INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

I.150

(03/93)

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

GENERAL STRUCTURE

B-ISDN ASYNCHRONOUS TRANSFER MODE FUNCTIONAL CHARACTERISTICS

ITU-T Recommendation I.150

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T 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 World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation I.150 was revised by the ITU-T Study Group XVIII (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation I.150

B-ISDN ASYNCHRONOUS TRANSFER MODE FUNCTIONAL CHARACTERISTICS

(Geneva, 1991; revised Helsinki, 1993)

1 Introduction

This Recommendation addresses specifically the functions of the Asynchronous Transfer Mode (ATM) layer. This layer is common to all services including signalling and OAM.

2 Basic principles of ATM

ATM is the transfer mode solution for implementing a B-ISDN. It influences the standardization of digital hierarchies, multiplexing structures, switching and interfaces for broadband signals.

ATM is used in this Recommendation 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 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 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 on top of 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.

3. ATM layer

3.1 ATM connections

3.1.1 Connection definition

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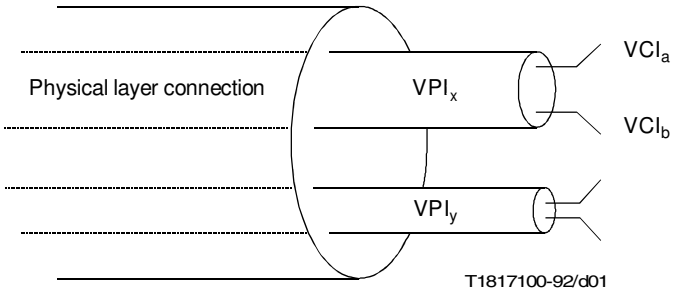
1) For a multipoint-to-point virtual channel connection, cell sequence integrity is preserved for cells from each VCC endpoint of the VCC.

3.1.2 Connection identifiers

3.1.2.1 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 virtual channel (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/I.150

ATM connection identifiers

3.1.2.2 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 virtual channel connection (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.

3.1.2.3 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 routing bits in the VPI and VCI fields used for routing 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 routing bits used within the VPI/VCI field are given in 2.2.3/I.361.

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

3.1.2.4 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 routing bits in the VPI and VCI fields used for routing across the interface 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 routing bits used within the VPI/VCI field are given in 2.2.3/I.361.

3.1.3 Aspects of virtual channel connections (VCCs)

3.1.3.1 General characteristics of VCCs

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

a) *Quality of Service* – A user of a VCC is provided with a Quality of Service specified by parameters such as cell loss ratio and cell delay variation.

b) *Switched and (semi-) permanent VCCs* – VCCs can be provided on a switched or (semi-) 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 routing 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 routing 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 Recommendation I.361). The routing field assignment is under the control of the user (e.g. user-to-user signalling procedures, user-to-user management procedures, etc.).

3.1.3.2 Establishment and release of a VCC

3.1.3.2.1 Establishment/release at the UNI

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

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

b) meta-signalling procedures (see Recommendation I.311), e.g. by using a meta-signalling VCC to establish/release a VCC used for signalling;

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

d) 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.

3.1.3.2.2 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- and intra-network signalling procedures; other methods are also possible.

3.1.3.3 Pre-assigned VCIs

Information concerning the use of the following VCI values in combination with VPI values can be found in Tables 1/I.361, 2/I.361 and 3/I.361.

Pre-assigned VCI values are used for

a) unassigned cell identification and physical layer cell identification.

NOTE – For the unassigned cell identification and cells reserved for use by the physical layer, a pre-assigned value of VPI/VCI combination is reserved. This combination can not 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 Recommendation I.311);

e) F4 OAM flows;

f) other uses are for further study.

3.1.3.4 Signalling VCs

Refer to Recommendation I.311.

3.1.3.5 OAM VCs

Refer to Recommendation I.610.

3.1.4 Aspects of virtual path connections (VPCs)

3.1.4.1 General characteristics of VPCs

The definition of a VPC is given in Recommendation I.113. This subclause provides additional explanations to facilitate the understanding of the following topics:

a) *Quality of Service* – A user of a VPC is provided with a Quality of Service specified by parameters such as cell loss ratio and cell delay variation.

b) *Switched and (semi-) permanent VPCs* – VPCs can be established on a switched 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 routing 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 routing 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).

3.1.4.2 Establishment and release of a VPC

A VPC may be established/released between VPC endpoints by one of the following methods. These methods 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.

3.1.4.3 Pre-assigned VPIs

Information concerning the use of VPI values in combination with VCI values can be found in Tables 1/I.361, 2/I.361, and 3/I.361.

3.1.5 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.

3.2 Service characteristics

3.2.1 Services expected from the physical layer

For further study.

3.2.2 Services provided to the higher layer

For further study.

3.3 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 coordination between all the planes.

ATM layer management information is conveyed via the following two method's.

– One method uses payload type 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 payload type 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.

3.4 Functions of the ATM layer

3.4.1 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 routing 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).

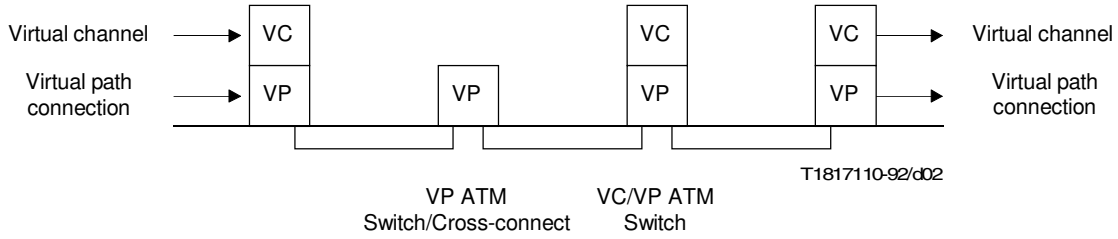


FIGURE 2/I.150

Types of ATM connections

3.4.2 Quality of Service provided by the ATM layer

3.4.2.1 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. Renegotiation of the QOS class may require the establishment of a new connection.

3.4.2.2 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 classes 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 must meet the most demanding QOS of the VC links carried.

3.4.2.3 QOS related to cell loss priority (CLP)

3.4.2.3.1 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 to provide different levels of network performance are described in Recommendation I.371. The network may selectively discard cells by making use of the CLP bit.

Some 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.

3.4.2.3.2 CLP indicator

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

The network will monitor the connection in accordance with mechanisms described in Recommendation I.371 in order to protect the QOS of other users.

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

NOTE – The cell loss priority 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.

3.4.3 Payload type functions

The payload type field is used to provide an indication of whether the cell payload (i.e. information field) contains user information or management information.

The payload type field codings for ATM user information are used to provide two additional indications. They are:

- congestion indication;
- ATM layer user to ATM 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 payload type field codings for management information are used to distinguish between three types of cells. They are:

- OAM F5 end-to-end associated cells (Recommendation I.610);
- OAM F5 segment associated cells (Recommendation I.610);
- resource management cells (Recommendation I.371).

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

3.4.4 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 4.1/I.361). The "uncontrolled transmission" procedures can be used across the interfaces 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 the SS_B (refer to Recommendation I.413) interface and 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 multiaccess and point-to-point 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 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:

i) GFC at S_B

The GFC field is present at the interface at the S_B reference point and the SS_B interface.

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 SS_B interface. Operation of the GFC mechanism within the 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 SS_B interface is for further study.

ii) GFC at T_B

The GFC field is present at the interface at the T_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.

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 2.2/I.413.

f) The GFC mechanism must 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 must be able to partition fairly and efficiently the capacity above that guaranteed for all active connections.

g) The GFC mechanism should not compromise terminal interchangeability.

Annex A

Alphabetical list of abbreviations contained in this Recommendation

(This annex forms integral part of this Recommendation)

AAL ATM adaptation layer

ATM Asynchronous transfer mode

CBR Constant bit rate

GFC Generic flow control

NNI Network-node interface

OAM Operations and maintenance

QOS Quality of Service

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