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ITU-T Y.1231

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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Architecture, access, network capabilities and resource management

IP access network architecture

ITU-T Recommendation Y.1231

(Formerly CCITT Recommendation)

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ITU-T Recommendation Y.1231

IP access network architecture

Summary

This Recommendation provides the definitions of terminology regarding IP access, and the high-level IP network architecture and models for the IP services. It describes the access types and interfaces to be supported by the IP access network, the IP access network capabilities and requirements, and the IP access network functional models and possible arrangements.

Source

ITU-T Recommendation Y.1231 was prepared by ITU-T Study Group 13 (2001-2004) and approved under the WTSA Resolution 1 procedure on 24 November 2000.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation Y.1231

IP access network architecture

1 Scope

This Recommendation defines the functional IP Access Network architecture and the functions and requirements above the transport access functions defined in ITU-T Y.1001. The functional requirements for the Access Network Transport are defined for the handling and transport of digital bearer signals defined in ITU-T G.902.

This Recommendation describes:

– the definitions of terminology regarding IP access;

– the high-level IP network architecture and models for the IP services;

– the access types and interfaces to be supported by the IP access network;

– the IP access network capabilities and requirements; and

– the IP access network functional models and possible arrangements.

The functional view of IP access network is independent of the access network transport functions described in ITU-T Y.1001.

2 References

The following ITU-T Recommendations and other references contain provisions which, through references in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

NOTE – A reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

2.1 Normative references

[1] ITU-T Q.922 (1992), *ISDN data link layer specification for frame mode bearer services*.

[2] ITU-T I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*.

[3] ITU-T I.414 (1997), *Overview of Recommendations on Layer 1 for ISDN and B-ISDN customer accesses*.

[4] ITU-T G.902 (1995), *Framework Recommendation on functional Access Networks (AN) – Architecture and functions, access types, management and service node aspects*.

[5] ITU-T Y.1001 (2000), *IP framework – A framework of convergence of telecommunications network and IP network technologies*.

[6] ITU-T Y.1401 (2000), *General requirements for interworking with Internet Protocol (IP)-based networks*.

[7] ISO/IEC 8802-2:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*.

2.2 Informative references

[8] IEEE Std 802.2 (1998), *Logical link control (802.2)*.

[9] IEEE Std 802.3 (1998), *CSMA/CD access method (802.3)*.

[10] Data-Over-Cable Service Interface Specifications, Cable Modem to Customer Premise Equipment Interface Specification, SP-CMCI-I03-991115, Cable Television Laboratories, Inc.

[11] IETF RFC 894 (1984), *A Standard for the Transmission of IP Datagrams over Ethernet Networks*.

[12] IETF RFC 1042 (1988), *A Standard for the Transmission of IP Datagrams over IEEE 802 Networks*.

[13] IETF RFC 1334 (1992), *Password Authentication Protocols*.

[14] IETF RFC 2684 (1999), *Multiprotocol Encapsulation over ATM Adaptation Layer 5*.

[15] IETF RFC 1661 (1994), *The Point-to-Point Protocol (PPP)*.

[16] IETF RFC 1662 (1994), *PPP in HDLC-like Framing*.

[17] IETF RFC 1994 (1996), *PPP Challenge Handshake Authentication Protocol (CHAP)*.

[18] IETF RFC 2138 (1997), *Remote Authentication Dial In User Services (RADIUS)*.

[19] IETF RFC 2225 (1998), *Classical IP and ARP over ATM*.

[20] IETF RFC 2364 (1998), *PPP over AAL5*.

[21] IETF RFC 2427 (1998), *Multiprotocol Interconnect over Frame Relay*.

[22] IETF RFC 2661 (1999), *Layer Two Tunnelling Protocol (L2TP)*.

[23] IETF RFC 2516 (1999), *A Method for Transmitting PPP Over Ethernet (PPPoE)*.

3 Definitions and abbreviations

3.1 Definitions

This Recommendation defines the following terms:

3.1.1 IP access network: An implementation comprising network entities to provide the required access capabilities between an "IP user" and an "IP service provider" for the provision of IP services. "IP user" and "IP service provider" are logical entities which terminate the IP layer and/or IP related functions, and may also include lower layer functions, and may also include lower layer functions.

3.1.2 IP core network: IP service provider's network, including one or more IP service providers.

3.2 Abbreviations

This Recommendation uses the following abbreviations:

AAA Authentication, Authorization and Accounting

AF Access Function

ARP Address Resolution Protocol

ATM Asynchronous Transfer Mode

CHAP Challenge Handshake Authentication Protocol

CMCI Cable Modem to CPE Interface

CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
CPN	Customer Premises Network
DHCP	Dynamic Host Configuration Protocol
DIX	Digital Intel Xerox
DOCSIS	Data-Over-Cable Service Interface Specifications
EF	Edge Function
FR	Frame Relay
HFC	Hybrid Fibre and Coax
IP	Internet Protocol
IPSEC	Internet Protocol Security
ISDN	Integrated Services Digital Network
IWF	InterWorking Function
LAN	Local Area Network
LLC	Logical Link Control
L2TP	Layer 2 Tunnelling Protocol
MAC	Medium Access Control
MPLS	Multiprotocol Label Switching
NAT	Network Address Translation
NSI	Network Side Interface
NT	Network Termination
PAP	Password Authentication Protocol
PC	Personal Computer
PCI	Peripheral Component Interface
PHY	Physical Layer
PON	Passive Optical Network
PPP	Point-to-Point Protocol
PSTN	Public Switched Telephone Network
RADIUS	Remote Access Dial In User Services
RFI	Radio Frequency Interface
RP	Reference Point
SNMP	Simple Network Management Protocol
TE	Terminal Equipment
TEL	Telephone
TFTP	Trivial File Transfer Protocol
UDP	User Datagram Protocol
VCI	Virtual Channel Identifier

VPI Virtual Path Identifier

WAN Wide Area Network

4 Architectural model of IP access networks

4.1 General network architecture of IP network

Figure 1a shows a general network architecture of IP network. In Figure 1a, the lines between various rectangles and ellipses represent connections that are bidirectional, that may be asymmetrical in bit rate, and that may be of differing media in the two directions. The reference points (RP) illustrated are logical separation between the functions and may not correspond to physical interfaces in certain network implementations. In certain network implementations, access and core networks may not be separable.

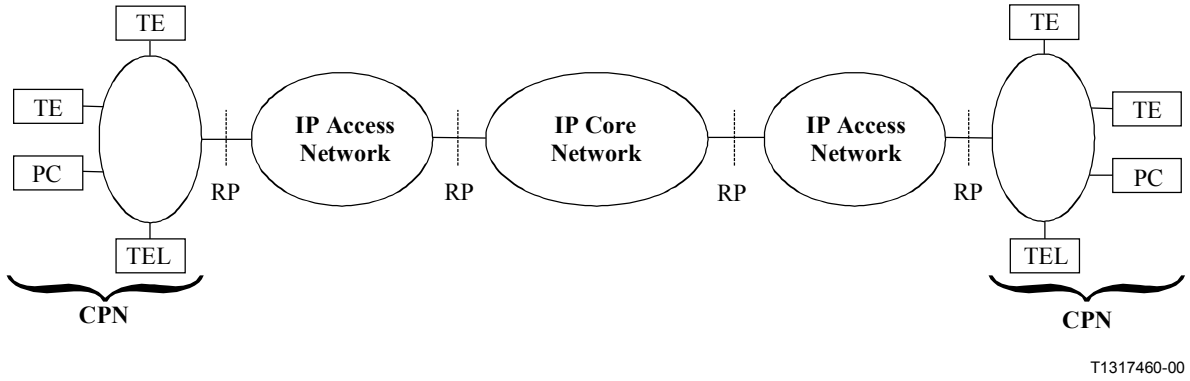


Figure 1a/Y.1231 – General network architecture of IP network

Figure 1b shows an example of relationship between IP network and PSTN/ISDN. In Figure 1b, some connections and InterWorking Function (IWF) between IP Access/Core network and PSTN/ISDN are shown as an example, but not all PSTN/ISDN connections may be necessary. A definition of IWF is described in ITU-T Y.1401 [6].

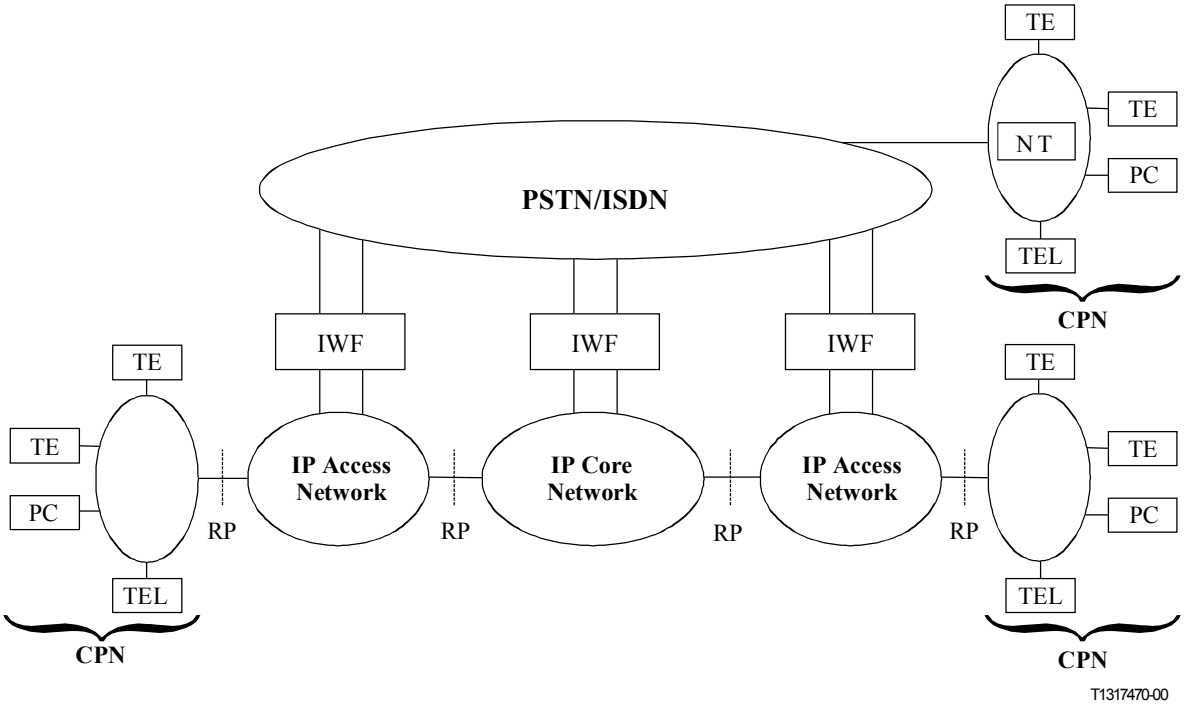


Figure 1b/Y.1231 – An example of relationship between IP network and PSTN/ISDN

4.2 IP access network reference model

Figure 2 shows an example of IP access network reference model. In some cases, the IP access Function (IP-AF) can be distributed within the IP Access Network. Examples of the IP-AF are described in clause 7.

The functional requirements for the Access Network Transport are defined for the handling and transport of digital bearer signals defined in ITU-T G.902 [4].

The functional view of IP access network is independent of the access network transport functions described in ITU-T Y.1001 [5].

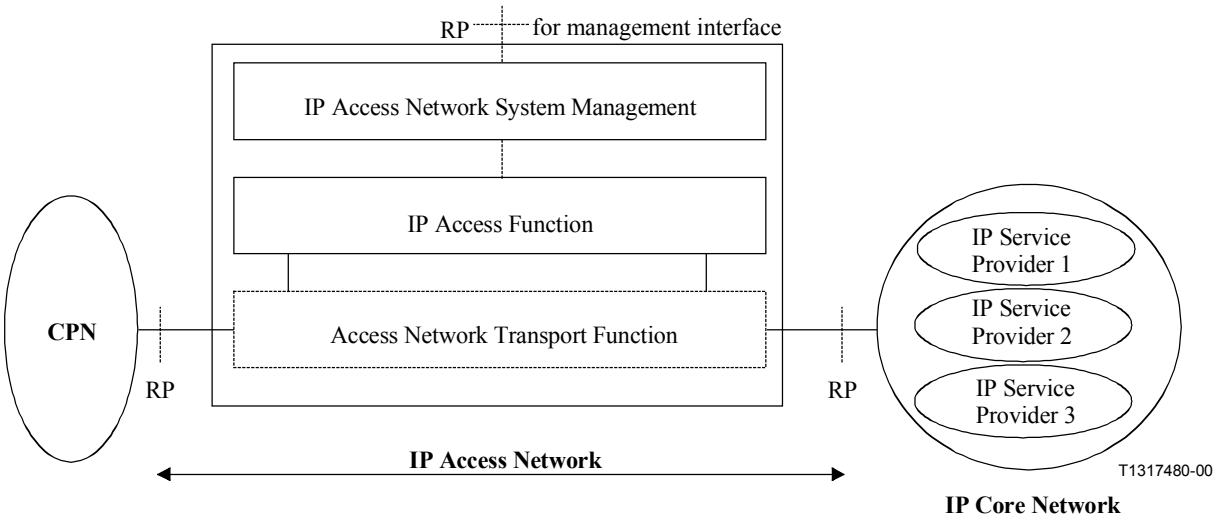


Figure 2/Y.1231 – IP Access Network architecture example

5 Examples of functional models of IP Access Network

5.1 Use of PPP

In this clause, PPP is shown as an example for protocol used to carry IP over access network. PPP is a widely used protocol for dial-up IP access and ADSL access. PPP termination point in the network side interacts with AAA (Authentication, Authorization and Accounting) server (e.g. RADIUS server) and provides AAA functions.

Figures 3a and 3b provide the following two options regarding PPP termination point in the network side:

1) PPP tunnelling aggregation (PPP is terminated by IP service provider); and
2) PPP terminated aggregation (PPP is terminated by the IP access function).

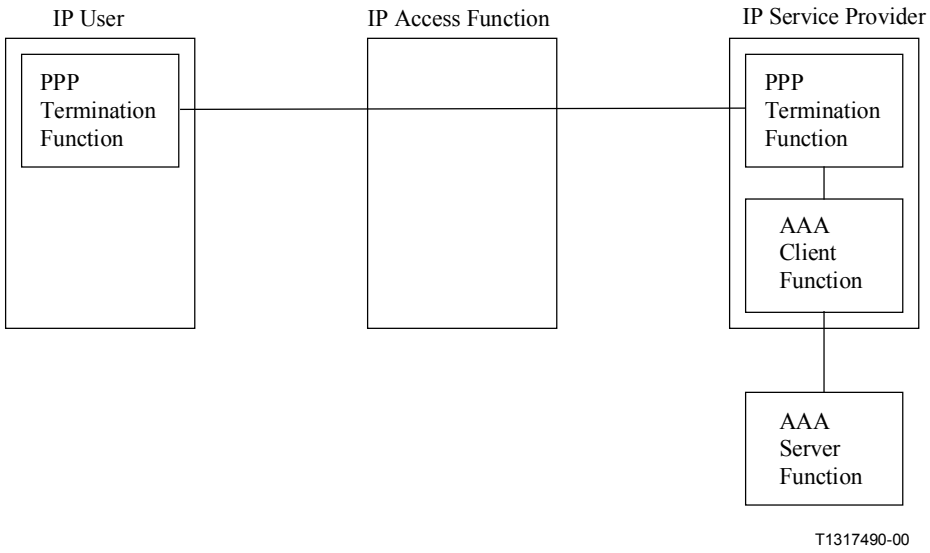


Figure 3a/Y.1231 – PPP tunnelling aggregation

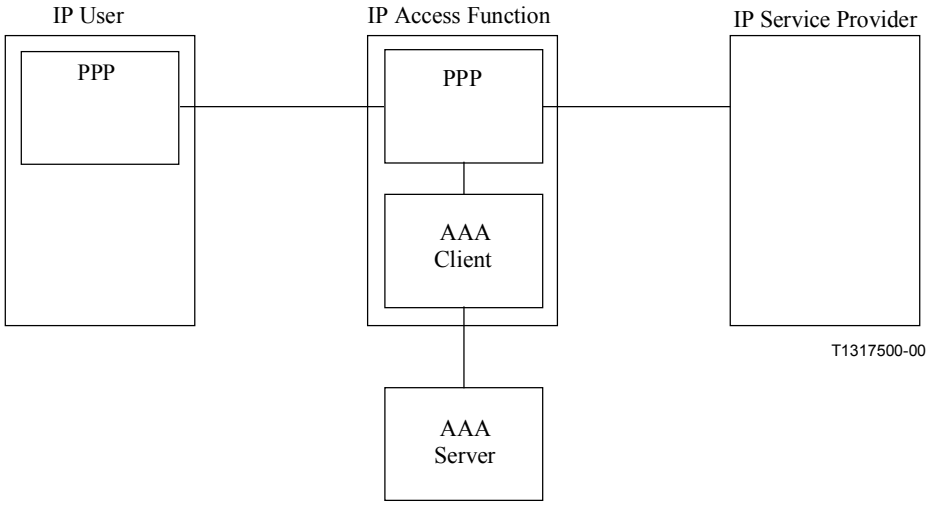


Figure 3b/Y.1231 – PPP terminated aggregation

5.1.1 PPP tunnelling aggregation

This clause gives some examples of protocol stacks for the PPP tunnelling aggregation. In this case, "IP user" directly accesses the "IP service provider". Several transport systems can be cascaded without IP and PPP processing in the access network.

Case 1) Layer 2 multiplexing in IP access network (e.g. direct IP access)

This is a case that only Layer 2 multiplexing transport function such as ATM or FR are supported in IP access network. This functional model is shown in Figure 4.

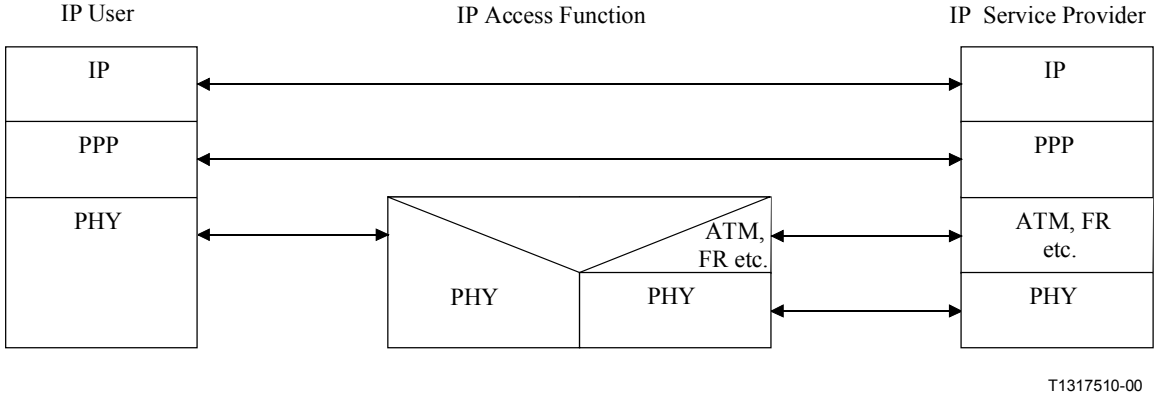
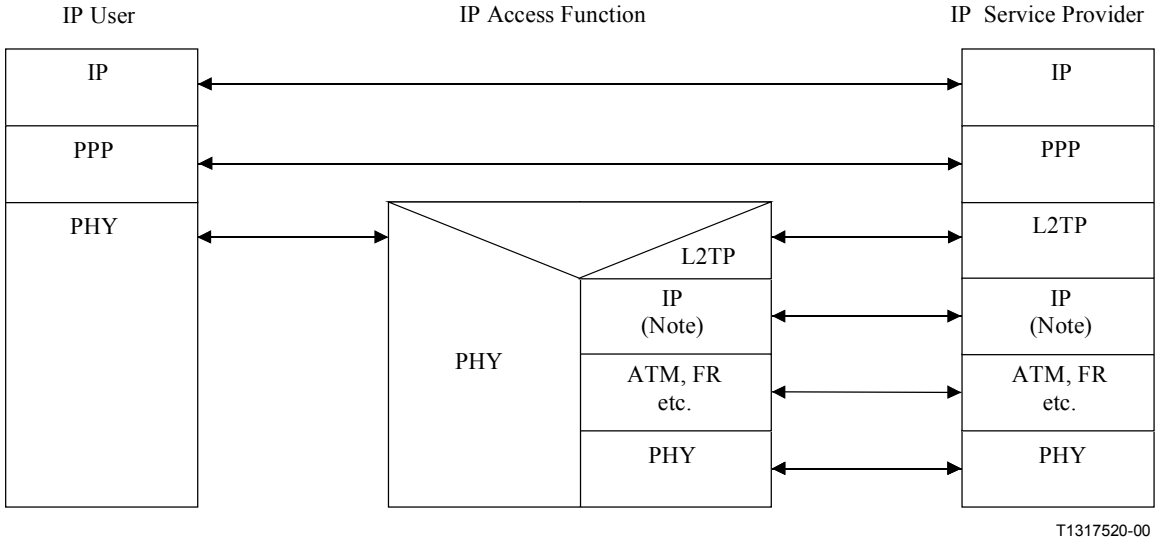


Figure 4/Y.1231 – Functional model of Layer 2 multiplexing

Case 2) PPP tunnelling (e.g. L2TP [22])

This is a case that L2TP function is used in IP access network. This functional model is shown in Figure 5.



NOTE – This IP layer provides a transport function between IP access function and IP service provider.

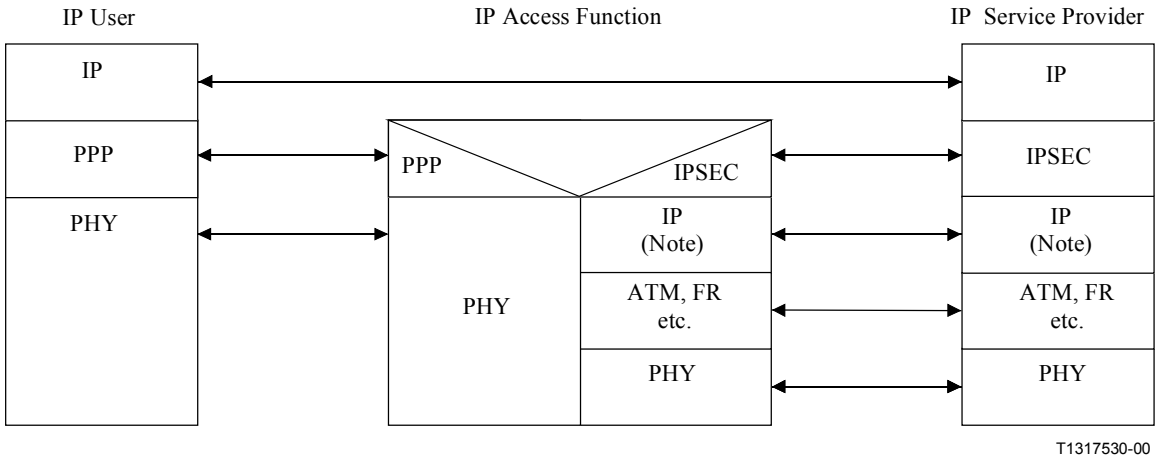
Figure 5/Y.1231 – Functional model of PPP tunnelling

5.1.2 PPP terminated aggregation

This clause gives some examples of protocol stacks for the PPP terminated aggregation. In this case, PPP is terminated in IP access network.

Case 1) IP tunnelling (e.g. IPSEC)

This is a case that IP tunnelling is used in IP access network. This functional model is shown in Figure 6.



NOTE – This IP layer provides a transport function between IP access function and IP service provider.

Figure 6/Y.1231 – Functional model of IP tunnelling

Case 2-1) Layer 3 routing (e.g. IP router)

This is a case that IP handling function such as IP router exists in IP access network. This functional model is shown in Figure 7.

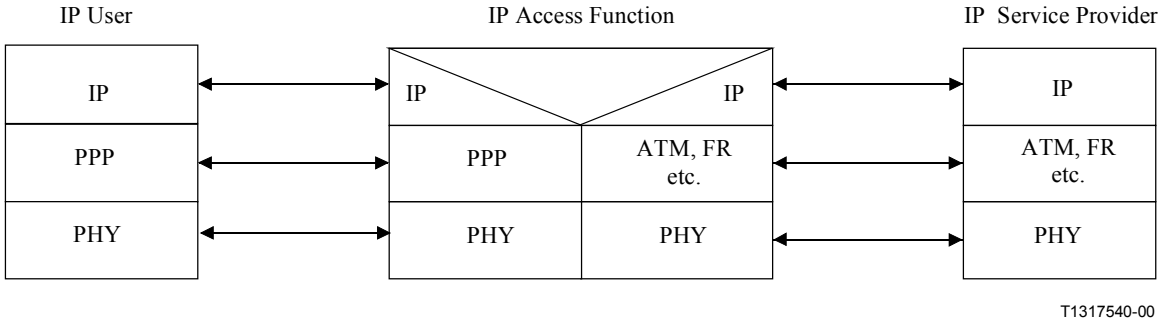


Figure 7/Y.1231 – Functional model of L3 routing

Case 2-2) Virtual router

This is also a case that IP handling function exists in IP access network. This functional model is shown in Figure 8.

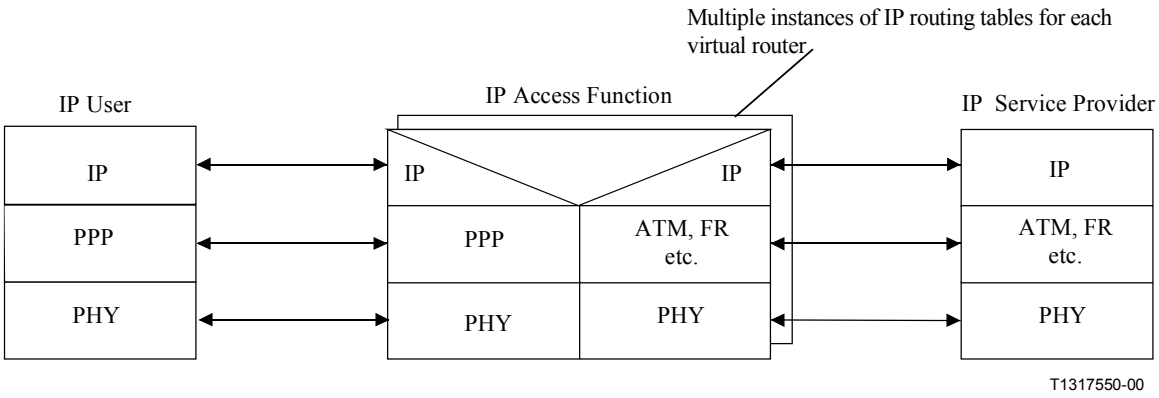


Figure 8/Y.1231 – Functional model of virtual router

Case 3) MPLS (multiprotocol label switching)

This is a case that IP transport function is translated by the lower layer such as ATM in IP access network. This functional model is shown in Figure 9. There is a case that "Label" stack is null in the user-plane, when the ATM VPI/VCIs are used as MPLS labels.

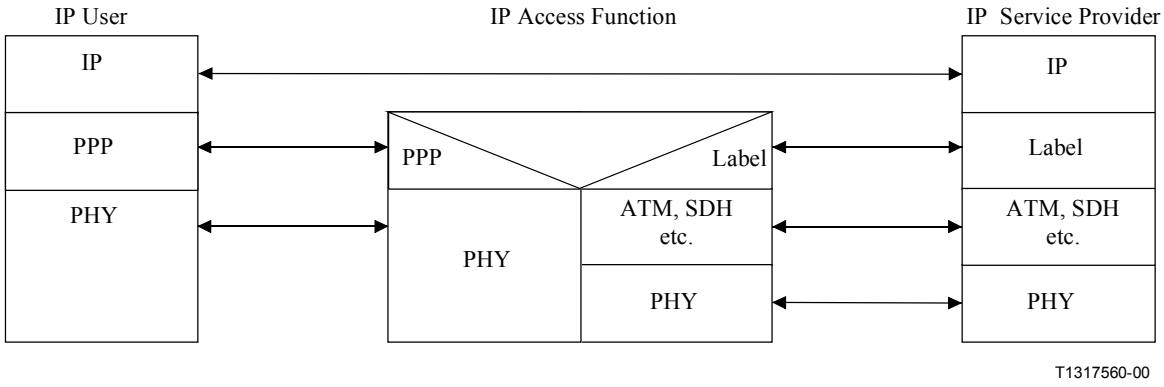


Figure 9/Y.1231 – Functional model of MPLS

5.2 Use of Ethernet

In this clause, Ethernet is an example of protocol used to carry IP over access network. Figure 10 shows examples of protocol stacks of Ethernet access.

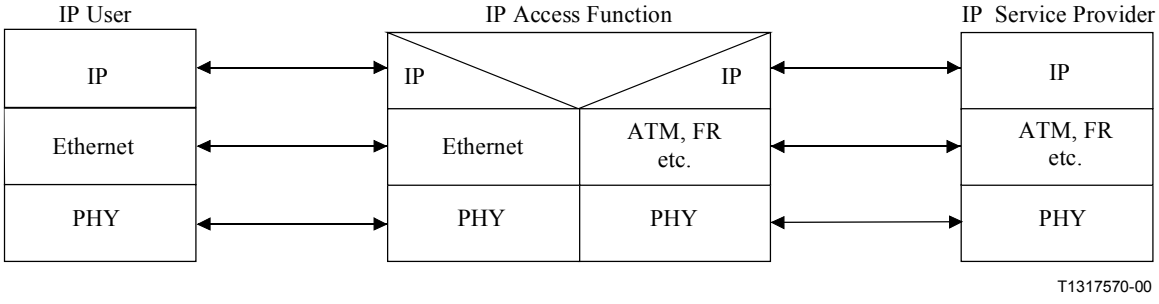


Figure 10/Y.1231 – Functional model of Ethernet use

6 Examples of access types and interfaces in IP access network

Possible transmission mechanisms for user access are shown as follows:

– ISDN:
  - Basic rate access (B/2B/D channel);
  - Primary rate (1544 kbit/s, 2048 kbit/s).
– B-ISDN access (1544 kbit/s-622 080 kbit/s).
– xDSL.
– Wireless and Satellite.
– PON, SDV, HFC and other optical systems.
– CATV access.
– LAN/WAN.

Examples of IP mapping mechanisms on each transmission system are shown in Appendix I.

An example of functional architecture of CATV access is shown in Appendix II.

Further examples and overview are described in ITU-T I.414 [3].

7 Examples of functional requirements for IP Access

Possible IP access functions are as follows:

– Dynamic selection of multiple IP service providers.
– Dynamic allocation of IP address using PPP.
– NAT.
– Authentication (PAP [13], CHAP [17]).
– Encryption.
– Billing usage metering and interaction with RADIUS [18] server.

APPENDIX I

Examples of IP mapping mechanisms

The following diagrams show protocol stacks for IP on various transmission systems. The detailed mapping mechanisms are described in the referenced documents.

I.1 IP over PPP over ATM

Figure I.1 shows IP over PPP over ATM mapping mechanism which is defined in IETF RFC 2364, "PPP over AAL5" [20].

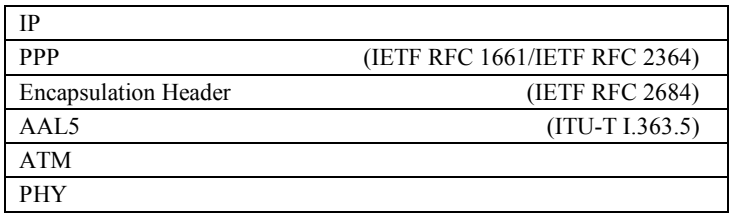


Figure I.1/Y.1231 – Mapping mechanism for IP over PPP over ATM

I.2 IP over ATM

Figure I.2 shows IP over ATM mapping mechanism which is defined in IETF RFC 2225, "Classical IP and ARP over ATM" [19].

Figure I.2/Y.1231 – Mapping mechanism for IP over ATM

I.3 IP over Frame Relay

Figure I.3 shows IP over FR mapping mechanism which is defined in IETF RFC 2427, "Multiprotocol Interconnect over Frame Relay" [21].

Figure I.3/Y.1231 – Mapping mechanism for IP over FR

I.4 IP over PPP over PHY

Figure I.4 shows PPP directly mapping to physical layer (e.g. ISDN, SDH).

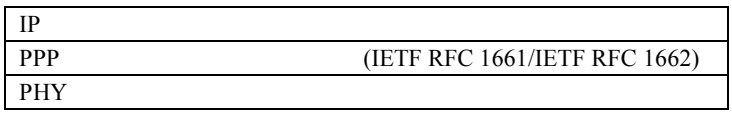


Figure I.4/Y.1231 – Mapping mechanism for IP over PPP

NOTE – Other mapping mechanisms may be used, for example to support the requirements of radio systems such as satellite systems.

I.5 IP over Ethernet

Two types of Ethernet are commonly used. Two types of IP over Ethernet mapping mechanism are defined in separate IETF documents (IETF RFC 894 [11] and IETF RFC 1042 [12]).

Figure I.5 shows IP mapping mechanism using Ethernet (IEEE 802.3 [9]/ISO|IEC 8802-2 [7]) and Figure I.6 shows IP mapping mechanism using Ethernet (IEEE 802.3 [9]/ISO|IEC 8802-2 [7]) with LLC.

Figure I.5/Y.1231 – Mapping mechanism for IP over Ethernet (IEEE 802.3/ISO|IEC 8802-2)

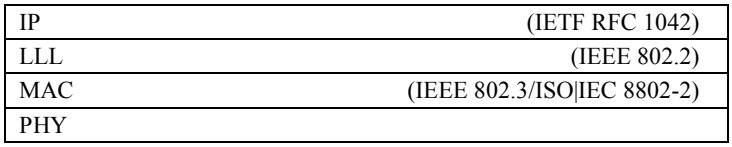


Figure I.6/Y.1231 – Mapping mechanism for IP over Ethernet (IEEE 802.3/ISO|IEC 8802-2) with LLC

I.6 IP over PPP over Ethernet

Figure I.7 shows IP over PPP over Ethernet mapping mechanism which is defined in IETF document (IETF RFC 2516 [23]).

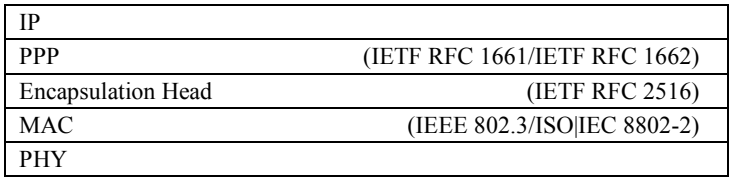
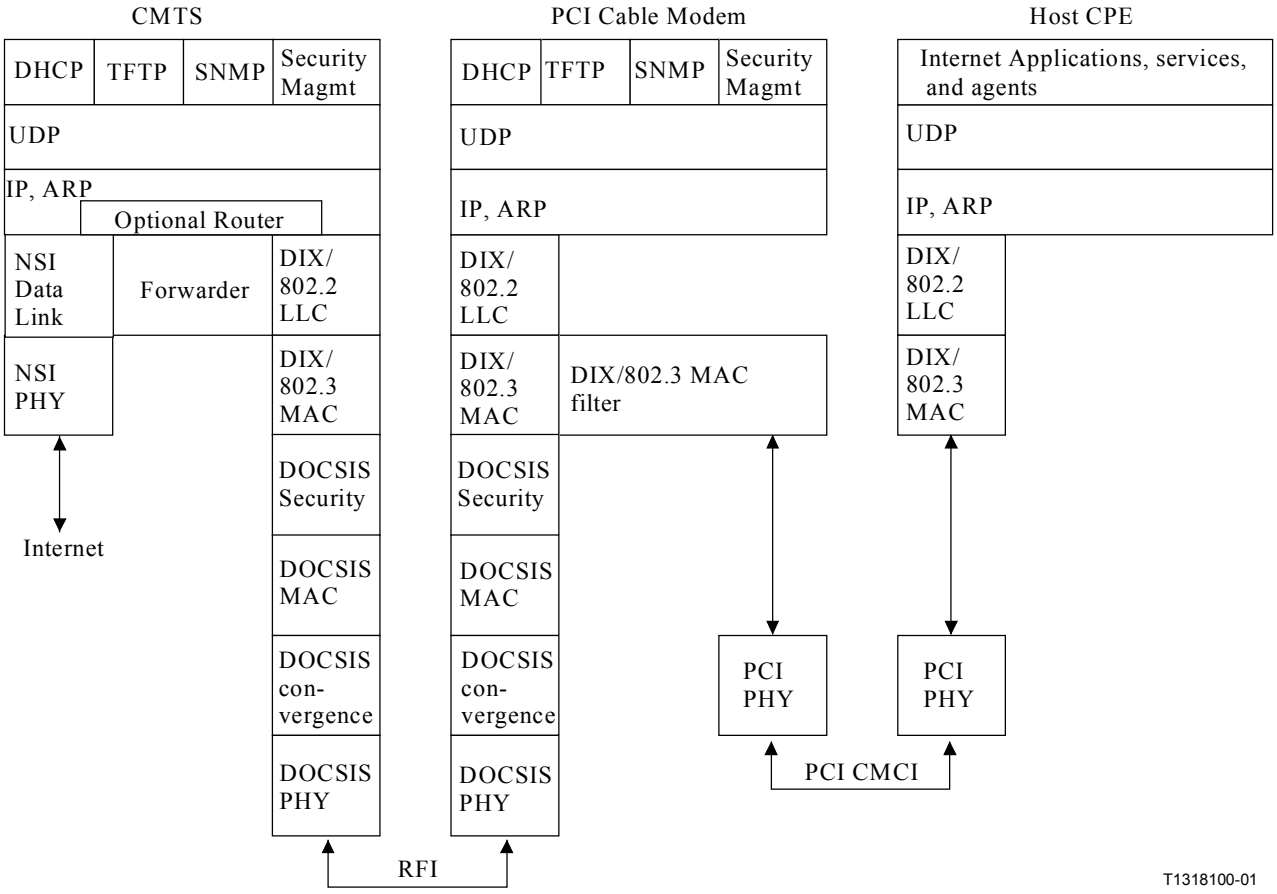


Figure I.7/Y.1231 – Mapping mechanism for IP over PPP over Ethernet

APPENDIX II

An example of functional model of CATV access

See Figure II.1.



NOTE – This figure is extracted from Cable Television Laboratores, Inc.'s specification – Data-Over-Cable Service Interface Specifications (SP-CMCI-I03-991115 [10]) in order to give an example of Ethernet use to carry IP over the access network.

Figure II.1/Y.1231 – Functional model of CATV access

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Geneva, 2001