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ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI).

Asynchronous Transfer Mode (ATM) is the transfer mode solution for implementing a Broadband Integrated Services Digital Network (B-ISDN). It influences the standardisation of digital hierarchies, multiplexing structures, switching and interfaces for broadband signals.

This ETS consists of 2 parts as follows:

Part 1: "B-ISDN ATM functional specification".

Part 2: "B-ISDN ATM layer specification".

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1 Scope

This European Telecommunication Standard (ETS) is a 2 Part ETS which gives the basic characteristics and functional specification of Asynchronous Transfer Mode (ATM).

This part specifically addresses the functions of the ATM layer (see CCITT Recommendation I.150 [1]). This layer is common to all services, including signalling and Operation And Maintenance (OAM).

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] CCITT Recommendation I.150: "B-ISDN asynchronous transfer mode functional characteristics".

[2] CCITT Recommendation I.113: "Vocabulary of terms for broadband aspects of ISDN".

[3] CCITT Recommendation I.311: "B-ISDN general network aspects".

[4] CCITT Recommendation I.610: "B-ISDN Operation and Maintenance principles and functions".

[5] CCITT Recommendation I.371: "Traffic control & congestion control in B-ISDN".

[6] CCITT Recommendation I.413: "B-ISDN user-network interface".

[7] ETS 300 298-2: "Network Aspects (NA); Basic characteristics and functional specification of Asynchronous Transfer Mode (ATM) Part 2: B-ISDN ATM layer specification".

3 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

AAL	ATM Adaptation Layer
B-NT2	Broadband Network Termination 2
B-TE	Broadband Terminal Equipment
CBR	Constant Bit Rate
CLP	Cell Loss Priority
GFC	Generic Flow Control
NNI	Network Node Interface
OAM	Operation And Maintenance
PT	Payload Type
QoS	Quality of Service
TE	Terminal Equipment
UNI	User-Network Interface
VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VP	Virtual Path
VPC	Virtual Path Connection
VPI	Virtual Path Identifier

4 Basic principles of ATM

ATM is used in this ETS for addressing a specific packet oriented transfer mode which uses asynchronous time division multiplexing techniques. The multiplexed information flow is organized into blocks of fixed size called cells. A cell consists of an information field and a header. The primary role of the header is to identify cells belonging to the same Virtual Channel (VC) within the asynchronous time division multiplex. Transfer capacity is assigned by negotiation and is based on the source requirements and the available capacity. Cell sequence integrity on a Virtual Channel Connection (VCC) is preserved by the ATM layer[1)].

ATM is a connection oriented technique. Connection identifiers are assigned to each link of a connection when required and released when no longer needed. In general, signalling and user information are carried on separate ATM connections.

ATM offers a flexible transfer capability common to all services, including connectionless services. Additional functionalities above the ATM layer (e.g. in the ATM Adaptation Layer (AAL)) are provided to accommodate various services. The boundary between the ATM layer and the AAL corresponds to the boundary between functions supported by the contents of the cell header and functions supported by AAL specific information. The AAL specific information is contained in the information field of the ATM cell.

The information field is transported transparently by the ATM layer. No processing, e.g. error control, is performed on the information field at the ATM layer.

The header and information field each consist of a fixed integer number of octets. The header size, (5 octets), and the information field size, (48 octets), remain constant at all reference points, including the User-Network Interface (UNI) and the Network Node Interface (NNI), where the ATM technique is applied.

5 ATM layer

5.1 ATM layer connections

5.1.1 Connection definition

An ATM layer connection consists of the concatenation of ATM layer links in order to provide an end-to-end transfer capability to access points.

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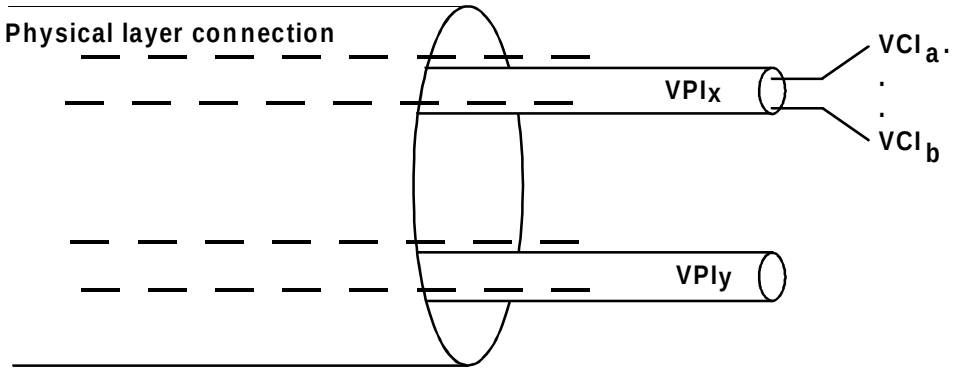
1) For a multipoint-to-point virtual connection, cell sequence integrity is preserved for cells from each VCC endpoint of the VCC.

5.1.2 Connection identifiers

5.1.2.1 Virtual Path Identifiers (VPIs) and Virtual Channel Identifiers (VCIs)

At a given interface, in a given direction, the different Virtual Path (VP) links multiplexed at the ATM layer into the same physical layer connection are distinguished by the VPI. The different VC links in a Virtual Path Connection (VPC) are distinguished by the VCI as indicated in figure 1.



NOTE: VCI_a and VCI_b represent two of the possible values of VCI within the VP link with the value VPI_x. Similarly, VPI_x and VPI_y refer to two of the possible values of VPI within the physical layer connection.

Figure 1: ATM layer connection identifier

5.1.2.2 VPI - VCI relationships

Two different VCs belonging to two different VPs at a given interface may have the same VCI value. Therefore, a VC is only fully identified at an interface by both VPI and VCI values.

A specific value of VCI has no end-to-end significance if the VCC is switched. VPIs may be changed wherever VP links are terminated (e.g. cross-connects, concentrators and switches). VCIs may only be changed where VC links are terminated. As a consequence, VCI values are preserved within a VPC.

5.1.2.3 Number of active connections at the UNI

At the UNI, 24 bits are available in the VPI/VCI field for connection identification. The actual number of routeing bits in the VPI and VCI fields used for routeing is negotiated between the user and the network, e.g. on a subscription basis. This number is determined on the basis of the lower requirement of the user or the network. The rules to determine the position of the routeing bits used within the VPI/VCI field are given in subclause 4.2.3 of ETS 300 298-2 [7].

NOTE: The number of VCI field routeing bits used in a user-to-user VP is negotiated between the users of the VP.

5.1.2.4 Number of active connections at the NNI

At the NNI, 28 bits are available in the VPI/VCI field for connection identification. The actual number of routeing bits in the VPI and VCI fields used for routeing is established at installation. This number is determined on the basis of the requirement of each entity. The rules to determine the position of the routeing bits used within the VPI/VCI field are given in subclause 4.3.2 of ETS 300 298-2 [7].

5.1.3 Aspects of VCCs

5.1.3.1 General characteristics of VCCs

The definition of a VCC is given in CCITT Recommendation I.113 [2]. This subclause provides additional explanations to facilitate the understanding of the following topics:

a) Quality of Service (QoS): a user of a VCC is provided with a QoS specified by parameters such as cell loss ratio and cell delay variation;

b) switched, semi-permanent and permanent VCCs: VCCs can be provided on a switched, semi-permanent or permanent basis;

c) cell sequence integrity: cell sequence integrity is preserved within a VCC;

d) traffic parameter negotiation and usage monitoring: when a user requests from the network the establishment of a VCC, traffic parameters shall be negotiated between a user and a network for each VCC at VCC establishment and may be subsequently renegotiated. Input cells from the user to the network may be monitored to ensure that the negotiated traffic parameters are not violated.

At a B-ISDN interface (e.g. UNI or NNI), there are two directions of transmission. When a routeing field value (i.e. VPI plus VCI) is assigned for a VC link at an interface (e.g. UNI or NNI), the same value is assigned for both directions of transmission. The routeing field value used in one direction is only to be used in the opposite direction to identify the VC link involved in the same communication. It should be noted that:

- the bandwidth in both directions may be the same (symmetric communication); or

- the bandwidth in both directions may be different (asymmetric communication); or

- the bandwidth of the opposite direction may be equal to zero (unidirectional communication without any reverse information); or

- the bandwidth of the opposite direction could be large enough to carry ATM layer management information (unidirectional communication with reverse management information).

Within a user-to-user VPC, the network passes the VCI field transparently with the exception of some standardized VCI values (see ETS 300 298-2 [7]). The routeing field assignment is under the control of the user (e.g. user-to-user signalling procedures, user-to-user management procedures, etc.).

5.1.3.2 Establishment and release of a VCC

5.1.3.2.1 Establishment/release at the UNI

VCCs may be established/released using one or more of the following four methods:

1) without using signalling procedures, e.g. by subscription, ((semi-)permanent connections);

2) meta-signalling procedures (see CCITT Recommendation I.311 [3]) e.g. by using a meta-signalling VCC to establish/release a VCC used for signalling;

3) user to network signalling procedures, e.g. using a signalling VCC to establish/release a VCC used for end-to-end communications;

4) user-to-user signalling procedures, e.g. using a signalling VCC to establish/release a VCC within a pre-established VPC between two UNIs.

The value assigned to a VCI at a UNI using the methods listed above could be assigned by one of the following:

a) the network;

b) the user;

c) negotiation between the user and the network;

d) standardization.

The specific value assigned to a VCI at a UNI is, in general, independent of the service provided over that VC. For terminal interchangeability and initialization, it is desirable to use the same value for certain functions on all UNIs. For example, the same VCI value for the meta-signalling VC will be used on all UNIs, in order to simplify initialization of the Terminal Equipment (TE).

5.1.3.2.2 Establishment/release at the NNI

ATM network elements (e.g. ATM switches, cross-connects and concentrators) process the ATM cell header and may provide VCI and/or VPI translation. Thus, whenever a VCC is established/released across the ATM network, VC links may need to be established/released at one or more NNIs. VC links are established/released between ATM network elements using inter-network and intra-network signalling procedures; other methods are also possible.

5.1.3.3 Pre-assigned VCIs

Information concerning the use of the following VCI values in combination with VPI values can be found in tables 1, 2 and 4 of ETS 300 298-2 [7].

Pre-assigned VCI values are used for:

a) unassigned cell identification and physical layer cell identification;

NOTE: For unassigned cell identification and cells reserved for use by the physical layer, a pre-assigned value of VPI/VCI combination is reserved. This combination cannot be used for any other purposes.

b) meta-signalling VC identification;

c) general broadcast signalling VC identification;

d) point-to-point signalling VC identification, see CCITT Recommendation I.311 [3];

e) F4 OAM flows;

f) others uses are for further study.

5.1.3.4 Signalling VCs

Refer to CCITT Recommendation I.311 [3].

5.1.3.5 OAM VCs

Refer to CCITT Recommendation I.610 [4].

5.1.4 Aspects of VPCs

5.1.4.1 General characteristics of VPCs

The definition of a VPC is given in CCITT Recommendation I.113 [2]. This subclause gives additional explanations to facilitate the understanding of the following topics:

a) QoS: a user of a VPC is provided with a QoS specified by parameters such as cell loss ratio and cell delay variation;

b) switched, permanent and semi-permanent VPCs: VPCs can be established on a switched, permanent or semi-permanent basis;

c) cell sequence integrity: cell sequence integrity is preserved within a VPC;

d) traffic parameters negotiation and usage monitoring: traffic parameters will be negotiated between a user and the network for each VPC at VPC establishment and may be subsequently renegotiated. Input cells from the user to the network will be monitored to ensure that the negotiated traffic parameters are not violated;

e) VCI restrictions within a VPC: one or more VCIs within a VPC may not be available to the user of the VPC. The number and values of these VCIs are for further study.

At a B-ISDN interface (e.g. UNI or NNI), there are two directions of transmission. When a routeing field value (VPI) is assigned for a VP link at an interface (e.g. UNI or NNI), the same value is assigned for both directions of transmission. The routeing field value used in one direction is only to be used in the opposite direction to identify the VP link involved in the same communication. It should be noted that:

- the bandwidth in both directions may be the same (symmetric communication); or

- the bandwidth in both directions may be different (asymmetric communication); or

- the bandwidth of the opposite direction may be equal to zero (unidirectional communication without any reverse information); or

- the bandwidth of the opposite direction could be large enough to carry ATM layer management information (unidirectional communication with reverse management information).

5.1.4.2 Establishment and release of a VPC

A VPC may be established/released between VPC endpoints by one of the following methods, which are for further study:

a) establishment/release without using signalling procedures. In this case, the VPC is established/released on a subscription basis;

b) establishment/release on demand:

   - customer controlled VPC establishment/release, where VP configuration may be performed by the user invoking signalling or network management procedures;

   - network controlled VPC establishment/release may be performed by network signalling procedures.

5.1.4.3 Pre-assigned VPIs

Information concerning the use of VPI values in combination with VCI values can be found in tables 1, 2 and 4 of ETS 300 298-2 [7].

5.1.5 Pre-assigned cell header values

Cells reserved for the use of the physical layer have pre-assigned values reserved for the whole header; these values are not to be used by the ATM layer.

5.2 Service characteristics

This ETS does not cover the service characteristics aspects.

5.3 Management plane interactions

ATM layer management is part of the management plane and only performs management functions specific to ATM layer such as meta-signalling, ATM layer OAM, and ATM resource management. These functions would support the management plane to perform management functions related to a system as a whole and to provide co-ordination between all planes.

ATM layer management information is conveyed via the following two methods:

- one method uses Payload Type (PT) indicating user information and ATM layer management information is placed in the cell payload. A bi-directional connection is established for the sole purpose of providing this layer management information;

- the other method uses PT indicating layer management information and ATM layer management information is placed in the cell payload. It is transported using the same VPI/VCI value as the user/control plane VCC.

5.4 Functions of the ATM layer

5.4.1 Cell multiplexing and switching

In the case of more than one ATM connection, the ATM layer is responsible for the multiplexing function.

The basic ATM routeing entity for switched services is the VC. It is handled in VC multiplexers/demultiplexers and switches. VCs are aggregated in VPCs which may be routed as such through VP multiplexers/demultiplexers and VP switches/cross connects (see figure 2).

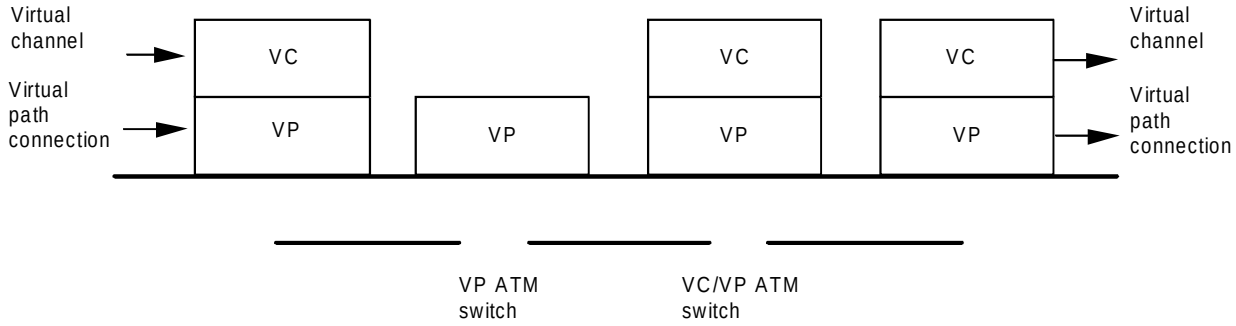


Figure 2: Types of ATM layer connections

5.4.2 QoS provided by the ATM layer

5.4.2.1 QoS related to VCCs

A user of a VCC is provided with one of a number of QoS classes supported by the network. Specific QoS classes and the quality provided by each QoS class require further study. Requested QoS classes are indicated to networks at call/connection establishment. The QoS class associated with a given connection within a call will not change for the duration of the connection. Re-negotiation of the QoS class may require the establishment of a new connection.

5.4.2.2 QoS related to VPCs

A user of a VPC is provided with one of a number of QoS classes supported by the network. Specific QoS classes and the quality provided by each class require further study. Requested QoS classes are indicated to networks at call/connection establishment. The QoS class associated with a VPC will not change for the duration of the VPC.

It should be noted that a VPC will carry VC links of various QoS classes. The QoS of the VPC is required to meet the most demanding QoS of the VC links carried.

5.4.2.3 QoS related to Cell Loss Priority (CLP)

5.4.2.3.1 General

Some services may require a certain QoS for one part of the cell flow and a lower QoS for the remainder. Exact use of the CLP bit and network mechanisms to monitor connections and provide different levels of network performance are described in CCITT Recommendation I.371 [5]. The network may selectively discard cells by making use of the CLP bit.

Some Variable Bit Rate (VBR) services will benefit if the user or service provider (e.g. layered coding video provider) can select which cells have the higher loss sensitivity.

5.4.2.3.2 CLP Indicator

One bit in the cell header is used for explicit CLP indication. This bit may be set by the user or service provider to indicate lower priority cells. Cells with the CLP bit not set have higher priority. Cells with the CLP bit set are subject to discard *with priority* depending on network conditions.

The network shall monitor the connection in accordance with mechanisms described in CCITT Recommendation I.371 [5] in order to protect the QoS of other users.

The rate of higher priority cells shall be determined at call establishment and may be subsequently renegotiated. Cells arriving at the network in excess of this rate shall be subject to usage parameter control. Cells arriving at the network in excess of other agreed parameters for the call shall also be subject to usage parameter control.

NOTE: The CLP mechanism would not normally be used for Constant Bit Rate (CBR) services, i.e. cells belonging to a CBR service would not normally have the CLP indicator set.

5.4.3 PT functions

The PT field is used to provide an indication of whether the cell payload (i.e. information field) contains user information or management information. The PT field codings for ATM user information are used to provide two additional indications. They are:

- congestion indication;

- ATM layer user-to- ATM layer user indication.

In user information cells the payload consists of user information. In management information cells, the payload does not form part of the user's information transfer. The PT field codings for management information are used to distinguish between three types of cells. They are:

- OAM F5 end-to-end associated cells: see CCITT Recommendation I.610 [4];

- OAM F5 segment associated cells: see CCITT Recommendation I.610 [4];

- resource management cells: see CCITT Recommendation I.371 [5].

When the PT field does not indicate user information, further information concerning the type of layer management can be found in the information field of the cell.

5.4.4 Generic Flow Control (GFC) at the UNI

The GFC mechanism assists in the control of the flow of traffic from ATM connections of various QoS classes (related to the ATM layer). More specifically, the GFC mechanism is used to control traffic flow in order to alleviate short term overload conditions that may occur.

There are two sets of procedures for use within the GFC field: "uncontrolled transmission" procedures and "controlled transmission" procedures (defined in subclause 6.1 of ETS 300 298-2 [7]). The "uncontrolled transmission" procedures can be used across the interface at the S_B and T_B reference points. The "uncontrolled transmission" procedures are not for use in shared medium configurations. The "controlled transmission" procedures can be used across internal customer premises network interfaces (see CCITT Recommendation I.413 [6]) and across the interface at the S_B reference point.

In cases where a TE is directly connected to the interface at the T_B reference point, the TE can execute the "controlled transmission" procedures. However, the public network can implement the "uncontrolled transmission" set of procedures.

The "controlled transmission" set of procedures for both multi-access and point-to-point Broadband Terminal Equipment (B-TE) configurations are for further study. They are expected to conform to the following:

a) the flow control at the UNI is supported by the ATM cell header. The GFC field is used to provide this function;

b) the GFC mechanism may assist the customer network in providing various QoS within the customer network;

c) the GFC mechanism should not perform flow control of traffic from the network. The use of GFC at S_B and T_B is as follows:

   1) GFC at S_B:

      - the GFC field is present at the interface at the S_B reference point and at the internal customer premises network interfaces;

      - the GFC mechanism should provide flow control of information generated locally by terminals within a customer's premises. This traffic may occur in directions to and from the terminal across the interface at the S_B reference point and the in interface. Operation of the GFC mechanism within the Broadband Network Termination 2 (B-NT2) to control the traffic in the B-NT2 to terminal direction is for further study. The specific mechanism at the interface at the S_B reference point and at the internal customer premises network interfaces is for further study;

   2) GFC at T_B:

      - the GFC field is present at the interface at the T_B reference point. In cases where a TE directly connected to the interface at the TB reference point, the TE can execute the "controlled transmission" procedures. However, the public network can implement the "uncontrolled transmission" set of procedures;

d) the GFC mechanism resides in the ATM layer and is independent of the physical layer;

e) the GFC mechanism applies at UNIs and should support the configurations of CCITT Recommendation I.413 [6], § 2.2;

f) the GFC mechanism shall allow a terminal to achieve an assured capacity of bandwidth allocated by the network to both CBR and VBR calls. In the case of VBR services, the GFC mechanism shall be able to partition fairly and efficiently the capacity above that guaranteed for all active connections;

g) the GFC mechanism should not compromize terminal interchangeability.

History

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