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INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

OVERALL NETWORK ASPECTS AND FUNCTIONS

B-ISDN ATM LAYER SPECIFICATION

ITU-T Recommendation I.361

(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.361 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 Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.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.361

B-ISDN ATM LAYER SPECIFICATION

(Geneva, 1991; revised Helsinki, 1993)

1 Introduction

This Recommendation specifically addresses:

a) the cell structure and the ATM cell coding;
b) the ATM protocol procedures.

2 Cell structure coding

Two different coding schemes have been adopted; the UNI format and the NNI format. They are described in 2.2 and 2.3.

2.1 Cell structure

The cell consists of a five octet header and a 48-octet information field as shown in Figure 1.

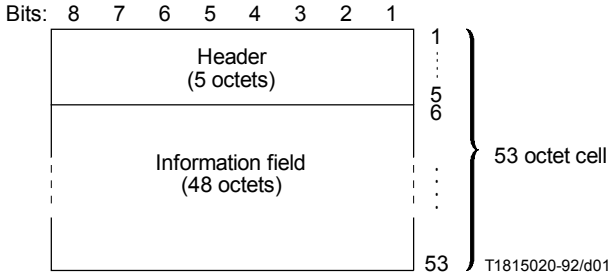

FIGURE 1/I.361

Cell structure at the UNI/NNI

NOTE – The header will be sent first followed by the information field.

When a field within the header is contained within a single octet, the lowest bit number of the field represents the lowest order value.

When a field spans more than one octet, the order of bit values within each octet progressively decreases as the octet number increases; the lowest bit number associated with the field represents the lowest order value.

This leads to the following conventions:

– bits within an octet are sent in decreasing order, starting with bit 8;
– octets are sent in increasing order, starting with octet 1;
– for all fields, the first bit sent is the most significant bit (MSB).

2.2 Cell header format and encoding at UNI

The structure of the header is shown in Figure 2. The fields contained in the header and their encoding are described in the following subclauses.

8	7	6	5	4	3	2	1	Bit Octet
GFC				VPI				1
VPI				VCI				2
VCI								3
VCI				PT			CLP	4
HEC								5

CLP Cell loss priority
GFC Generic flow control
PT Payload type
HEC Header error control
VPI Virtual path identifier
VCI Virtual channel identifier

FIGURE 2/I.361

Header structure at UNI

2.2.1 Pre-assigned values of the cell header reserved for use by the physical layer

Pre-assigned values of the cell header (to differentiate cells for the use of the ATM layer from cells for the use of the physical layer) are given in Table 1. All other values are for the use of the ATM layer.

TABLE 1/I.361

Pre-assigned cell header values at the UNI for use by the physical layer (excluding the HEC field)

	Octet 1	Octet 2	Octet 3	Octet 4
Idle cell identification (Notes 1 and 2)	00000000	00000000	00000000	00000001
Physical layer OAM cell identification (Note 2)	00000000	00000000	00000000	00001001
Reserved for use of the physical layer (Notes 1, 2 and 3)	PPPP0000	00000000	00000000	0000PPP1

P Indicates the bit is available for use by the physical layer.
Values assigned to these bits have no meaning with respect to the fields occupying the corresponding bit positions at the ATM layer.

NOTES

1 In the case of physical layer cells, the bit in the location of the CLP indication is not used for the CLP mechanism as specified in 3.4.2.3.2/I.150.

2 Cells having header values which are identified as idle, physical layer OAM, and reserved for use by the physical layer are not passed to the ATM layer from the physical layer.

3 Specific pre-assigned physical layer cell header values are given in Recommendation I.432.

2.2.2 Generic flow control (GFC) field

The GFC field contains 4 bits. When the GFC function is not used, the value of this field is 0000. When the GFC mechanism is standardized, all values of this field are available for coding. This coding is for further study. The coding must take into account the relationship with the procedures described in 4.1.

2.2.3 Routing field (VPI/VCI)

Twenty-four bits are available for routing: 8 bits for virtual path identifier (VPI) and 16 bits for virtual channel identifier (VCI). Pre-assigned combinations of VPI and VCI values are shown in Table 2. Other pre-assigned values of VPI and VCI are for further study. The VCI value of zero is not available for user virtual channel identification.

TABLE 2/I.361

Combinations of pre-assigned VPI, VCI, PT and CLP values at the UNI

Use	VPI	VCI	PT	CLP
Meta-signalling (Refer to Recommendation I.311)	XXXXXXXX (Note 1)	00000000 00000001 (Note 5)	0A0	C
General broadcast signalling (Refer to Recommendation I.311)	XXXXXXXX (Note 1)	00000000 00000010 (Note 5)	0AA	C
Point-to-point signalling (Refer to Recommendation I.311)	XXXXXXXX (Note 1)	00000000 00000101 (Note 5)	0AA	C
Segment OAM F4 flow cell (Refer to Recommendation I.610)	YYYYYYYY (Note 2)	00000000 00000011 (Note 4)	0A0	A
End-to-end OAM F4 flow cell (Refer to Recommendation I.610)	YYYYYYYY (Note 2)	00000000 00000100 (Note 4)	0A0	A
Segment OAM F5 flow cell (Refer to Recommendation I.610)	YYYYYYYY (Note 2)	ZZZZZZZZ ZZZZZZZZ (Note 3)	100	A
End-to-end OAM F5 flow cell (Refer to Recommendation I.610)	YYYYYYYY (Note 2)	ZZZZZZZZ ZZZZZZZZ (Note 3)	101	A
Resource management cell (Refer to Recommendation I.371)	YYYYYYYY (Note 2)	ZZZZZZZZ ZZZZZZZZ (Note 3)	110	A
Unassigned cell	00000000	00000000 00000000	BBB	0

The GFC field is available for use with all of these combinations.

A Indicates that the bit may be 0 or 1 and is available for use by the appropriate ATM layer function.

B Indicates the bit is a “don’t care” bit.

C Indicates the originating signalling entity shall set the CLP bit to 0. The value may be changed by the network.

NOTES

1 XXXXXXXX: Any VPI value. For VPI value equal to 0, the specific VCI value specified is reserved for user signalling with the local exchange. For VPI values other than 0, the specified VCI value is reserved for signalling with other signalling entities (e.g. other users or remote networks).

2 YYYYYYYY: Any VPI value.

3 ZZZZZZZZ ZZZZZZZZ: Any VCI value other than 0.

4 Transparency is not guaranteed for the OAM F4 flows in a user-to-user VP.

5 The VCI values are pre-assigned in every VPC at the UNI. The usage of these values depends on the actual signalling configurations. (See Recommendation I.311.)

The number of bits of the VPI and VCI fields used for routing are established by negotiation between the user and the network as described in 3.1.2.3/I.150. The bits within the VPI and VCI fields used for routing are allocated using the following rules:

- the allocated bits of the VPI field will be contiguous;
- the allocated bits of the VPI field will be the least significant bits of the VPI field (beginning at bit 5 of octet 2);
- the allocated bits of the VCI field will be contiguous;
- the allocated bits of the VCI field will be the least significant bits of the VCI field (beginning at bit 5 of octet 4).

In addition, unallocated bits, i.e. bits not utilized by the user or the network, within the 24-bit routing field will be set to zero.

See 3.1.3/I.150 and 3.1.4/I.150 for VPI/VCI assignment information.

2.2.4 Payload type (PT) field

Three bits are available for PT identification. The following table describes the payload type identifier (PTI) coding.

	PTI coding	Interpretation
Bits	4 3 2	
	0 0 0	User data cell, congestion not experienced. ATM-user-to-ATM-user indication = 0
	0 0 1	User data cell, congestion not experienced. ATM-user-to-ATM-user indication = 1
	0 1 0	User data cell, congestion experienced. ATM-user-to-ATM-user indication = 0
	0 1 1	User data cell, congestion experienced. ATM-user-to-ATM-user indication = 1
	1 0 0	OAM F5 segment associated cell
	1 0 1	OAM F5 end-to-end associated cell
	1 1 0	Resource management cell
	1 1 1	Reserved for future functions

Any congested network element, upon receiving a user data cell, may modify the PTI as follows. Cells received with PTI = 000 or PTI = 010 are transmitted with PTI = 010. Cells received with PTI = 001 or PTI = 011 are transmitted with PTI = 011. Non-congested network elements should not change the PTI. See Recommendation I.371.

The use of PTI = 110 is reserved for resource management use. See 3.2.6/I.371.

The use of PTI = 100 is discussed in Recommendation I.610.

The use of PTI = 101 is discussed in Recommendation I.610.

2.2.5 Cell loss priority (CLP) field

Depending on network conditions, cells where the CLP is set (CLP value is 1) are subject to discard prior to cells where the CLP is not set (CLP value is 0). (See Recommendation I.371 for further details about the use of the CLP bit.)

2.2.6 Header error control (HEC) field

The HEC field consists of 8 bits. Use of this field is described in 4.3/I.432.

2.3 Cell header format and encoding at NNI

The structure of the header is shown in Figure 3. The fields contained in the header and their encoding are described in the following subclauses.

8	7	6	5	4	3	2	1	Bit Octet
VPI								1
VPI				VCI				2
VCI								3
VCI				PT			CLP	4
HEC								5

FIGURE 3/I.361

Header structure at NNI

2.3.1 Pre-assigned values of the cell header

Pre-assigned values of the cell header (to differentiate cells for the use of the ATM layer from cells for the use of the physical layer) are given in Table 3. All other values are for use of the ATM layer.

TABLE 3/I.361

Pre-assigned cell header values at the NNI for use by the physical layer (excluding the HEC field)

	Octet 1	Octet 2	Octet 3	Octet 4
Idle cell identification (Notes 1 and 2)	00000000	00000000	00000000	00000001
Physical layer OAM cell identification (Note 2)	00000000	00000000	00000000	00001001
Reserved for use of the physical layer (Notes 1, 2 and 3)	00000000	00000000	00000000	0000PPP1

P Indicates the bit is available for use by the physical layer.
Values assigned to these bits have no meaning with respect to the fields occupying the corresponding bit positions at the ATM layer.

NOTES

1 In the case of physical layer cells, the bit in the location of the CLP indication is not used for the CLP mechanism as specified in 3.4.2.3.2/I.150.

2 Cells having header values which are identified as idle, physical layer OAM, and reserved for use by the physical layer are not passed to the ATM layer from the physical layer.

3 Specific pre-assigned physical layer cell header values are given in Recommendation I.432.

2.3.2 Routing field (VPI/VCI)

Twenty-eight bits are available for routing: 12 bits for VPI and 16 bits for VCI.

The unassigned cell is identified by the following pre-assigned field values: VPI = 0, VCI = 0 and CLP = 0. The PT field is unused.

Two pre-assigned VCI values are used to distinguish the F4 OAM flows:

- end-to-end associated flows (VCI = 4);
- segment associated flow (VCI = 3).

VCI value 5 is pre-assigned at the NNI for signalling.

Other pre-assigned values of VPI and VCI are for further study. The VCI value of zero is not available for user virtual channel identification.

See 3.1.3/I.150 and 3.1.4/I.150 for VPI/VCI assignment information.

2.3.3 Payload type (PT) field

Three bits are available for PT identification. The following table describes the payload type identifier (PTI) coding.

	PTI coding	Interpretation
Bits	4 3 2	
	0 0 0	User data cell, congestion not experienced. ATM-user-to-ATM-user indication = 0
	0 0 1	User data cell, congestion not experienced. ATM-user-to-ATM-user indication = 1
	0 1 0	User data cell, congestion experienced. ATM-user-to-ATM-user indication = 0
	0 1 1	User data cell, congestion experienced. ATM-user-to-ATM-user indication = 1
	1 0 0	OAM F5 segment associated cell
	1 0 1	OAM F5 end-to-end associated cell
	1 1 0	Resource management cell
	1 1 1	Reserved for future functions

Any congested network element, upon receiving a user data cell may modify the PTI as follows. Cells received with PTI = 000 or PTI = 010 are transmitted with PTI = 010. Cells received with PTI = 001 or PTI = 011 are transmitted with PTI = 011. Non-congested network elements should not change the PTI. See Recommendation I.371.

The use of PTI = 110 is reserved for resource management use. See 3.2.6/I.371.

The use of PTI = 100 is discussed in Recommendation I.610.

The use of PTI = 101 is discussed in Recommendation I.610.

2.3.4 Cell loss priority (CLP) field

Depending on network conditions, cells where the CLP is set (CLP value is 1) are subject to discard prior to cells where the CLP is not set (CLP value is 0).

2.3.5 Header error control (HEC) field

The HEC field consists of 8 bits. The HEC mechanism of the NNI is identical to that at the UNI and is described in 4.3/I.432.

2.4 Cell information field

2.4.1 Pre-assigned values

The pre-assigned values of the information field of all unassigned cells are for further study.

3 Service primitives

Service primitives describe in an abstract manner the logical exchange of information and control through a service access point (SAP). The primitives do not specify nor constrain the implementation of entities or interfaces.

3.1 Primitives exchanged with the upper layer

The information exchanged between the ATM layer and the upper layer (e.g. the AAL) across the ATM-SAP includes the following primitives:

- ATM-DATA request (ATM-SDU, submitted loss priority, congestion indication, ATM-user-to-ATM-user indication);
- ATM-DATA indication (ATM-SDU, congestion indication, ATM-user-to-ATM-user indication).

Additional parameters require further study.

3.1.1 Description of primitives

- ATM-DATA request: This primitive is issued by an upper layer entity (e.g. AAL-entity) to request the transfer of an ATM-SDU to its corresponding entity (or entities) over an ATM connection. The submitted loss priority parameter and the ATM-user-to-ATM-user indication parameter are used to assign the proper CLP and PTI fields to the ATM-PDU generated at the ATM layer. The generated ATM-PDU is transferred over the PHY-CEs assigned to that ATM connection or the indicated group of PHY-CEs;
- ATM-DATA indication: This primitive is issued to an upper layer entity (e.g. AAL-entity) to indicate the arrival of an ATM-SDU from the indicated PHY-CE over an ATM connection, with congestion indication and received ATM-user-to-ATM-user indication. In the absence of error, the ATM-SDU is the same as the ATM-SDU sent by the corresponding upper layer entity in the ATM-DATA request primitive.

3.1.2 Descriptions of parameters

- ATM-SDU: This parameter contains 48 octets of ATM layer user data (e.g. the AAL SAR-PDU) to be transferred by the ATM layer between corresponding upper layer entities;
- Submitted loss priority: This parameter indicates the relative importance of the requested transport for the information carried in the ATM-SDU. It can take only two values, one for high priority and the other for low priority;
- Congestion indication: This parameter indicates that the received ATM-SDU has passed through a network node in congestion;
- ATM-user-to-ATM-user indication (AUU): This parameter is transported transparently by the ATM layer.

The use of the parameters is summarized in Table 4.

TABLE 4/I.361

Parameters of ATM-DATA

Parameter	Type	Use	Comments
ATM-SDU	Request Indication	M M	48 octets of ATM layer user data
Submitted CLP	Request	M	(Note 1)
AUU	Request Indication	M M	(Note 2)
Congestion indication	Request Indication	O (Note 3) M	Indication of congestion experienced

M Mandatory

O Optional

NOTES

1 CLP = 0: CLP bit set to "0". CLP = 1: CLP bit set to "1".

2 ATM-user-to-ATM-user = "0".
ATM-user-to-ATM-user = "1".

3 This parameter might be needed for interworking (e.g. with Frame Relay service).

3.2 Primitives exchanged with the lower layer

The ATM layer expects the PHY to provide for the transport of ATM cells between corresponding ATM-entities. The information exchanged between the ATM layer and the PHY across the PHY-SAP includes the following primitives:

- PHY-DATA request (PHY-SDU);
- PHY-DATA indication (PHY-SDU).

3.2.1 Description of primitives

- PHY-DATA request: This primitive is issued by the ATM layer to request the transfer of an ATM cell from a local ATM-entity to the corresponding ATM-entity over an existing PHY connection. Each cell is exchanged between the ATM layer and the PHY across the PHY-SAP. The entire cell (except for the HEC field) is transported unmodified by the PHY via the existing PHY connection;
- PHY-DATA indication: This primitive is issued by the PHY to the ATM layer to indicate the arrival of a PHY-SDU from a corresponding PHY-entity over an existing PHY connection. In the absence of error, this PHY-SDU (except for the HEC field) is the same as the PHY-SDU sent by the corresponding ATM-entity in a PHY-DATA request primitive.

3.2.2 Description of parameter

- PHY-SDU: This parameter contains one ATM cell to be transferred between corresponding ATM-entities.

3.3 Primitives exchanged with ATM Management (ATMM)-entity

Figure 4 shows two types of interactions between the ATM-entity and the ATMM-entity. One interaction is for the exchange of local information between these two entities. The other interaction is for peer-to-peer communication between ATMM-entities, and has the following associations between the ATM-entity and the ATMM-entity: segment OAM F5 flow, end-to-end OAM F5 flow and resource management.

For peer-to-peer communication between ATMM-entities:

- ATMM-DATA request (ATM-SDU, Submitted Loss Priority, PHY-CEI);
- ATMM-DATA indication (ATM-SDU, Congestion Indication, Received Loss Priority, PHY-CEI).

The exchange of local information between the ATM-entity and the ATMM-entity requires further study.

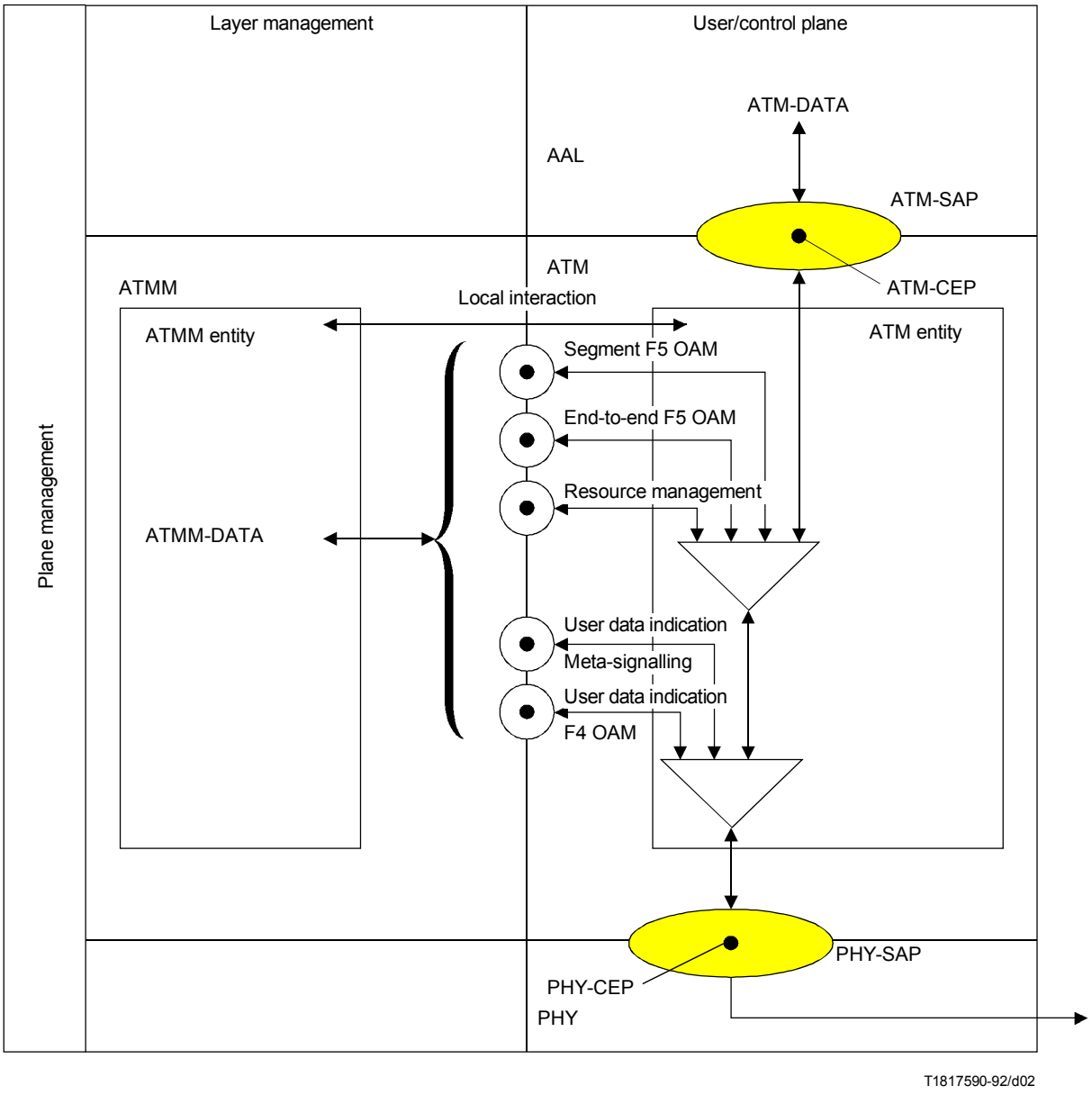

FIGURE 4/I.361

Interactions between ATM- and ATMM-entities

3.3.1 Description of primitives

- ATMM-DATA request: This primitive is issued by an ATMM-entity to request the transfer of a management ATM-SDU.
- ATMM-DATA indication: This primitive is issued to an ATMM-entity to indicate the arrival of an ATM-SDU.

3.3.2 Description of parameters

- Submitted Loss Priority: This parameter indicates the relative importance of the requested transport for the information carried in the ATM-SDU. It can take only two values, one for high priority and the other for low priority;
- Received Loss Priority: This parameter indicates the relative importance of the transport given to the information carried in the ATM-SDU. It can take only two values, one for high priority and the other for low priority.
- PHY-CEI: This parameter identifies the PHY-CE within the PHY-SAP. Certain characteristics are uniquely associated with this identifier, such as UNI or NNI cell format;[1)]
- ATM-SDU: This parameter contains 48 octets of ATM layer management data to be transparently transferred between corresponding ATMM-entities;
- Congestion indication: This parameter indicates that the received ATM-SDU has passed through a network node in congestion.

The use of the parameters is summarized in Table 5.

TABLE 5/I.361

Parameters of ATMM-DATA

Parameter	Type	Use	Comments
ATM-SDU	Request Indication	M M	48 octets of ATM layer management data
Submitted CLP	Request	M	(Note)
Received CLP	Indication	O	(Note)
Congestion indication	Indication	M	Indication of congestion experienced
PHY-CEI	Request Indication	M M	Identification of PHY-CE within PHY-SAP
M Mandatory O Optional NOTE – CLP = 0: CLP bit set to "0". CLP = 1: CLP bit set to "1".			

1) In some cases, such as multipoint connections, multiple PHY-CEIs could be associated with the same ATM connection. Also, in nodes performing relaying functions, at least two PHY-CEIs are associated with the same ATM connection.

4 ATM protocol procedures

This clause will contain procedures that describe the operation of the ATM protocol (including the peer-to-peer and inter-layer information flows).

4.1 GFC protocol

For equipment implementing the "uncontrolled transmission" set of procedures, the GFC function is not used. Therefore, no action is taken upon reception of any GFC field setting (except as described below) and the GFC field is always set to all zeros upon transmission. For equipment implementing the "controlled transmission" set of procedures, the actions taken upon reception of the GFC field and the settings of the GFC field upon transmission are for further study.

In order to minimize the interactions between these two sets of procedures, it is necessary to identify the procedures operating on a specific interface at any particular time. The mechanism to distinguish between procedures is as follows: any piece of equipment which receives ten or more non-zero GFC fields within 30 000 cell times should consider the other ATM entity to be executing the "controlled transmission" set of procedures. Any TE which implements the "uncontrolled transmission" set of procedures which detects that the peer ATM entity is executing the "controlled transmission" set of procedures should notify layer management.

The procedures related to "controlled transmission" must assure compatibility with the discrimination mechanism between "controlled transmission" procedures and "uncontrolled transmission" procedures.

4.2 Layer management communication

4.2.1 Functions

For further study.

4.2.2 Procedures

For further study.

4.3 Layer management

4.3.1 Meta-signalling

Refer to Recommendation I.311.

4.3.2 Fault management

4.3.2.1 Functions

Refer to Recommendation I.610.

4.3.2.2 Procedures

For further study.

4.3.3 Performance management

4.3.3.1 Functions

Refer to Recommendation I.610.

4.3.3.2 Procedures

For further study.

4.3.4 Configuration management

4.3.4.1 Functions

Refer to Recommendation I.610.

4.3.4.2 Procedures

For further study.

4.3.5 Resource management

4.3.5.1 Functions

Refer to Recommendation I.371.

4.3.5.2 Procedures

For further study.

Annex A

Alphabetical list of abbreviations used in this Recommendation

(This Annex forms an integral part of this Recommendation)

ATM Asynchronous transfer mode

CLP Cell loss priority

GFC Generic flow control

HEC Header error control

MSB Most significant bit

NNI Network-node interface

OAM Operation and maintenance

PT Payload type

PTI Payload type identifier

UNI User-network interface

VCI Virtual channel identifier

VPI Virtual path identifier

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