placed with the least significant bit right justified in the CRC field.

5.3.2 *Convergence sublayer (CS)*

5.3.2.1 *Functions of CS*

The CS functions are performed per CS-PDU. The CS provides several functions in support of the AAL type 4 service user. The functions provided depend on whether the AAL service user is operating in MESSAGE or STREAMING mode, and include:

a) *Preservation of AAL-SDU*

Higher layer PDU delineation and transparency (layer 2 frame delineation functions, such as flag synchronization for LAPD, will not be needed in higher layer protocol).

b) *Mapping between AAL-SAPs and ATM layer connections*

c) *Error detection and handling*

Detection and handling of CS-PDU corruption and the optional discarding of these corrupted CS-PDUs.

d) *Message segmentation and reassembly*

The optional segmentation and reassembly of an AAL-SDU into two or more CS-PDUs for efficient transport across the ATM network.

e) *Identification of information*

This function provides an explicit indication of the information being carried within the CS-PDU. Further study is needed on the necessity of this identification.

f) *Buffer allocation size*

The optional indication to the receiving peer entity of the maximum buffering requirements to receive the CS-PDU.

Other functions are for further study.

5.3.2.2 *CS structure and coding*

For further study.

ANNEX A

(to Recommendation I.363)

Details of the data unit naming convention

Figure A-1/I.363 = 17,5 cm

ANNEXE B

(to Recommendation I.363)

Alphabetical list of abbreviations used in this Recommendation

AAL	ATM Adaptation Layer
AAL-PCI	AAL protocol control information
AAL-SDU	AAL service data unit
ATM-SDU	ATM service data unit
BOM	Beginning of message
COM	Continuation of message
CRC	Cyclic redundancy check
CS	Convergence sublayer
CS-PDU	Convergence sublayer protocol data unit
EOM	End of message
IT	Information type
LI	Length indicator
MID	Multiplexing identification
RES	Reserved field
SAP	Service access point
SAR	Segmentation and reassembly sublayer
SN	Sequence number
SNP	Sequence number protection
SSM	Single segment message
ST	Segment type