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Foreword

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

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Introduction

This ETS is based on the Broadband Integrated Services Digital Network (B-ISDN) Protocol Reference Model (PRM) as defined in ITU-T Recommendation I.320 [**Error! Bookmark not defined.**]. The purpose of this ETS is to take into account the functionalities of B-ISDN, in order to enhance the existing ISDN PRM. The PRM in this ETS will be referred to as the B-ISDN PRM.

The B-ISDN layered model reflects the principles of layered communication defined in ITU-T Recommendation X.200 [6].

Open Systems Interconnection (OSI) is a logical architecture and, as such, defines a set of principles including protocol layering, layer service definition, service primitives, modularity and independence. In general, these principles have been followed in the definition of the B-ISDN PRM. However, the principle of layer independence has not been fully applied in this B-ISDN PRM.

The OSI reference model has seven layers, each with specific functions and offering defined services to the layer above and utilizing services of the layer below. This logical architecture seems applicable also to the B-ISDN.

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1 Scope

This European Telecommunication Standard (ETS) addresses the Broadband Integrated Services Digital Network (B-ISDN) Protocol Reference Model (PRM) and its applications. It is an extension of the CCITT Recommendation I.321 [**Error! Bookmark not defined.**], including also a description of the Physical Layer (PL) and Asynchronous Transfer Mode (ATM) layer internal structure, as well as the primitives between these two layers, and towards the Layer Management Entities (LME), and the primitives between the ATM layer and the ATM Adaptation Layer (AAL).

2 Normative references

This ETS incorporates by dated and 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] ITU-T Recommendation I.320 (1993): "ISDN protocol reference model".

[2] CCITT Recommendation I.321 (1991): "B-ISDN protocol reference model and its applications".

[3] ITU-T Recommendation I.361 (1993): "B-ISDN ATM layer specification".

[4] ITU-T Recommendation I.432 (1993): "B-ISDN user-network interface - Physical layer specification".

[5] ITU-T Recommendation I.610 (1993): "B-ISDN operation and maintenance principles and functions".

[6] ITU-T Recommendation X.200 (1994): "Information technology - Open systems interconnection - Basic reference model: The basic model".

[7] CCITT Recommendation Q.940 (1988): "ISDN user-network interface protocol for management - General aspects".

[8] CCITT Recommendation G.703 (1991): "Physical/Electrical characteristics of hierarchical digital interfaces".

3 Definitions and abbreviations

3.1 Definitions

idle cell (physical layer): Cell which is inserted/extracted by the PL in order to adapt the cell flow rate at the boundary between the ATM layer and the PL to the available payload capacity of the transmission system used.

valid cell (physical layer): Cell whose header has no errors or has been modified by the cell Header Error Control (HEC) verification process.

invalid cell (physical layer): Cell whose header has errors and has not been modified by the cell HEC verification process (discarded at the PL).

assigned cell (ATM layer): Cell which provides a service to an application using the ATM layer service.

unassigned cell (ATM layer): ATM layer cell which is not an assigned cell.

(N)-Service Access Point (SAP): The point at which (N)-services are provided by an (N)-entity to an (N+1)-entity (ITU-T Recommendation X.200 [6]).

In this ETS the above definition is used for the term SAP. In this ETS, (N) is the PL or the ATM layer.

3.2 Abbreviations

For the purposes of this ETS the following abbreviations apply:

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
ATMM	ATM layer Management
B-ISDN	Broadband Integrated Services Digital Network
CE	Connection End-point
CEI	Connection End-point Identifier
CES	Connection End-point Suffix
CLP	Cell Loss Priority
CME	Connection Management Entity
CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
DSS	Distributed Sample Scrambler
EBCN	Explicit Backward Congestion Notification
EC	Error Correction
ED	Error Detection
EFCN	Explicit Forward Congestion Notification
GFC	Generic Flow Control
GME	Global Management Entity
HEC	Header Error Control
LE	Layer Entity
LI	Link Identifier
LME	Layer Management Entity
NNI	Network Node Interface
NPC	Network Parameter Control
OAM	Operation and Maintenance
OSI	Open Systems Interconnection
PCI	Protocol Control Information
PDH	Plesiochronous Digital Hierarchy
PDU	Protocol Data Unit
PL	Physical Layer
PM	Physical Medium
PRM	Protocol Reference Model
PT	Payload Type
QoS	Quality of Service
SAP	Service Access Point
SAPI	Service Access Point Identifier
SAR	Segmentation and Reassembly
SDH	Synchronous Digital Hierarchy
SDU	Service Data Unit
SLE	Sub-Layer Entity
TC	Transmission Convergence
UNI	User-Network Interface
UPC	Usage Parameter Control
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VP	Virtual Path
VPC	Virtual Path Connection
VPI	Virtual Path Identifier

4 The B-ISDN PRM

The B-ISDN PRM is shown in figure 1; it is composed of a user plane, a control plane, and a management plane.

Above the PL, the ATM layer provides for the transport of data for all services. The service provided by the AAL to the layer above depends on the service class to be supported.

The layer above the AAL in the control plane provides call control and connection control. The management plane provides network supervision functions. Functional description of the PL, the ATM layer, and the AAL are given in the following sections. Further study is required on the layers above the AAL.

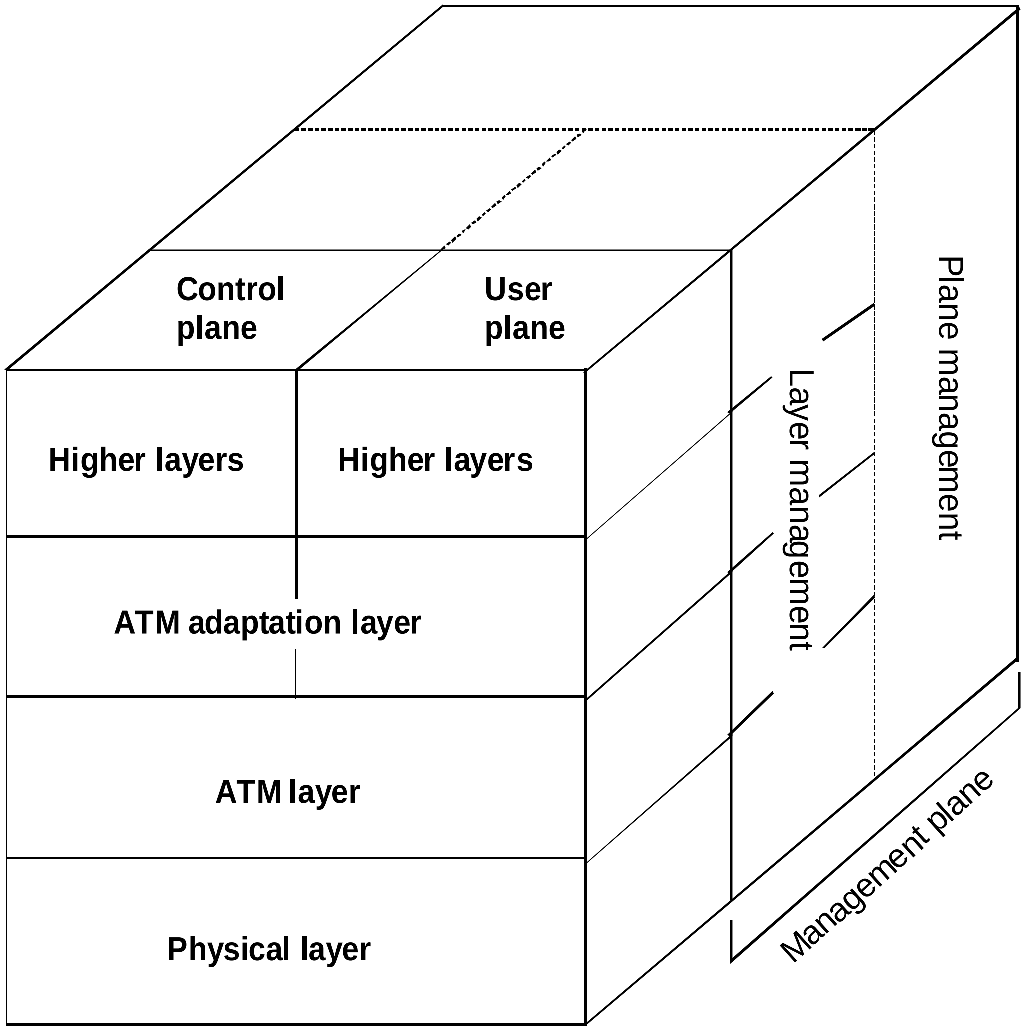

Figure 1: B-ISDN PRM

5 Description of the planes

5.1 User plane

The user plane, with its layered structure, provides for user information transfer, along with associated controls (e.g. flow control, recovery from errors, etc.).

5.2 Control plane

This plane has a layered structure and performs the call control and connection control functions; it deals with the signalling necessary to set up, supervise, and release calls and connections.

5.3 Management plane

The management plane provides two types of functions, namely layer management and plane management functions.

5.3.1 Plane management function

The plane management performs management functions related to a system as a whole and provides co-ordination between all planes. Plane management has no layered structure.

5.3.2 Layer management functions

Layer management performs management functions (e.g. metasignalling) relating to resources and parameters related to the protocol entities within the layer. Layer management handles the Operation and Maintenance (OAM) information flows specific to the layer concerned. Additional details are provided in CCITT Recommendation Q.940 [7].

6 Functions of the individual layers of the B -ISDN PRM

The functions of each layer, the primitives exchanged between layers, and primitives exchanged between the layers and the management plane are described below. The information flows described do not imply a specific physical realization. Figure 2 illustrates the layers of the PRM, and identifies the functions of the PL, the ATM layer, and the AAL.

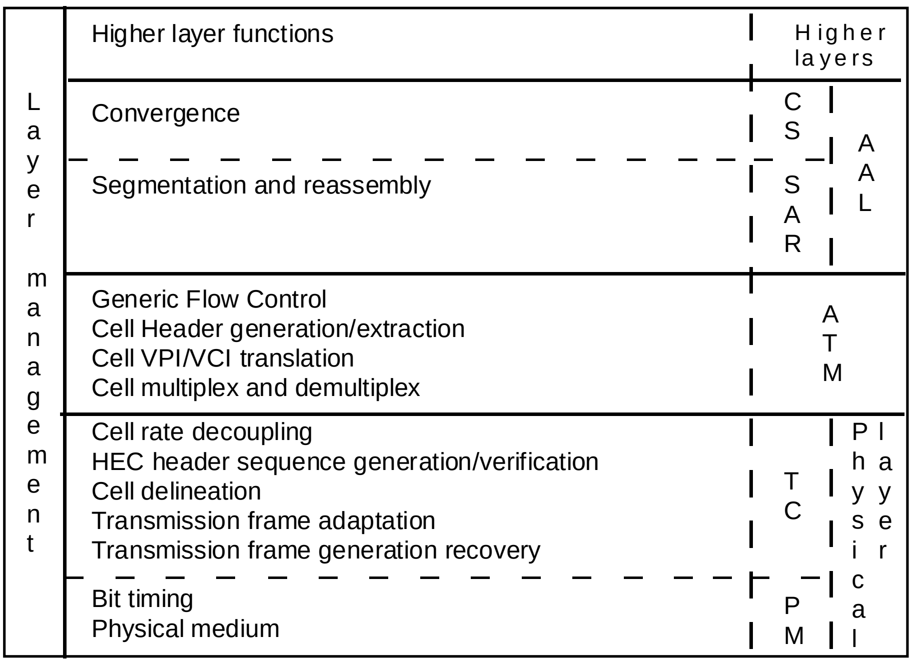

Figure 2: Functions of the B -ISDN in relation to the PRM

6.1 Physical layer

The PL consists of two sublayers. The Physical Medium (PM) sublayer includes only PM dependent functions. The Transmission Convergence (TC) sublayer performs all functions required to transform a flow of cells into a flow of data units (e.g. bits) which can be transmitted and received over a PM. The Service Data Unit (SDU) crossing the boundary between the ATM layer and the PL is a valid cell. The ATM layer is independent of the underlying PL. The data flow inserted in the transmission system payload is PM independent and self-supported; the PL merges the ATM cell flow with the appropriate information for cell delineation, according to the cell delineation mechanism described in ITU-T Recommendation I.432 [4] and carries OAM information relating to this cell flow.

6.1.1 Physical medium sublayer functions

The PM sublayer provides bit transmission capability including bit transfer and bit alignment. It includes line coding and electrical-optical transformation.

6.1.1.1 Physical medium

The transmission functions are highly dependent on the medium used and are outside the scope of this ETS.

6.1.1.2 Bit timing

To enable clock recovery, the principal function is the generation and reception of waveforms suitable for the medium, the insertion and extraction of bit timing information and line coding (if required). The primitives identified at the border between the PM and TC sublayers are a continuous flow of logical bits or symbols with this associated timing information.

6.1.2 TC sublayer functions

6.1.2.1 Transmission frame generation and recovery

This function performs the generation and recovery of the transmission frame.

6.1.2.2 Transmission frame adaptation

This function performs the actions which are necessary to structure the cell flow according to the payload structure of the transmission frame (transmit direction) and to extract this cell flow out of the transmission frame (receive direction). The transmission frame may be a cell equivalent (i.e. no external envelope is added to the cell flow), a Synchronous Digital Hierarchy (SDH) envelope, a Plesiochronous Digital Hierarchy (PDH) envelope, a CCITT Recommendation G.703 [8] envelope, etc.

6.1.2.3 Cell delineation

Cell delineation is the process which allows the receiving side to recover cell boundaries. The HEC field of the cell header is used to achieve cell delineation according to the self-delineating mechanism defined in ITU-T Recommendation I.432 [4]. In the transmit direction, the ATM payload part only of the cell stream is scrambled. Scrambling[1)] is used to improve the security and robustness of the HEC cell delineation mechanism as described in ITU-T Recommendation I.432 [4], § 4.5.1.1. In the receive direction, cell boundaries are identified and confirmed (using the HEC mechanism) and the cell flow is descrambled.

6.1.2.4 HEC sequence generation and cell header verification

In transmit direction, it calculates the HEC sequence and inserts it in the header. In receive direction, cell headers are checked for errors and, if possible (see ITU-T Recommendation I.432 [4]), header errors are corrected. Cell whose headers are determined to be errored and non-correctable are discarded.

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1) Any scrambler specification shall not alter the ATM header structure (as described in ITU-T Recommendation I.361 [3]), header error control (as described in ITU-T Recommendation I.432 [4], § 4.3), and the cell delineation algorithm (as described in ITU-T Recommendation I.432 [4], § 4.5.1.1).

6.1.2.5 Cell rate decoupling

Cell rate decoupling includes insertion and suppression of idle cells, in order to adapt the rate of valid ATM cells to payload capacity of the transmission system.

6.1.3 Physical layer model

The model of the PL is shown in figure 3. The following assumptions are made:

One PL-SAP is introduced between the PL and the ATM layer.

Associated with the PL-SAP there is one Connection End-point (CE).

The TC Sub-Layer Entity (SLE) exchanges information with the ATM-Layer Entity (LE) across the PL-SAP by means of service primitives.

The TC-SDU crossing the PL-SAP (see figure 4) is the ATM Protocol Data Unit (ATM-PDU) where the Protocol Control Information (PCI) does not include the HEC value. This value is inserted at the TC sub-layer in the relevant field and represents the TC-PCI.

The TC-PDU consists of the complete 53 octets of the TC-SDU with the related TC-PCI.

The presence of a SAP between TC and PM is for further study, however internal primitives, invoke and signal, between the two sublayers are defined.

The PM-SDU crossing the boundary between the TC sub-layer and the PM sub-layer is a logical bit or symbol.

The PM-PDU is PM dependent and is associated with waveforms suitable for the medium.

A SAP is identified between the PL and the PL management.

Associated with the PLM-SAP there are different CEs.

In the adopted model a fixed association between a PL management entity and the related CE within the PLM-SAP is assumed. Each PL-LME is assumed to include a specific set of management functions (e.g. OAM section and path related functions, Activation/Deactivation, etc.).

A PL-SLE discriminates the related layer management CE by means of preassigned address values (first four octets of TC-SDU)[2)].

A PL-SLE exchanges information with a PL-LME across the PLM-SAP by means of service primitives.

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2) According to OSI, a (N)-entity has not access to the meaning of a (N)-SDU. The incongruities here are caused by the ATM related functions allocation in the adopted PRM.

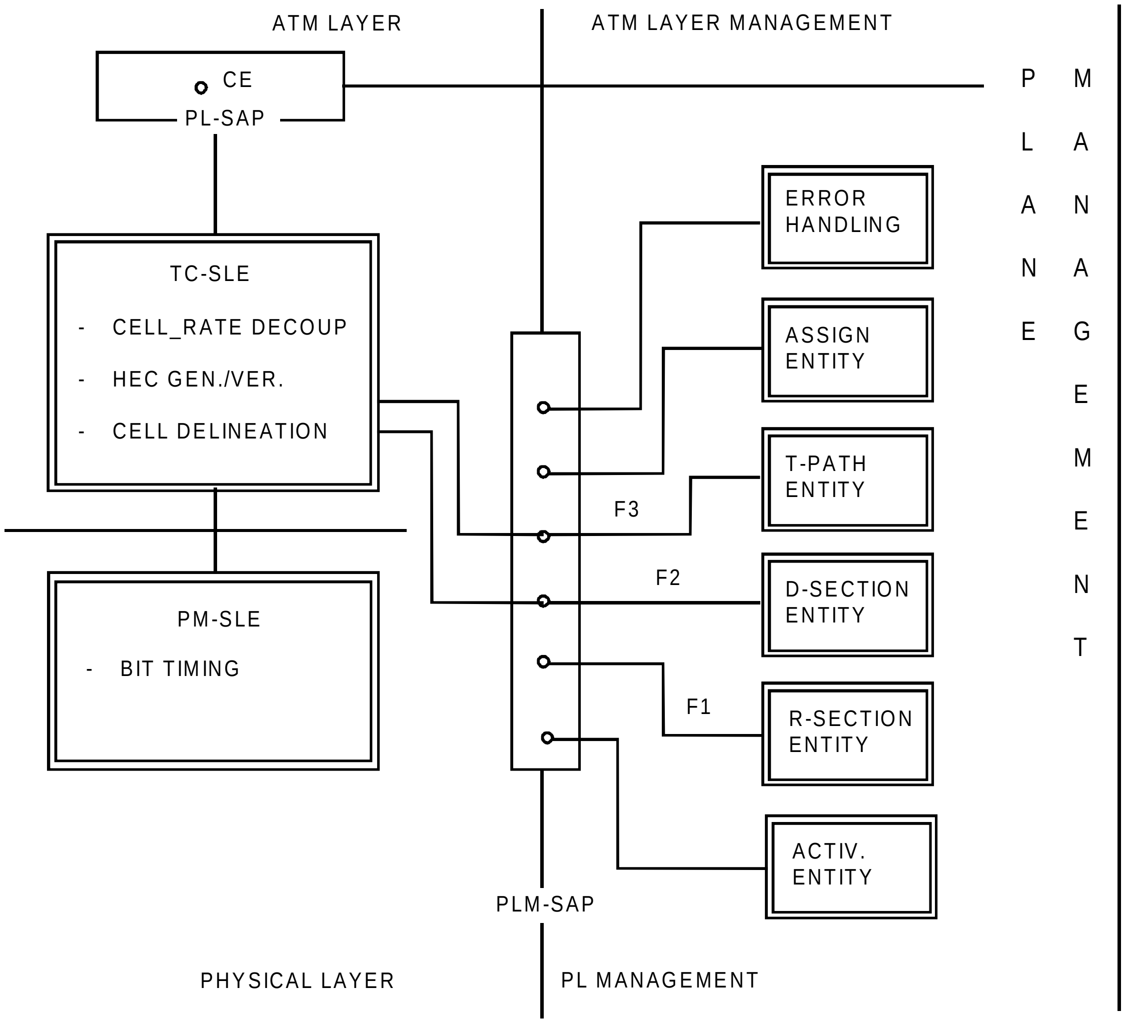
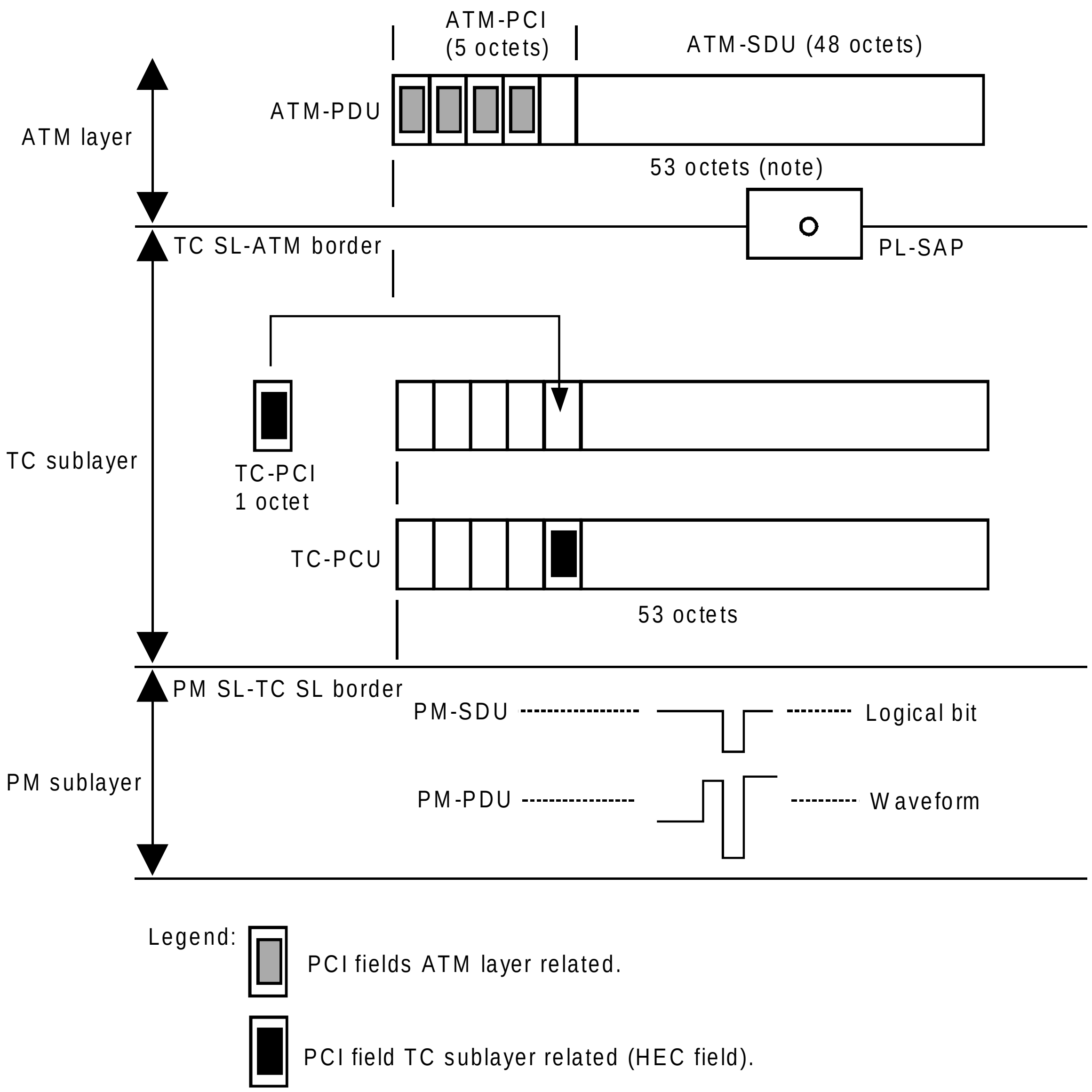


Figure 3: Functional model of PL

In figure 3, the following management entities appear:

- assign entity: this associates the layer resources to form the internal link for the transfer of the PL information;
- T-Path entity (Transmission Path entity): this handles the F3 flow;
- D-Section entity (Digital Section entity): this handles the F2 flow;
- R-Section entity (Repeater Section entity): this handles the F1 flow;
- activation entity: this activates/deactivates the PM;
- error handling: this handles HEC error conditions.



NOTE: The use of the last octet of the ATM-PCI is reserved to the TC-sublayer.

Figure 4: PL data units

6.1.4 Physical layer primitives

On the basis of the model identified in the above section, two types of primitives are defined in the PL: the primitives across the PL-SAP, between the PL (TC sub-layer) and the ATM layer, and the primitives across the SAP between the PL and the PL management.

In addition internal primitives between the TC sub-layer and the PM sub-layer are defined. As no SAP is introduced between the two sub-layers (see figure 3), the conventions used for the names of the primitives exchanged across this boundary are not the standard Open Systems Interconnection (OSI); invoke and signal type of primitives are used in place of request and indication.

6.1.4.1 Primitives between the PL and the ATM layer

PL_UNITDATA.request

Function:

This primitive requests the transfer of an ATM-PDU (TC-SDU) from a local ATM-LE.

Semantics of service primitive:

```
PL_UNITDATA.request (
                    Data
                    )
```

The Data parameter contains the TC-SDU to be transferred.

When generated:

This primitive is generated by a ATM-LE to transfer an ATM-PDU to a peer ATM-LE or to peer ATM-LEs.

Effect on receipt:

In the case of the cell based option, the receipt of this primitive causes the TC-SLE to:

- perform the Cyclic Redundancy Check (CRC) calculation over the first four octets of the TC-SDU to generate the HEC of the ATM-PCI;
- apply the Distributed Sample Scrambler (DSS) over the entire TC-PDU;
- modify the first two bits of the HEC field according to DSS synchronization mechanism.

Additional comments:

The name UNITDATA has been chosen coherently with the name used in case of unacknowledged information transfer.

PL_UNITDATA.indication

Function:

This primitive indicates the delivery of a TC-SDU to a local ATM-LE. In the absence of errors, the delivered TC-SDU will be identical to the ATM-PDU sent by the corresponding remote peer ATM-LE in a PL_UNITDATA.request primitive.

Semantics of service primitive:

```
PL_UNITDATA.indication  (
                        Data
                        )
```

The Data parameter contains the received TC-SDU where the fifth octet is not significant at the ATM layer.

When generated:

This primitive is generated by the TC-SLE when a TC-SDU has to be delivered to a local ATM-LE.

TC-SDUs addressed to the PL-LME do not cause the primitive generation.

Idle cells are not TC-SDUs and are neither passed to the ATM-LE nor to the PL-LME.

Effect on receipt:

The receipt of this primitive causes the ATM-LE to activate the ATM-PDU reception procedure.

Additional comments:

A TC-SDU is obtained by a valid TC-PDU. Valid TC-PDUs are peer TC-PDUs that have been received with no error or with correctable error in the ATM-PCI according to the HEC verification process.

Depending on the two states HEC verification process a TC-SDU is issued:

- when no errors are detected in the first 4 octets of TC-PDUs, both in Error Detection (ED) and Error Correction (EC) mode;
- after single bit error correction in EC mode.

6.1.4.2 Primitives between the TC sublayer and the PM sublayer

PM_UNITDATA.invoke

Function:

This primitive requests the transfer of a PM_SDU from a local TC-SLE.

Semantics of service primitive:

```
PM_UNITDATA.invoke  (
                    Data
                    )
```

The Data parameter contains the PM-SDU to be transferred.

When generated:

This primitive is generated by a TC-SLE to transfer a TC-PDU to a peer TC-SLE.

Effect on receipt:

The receipt of this primitive causes the PM-SLE to generate the PM-PDU.

PM_UNITDATA.signal

Function:

This primitive indicates the delivery of a PM-SDU to a local TC-SLE.

Semantics of service primitive:

```
PM_UNITDATA.signal  (
                    Data
                    )
```

The Data parameter contains the received PM-SDU.

When generated:

This primitive is generated by the PM-SLE when a PM-SDU has to be delivered to a local TC-SLE.

Effect on receipt:

The effect of this primitive is dependent upon the state of the TC-SLE HEC cell delineation procedure.

6.1.4.3 Primitives between the PL and the PL management

For further study.

6.1.5 OAM related to the PL

The required OAM functions relating to the PL are outlined in ITU-T Recommendations I.432 [4] and I.610 [5].

6.2 ATM layer

The characteristics of the ATM layer are independent of the PM.

6.2.1 ATM layer functions

6.2.1.1 Cell multiplexing and demultiplexing

In the transmit direction, the cell multiplexing function combines cells from individual Virtual Paths (VPs) and Virtual Channels (VCs) into a non-continuous cell flow. In the receive direction, the cell demultiplexing function directs individual cells from a non-continuous composite cell flow in the TC-sublayer to the appropriate VP or VC.

6.2.1.2 Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) translation

This function occurs at ATM switching and cross-connect nodes (including B-NT2). The values of the VPI and/or VCI fields of each incoming ATM cell is mapped into a new VPI and/or VCI value. This mapping function could be null; if not null a new HEC needs to be generated.

6.2.1.3 Cell header generation/extraction

These functions apply at points where an ATM connection is terminated.

In the transmit direction, the cell header generation function receives a cell information field from a higher layer and generates an appropriate ATM cell header except for the HEC sequence. This function could also include the translation from a SAP identifier to a VP and VC identifier.

In the receive direction, the cell header extraction function removes the ATM cell header and passes the cell information fields to a higher layer. This function could also include a translation of a VP and VC identifier into a SAP identifier.

6.2.1.4 Generic flow control

The Generic Flow Control (GFC) mechanism applies at the User-Network Interface (UNI). It may assist in the control of the flow of traffic from ATM connections of various Quality of Service (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.

The GFC mechanism should not perform flow control of the traffic from the network

When GFC is applied at the ATM layer, the flow control information is carried in assigned and unassigned cells. Cells carrying this information are generated at the ATM layer.

6.2.2 ATM layer model

The model of the ATM layer is shown in figure 5. The following assumptions are made:

- one ATM-SAP is introduced between the ATM layer and the AAL;
- one SAP is introduced between the ATM layer Management and the ATM layer (ATMM-SAP);
- one SAP is introduced between the PL and the ATM layer (PL-SAP).

Associated with the ATM-SAP there are several CEs. Associated with the PL-SAP there is one CE which is associated to one physical link.

One physical link is associated with an instance of the ATM layer. Figure 5 shows only one instance of the ATM layer.

The functions of the ATM layer are subdivided into two levels: VC level and VP level. A LE is introduced for each VC/VP. One multiplexer/demultiplexer entity is introduced at VC level, and a second one is introduced at VP level. The GFC function is represented as the lowest function controlling the access to the PL.

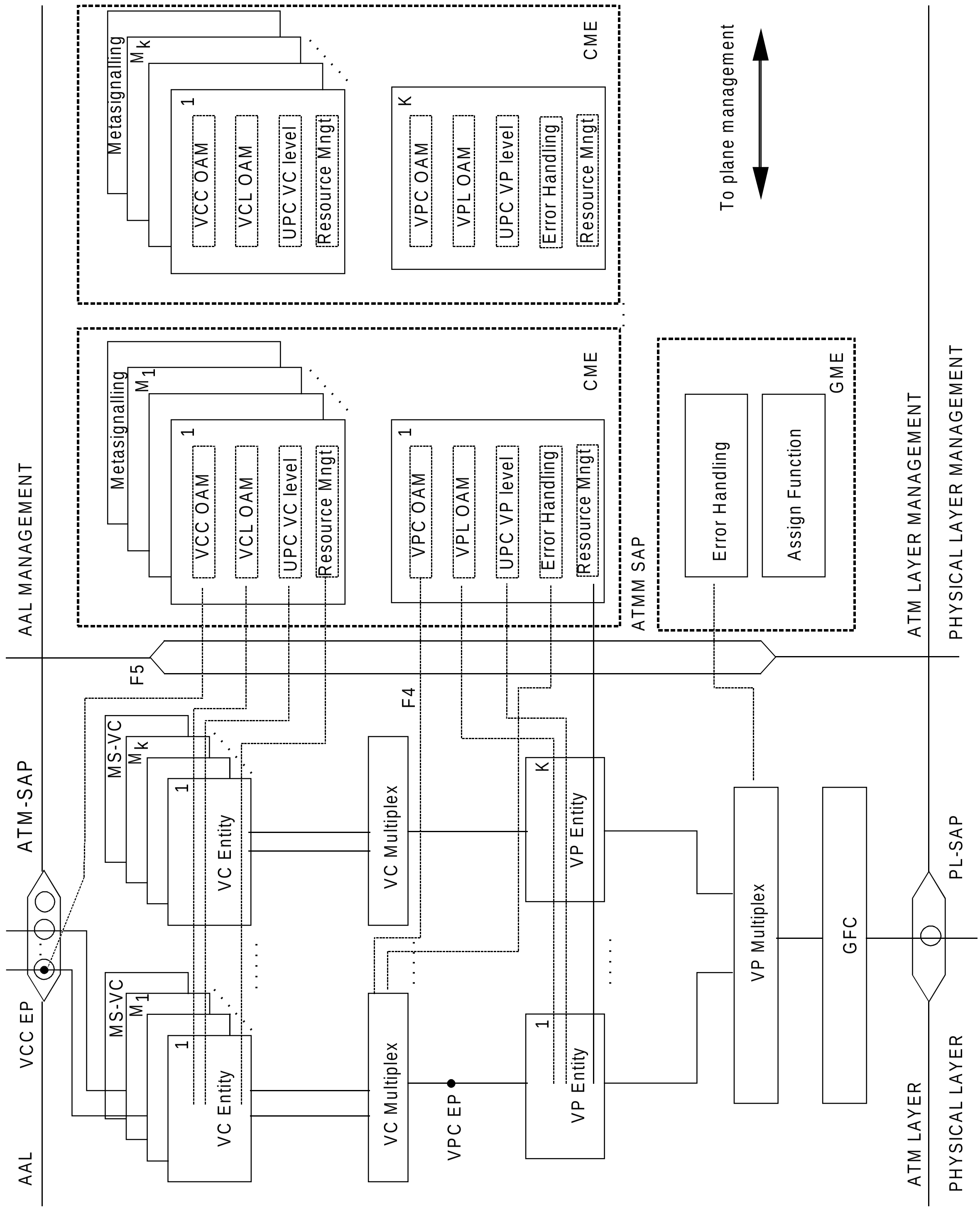
The function of the ATMM is also subdivided into two levels: VC management level, and VP management level. Layer management entities are introduced at VC and VP level. Each LME is assumed to include the set of functions related to a specific ATM level (e.g. metasignalling, OAM F4, OAM F5, etc.). Specific layer management entities for GFC are for further study. The management entities are classified into two categories: Global Management Entity (GME) related to management functions applicable to the layer as a whole, and Connection Management Entity (CME) related to specific connections. The grouping of management functions into a CME is done per VP; this includes the related VC functions. The number of management entities actually involved depends on the type of system (i.e. Virtual Channel Connection (VCC) and/or Virtual Path Connection (VPC) related functions may not be present in relaying systems). A fixed association between the management entities and the related CEs within the ATMM-SAP is assumed.

The ATM layer discriminates the related layer management CEs by means of the ATM-PCI (preassigned ATM-PCI values). OAM ATM-SDUs related to Local or end-to-end F5 flow are discriminated by the Payload Type (PT) identifier. OAM ATM-SDUs related to Local or end-to-end F4 and metasignalling ATM-SDUs are discriminated by dedicated VCI values.

The following management sub-entities are shown in figure 5:

- CME performing functions specific to each connection such as handling of F4 and F5 flows (VPC OAM, VCC OAM, etc.), Usage Parameter Control (UPC VC level and VP level) and handling of errors (e.g. unassigned VCIs);

- GME performing functions related to the LE as a whole, such as error handling (e.g. unassigned VPIs) and assign functions associating the layer resources to form the internal link for the cell transfer.



NOTE 1: K = Number of established VPs.

NOTE 2: Mi = Number of established VCs inside the i-th VP.

NOTE 3: EP = End Point.

NOTE 4: Cells with unassigned VPI are handled by the Error Handling (GME).

NOTE 5: Cells with unassigned VCI are handled by the Error Handling at VP level (CME).

NOTE 6: The CEs within the ATMM-SAP are not shown.

NOTE 7: This figure is related to both the UNI and the Network Node Interface (NNI), however, the GFC and UPC boxes are valid for the UNI only.

Figure 5

6.2.3 ATM layer primitives

On the basis of the model identified in the above section, two types of primitives are defined at the ATM layer: the primitives across the SAP(s) between ATM layer and AAL, and the primitives across the SAP(s) between ATM layer and ATMM.

At each SAP, the SDU crossing the boundary between the ATM layer and AAL is the cell information field.

6.2.3.1 Primitives between ATM layer and AAL

Between the ATM layer and the AAL two primitives are defined:

ATM_UNITDATA.request

Function:

This primitive requests the transfer of a SAR-PDU (ATM-SDU) from a local AAL-LE.

Semantics of service primitive:

```
ATM_UNITDATA.request    (
                        Data,
                        Submitted Loss Priority,
                        User-to-User indication
                        )
```
[3]

The Submitted Loss Priority parameter specifies the priority value desired for the SAR-PDU transfer. It can take only two values: high or low priority.

The Data parameter contains the SAR-PDU to be transferred.

When generated:

This primitive is generated by a AAL-LE to transfer a SAR-PDU (ATM-SDU) to a peer AAL-LE or to peer AAL-LEs.

Effect on receipt:

The receipt of this primitive causes the ATM-LE to generate the ATM-PCI to form the ATM-PDU.

Additional comments:

The Priority parameter value is used by the ATM-LE to set the Cell Loss Priority (CLP) bit in the ATM-PCI; CLP=1 for low priority, CLP=0 for high priority.

ATM_UNITDATA.indication

Function:

This primitive indicates the delivery of an ATM-SDU (SAR-PDU) to a local AAL-LE. In the absence of errors, the delivered ATM-SDU will be identical to the ATM-SDU sent by the corresponding remote peer AAL-LE in an ATM_UNITDATA.request primitive.

Semantics of service primitive:

```
ATM_UNITDATA.indication (
                        Congestion Indication,
                        Data,
                        User-to-User indication
                        )
```

The Data parameter contains the received ATM-SDU.

---

3) The parameters of this primitive do not fully align with ITU-T Recommendation I.361 [3].

When generated:

This primitive is generated by the ATM-LE when an ATM-SDU has to be delivered to a local AAL-LE.

Effect on receipt:

The effect of this primitive is dependent upon the protocol between the peer AAL-LEs making use of the ATM layer service.

Other primitives between the ATM layer and the AAL are for further study.

6.2.3.2 Primitives between the ATM layer and the ATMM

6.2.3.2.1 Connection assign/remove primitives

ATMM_ASSIGN.request

Function:

This primitive requests the ATM-LE to create an association between an ATM-connection endpoint, the PL-connection endpoint, and an ATM-Link Identifier (LI).

Semantics of service primitive:

```
ATMM_ASSIGN.request (
                    ATM-CEI,
                    ATM-LI
                    )
```

The ATM Connection End-point Identifier (ATM-CEI) (i.e. Service Access Point Identifier + Connection End-point Suffix (SAPI+CES)) parameter specifies the ATM connection endpoint to the upper layer.

The ATM-LI (i.e. VCI+VPI) parameter specifies the related ATM connection LI to be used.

When generated:

This primitive is generated by the ATM-LME:

- in case of control plane connection establishment (signalling phase), as soon as the metasignalling SVCI_ASSIGNED message is received;

- in case of user plane connection establishment, after the reception of signalling connect messages stimulated by the plane management.

Effect on receipt:

The receipt of this primitive causes the ATM-LE to associate the PL-CEI, ATM-CEI, and ATM-LI.

Additional comments:

Primitives for the association of the PL-CEI and ATM LIs, where relay functions are performed are for further study.

ATMM_ASSIGN.confirm

Function:

This primitive confirms to the ATM-LME the created association between ATM-CEI, PL-CEI, and ATM-LI.

Semantics of service primitive:

```
ATMM_ASSIGN.confirm (
                     ATM-LI
                     )
```

The ATM-LI (i.e. VCI+VPI) parameter specifies the associated LI and the associated connection endpoints.

When generated:

This primitive is generated by the ATM-LE to confirm the establishment of the association required by the ATM-LME.

Effect on receipt:

The receipt of this primitive causes the ATM-LME to inform the plane management that the connection is ready to transfer SAR-PDUs between communicating peer AAL-LEs.

Additional comments:

Since this confirm primitive is related to a local establishment function further study are necessary about its actual need.

ATMM_REMOVE.request

Function:

This primitive requests the ATM-LE to release the established association between ATM-CEI, PL-CEI, and ATM-LI.

Semantics of service primitive:

```
ATMM_REMOVE.request (
                     ATM-LI
                     )
```

The ATM-LI (i.e. VCI+VPI) parameter specifies the associated LI and the associated connection endpoints.

When generated:

This primitive is generated by the ATM-LME:

- in case of control plane connection release, as soon as the metasignalling SVCI_REMOVE message is received;
- in case of user plane connection release, after the reception of Signalling Disconnect messages, stimulated by the plane management;
- in case of failure conditions causing the need to release the ATM connection.

Effect on receipt:

The receipt of this primitive causes the ATM-LE to release the association between the PL-CEI, ATM-CEI, and ATM-LI.

ATMM_REMOVE.confirm

Function:

This primitive confirms to the ATM-LME the release of the association between ATM-CEI, PL-CEI and ATM-LI.

Semantics of service primitive:

```
ATMM_REMOVE.confirm (
                    ATM-LI
                    )
```

The ATM-LI (i.e. VCI+VPI) parameter specifies the released connection endpoints identifier.

When generated:

This primitive is generated by the ATM-LE to confirm the release of the connection required by the ATM-LME.

Effect on receipt:

The receipt of this primitive causes the ATM-LME to inform the plane management that the connection is released.

Additional comments:

Since this confirm primitive is related to a local release function, further study are necessary about its actual need.

6.2.3.2.2 Management data transfer primitives

Peer-to-peer data transfer between ATM-LMEs are related to:

- metasignalling protocol;
- OAM flows (F4, F5);
- resource management;
- etc.

Additional primitives and parameters may be identified and require further study.

ATMM_UNITDATA.request

Function:

This primitive requests the transfer of a ATM-SDU from a local ATM-LME.

Semantics of service primitive:

```
ATMM_UNITDATA.request   (
                        Data,
                        ATM-LI
                        )
```

The ATM-LI (VCI, VPI) parameter specifies the related ATM connection identifier.

The Data parameter contains the management ATM-SDU to be transferred.

When generated:

This primitive is generated by the ATM-LME to transfer a management ATM-SDU to a peer (or peers) ATM-LME.

Effect on receipt:

The receipt of this primitive causes the ATM-LE to generate the ATM-PCI to form the ATM-PDU.

Additional comments:

In the ATM-LE an association between ATM-PCIs and ATM-LM-CEI is made:

- OAM ATM-SDUs related to local and/or end-to-end F5 flow have the same ATM-LI as the user ATM-SDUs and are discriminated by two preassigned PT identifiers;

- OAM ATM-SDUs related to local and/or end-to-end F4 flow have the same VPI as the user ATM-SDU and OAM ATM-SDUs related to F5 flow and are discriminated by two preassigned VCI values;

- metasignalling ATM-SDUs have a preassigned ATM-LI (VCI value).

ATMM_UNITDATA.indication

Function:

This primitive indicates the delivery of an ATM-SDU to a local ATM-LME.

Semantics of service primitive:

```
ATMM_UNITDATA.indication    (
                            Data,
                            ATM-LI
                            )
```

The ATM-LI (VCI, VPI) parameter specifies the related ATM connection Identifier.

The Data parameter contains the received ATM-SDU.

When generated:

This primitive is generated by the ATM-LE when an ATM-SDU has to be delivered to a local ATM-LME.

Effect on receipt:

The effect of this primitive is dependent upon the protocol between the peer ATM-LMEs making use of the ATM layer service.

Additional comments:

In the ATM-LE an association between ATM-PCIs and ATMM-CEI is made:

- OAM ATM-SDUs related to F5 flow have the same ATM-LI as the user ATM-SDUs and are discriminated by PT identifier;

- OAM ATM-SDUs related to F4 flow have the same VPI (sub-part of ATM-LI) as the user ATM-SDU and OAM ATM-SDUs related to F5 flow and are discriminated by preassigned VCI values;

- metasignalling ATM-SDUs have preassigned ATM-LI.

6.2.3.2.3 Error reporting primitives

ATMM_ERROR.indication

Function:

This primitive indicates to the ATM-LME that an error has occurred on the VP or VC connection related to an ATM-LI (VPI or VPI+VCI).

Semantics of the service primitive:

```
ATMM_ERROR.indication    (
                         Error_Type,
                         ATM-LI
                         )
```

The Error_Type parameter assumes the following values:

- buffer overflow;

- ATM-LI unassigned.

The ATM-LI (VCI, VPI) parameter specifies the related ATM connection identifier.

These parameters allows to the ATM-LME a continuous monitoring of the VP or VC connection performance in terms of ATM-PDU loss and misinsertion.

When generated:

This primitive is generated by the ATM-LE when certain errors occur on the VP or VC connection and an ATM-PDU discard is made.

Effect of receipt:

The receipt of this primitive allows the management plane through the ATM-LME to take suitable actions to handle the error condition.

6.2.3.2.4 Other primitives

ATMM_MONITOR.request

Function:

This primitive requests the transfer or the arrival notification of ATM-PDUs containing user information (AAL-PDU) on the indicated VP or VC connection from a local ATM-LE.

Semantics of the service primitive:

```
ATMM_MONITOR.request     (
                         BS,
                         Copy,
                         ATM-LI
                         )
```

The Block Size (BS) parameter specifies the ATM-PDUs Block Size with ATM user information (SAR-PDU) that must be send to the ATM-LME on the related VP or VC connection. This parameter is present only in case of invoking performance monitoring OAM functions.

The Copy parameter requests the activation of the ATM-SDU copying function. This parameter is present only in case of invoking performance monitoring OAM functions.

The ATM-LI (VCI, VPI) parameter specifies the ATM connection Identifier of the invoked monitoring connection. This parameter is present in both cases of invoking:

- performance monitoring OAM functions; and

- traffic or congestion control functions.

When generated:

This primitive is generated under two different conditions by the ATM-LME to request the ATM-LE:

- either to send blocks of ATM-SDUs containing user information (SAR-PDU) on the indicated VP or VC connection in order to perform OAM monitoring functions. This primitive is generated by the ATM-LME as soon as a peer performance monitoring activation message is received;

- or to notify the arrival of an ATM-SDU containing user information (SAR-PDU) on the indicated VP or VC connection in order to perform traffic or congestion control functions.

Effect of receipt:

The receipt of this primitive causes the ATM-LE to activate:

- the ATM-SDU copying function which extracts the ATM-PCI, copies the user ATM-SDU and transmits it to the ATM-LME in case of OAM monitoring functions;

- the ATM-SDU arrival notification function in case of traffic or congestion control functions.

ATMM_MONITOR.indication

Function:

This primitive indicates to the ATM-LME (CME) the arrival/transfer of an ATM-SDU containing user information (AAL-PDU) on the indicated VP or VC connections.

Semantics of the service primitive:

```
ATMM_MONITOR.indication (
                         Priority,
                         Data,
                         ATM-LI
                         )
```

The Priority parameter specifies the loss priority value related to the received ATM-PDU with ATM user information (SAR-PDU). This parameter is present only in case of invoked traffic or congestion control functions.

The Data parameter contains the ATM-SDU with ATM user information. This parameter is present only in case of invoked performance monitoring OAM functions;

The ATM-LI (VCI, VPI) parameter specifies the ATM connection Identifier of the monitored connection.

When generated:

This primitive is generated under two different conditions by the ATM-LE to:

- inform the ATM-LME of the arrival of an ATM-PDU containing user information (SAR-PDU) on the indicated VP or VC connection, in case of LME performing traffic and congestion control functions;

- transfer to the ATM-LME the ATM-SDU containing user information (SAR-PDU) of the indicated VP or VC connection, in case of LME performing monitoring OAM functions.

Effect of receipt:

The effect of this primitive depends on the function performed and on the localization of the involved system inside the network. It allows the layer management to take suitable actions to apply:

- traffic control functions (e.g. UPC, Network Parameter Control (NPC), Priority control, selective cell discarding etc.);
- congestion control functions (e.g. Explicit Forward Congestion Notification (EFCN), selective cell discarding);
- performance monitoring OAM functions (end-to-end or segment VCC/VPC monitoring).

Additional comments:

The Priority parameter allows the ATM-LME to take suitable actions in order to perform traffic or congestion control functions: e.g. the network will monitor the rate of high and low priority cells. Cells arriving at the network access in excess of this rate will be subject to the UPC.

ATMM_MONITOR_REMOVE.request

Function:

This primitive requests to remove the monitor function invoked by the primitive ATMM_MONITOR.request.

Semantics of the service primitive:

```
ATMM_MONITOR_REMOVE.request (
                            ATM-LI
                            )
```

The ATM-LI (i.e. VCI and VPI) parameter specifies the ATM connection Identifier of the monitored connection.

When generated:

This primitive is generated by the ATM-LME to request the ATM-LE to stop:

- the transfer of blocks of ATM-SDUs containing user information (SAR-PDU) on the indicated VP or VC connection, in case of performed OAM monitoring functions. This primitive is generated by the ATM-LME as soon as a peer Performance Monitoring deactivation message is received;
- the ATM-SDU arrival notification function in case of traffic or congestion control functions.

Effect of receipt:

The receipt of this primitive causes the ATM-LE to deactivate:

- the ATM-SDU copying function in case of performed OAM monitoring functions;
- the ATM-SDU arrival notification function in case of traffic or congestion control functions.

ATMM_CONGESTION.indication

Function:

This primitive indicates to the ATM-LME that a local or a remote congestion has occurred on the indicated VP or VC connection.

Semantics of the service primitive:

```
ATMM_CONGESTION.indication  (
                            Congestion Indication,
                            Queue Status,
                            ATM-LI
                            )
```

The Congestion Indication (CI) parameter specifies whether the received ATM-PDU with ATM user information (SAR-PDU) has encountered remote congested resources. It can take only two values: congested (1) or not congested (0).

The rule given in table 1 is used by the receiving ATM-LE to associate the CI parameter to the EFCN contained in the PT field.

Table 1

CI	**PTI**			
	4	3	2	(bit)
0	0	0	0	
1	0	1	0	(note)
0	0	0	1	
1	0	1	1	(note)
NOTE: PTI values Network related reserved for EFCN.				

The Queue status parameter specifies whether the receiving ATM-LE has local congested resources.

The ATM-LI (VCI, VPI) parameter specifies the ATM connection Identifier related to the congested connection.

When generated:

This primitive is generated by the ATM-LE to inform the ATM-LME that the received ATM-PDU with ATM user information (SAR-PDU) has encountered local or remote congested resources.

Effect of receipt:

The effect of this primitive depends on the type of system involved:

In intermediate systems its receipt allows the management plane (through the ATM-LME) to take suitable actions to:

- handle the local congestion condition;
- notify the congestion state to the destination end-systems by setting the EFCN in the transmitting ATM-LE.

In end-systems its receipt allows the end-to-end higher layer protocols to assist in the recovery during the network congested state.

Additional comments:

Non congested intermediate systems will not modify the PT field value.

The ATM-LME (or the AAL-LME) in the receiving end-systems should evaluate the number of congestion indication over a given measurement interval: Higher layer may use this information to implement protocols that adaptively reduce their offered load to face network congestion.

Since Explicit Backward Congestion Notification (EBCN) is not foreseen, congested intermediate systems should notify the congestion state to the source end-system by means of ATM-management messages or higher layer messages.

The Queue status is a global parameter in the sense that it specifies local congestion state for all virtual connections at a given moment.

6.2.4 OAM related to the ATM layer

The required OAM functions related to the ATM layer are outlined in ITU-T Recommendation I.610 [5].

6.3 AAL

The functions of the AAL, including its Segmentation and Reassembly (SAR) sublayer and Convergence Sublayer (CS), are described in ITU-T Recommendations I.362, and I.363.

The model and the primitives for the AAL are contained in ITU-T Recommendation I.363.

6.4 Higher layers

The functions and the modelling of the higher layers are for further study, in particular the modelling of the layer directly above the AAL will depend on the AAL type used, as different AAL types provide different services to the layer above.

Annex A (normative): PRM information flow for user plane connection establishment

A.1 Example

This clause contains an example of the PRM information flow for user plane connection establishment.

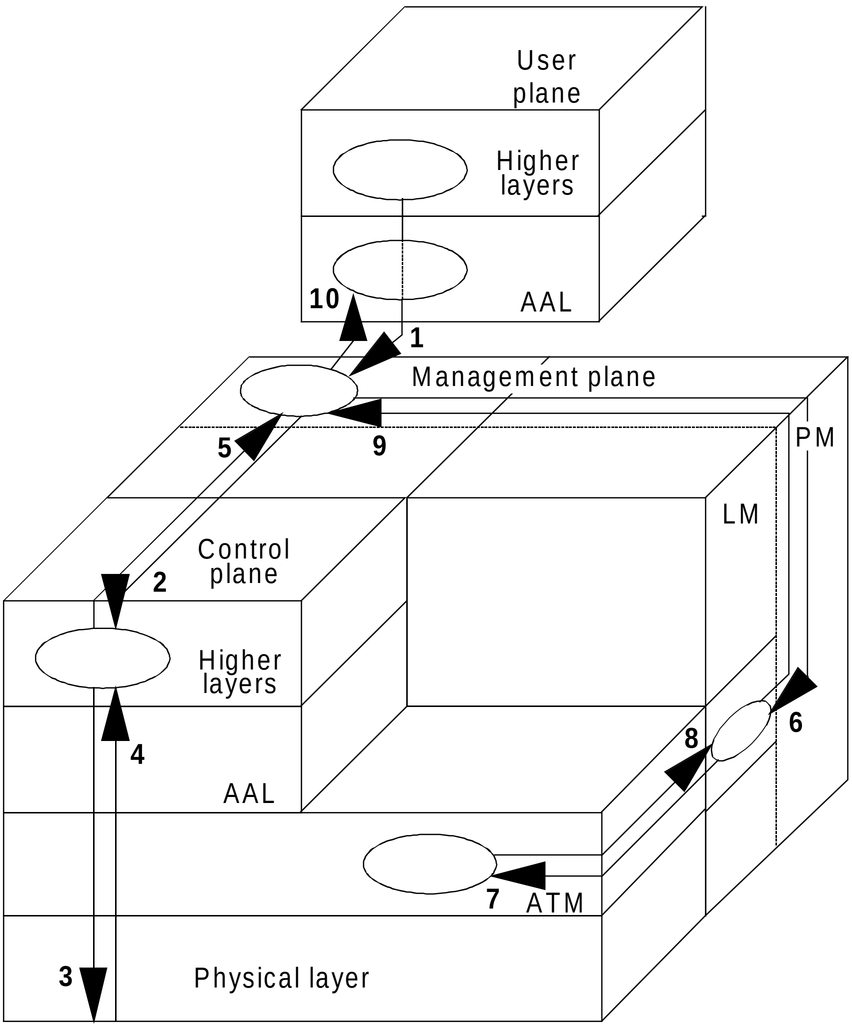
The following assumptions are made:

- the user plane protocol stack for the higher layers is conforming to OSI;
- the user plane connection in the network is limited to the ATM layer and is established hop-by-hop, while the AAL connection, and higher layer connections, are established end-to-end and are transparent to the network;
- a modified graphic representation of the PRM is used in order to achieve better clarity;
- the example only describes the information flow inside a system; however a figure showing the peer-to-peer information flow is added for clarification.

A.2 PRM information flow

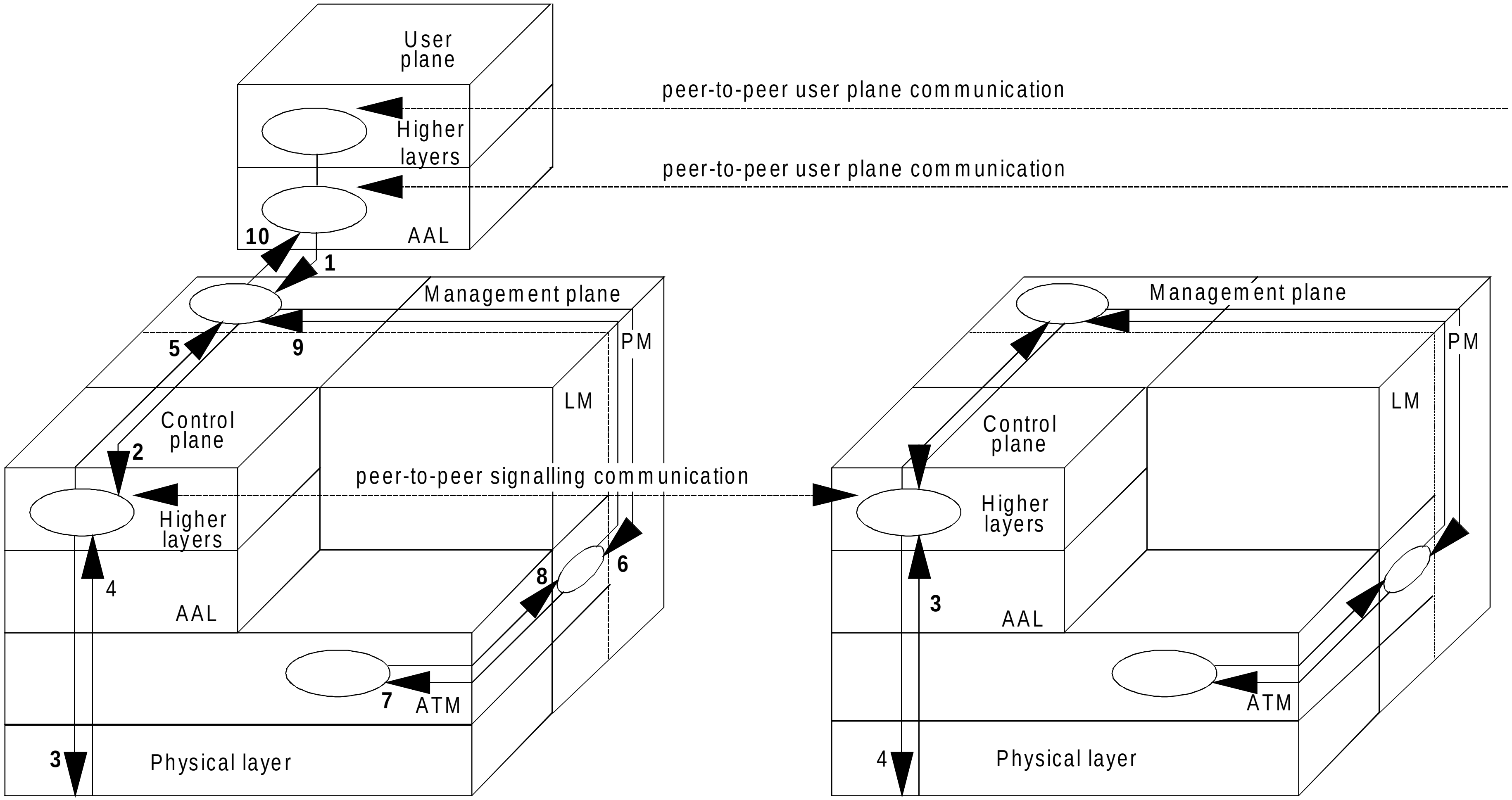
When a user initiates a call, the following operations are performed in order to establish user plane connection(s). The sequence of the operations (PRM information flow) is shown in figure A.1.

Figure A.2 shows the peer-to-peer relationships involved in the user plane connection establishment.



PM	Plane Management
LM	Layer management
1)	The user makes a request for a call. This request is performed by an application through the higher layers and the AAL in the user plane to the plane management.
2)	The plane management triggers the Signalling Entity (SE), in the control plane higher layers.
3,4)	The SE starts a negotiation process with the peer SE, using the signalling protocol over the signalling VC.
5)	Once the call has been accepted, and all parameters have been negotiated, the SE notifies the PM of the results of this negotiation.
6,7)	The plane management, through the ATMM send a request to the ATM layer to establish the proper association.
8,9)	The ATM layer confirms, via the layer management, the establishment of the association to the plane management.
10)	The plane management confirms the establishment of the ATM connection to the AAL.

Figure A.1: Information flow for user plane connection establishment



PM: Plane Management
LM: Layer Management

Figure A.2: Peer-to-peer relationships

Annex B (informative): Bibliography

1) ITU-T Recommendation I.362: "B-ISDN ATM adaptation layer functional description".

2) ITU-T Recommendation I.363: "B-ISDN ATM adaptation layer specification".

History

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