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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Interworking

General requirements for interworking with Internet protocol (IP)-based networks

ITU-T Recommendation Y.1401

(Formerly CCITT Recommendation)

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ITU-T RECOMMENDATION Y.1401

GENERAL REQUIREMENTS FOR INTERWORKING WITH INTERNET PROTOCOL (IP)-BASED NETWORKS

Summary

This ITU-T Recommendation addresses the framework architecture for interworking of IP-based networks with non-IP networks. The service plane concept applied for interworking is defined in terms of both service and network interworking. General interworking scenarios for service interworking and network interworking are also identified. Details of the interworking model and required interworking functions are described for the case of B-ISDN, N-ISDN or PSTN interworking with IP-based networks.

Source

ITU-T Recommendation Y.1401 was prepared by ITU-T Study Group 13 (1997-2000) and approved by the World Telecommunication Standardization Assembly (Montreal, September 27-October 6, 2000).

Keywords

B-ISDN, Interworking, IP, N-ISDN, Network, PSTN, Service Plane, Transfer Capability.

FOREWORD

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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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CONTENTS

Introduction

There is a need to define comprehensive requirements of interworking between IP-based networks and non-IP-based, i.e. telecommunications, networks. Thus, there is a need to provide a framework architecture of incorporating IP-based networks into telecommunications and the detailed requirements for IP interworking. One of the key aspects of network interworking is to provide network support for IP-based services during the evolution of networks. It is axiomatic that networks will evolve and interwork to support the demand. It may be argued that service interworking between services on telecommunications networks and services supported on IP-based networks has higher priority than network interworking.

Recommendation Y.1401

GENERAL REQUIREMENTS FOR INTERWORKING WITH INTERNET PROTOCOL (IP)-BASED NETWORKS

1 Scope

This Recommendation focuses on required functions of interworking between different services provided by IP-based networks and N-ISDN, PSTN or B-ISDN, i.e. service interworking, and network interworking between IP-based networks and N-ISDN, PSTN or B-ISDN. However, the main emphasis is on the service interworking aspects.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference 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.

[1] ITU-T Recommendation G.707 (1996), *Network node interface for the synchronous digital hierarchy (SDH)*.

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

[3] ITU-T Recommendation H.323 (1999), *Packet-based multimedia communications systems*.

[4] ITU-T Recommendation I.112 (1993), *Vocabulary of terms for ISDNs*.

[5] ITU-T Recommendation I.120 (1993), *Integrated services digital networks (ISDNs)*.

[6] ITU-T Recommendation I.210 (1993), *Principles of telecommunication services supported by an ISDN and the means to describe them*.

[7] ITU-T Recommendation I.311 (1996), *B-ISDN general network aspects*.

[8] ITU-T Recommendation I.313 (1997), *B-ISDN network requirements*.

[9] CCITT Recommendation I.321 (1991), *B-ISDN protocol reference model and its application*.

[10] ITU-T Recommendation I.325 (1993), *Reference configurations for ISDN connection types*.

[11] CCITT Recommendation I.340 (1988), *ISDN connection types*.

[12] ITU-T Recommendation I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDNs*.

[13] ITU-T Recommendation I.355 (1995), *ISDN 64 kbit/s connection type availability performance*.

[14] ITU-T Recommendation I.510 (1993), *Definitions and general principles for ISDN interworking*.

[15] ITU-T Recommendation I.570 (1993), *Public/private ISDN interworking*.

[16] ITU-T Recommendation I.580 (1995), *General arrangements for interworking between B-ISDN and 64 kbit/s based ISDN*.

[17] ITU-T Recommendation I.581 (1997), *General arrangements for B-ISDN interworking*.

[18] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[19] ITU-T Recommendation Y.1241 (2001), *Support of IP based services using IP transfer capabilities*.

[20] ITU-T Recommendation Y.1310 (2000), *Transport of IP over ATM in public networks*.

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

3 Definitions

This Recommendation defines the following terms:

3.1 Service Plane: The service plane comprises:

a) service presentation functionality being presented to the end user;

b) service implementation aspects with which the end user interacts. For example, service invocation, control service level agreement function, etc.

Note that a) and b) use the totality of the transfer capabilities including control and management functionalities.

3.2 IP-based service: An IP-based service is defined as the functions, facilities, and capabilities implemented and executed above IP network services. It utilizes the IP Transfer Capabilities offered by a network provider.

3.3 IP Network Service: An IP Network Service is defined as a data transmission service in which the data passed across the interface between the user and provider is transferred in the form of Internet Protocol (IP) packets (sometimes called datagrams). IP Network Service includes the service provided by using the IP Transfer Capabilities.

3.4 IP transfer capability: IP Transfer Capability is defined as the set of network capabilities provided by the IP layer. It may be characterized by the traffic contract as well as performance attributes supported by control and management functions of the underlying protocol layers.

3.5 Service Level Agreement (SLA): A negotiated agreement between an end user and the service provider. Its significance varies depending on the service offerings. The SLA may include a number of attributes such as, but not limited to, traffic contract, availability, performance, encryption, authentication, pricing and billing mechanism, etc.

3.6 IP-based network: A network in which IP is used as one of the Layer 3 protocols.

4 Abbreviations

This Recommendation uses the following abbreviations.

AF Additional Function

AN Access Network

ATM Asynchronous Transfer Mode

FTP File Transfer Protocol

IWF InterWorking Function

LC Line Connection

PCI Protocol Control Information

PDU Protocol Data Unit

PRM Protocol Reference Model

SAP Service Access Point

SDU Service Data Unit

SLA Service Level Agreement

SN Service Node (defined in Recommendation G.902)

WDM Wave Division Multiplexing

5 Service and network interworking

5.1 Service Plane Concept for Interworking

The concept of "Service Plane", is used in this ITU-T Recommendation in describing the interworking scenarios. Figure 1 illustrates the service plane concept applied for interworking.

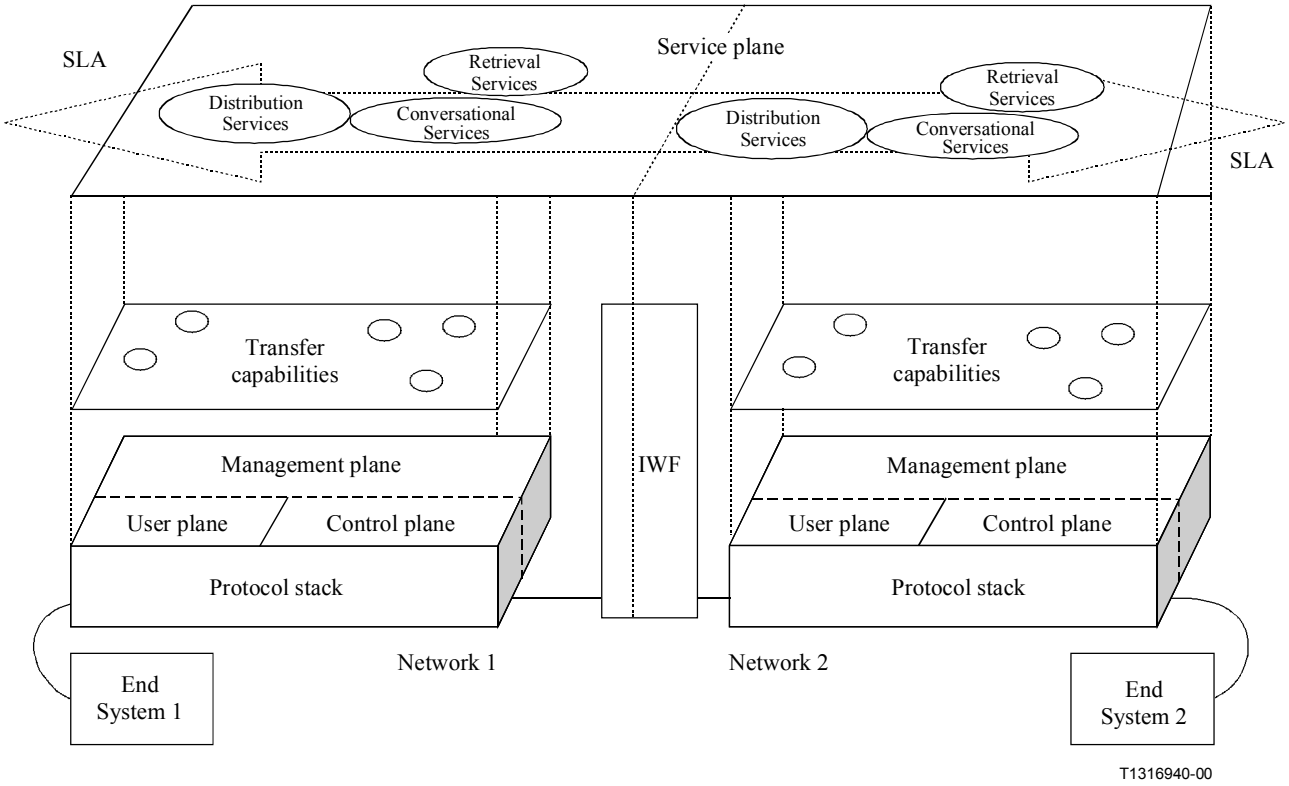


Figure 1/Y.1401 – Service Plane for Interworking

The service plane concept allows use of IP transfer capabilities along with control and management related capabilities in the construction of services, as may be specified within an overall Service Level Agreement (SLA) between service provider and the end user. The service plane utilizes the capabilities provided by the underlying transfer functions, as well as the control and management plane functions. Consequently the service plane incorporates more than just a layer service as defined in a Service Access Point (SAP) in the protocol stack.

The interworking function (IWF) deals with the processing of the protocol layer functions in order to support the service across different networks. For some services there is also the case in which the IWF deals with interworking between the application layer functions.

5.2 Service Interworking

In service interworking, the IWF of Figure 1 terminates the protocol used in network 1 and translates (i.e. mapping) the Protocol Control Information (PCI) to the PCI of the protocol used in network 2 for User, Control and Management Plane functions to the extent possible. In general, since not all functions may be supported in one or other of the networks, the translation of PCI may be partial or non-existent. However, this should not result in any loss of user data since the payload is not affected by PCI conversion at the service interworking IWF.

5.3 Network Interworking

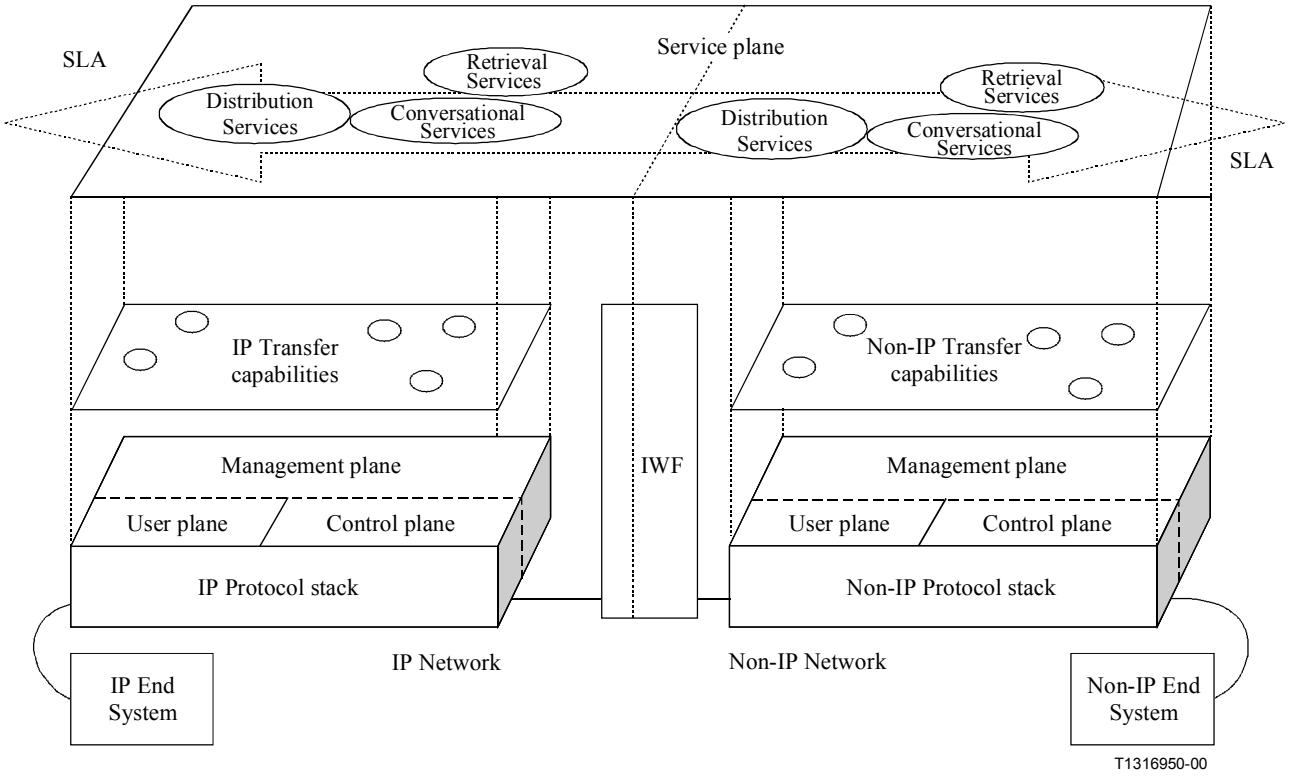
In network interworking, the PCI of the protocol used in network 1 and network 2 and the payload information are transferred transparently by an IWF of Figure 1. Typically the IWF encapsulates (known as tunnelling in some specifications) the information which is transmitted by means of an adaptation function and transfers it transparently to the other network.

5.4 Scenarios for interworking with IP-based networks

In this subclause, a few scenarios for interworking with IP-based networks are described, based on the general model shown in Figure 1.

5.4.1 Scenario I: Service Interworking between an IP-based network and a non-IP network

Figure 2 is a case of Figure 1 in which one of the two networks is a non-IP (either B-ISDN, N-ISDN or PSTN) network and the other is an IP-based network.



NOTE – In most cases the IWF will include application-layer interworking such as media conversion.

Figure 2/Y.1401 – Service Interworking between an IP-based network and a non-IP network

5.4.2 Scenario II: Network Interworking between IP Networks via a non-IP network

Figure 3 describes the scenario in which a non-IP network is between two IP-based networks. In this scenario, two IP end systems are connected to the IP networks, while the network in the middle is a non-IP. The non-IP network is either a B-ISDN, N-ISDN or PSTN.

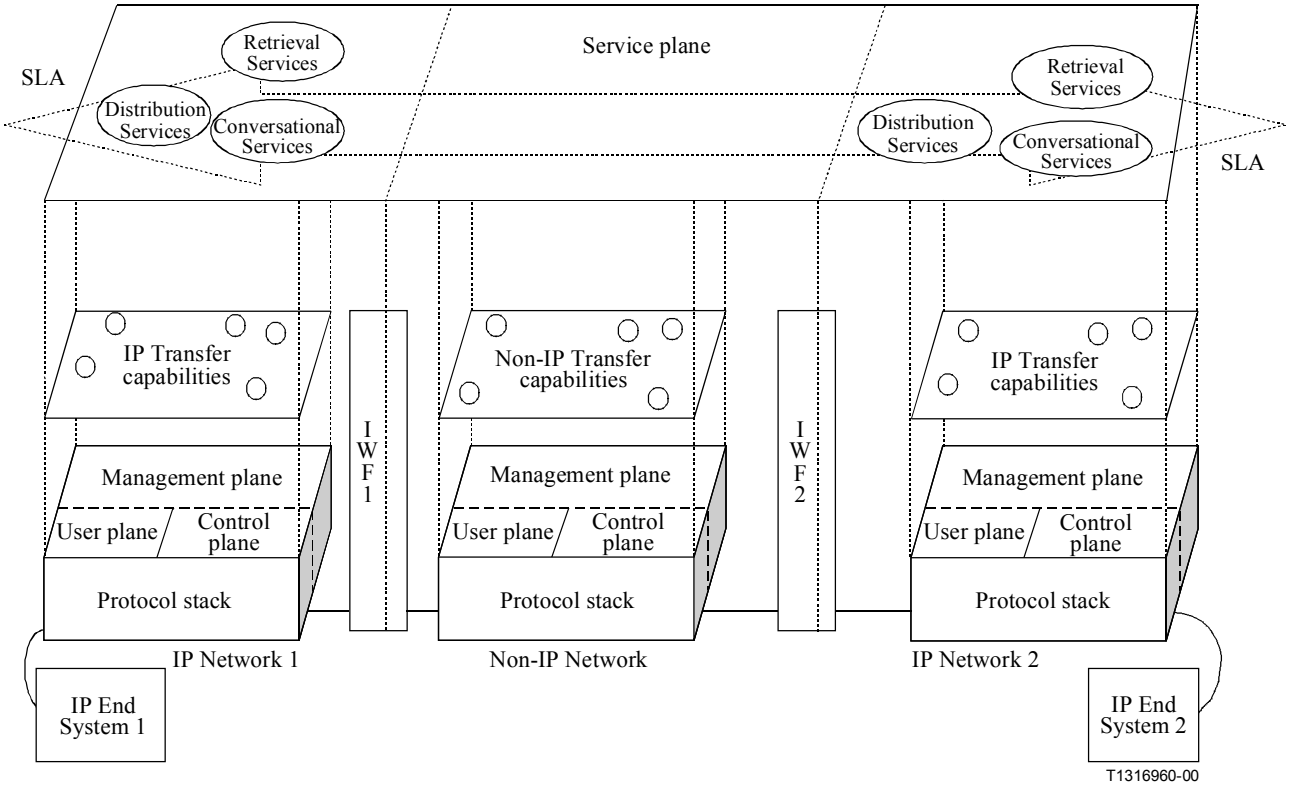


Figure 3/Y.1401 – Network Interworking between IP Networks via a non-IP network

5.4.3 Scenario III: Network Interworking between non-IP networks via an IP-based network

Figure 4 describes the scenario in which an IP-based network is between two non-IP networks. In this scenario, two end systems are connected to the non-IP networks. The non-IP networks are either B-ISDN, N-ISDN or PSTN.

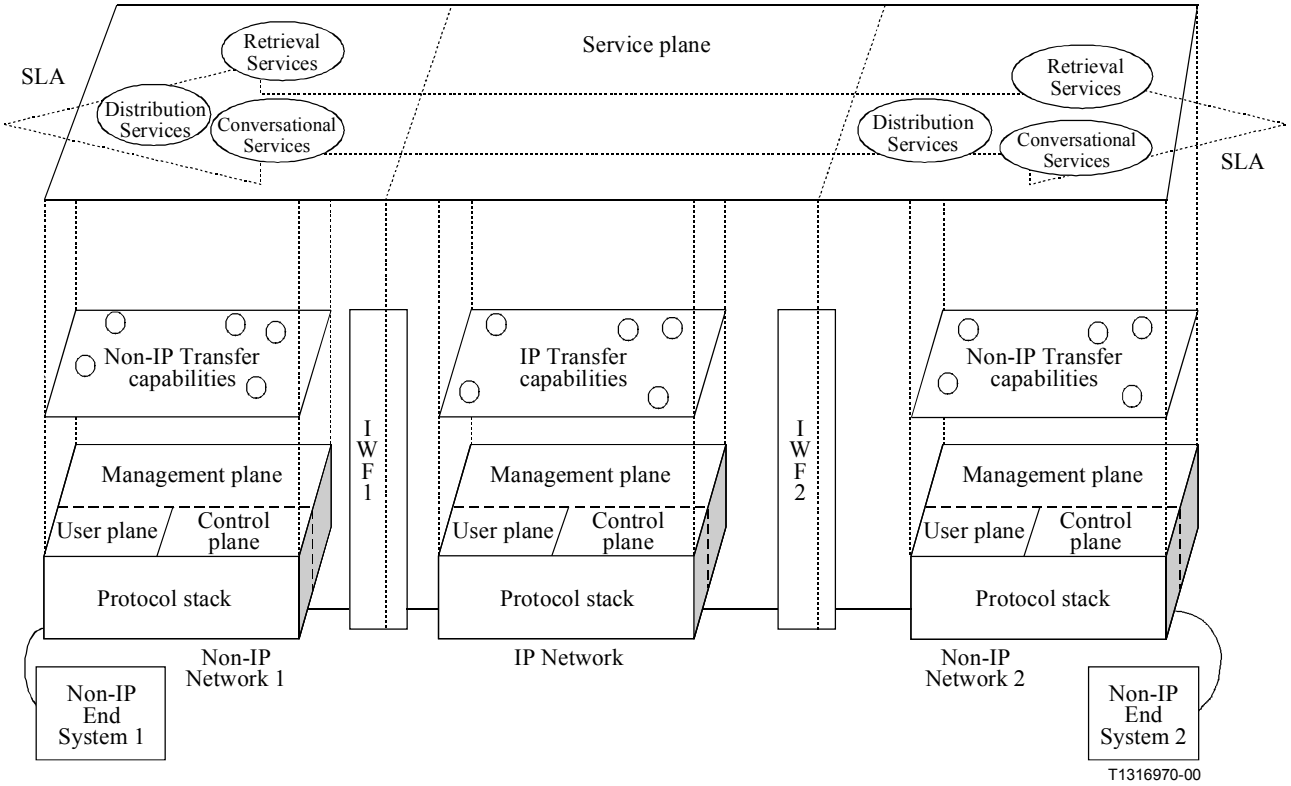


Figure 4/Y.1401 – Network Interworking between non-IP networks via an IP-based network

6 Interworking between B-ISDN and IP-based Networks

6.1 Interworking Scenarios

6.1.1 General considerations

In this subclause interworking between B-ISDN and IP-based networks is being considered. The following interworking scenarios are identified:

- Scenario I is a direct interconnection between B-ISDN and IP-based networks.
- Scenario II is a network concatenation interworking in which IP-based networks are connected via B-ISDN.
- Scenario III is a network concatenation interworking in which B-ISDNs are connected via IP-based networks.

6.1.2 Layered model for IP-based networks

In general, a layered model is used to describe the function of the layers and the relationship between the layers. Each layer has its own specific function and provides capabilities to its upper layer. In this model Additional Function (AF) may exist between IP and existing telecommunication networks such as Frame Relay (FR), ATM, SDH, etc. AF provides appropriate means to convey IP datagrams over the underlying transport layer. Layered model of IP-based network is shown in Figure 5.

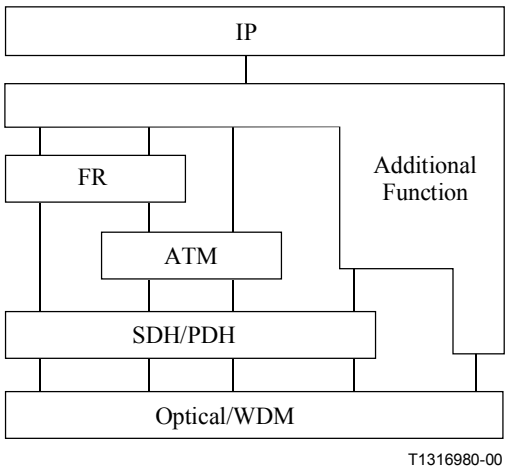


Figure 5/Y.1401 – Layered model of IP-based network

6.1.3 General interworking cases of IP-based network

Based on the layered model as described in 6.1.2, general interworking cases can be identified as follows, shown in Figure 6:

- Case 1: FR is used as the transport for interworking with B-ISDN.
- Case 2: ATM is used as the transport for interworking with B-ISDN.
- Case 3: SDH is used as the transport for interworking with B-ISDN.
- Case 4: WDM is used as the transport for interworking with B-ISDN.

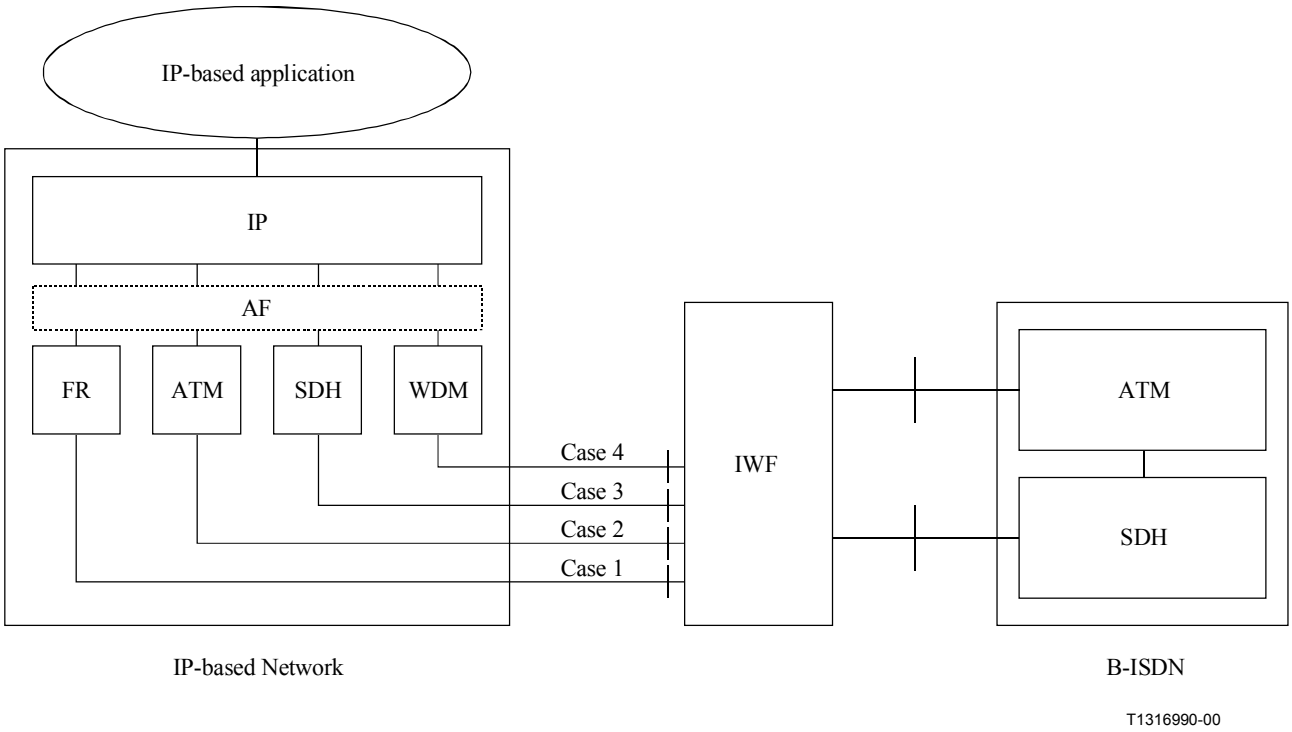


Figure 6/Y.1401 – General interworking cases of IP-based network

From the above cases, scenarios of network interworking and service interworking can be identified. The IWF can be shown as illustrated in Figure 7. In IP-based network side of the IWF, each layer terminates its own functions supported as transport layer for carrying IP packet transparently in telecommunication networks such as FR, ATM, etc.

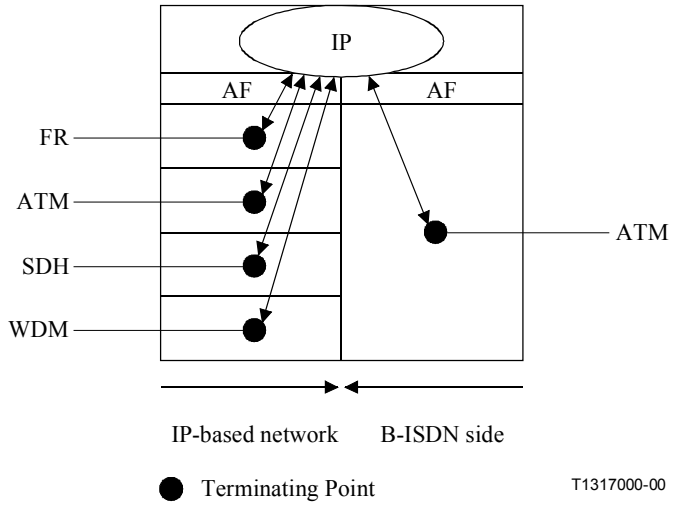


Figure 7/Y.1401 – Functional architecture of IWF

6.2 Service Interworking

From application point of view, service interworking takes place between IP-based services and telecommunication services. Currently, voice, fax and messaging services are dominant in IP-based services. These services mainly make use of IP transfer capabilities. Some services may require network capabilities related to control and management function as well as user plane functions for interworking.

Figure 8 shows the possible services that may use IP-based service interworking.

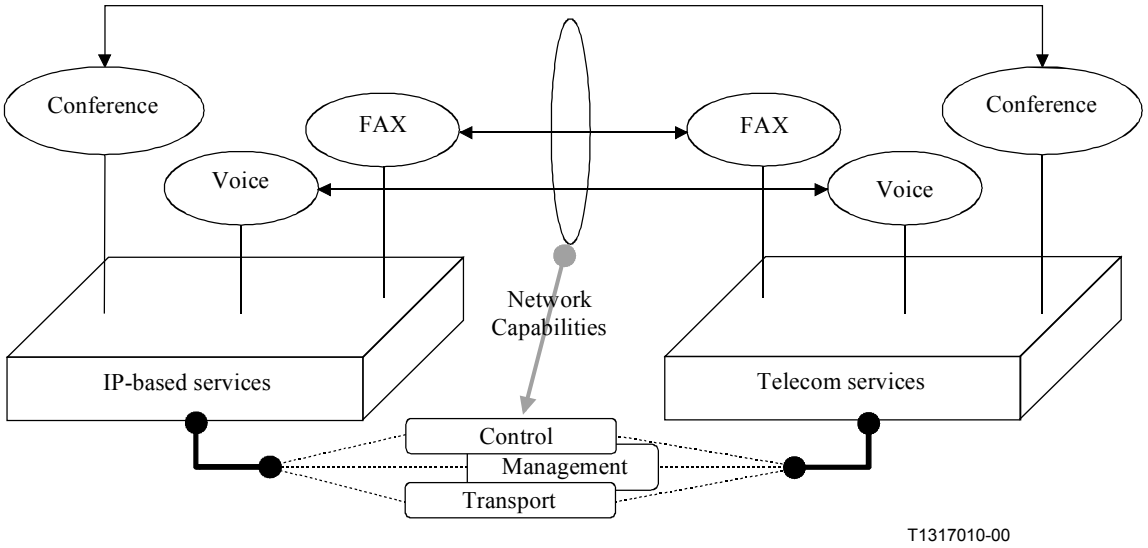


Figure 8/Y.1401 – IP-based service interworking

Figure 9 shows an example of service interworking scenarios using network IWF and Gateway IWF. In this figure, it is required to use network interworking functions among transport networks. Gateway IWF is used to process the service specific functions.

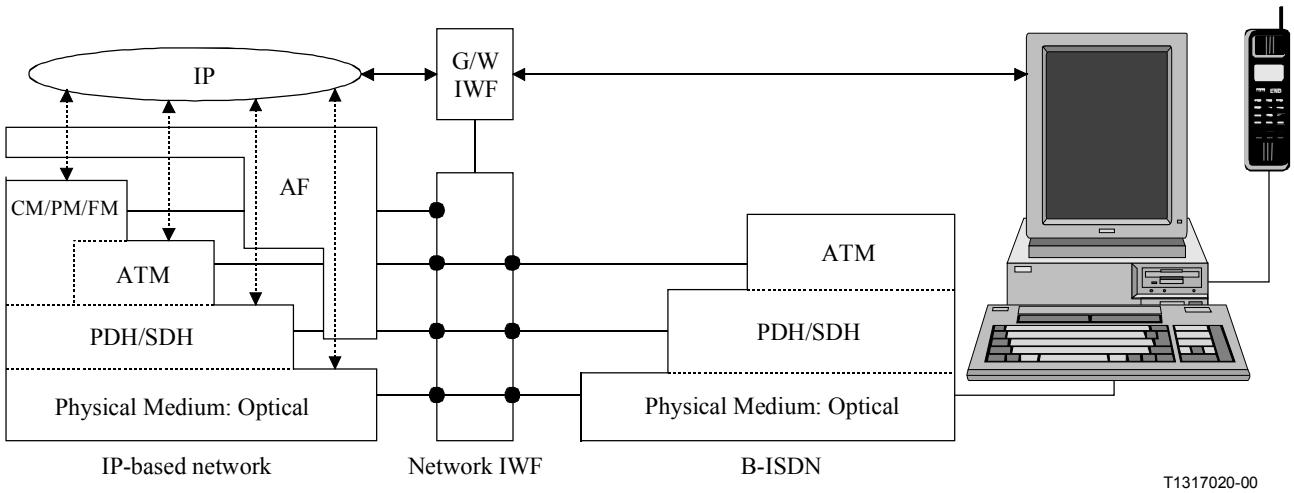
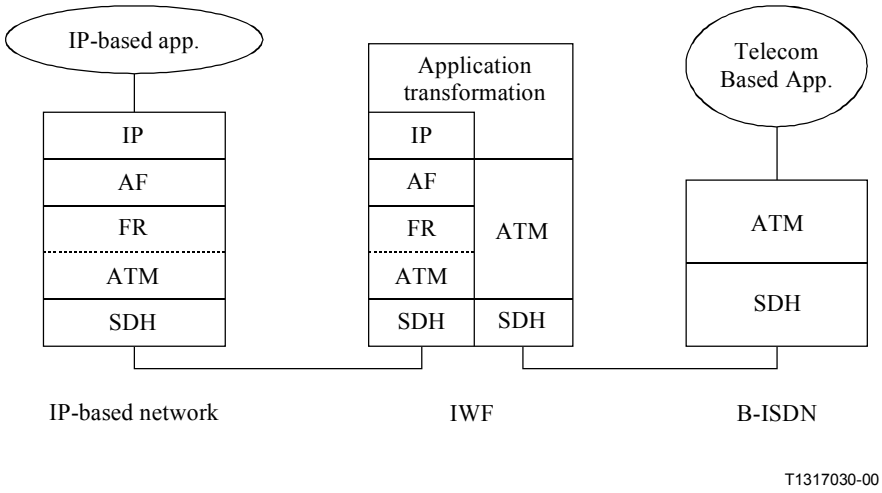


Figure 9/Y.1401 – Example of service interworking scenario

Service interworking may be used for such services as IP voice, IP FAX, IP conference, IP distance learning, IP catalogue shopping and IP video on demand to similar services supported in B-ISDN. Network interworking function is required for all these cases.

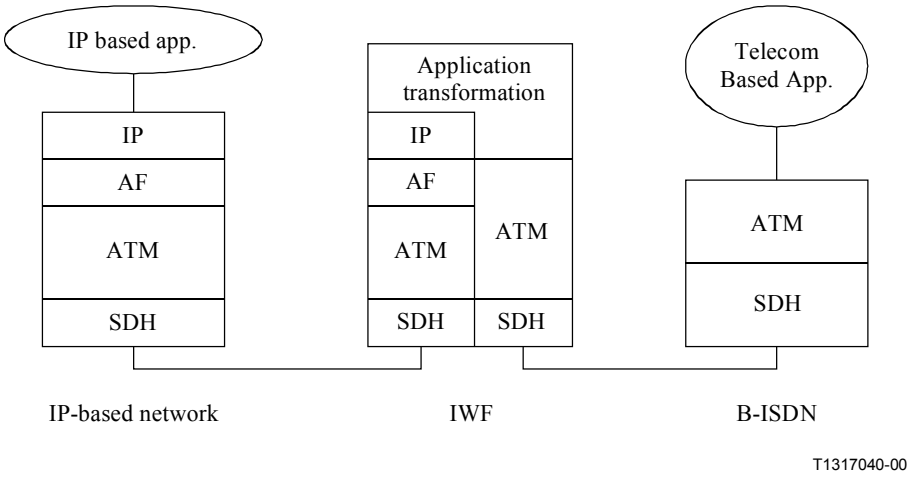
Protocol stacks of service interworking are shown in Figures 10 to 13 in case of each interworking scenario of 6.1.1.

IWF for service interworking has transformation function, which depends on whether the types of services are the same or not. In the same types of services, media transformation is used as transformation function and, in case of the different types of services such as voice-to-text messaging, application transformation is used as transformation function.



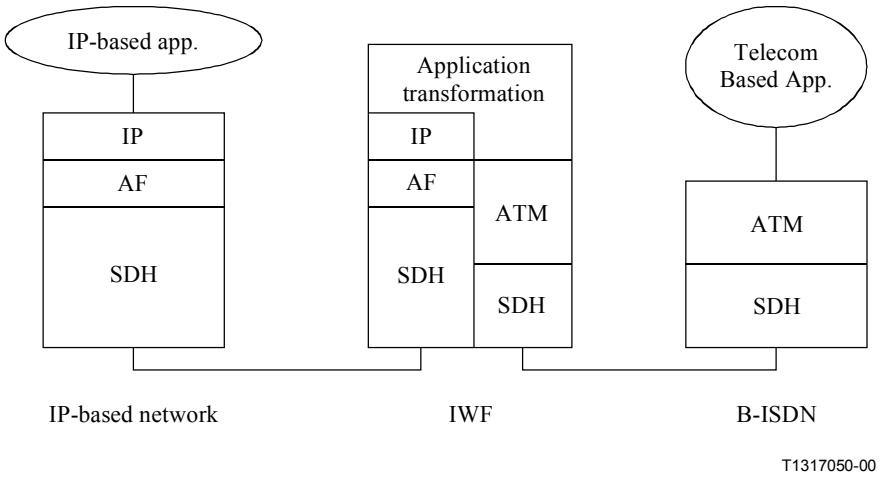
NOTE – AF is additional function which is used for IP over FR (encapsulation of IP packet into FR).

Figure 10/Y.1401 – Protocol stack of service interworking case 1



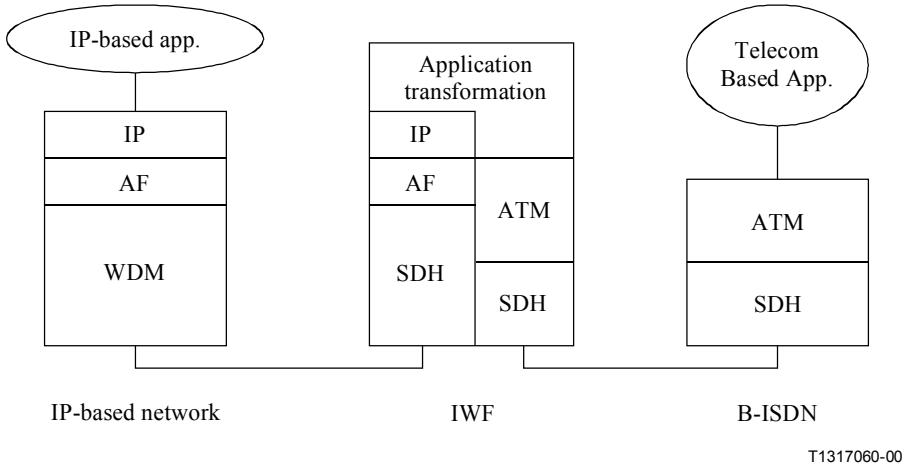
NOTE – AF is additional function which is used for IP over ATM (specified in Recommendation Y.1310).

Figure 11/Y.1401 – Protocol stack of service interworking case 2



NOTE – AF is additional function which is used for IP over SDH (specified in Recommendation G.707).

Figure 12/Y.1401 – Protocol stack of service interworking case 3

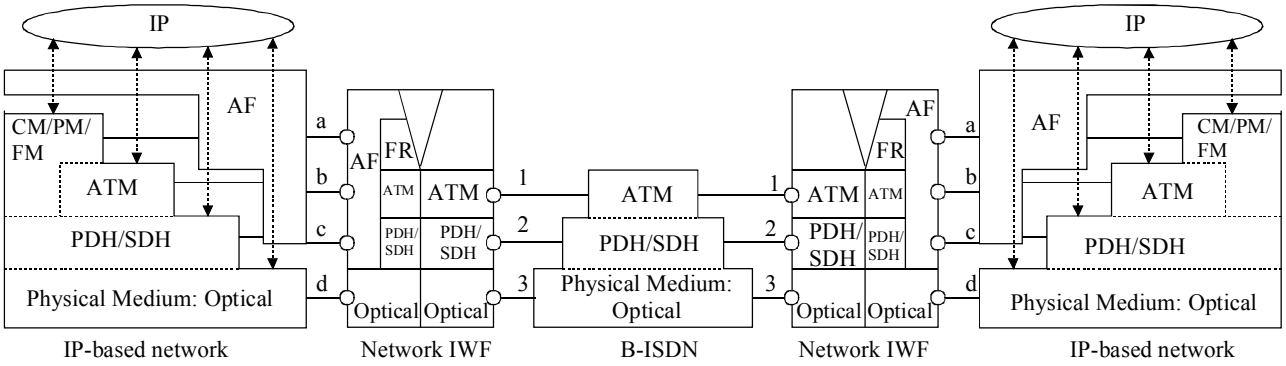


NOTE – AF is additional function which is used for IP over WDM.

Figure 13/Y.1401 – Protocol stack of service interworking case 4

6.3 Network Interworking

Figure 14 describes relationship between different layers for network interworking between IP-based network and B-ISDN for scenario II as described in clause 5. Required functionalities of IWF may be identical to the case of scenario III of clause 5.

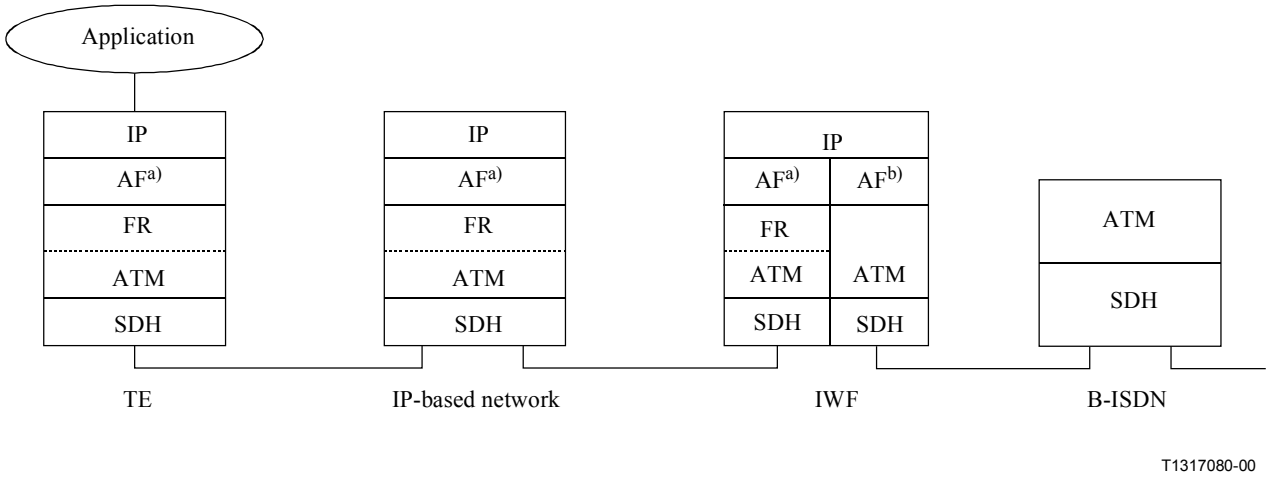


NOTE 1 – (a, b, c, d) and (1, 2, 3) indicate the terminating level of protocols in the network IW.

NOTE 2 – AF indicates possible additional function.

Figure 14/Y.1401 – Network interworking scenarios in case of scenario II of communication scenario model

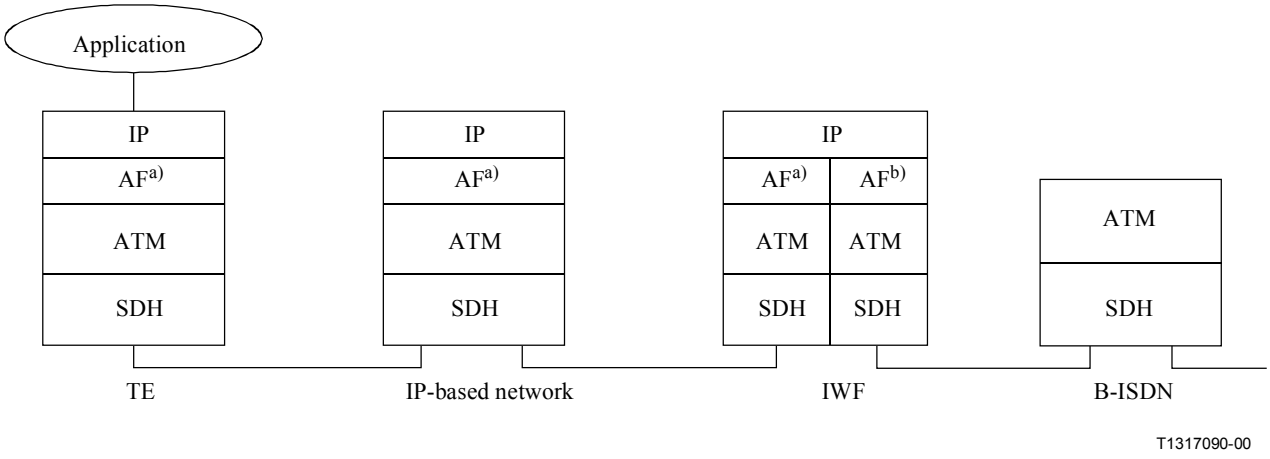
Protocol stacks of network interworking are shown in Figures 15 to 18 in case of each interworking cases of 6.1.3.



[a)] AF is additional function which is used for IP over FR (encapsulation of IP packet into FR).

[b)] AF is additional function which is used for IP over ATM (specified in e.g. RFC 2684).

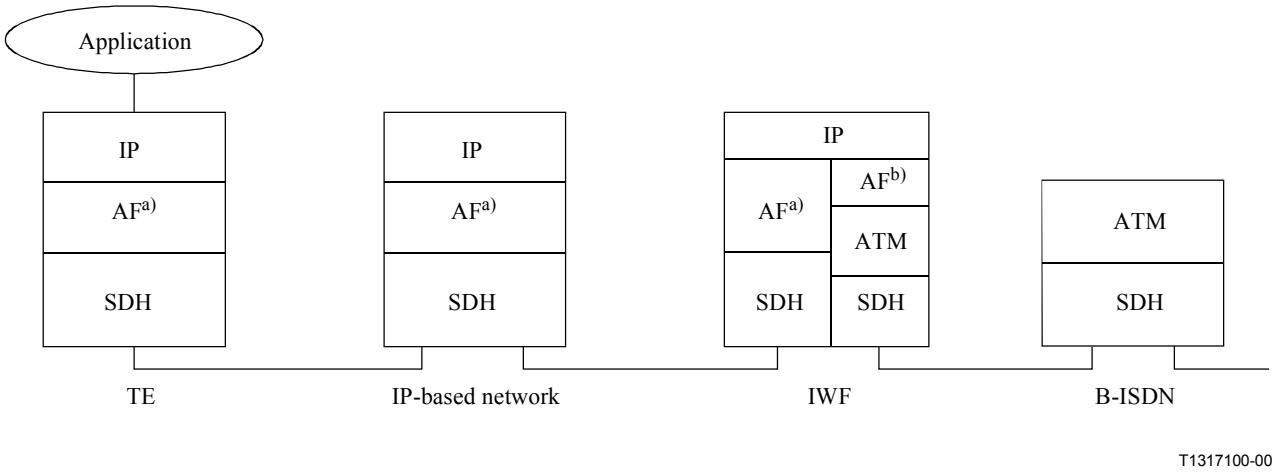
Figure 15/Y.1401 – Protocol stack of network interworking case 1



a) AF is additional function which is used for IP over ATM (specified in Recommendation Y.1310).

b) AF is additional function which is used for IP over ATM (specified in e.g. RFC 2684).

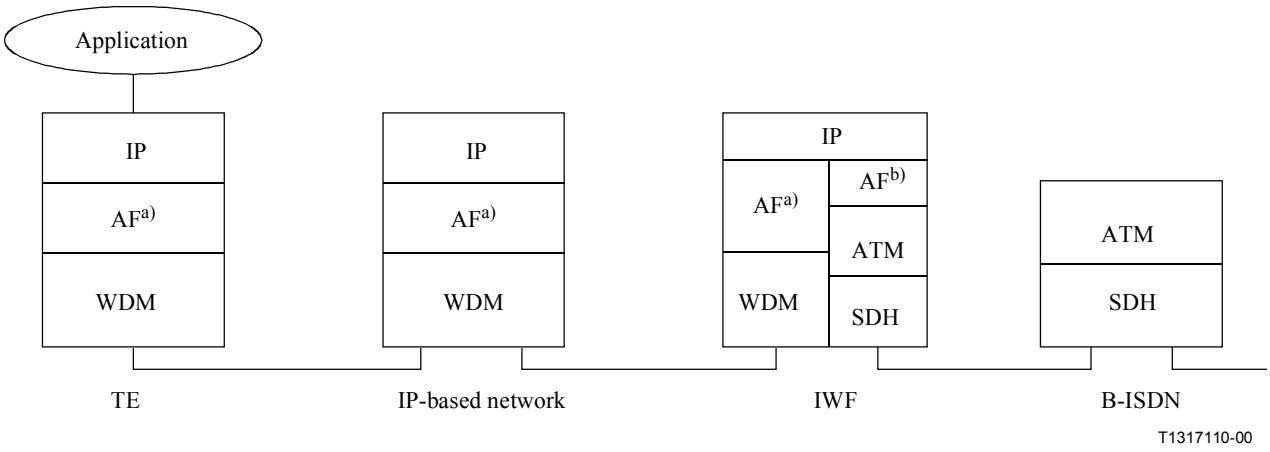
Figure 16/Y.1401 – Protocol stack of network interworking case 2



a) AF is additional function which is used for IP over SDH (specified in Recommendation G.707).

b) AF is additional function which is used for IP over ATM (specified in e.g. RFC 2684).

Figure 17/Y.1401 – Protocol stack of network interworking case 3



[a)] AF is additional function which is used for IP over WDM.

[b)] AF is additional function which is used for IP over ATM (specified in e.g. RFC 2684).

Figure 18/Y.1401 – Protocol stack of network interworking case 4

6.4 Requirements of Interworking Functions

6.4.1 User Plane's requirements

The user plane requirements are:

- Protocol conversion
  Including voice/video coding mapping especially in the case of service interworking;
- Encapsulation;
- QoS/Transfer capabilities mapping;
- Traffic management.

6.4.2 Control Plane's requirements

The Control plane requirements are:

- Signalling messages mapping;
- Numbering/addressing;
- Routing.

6.4.3 Management Plane's requirements

The Management plane requirements are:

- Resource management;
- OAM mapping;
- Billing.

7 Interworking between N-ISDN or PSTN and IP-based Networks

7.1 Interworking Scenarios

7.1.1 General considerations

In this subclause interworking between N-ISDN or PSTN and IP-based networks is being considered in the same way as 6.1.1 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

7.1.2 Layered model for IP-based networks

Same as 6.1.2 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

7.2 Service Interworking

Same as 6.2 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

7.3 Network Interworking

When establishing a call, a two-stage selection is required in accordance with 6.1.2/I.510. First, a bearer connection is established through the ISDN to the end system within IP-based network. Second, a logical connection is established between the calling terminal and the end system.

The general arrangements are depicted in Figure 19.

Figure 19/Y.1401 – General arrangement for ISDN and IP-based network interworking

7.4 Requirements of Interworking Functions

7.4.1 User Plane's requirements

Same as 6.4.1 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

7.4.2 Control Plane's requirements

Same as 6.4.2 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

7.4.3 Management Plane's requirements

Same as 6.4.3 with changing *B-ISDN* to *N-ISDN* or *PSTN*.

8 Bibliography

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Geneva, 2001