INTERNATIONAL TELECOMMUNICATION UNION

CCITT

I.321

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

OVERALL NETWORK ASPECTS AND FUNCTIONS, ISDN USER-NETWORK INTERFACES

B-ISDN PROTOCOL REFERENCE MODEL AND ITS APPLICATION

Recommendation I.321

Geneva, 1991

FOREWORD

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

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

Recommendation I.321 was prepared by Study Group XVIII and was approved under the Resolution No. 2 procedure on the 5 of April 1991.

CCITT NOTES

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

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

Preamble to B-ISDN Recommendations

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

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

I.121 – Broadband aspects of ISDN

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

I.211 – B-ISDN service aspects

I.311 – B-ISDN general network aspects

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

I.327 – B-ISDN functional architecture

I.361 – B-ISDN ATM layer specification

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

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

I.413 – B-ISDN user-network interface

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

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

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

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

Recommendation I.321

B-ISDN PROTOCOL REFERENCE MODEL AND ITS APPLICATION

1 Introduction

1.1 *General*

Recommendation I.320 contains the description of the ISDN protocol reference model (PRM). This Recommendation is based on the ISDN protocol reference model as defined in Recommendation I.320, and wherever not explicitly indicated, it should conform with Recommendation I.320. The purpose of this Recommendation is to take into account the functionalities of B-ISDN, which may eventually be incorporated into Recommendation I.320, as an expansion of the existing ISDN protocol reference model. The Protocol Reference Model in this Recommendation is called "B-ISDN PRM" (protocol reference model of the broadband aspects of ISDN). By applying this B-ISDN PRM, § 4 describes functions associated with individual layers of B-ISDN.

1.2 *Relationship with the OSI reference model (X.200)*

The B-ISDN layered model reflects the principles of layered communication defined in Recommendation X.200 [the reference model of open systems interconnection (OSI) for CCITT applications].

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 seem appropriate to the broadband environment. 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 should be applicable to the broadband network and user applications.

The exact relationship between the lower layers of the OSI model and the ATM Adaptation Layer (AAL), the ATM Layer and the Physical Layer of the B-ISDN PRM are for further study.

2 The B-ISDN protocol reference model

The B-ISDN protocol reference model is shown in Figure 1/I.321; it is composed of a user plane, a control plane and a management plane.

Above the Physical Layer, the ATM Layer provides call transfer for all services and the AAL provides service-dependant functions to the layer above the AAL.

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

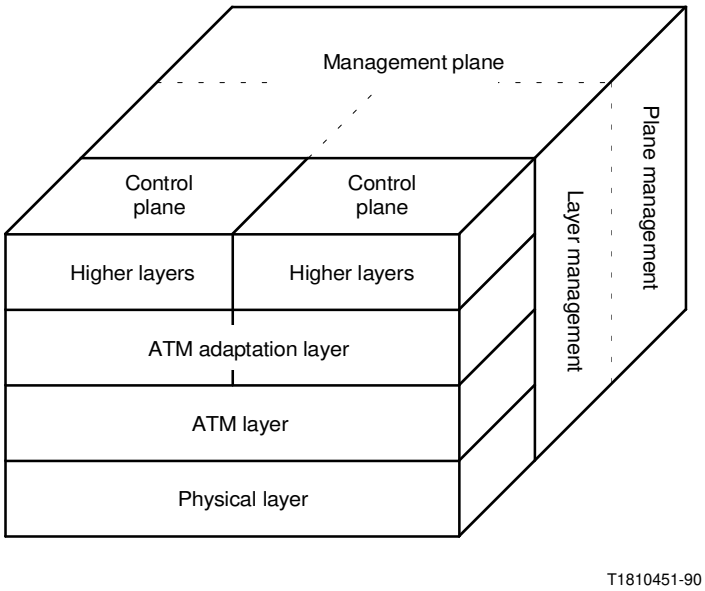

FIGURE 1/I.321

B-ISDN protocol reference model

3 Description of the planes

3.1 *User plane*

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

3.2 *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.

The distinction, if any, between local and global control plane functions in the broadband environment is for further study.

3.3 *Management plane*

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

3.3.1 *Plane management functions*

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

3.3.2 *Layer Management functions*

Layer Management performs management functions (e.g. meta-signalling) relating to resources and parameters residing in its protocol entities. Layer Management handles the operation and maintenance (OAM) information flows specific to the layer concerned. Additional details are provided in Recommendation Q.940.

Note – A possible merger of plane management and Layer Management functions is for further study.

4 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/I.321 illustrates the layers of the PRM, and identifies the functions of the Physical Layer, the ATM Layer, and the AAL.

<table>
<tr><td rowspan="6"></td><td>Higher layer functions</td><td colspan="2">Higher layers</td></tr>
<tr><td>Convergence</td><td>CS</td><td rowspan="2">AAL</td></tr>
<tr><td>Segmentation and reassembly</td><td>SAR</td></tr>
<tr><td>Generic flow control
Cell header generation/extraction
Cell VPI/VCI translation
Cell multiplex and demultiplex</td><td colspan="2">ATM</td></tr>
<tr><td>Cell rate decoupling
HEC header sequence generation/verification
Cell delineation
Transmission frame adaptation
Transmission frame generation/recovery</td><td>TC</td><td rowspan="2"></td></tr>
<tr><td>Bit timing
Physical medium</td><td>PM</td></tr>
</table>

CS Convergence sublayer
PM Physical medium
SAR Segmentation and reassembly sublayer
TC Transmission convergence

FIGURE 2/I.321

Functions of the B-ISDN in relation to the protocol reference model

4.1 *Terminology*

4.1.1 **idle call (Physical Layer)**

Cell which is inserted/extracted by the Physical Layer in order to adapt the cell flow rate at the boundary between the ATM Layer and the Physical Layer to the available payload capacity of the transmission system used.

4.1.2 **valid cell (Physical Layer)**

Cell whose header has no errors or has been modified by the cell header error control (HEC) verification process.

4.1.3 **invalid cell (Physical Layer)**

Cell whose header has errors and has not been modified by the cell HEC verification process (discarded at the Physical Layer).

4.1.4 **assigned cell (ATM Layer)**

Cell which provides a service to an application using the ATM Layer service.

4.1.5 **unassigned cell (ATM Layer)**

ATM Layer cell which is not an assigned cell.

4.2 *Physical Layer*

The Physical Layer consists of two sublayers. The physical medium (PM) sublayer includes only physical medium dependant 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 physical medium. The service data unit (SDU) crossing the boundary between the ATM Layer and the Physical Layer is a flow of valid cells. The ATM Layer is unique, i.e. independent of the underlying Physical Layer. The data flow inserted in the transmission system payload is physical medium independent and self-supported; the Physical Layer merges the ATM cell flow with the appropriate information for cell delineation, according to the cell delineation mechanism described in Recommendation I.432 and carries operations and maintenance (OAM) information relating to this cell flow.

4.2.1 *Physical medium sublayer functions*

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

4.2.1.1 *Physical medium*

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

4.2.1.2 *Bit timing*

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.

4.2.2 *Transmission convergence sublayer functions*

4.2.2.1 *Transmission frame generation and recovery*

This function performs the generation and recovery of transmission frame.

4.2.2.2 *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), an SDH envelope, a Recommendation G.703 envelope, etc.

4.2.2.3 *Cell delineation*

Cell delineation prepares the cell flow in order to enable the receiving side to recover cell boundaries according to the self-delineating mechanism defined in Recommendation I.432. In the transmit direction, the ATM cell stream is scrambled. In the receive direction, cell boundaries are identified and confirmed (using the HEC mechanism) and the cell flow is descrambled.

4.2.2.4 *HEC sequence generation and cell header verification*

In transmit direction, the HEC sequence is calculated and inserted in the header. In receive direction, cell headers are checked for errors and, if possible, header errors are corrected. Cells whose headers are determined to be errored and non-correctable are discarded.

4.2.2.5 *Cell rate decoupling*

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

4.2.3 *OAM related to the Physical Layer*

The required OAM functions relating to the Physical Layer are outlined in Recommendations I.432 and I.610.

4.2.4 *Physical Layer primitives*

Between the Physical Layer and the ATM Layer, two primitives are currently defined:

PH-DATA request: The ATM Layer requests the Physical Layer that the SDU associated with this primitive should be transported to its peer.

PH-DATA-indication: The ATM Layer is notified by the Physical Layer that the SDU associated with the primitive coming from its peer is available.

Note – The Physical Layer will provide a clock to the ATM Layer. This clock is derived from the line rate of the Physical Layer (e.g. a bit clock at 155.52 Mbit/s for the user network interface standardized in Recommendation I.432).

For certain applications, there may be a need to indicate to the ATM Layer that an idle cell has been discarded by the Physical Layer. Two possible applications are generic flow control (GFC) and the shaping of traffic flows.

The exact definitions of the primitives needed are for further study.

4.3 *ATM Layer*

The characteristics of the ATM Layer are independent of the physical medium.

4.3.1 *ATM Layer functions*

4.3.1.1 *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 composite cell flow. In the receive direction, the cell demultiplexing function directs individual cells from a non-continuous composite cell flow to the appropriate VP or VC.

4.3.1.2 *Virtual path identifier (VPI) and virtual channel identifier (VCI) translation*

This function occurs at ATM switching fields and/or cross-connect nodes (including B-NT2). The value 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.

4.3.1.3 *Cell header generation/extraction*

These functions apply at points where the ATM Layer 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 header error control (HEC) sequence. This function could also include the translation from a service access point (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 field to a higher layer. This function could also include a translation of a VP and VC identifier into an SAP identifier.

4.3.1.4 *Generic flow control*

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.

4.3.2 *ATM Layer primitives*

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

Between the ATM Layer and the AAL, two primitives are defined:

ATM-DATA request: AAL requests the ATM Layer that the ATM-SDU associated with this primitive be transported to its peer.

ATM-DATA-indication: The AAL is notified by the ATM Layer that the ATM-SDU associated with the primitive coming from its peer is available.

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

4.3.3 *OAM related to the ATM Layer*

The required OAM functions related to the ATM Layer are outlined in Recommendation I.610.

4.4 *ATM Adaptation Layer*

The functions of the ATM Adaptation Layer, including its segmentation and reassembly sublayer (SAR) and convergence sublayer (CS), are described in Recommendation I.362

4.5 *Higher layers*

The functions of the higher layers are for further study.

ANNEX A

(to Recommendation I.321)

Alphabetical list of abbreviations used in this Recommendation

AAL	ATM Adaptation Layer
ATM	Asynchronous transfer mode
B-ISDN	Broadband aspects of integrated services digital network
B-ISDN PRM	Protocol reference model of the broadband aspects of ISDN
CS	Convergence sublayer
GFC	Generic flow control
HEC	Header error control
B-NT2	Broadband network termination 2 for B-ISDN
OAM	Operation and maintenance
PM	Physical medium
PRM	Protocol reference model
SAP	Service access point
SAR	Segmentation and reassembly sublayer
SDU	Service data unit
TC	Transmission convergence
VC	Virtual channel
VCI	Virtual channel identifier
VP	Virtual path
VPI	Virtual path identifier