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Integrated Services Digital Network (ISDN);
The protocol reference model
and its relationship with the OSI reference model

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New presentation - see History box

Contents

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Foreword

ETSI Technical Reports (ETRs) are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim-European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

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1 Scope

The aims of this ETSI Technical Report (ETR) are to:

- present, and clarify where necessary, the architecture principles adopted in order to model connections and exchanges of information (i.e. user information, control information and management information) in an Integrated Services Digital Network (ISDN), and Broadband-ISDN (B-ISDN), environment, as presented in CCITT Recommendations I.320 [1] and I.321 [2];

- elaborate how the ISDN and B-ISDN Protocol Reference Models (PRMs) can be harmonised into one PRM;

- compare these principles to those adopted by the Open System Interconnection (OSI) reference model, and other models;

- present the ETSI views on this subject.

    NOTE: The two PRMs are not fully stable, and not aligned, thus possibly leading to misinterpretations.

As a result, this document will evolve with time, to reflect the progress made in the area of protocol modelling in the ISDN context (in CCITT Study Group (SG) XVIII).

2 Normative references

[1]   CCITT Recommendation I.320 (1992): "ISDN protocol reference model".

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

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

3 Definitions

For the purposes of this ETR, the following definition applies:

Network: an ISDN, in the OSI context, corresponds to a sub-network.

4 Symbols and abbreviations

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

AAL	ATM Adaptation Layer
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband aspects of ISDN
BRM	Basic Reference Model
CBO	Continuous Bitstring Oriented
CL	Connectionless
CO	Connection Oriented
C-plane	Control plane

DBO   Delimited Bitstring Oriented

IN   Intelligent Network

ISDN   Integrated Services Digital Network

LAN   Local Area Network

LSE   Local System Environment

MAN   Metropolitan Area Network

NS   Network Service

OSI   Open Systems Interconnection

PRM   Protocol Reference Model

SCF   Synchronisation and Coordination Function

TMN   Telecommunications Management Network

U-plane   User plane

VCI   Virtual Channel Identifier

VPI   Virtual Path Identifier

5   The ISDN protocol reference model

Subclause 5.1 gives an overview of the current version of CCITT Recommendation I.320 [1]. Subclauses 5.2 and 5.3 present aspects requiring further clarification, or which are not covered in the referenced version of CCITT Recommendation I.320 [1].

5.1   Introduction, presentation

The ISDN PRM models the interconnection and exchange of information (both user and control) between communicating entities involving an ISDN. Such communicating entities can be either ISDN users or functional entities inside or outside an ISDN.

The services provided by an ISDN to allow such communications are, in particular:

-       circuit-switched connections, using common channel signalling;

-       packet-switched communication over the B, D or H channels;

-       signalling between user and network based facility;

-       user-to-user signalling, or end-to-end signalling;

-       combination of the above, e.g. in a multimedia communication.

The ISDN PRM uses some principles established for the OSI Reference Model (OSI Basic Reference Model (BRM)), but is not itself limited to data communications.

On the other hand, the OSI BRM is independent of the underlying network type. While the OSI BRM used a top-down approach for its design, starting from application needs, the ISDN PRM uses a bottom-up approach, to make it easier to exploit the benefit from newer technologies in networking and transmission.

As a result, only some of the principles of the OSI BRM can be applied to the ISDN PRM, such as the concepts of layer, layer service, peer-to-peer protocols and peer entities.

5.1.1 Layer and stratum

To allow more flexibility in the description of the three lower layers (i.e. the layers up to the network layer), the ISDN PRM introduces the concept of stratum: i.e. it is a layered structure of three layers:

- the network layer (network connections, routing and relaying);

- the data link layer (data link connections, sequencing, etc.); and

- the infrastructure layer (infrastructure connection and connection identification). The infrastructure layer can itself be described, in a recursive manner, as a stratum, e.g. to model overlaid networks.

5.1.2 Planes and protocol blocks

According to the ISDN PRM, a protocol block is a layered stack of protocol entities providing a well defined service.

Two types of protocol blocks are identified:

- the user protocol block, for the transfer of user information in a transparent manner; and

- the control protocol block, to support ISDN signalling.

Additionally, the concept of the plane is introduced. A plane is composed of protocol blocks of the same type and belonging to two or more connected systems, with a well defined peer-to-peer relationship. There are, therefore, two planes identified:

- the User plane (U-plane); and
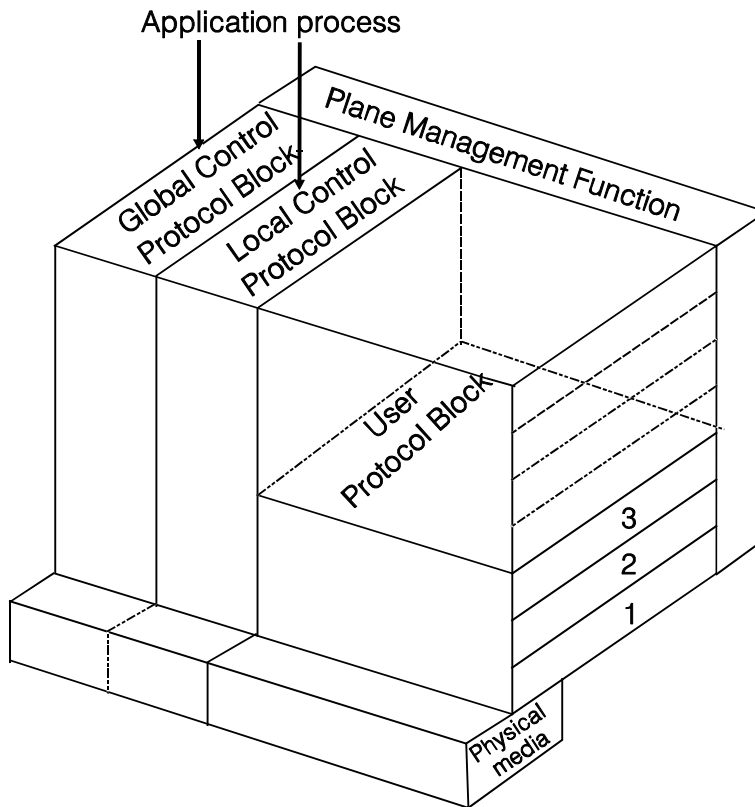
- the Control plane (C-plane).

Figure 1: ISDN PRM protocol blocks

5.1.3 The synchronisation and coordination function

ISDN services are in general offered by a combination of at least one control protocol block and one user protocol block. The purpose of the Synchronisation and Coordination Function (SCF) is to coordinate the operations of these two blocks to ensure that the communication can take place.

The SCF forms the upper boundary of the C and U protocol blocks, and is positioned at the service boundary in the OSI sense.

Some of the functionalities offered by the SCF are similar to the one offered by the Local System Environment (LSE) in the OSI context.

5.1.4 ISDN management

Management is only partially introduced in CCITT Recommendation I.320 [1], as a set of plane management functions. It mentions the SCF, whose functionality is described in subclause 5.1.3 and layer management functions, which are responsible for managing resources offered by the different protocol entities comprising the various protocol blocks.

However, the principles to be applied and the functions to deploy, are not described.

5.1.5 Interworking

Because of the number of applications of an ISDN, the aspects of interworking are of particular importance. Example of interworking scenarios are:

- interworking with an OSI network or sub-network;

- interworking with non-ISDN terminals;

- interworking between ISDNs not offering the same set of facilities.

Interworking between an ISDN and another network implies the operation of an implicit or explicit Interworking Function (IWF); the end user may or may not be aware of the presence of this IWF.

The purpose of this IWF is to allow a mapping of the service provided by the ISDN to the service provided by the interconnected network. These services are described in terms of functions that are carried by means of protocols. These functions and protocols vary depending on the level at which interworking is required. The notion of reference point is used, to identify the set of functions and protocols provided at a given level.

Interworking at a particular reference point will depend on the capabilities of the network or terminal to connect to the ISDN.

The concept of stratification is also fully applicable in this context, where one of the networks can be seen by the other(s) as a stratum infrastructure layer.

5.2 Aspects of CCITT Recommendation I.320 requiring further clarification

5.2.1 Scope

In the referenced version of CCITT Recommendation I.320 [1], a list of capabilities and needs, that the ISDN should cater for is given (see CCITT Recommendation I.320 [1], paragraph 2.1).

Such a list cannot be exhaustive, and therefore may result in a restriction of the scope of the ISDN PRM, and in a limitation of its use.

5.2.2 Concept of local and global significance

Local and global significance, applicable only to the control plane, is introduced in CCITT Recommendation I.320 [1], paragraph 2.3, to permit more efficient implementation of services.

However, no quantifiable metrics are given to allow for the separation between local and global (sometimes associated with remote) in a deterministic fashion.

In addition, the splitting of the C protocol block into a local C protocol block and a global C protocol block is not necessarily implied by the significance concept.

5.2.3 Alignment with OSI BRM

In CCITT Recommendation I.320 [1], a brief comparison is made between the ISDN PRM and the OSI reference model (OSI BRM), and an intuitive positioning of the two models is given.

In order to facilitate both the interworking between the two worlds and the applicability of solutions standardised within the framework of OSI in an ISDN environment, it appears crucial to better align the ISDN PRM onto priciples that have been successfully adopted for OSI.

5.3 Aspects not covered in CCITT Recommendation I.320

5.3.1 Provision of the OSI connectionless network service

The ISDN PRM must cover both the Connection-Oriented (CO) and the Connectionless (CL) aspects. Although CO mode is still predominant in the telecommunications world, the introduction of new techniques has favoured the development of CL mode of communications (e.g. to services offered by LANs, and soon to be offered by MANs).

5.3.2 ISDN Management - relation with OSI management

As seen in subclause 5.1.4, management aspects of an ISDN are only partially covered in CCITT Recommendation I.320 [1].

However, an immense effort is currently being made, both in OSI and in the telecommunications world, to provide a powerful and adaptable method for managing networks and their associated services and equipments. In particular, the OSI management principles are adopted in the framework of Telecommunication Management Networks (TMNs).

It is important therefore that a proper model for the management of ISDN is introduced, to provide guidance for a uniform approach to ISDN management.

5.3.3 Modelling of isochronous services

OSI, specialised for data communications, uses Delimited Bitstring Oriented (DBO) mechanisms. DBO services and bearers are normally, considered at a level of abstraction where timing aspects of the underlying service(s) or bearer(s) can be ignored.

On the contrary, ISDN supports both DBO and Continuous Bitstring Oriented (CBO) mechanisms. CBO services and bearers can only be considered properly if the inherent timing aspects of the information units (bits, bytes, etc.) are taken into account.

6 Broadband aspects of ISDN: the "B-ISDN PRM"

Subclause 6.1 gives an overview of the referenced version of CCITT Recommendation I.321 [2]. Subclauses 6.2, 6.3 and 6.4 present aspects requiring further clarification, or which are not covered in the referenced version of CCITT Recommendation I.321 [2].

6.1 Introduction, presentation

B-ISDN can be considered as a particular application of the principles developed for ISDN.

As a consequence, the B-ISDN PRM should derive from the ISDN PRM, adding only principles specific to broadband aspects, which is based on ATM principles.

As in CCITT Recommendation I.320 [1], CCITT Recommendation I.321 [2] uses the concept of user plane and control plane. It adds to it the notion of management plane which encompasses the notion of plane management functions as introduced in the ISDN PRM. This management plane also includes a set of layer management functions, similar to those in CCITT Recommendation I.320 [1].
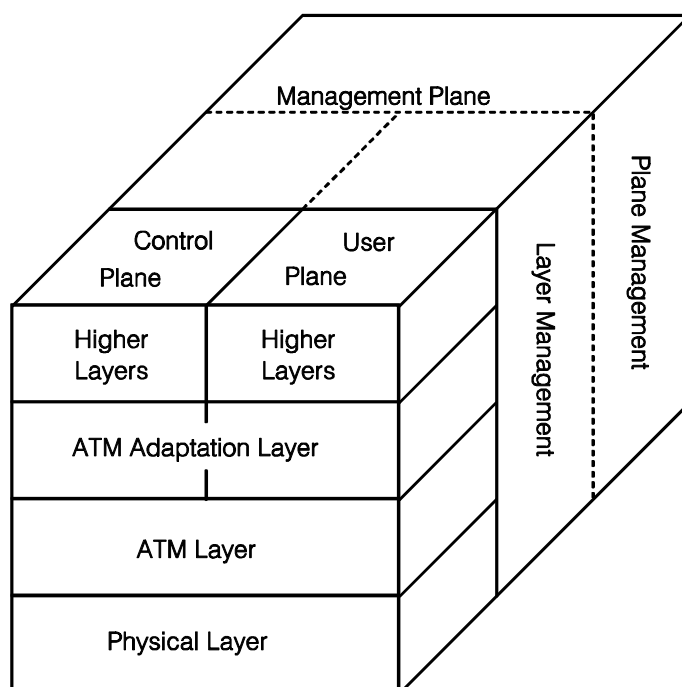

Figure 2: The B-ISDN PRM

CCITT Recommendation I.321 [2] describes in details the structure and composition of the lower layers of both the control and the user planes. These layers, the physical layer, the ATM layer and the ATM Adaptation Layer (AAL) are not directly relatable to layers in the OSI BRM (it is possible that most of the functions of these layers could architecturally be positioned at the physical layer and at the bottom of the data link layer of the OSI BRM).

The ATM layer provides such functions as cell header generation/extraction, cell multiplexing/demultiplexing, cell Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) translation at ATM switching or cross-connect nodes, and generic flow control.

The purpose of the AAL is to adapt to the specifics of the layer above, and it depends on the service this above layer provides. The AAL is further subdivided into a segmentation and reassembly sublayer and a convergence sublayer.

The functions of the higher layers are not described and remain for further study in CCITT Recommendation I.321 [2].

The B-ISDN PRM, as described in CCITT Recommendation I.321 [2], is very much associated with a particular underlying technology (i.e. ATM).

6.2 Comparison with the ISDN PRM

6.2.1 Design approaches

The B-ISDN PRM was devised using the ISDN PRM as a reference, to permit the best use of a technology (i.e. ATM).

CCITT Recommendation I.321 [2] has, therefore, many points in common with CCITT Recommendation I.320 [1], but still differs in some aspects, where CCITT Recommendation I.320 [1] has failed to provide an adequate and usable model.

Ideally, B-ISDN should be considered as an application of the ISDN PRM. The difference with the ISDN PRM should only relate to the structure for provision of bearer services specific to broadband capabilities.

6.2.2 Relationship to the OSI BRM

Although it is stated in CCITT Recommendation I.321 [2], paragraph 1.2, that the OSI BRM should be applicable to the B-ISDN PRM, no indication is provided on how this can be achieved.

6.2.3 Local and global significance

The potential advantages of this concept and are left for further study in CCITT Recommendation I.321 [2].

6.2.4 Management aspects

B-ISDN PRM introduces the concept of management plane that encompasses both plane management functions and layer management functions.

ISDN PRM introduces a set of plane management functions that include both the SCF and layer management functions.

It is clear that such contradictory approaches can lead to confusion in the application of these models.

6.3 Aspects of CCITT Recommendation I.321 requiring further clarification

Most of the remarks made about CCITT Recommendation I.320 [1] apply to CCITT Recommendation I.321 [2], as the former served as a model for the latter.

6.3.1   Clarification of scope

CCITT Recommendation I.321 [2] does not define the scope of the B-ISDN PRM.

The only indication given to the reader is that the B-ISDN PRM covers broadband aspects of ISDN. A clearer view of the scope of the B-ISDN PRM is necessary to fully understand the applicability of this model.

6.3.2   Management aspects

Similarly with ISDN PRM, very little information is provided on how management functions are provided in the B-ISDN environment. Furthermore, this information contradicts the information given in CCITT Recommendation I.320 [1].

It is desirable that a common approach is taken among these various models: ISDN PRM, B-ISDN PRM, OSI BRM and CCITT Recommendation Q.940 [3].

6.3.3   Adaptation layer

While CCITT Recommendation I.321 [2] has not been modified since its approval in 1990, work on the adaptation layer has progressed, with the result that three sub-layers are now defined for service classes C and D (AAL types 3 and 4).

6.4   Aspects not covered in CCITT Recommendation I.321

6.4.1   Application of the stratification concept

The stratification concept, as introduced in CCITT Recommendation I.320 [1], is not mentioned at all in CCITT Recommendation I.321 [2], thus limiting the applicability of this model, in particular with regard to interworking scenarios with other networks.

6.4.2   Relationship of higher layers (above AAL) to the OSI BRM

No indication is given in CCITT Recommendation I.321 [2] on how B-ISDN PRM relates to the OSI BRM. This is particularly true for the provision of the OSI Network Service (NS) above the AAL. This weakness makes it difficult for CCITT Recommendations requiring such a service to follow a unique model, and thus to be homogeneous in their approach.

7   Applicability of the models

Examples to demonstrate the applicability (and limitations) of the models will be provided in future editions of this ETR.

History

Document history	
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