INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Y.1241

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(03/2001)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

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

Support of IP-based services using IP transfer capabilities

ITU-T Recommendation Y.1241

(Formerly CCITT Recommendation)

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	**Y.1200–Y.1299**
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation Y.1241

Support of IP-based services using IP transfer capabilities

Summary

This Recommendation classifies IP-based services, introduces the concept of the IP service plane and presents resulting IP transfer capability attributes. This Recommendation describes the service level agreement and identifies the range of SLA attributes to be considered.

Source

ITU-T Recommendation Y.1241 was prepared by ITU-T Study Group 13 (2001-2004) and approved under the WTSA Resolution 1 procedure on 1 March 2001.

Keywords

ATM, B-ISDN, Interworking, IP, Network, PSTN, Service Plane, Service Level Agreement (SLA), Transfer Capability.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T 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 World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

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.1241

Support of IP-based services using IP transfer capabilities

1 Scope

This Recommendation specifies:

– service plane concept for IP-based services;

– support of IP-based services by ATM;

– attributes for IP transfer capabilities to support IP-based services;

– service level agreement for IP-based services.

By introducing the concept of the service plane, the possible sets of attributes for IP transfer capabilities to support the IP-based services are given.

Figure 1 shows the relationship of this Recommendation with related IP Recommendations.

IP-based services may be supported on IP above any layer 1 and layer 2 transport capable of supporting IP. While Figure 1 shows ATM as the transport mechanism, other underlying transfer mechanisms can be used to provide the same IP-based services. The use of IP over these other transfer mechanisms is described in other Recommendations.

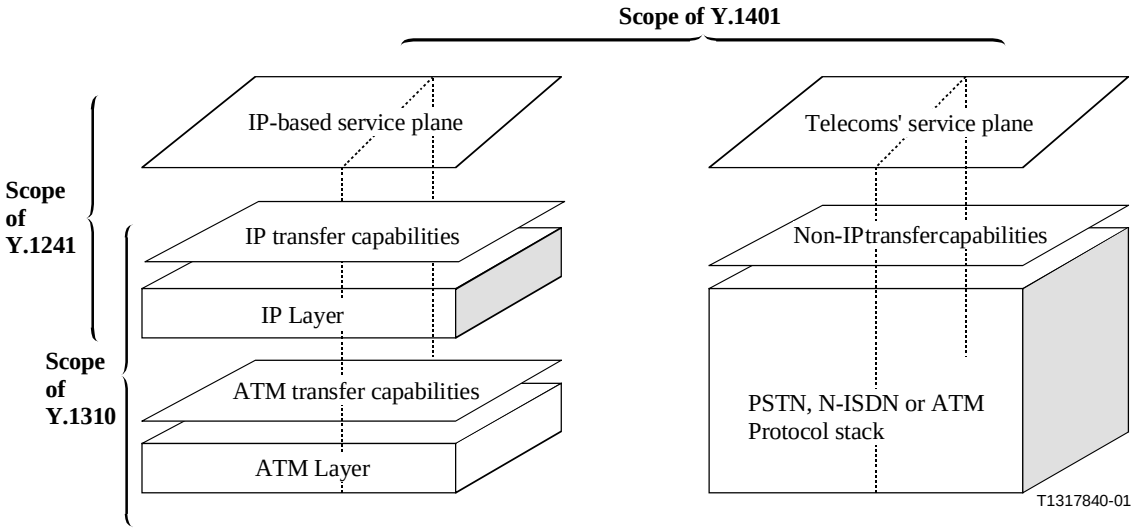


Figure 1/Y.1241 – Relationship of IP-based services transport and interworking Recommendations

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; 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 I.211 (1993), *B-ISDN service aspects.*

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

[3] ITU-T I.321 (1991), *B-ISDN protocol reference model and its application.*

[4] ITU-T I.327 (1993), *B-ISDN functional architecture.*

[5] ITU-T I.371 (2000), *Traffic control and congestion control in B-ISDN.*

[6] ITU-T I.414 (1997), *Overview of Recommendations on layer 1 for ISDN and B-ISDN customer access.*

[7] ITU-T Y.1310 (2000), *Transport of IP over ATM in Public Networks.*

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

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

[10] ITU-T Y.1231 (2000), *IP access network architecture.*

[11] ITU-T G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy* (SDH).

[12] ITU-T I.371.1 (2000), *Guaranteed frame rate ATM transfer capability.*

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 a service provided by the service plane to an end user (e.g. a host (end system) or a network element) and which utilizes the IP transfer capabilities and associated control and management functions, for delivery of the user information specified by the service level agreements.

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 IP (Internet Protocol) 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: Service Level Agreement (SLA) is a negotiated agreement between a customer and the service provider on levels of service characteristics and the associated set of metrics. The content of SLA varies depending on the service offering and includes the attributes required for the negotiated agreement.

4 Abbreviations

This Recommendation uses the following abbreviations:

ABR	Available Bit Rate
ABT	ATM Block Transfer
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
CoS	Class of Service
CPN	Customer Premises Network
DBR	Deterministic Bit Rate
FTP	File Transfer Protocol
GFR	Guaranteed Frame Rate
IP	Internet Protocol
IP-NE	IP Network Element
IP-TE	IP Terminal Equipment
IPTC	IP Transfer Capability
LAN	Local Area Network
MPLS	Multi-Protocol Label Switch
OAM	Operation, Administration and Maintenance
QoS	Quality of Service
SAP	Service Access Point
SBR	Statistical Bit Rate
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
SLO	Service Level Objective
SVC	Switched Virtual Circuit
TCP	Transmission Control Protocol
UDP	User Data Protocol
UNI	User Network Interface
VoD	Video-on-Demand
WWW	World Wide Web

5 IP-based service

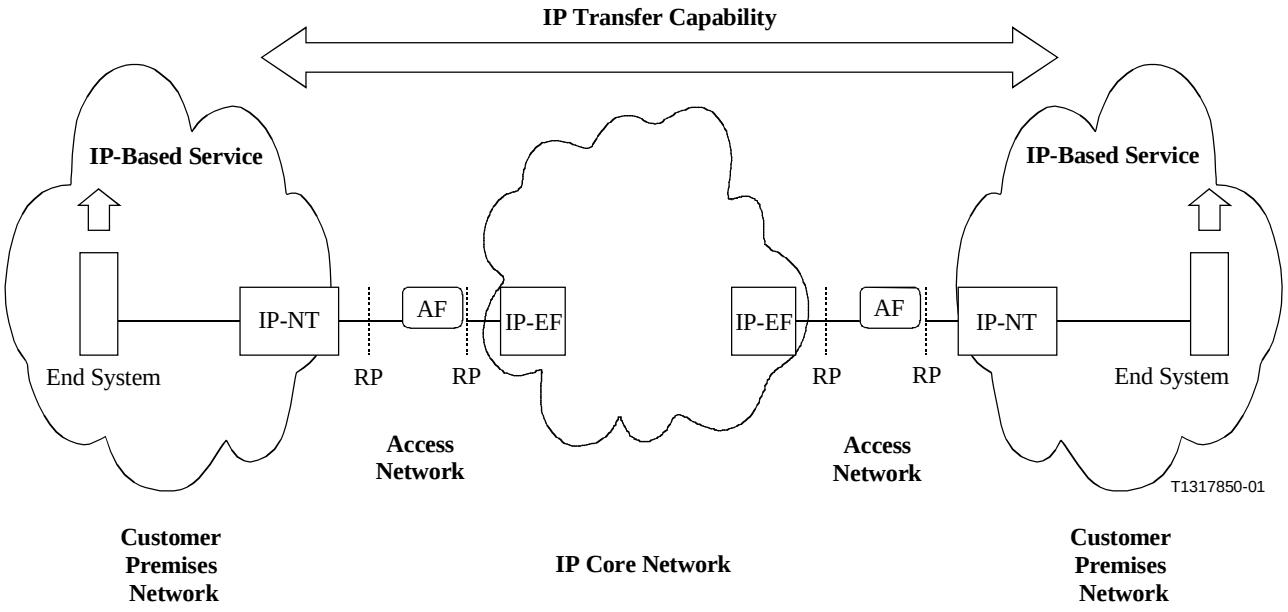
5.1 General

An IP-based service is defined in clause 3.

An IP-based service is specified according to the Service Level Agreement (SLA) attributes assigned (see clause 7). While an IP-based service usually has an end-to-end context it may be provided in situations in which part of the connection is IP-based network while another part of the connection is

not IP-based. One typical example is a voice service, with voice over IP in an IP-based network interworking with the existing circuit switched voice network. Other examples of non IP-based network interworking with IP-based network to support an IP-based service end to end exist. Further information on IP interworking is given in ITU-T Y.1401 [9]. In the case of interworking, the SLA attributes will be specified only for the IP-based network portion of the connection.

Figure 2 presents a reference framework illustrating applications of IP transfer capability and IP-based services. This figure is based on the figures introduced in ITU-T I.414 [6], ITU-T Y.1001 [8] and Y.1231 [10]. The following subclauses provide information regarding, IP-based services, service plane concept, IP-based service classes and categories and IP transfer capability attributes.



AF Access Function
IP-EF IP Edge Function
IP-NT IP Network Termination
RP Reference Point

NOTE – The box between RPs is covered in ITU-T Y.1231 and I.414. This arrangement is also aligned with ITU-T Y.1001.

Figure 2/Y.1241 – IP-based network reference framework

5.2 IP-based service classes and categories

IP-based service classes are closely related to QoS classes which provide assurances to users on the service performance to be achieved in any given service contract. The IP-based services are specified and characterized by the SLA attributes assigned in the service contract.

However, using similar concepts as in ITU-T I.211 [1], IP-based services can be categorized as "Interactive" and "Distributive".

The interactive category is subdivided into three classes:

- conversational services: such as internet telephony, remote login, electronic data exchange, videoconferencing, video telephony, home banking, tele-education and interactive games;
- messaging services: such as electronic mail (e-mail), voice e-mail, video e-mail, and internet fax;

- retrieval services: such as web browsing (www, gopher), file downloading (ftp), internet VoD (Video-on-demand) and news retrieval.

The distributive category is subdivided into two classes:

- distribution services without user individual presentation control: such as broadcasting, multicasting and electronic newspaper;
- distribution services with user individual presentation control: such as video-on-demand and news-on-demand.

5.3 Communication configurations

Communication in IP-based networks can be divided in several configurations similar to B-ISDN as defined in ITU-T I.313 [2]. In this Recommendation configurations are classified as point-to-point, unidirectional point-to-multipoint, unidirectional multipoint-to-point, multipoint-to-multipoint and bidirectional point-to-multipoint.

5.3.1 Point-to-point communication configuration

A point-to-point connection configuration may provide unidirectional or bidirectional symmetric or asymmetric communication between two parties. Examples of services applicable to point-to-point communication configuration are:

– conversational services;

– messaging services;

– retrieval services;

– distribution services with user individual presentation control.

5.3.2 Unidirectional point-to-multipoint communication configuration

A unidirectional point-to-multipoint connection configuration may provide unidirectional communication between one-to-many parties. Examples of services applicable to unidirectional point-to-multipoint communication configuration are:

– messaging services;

– distribution services without user individual presentation control.

5.3.3 Unidirectional multipoint-to-point communication configuration

A unidirectional multipoint-to-point connection configuration may provide unidirectional communication between many-to-one parties. Examples of services applicable to unidirectional multipoint-to-point communication configuration are:

– messaging services;

– distribution services without user individual presentation control.

5.3.4 Multipoint-to-multipoint communication configuration

A multipoint-to-multipoint connection configuration may provide communication between many-to-many parties. Examples of services applicable to multipoint-to-multipoint communication configuration are:

– conversational services;

– messaging;

– distribution services with or without user individual presentation control.

5.3.5 Bidirectional point-to-multipoint communication configuration

A bidirectional point-to-multipoint connection configuration may provide communication between one-to-many parties. Examples of services applicable to bidirectional point-to-multipoint communication configuration are:

– conversational services;

– messaging services with return path;

– retrieval services;

– distribution services with and without user individual presentation control.

Table 1 provides examples of performance attributes for some IP-based services.

Table 1/Y.1241 – Examples of guaranteed performance attributes for IP-based services

IP-based service class	IP-based service	Guaranteed performance attribute(s) for IP-based service
Conversational	• Internet telephony • Videoconferencing • Video telephony • Interactive games	Loss, delay and delay variation
	• Internet shopping • Electronic data exchange	Loss
	• Remote login	None
Messaging	• Voice e-mail • Internet fax • Video e-mail • Group e-mail	None
Retrieval	• Web browsing • News retrieval • File downloading	None
	• Video-on-demand	Loss and delay variation
Distribution Service without Individual presentation control	• Electronic newspaper • Internet advertising	None
	• Live broadcasting	Loss
Distribution Service with Individual presentation control	• News-on-demand • Video-on-demand	Loss and delay variation

5.4 IP service plane

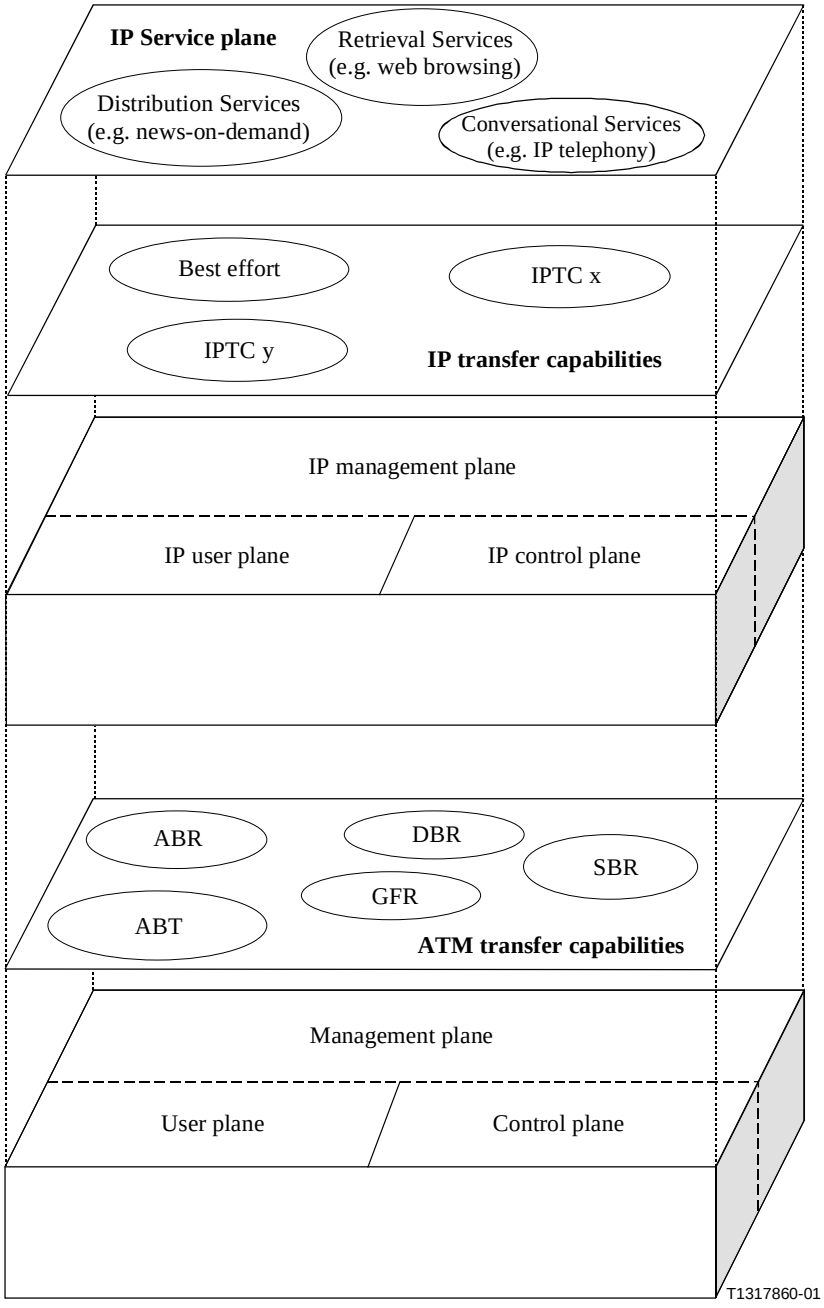
The service plane concept is introduced as a model to relate use of the following in the construction of IP-based services:

• IP transfer capabilities;

• control capabilities; and

• management related capabilities.

IP-based services, may be specified within a Service Level Agreement (SLA) between service provider and the customer. This concept is illustrated in Figure 3, which shows that the service plane utilizes the capabilities provided by the underlying transfer functions, as well as the control and management plane functions. Consequently the IP service plane incorporates more than a layer service as defined in a SAP (service access point) in the protocol stack. In specifying an IP-based service for use by a customer the terms and features of clauses 6 and 7 are used.

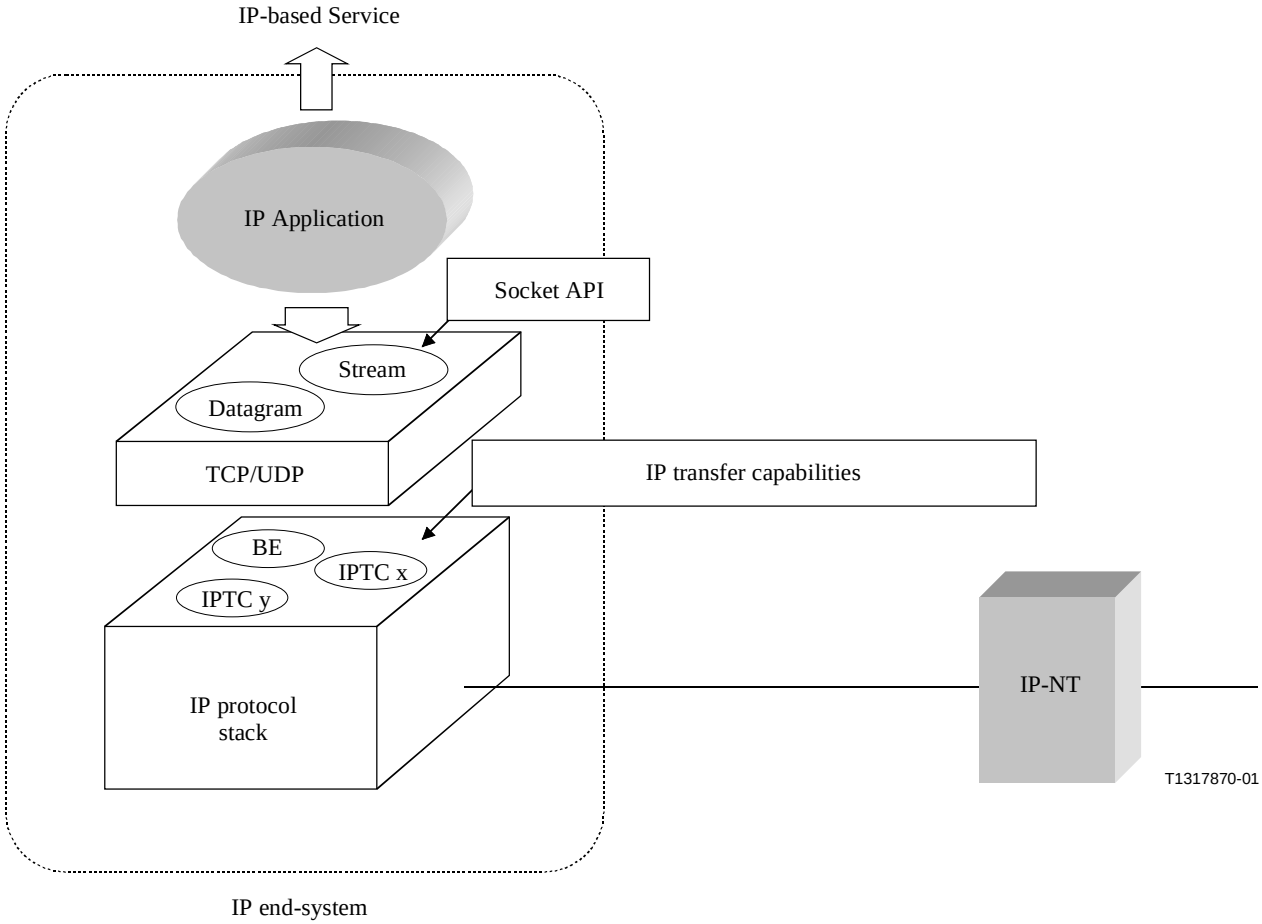


NOTE – This figure shows ATM being used for transport. Other transport technologies (e.g. Frame relay, SDH, etc.) may also be applied using the same principle.

Figure 3 /Y.1241 – Service plane concept for IP-based services

5.5 End-system model

Figure 4 shows an end-system model. In this model, the IP end-system has two types of interface points; one is the socket API (Application Programming Interface) and the other is the interface to the IP transfer capability. The socket API allows IP applications to use capability provided by TCP layer (e.g. TCP or UDP). The interface to the IP transfer capability provides access to desired IP transfer capabilities for a given IP-based service.



BE Best Effort
CPE Customer Premises Equipment
IP-NT IP Network Termination

NOTE – IP transfer capabilities include user, control and management plane functions.

Figure 4/Y.1241 – IP end-system model

6 IP transfer capability attributes

6.1 General

The IP transfer capabilities, as defined in another ITU-T Recommendation, can be used to characterize capabilities provided by the IP layer. The transport of data packets may be provided by an IP transfer capability (including a set of parameters) and a QoS class.

Figure 2 depicts how the concept of IP transfer capability and IP QoS class can be applied. In this application, the IP Transfer Capability is specified at the RP (reference point) interface, e.g. the boundary between customer side and provider side. The IP QoS class characterizes the properties of the transport between two RPs, e.g. the ingress and the egress boundaries between customers and the network. Network operators could use these concepts to offer an IP-based service to their customers.

The IP transfer capability, including all relevant parameter values, and the QoS class may be used in preparation of a SLA (see clause 7).

6.2 Attributes for IP transfer capability

An IP transfer capability with an associated IP QoS class is intended to support an IP-based service with the desired performance attributes. In order to reach that objective, this Recommendation lists a number of properties which IP transfer capabilities (to be specified in other Recommendations) should have:

- IP transfer capabilities should support IP-based Services as specified in this Recommendation;
- IP transfer capabilities should be implicitly or explicitly declared at the moment the service is requested;
- an IP transfer capability is not required to have a one-to-one correspondence with a given IP-based service. That is, there may be more than one IPTC which is able to support the requested IP-based service.

7 Service level agreement

7.1 General

To support a given IP-based service a Service Level Agreement (SLA) is negotiated between a customer and a service provider. The SLA is a formal contract between the service provider and the customer that defines the terms of the service provider's responsibility to the customer, the type and extent of penalty if those responsibilities are not met and the price of the service provided. A service level agreement is a document, which may be written by the customer, service provider, or both, to define specific levels of service and the associated financial aspects.

A complete SLA document may include the names of the parties involved, the terms of the agreement, the application and support services to be provided, the service level objectives, and the attribute values. The SLA may also include reporting requirements (including both the frequency of report generation and the level of reporting detail), penalties for non-compliance with the agreement, arbitration policies, modification terms, and responsibilities of both parties.

7.2 SLA components

The SLA should be composed of three building blocks:

- service level objectives;
- service monitoring components;
- financial compensation components.

Service level objectives (SLOs) are specific service metrics, including service performance. Service monitoring involves either the customer or the service provider use of monitoring devices to ensure compliance to the terms of the contract. The financial component may include service price information as well as the penalties for the service provider's failure to meet the requirements of the SLA.

7.3 SLA attributes

The following SLA attributes may be considered as appropriate in the development of a Service Level Agreement.

7.3.1 Service level objectives

- IP transfer capability;
- QoS Parameters or CoS provided;
- availability – access blocking probability;
- reliability – active system time, network failure rate;
- interoperability;
- delivery confirmation;
- mobility and Portability support;
- security – encryption, etc.;
- bandwidth – constant, variable, etc.;
- priority;
- authentication – User ID for admission control;
- signalling protocols – CR-LDP, etc.;
- flexibility – scaling and global connectivity;
- life of the SLA.

7.3.2 Service monitoring

- QoS monitoring – comparison against objectives;
- flow tracking – comparison against IPTC objectives;
- tracking – time stamping at the beginning and end of session;
- reports on service level objectives as necessary.

7.3.3 Financial issues

- billing option – flat rate, timed, per transaction, per packet, etc.;
- penalties for failing to deliver service level objectives by the service provider;
- pricing;
- early termination charges;
- shortfall charges – early withdrawal from service by the customer.

SLAs may be between the customer and the service provider or between the service provider and the provider of the network.

7.4 Procedure for service level agreements

The following steps may be taken when developing and implementing a service level agreement.

The procedure in the development of the SLA includes identification of:

- the customer and associated service level;
- network performance objectives;
- ways to revise the network configuration and resource management;
- ways to revise the service level agreement.

The implementation of the SLA in the network occurs in the following steps:

- design and provisioning of the network to satisfy the SLA;
- configuration of ingress device as per information in the policy server to satisfy the SLA;
- classification of the packets into different classes and collection of statistics regarding their performance at ingress device;
- verification of the SLA based on the collected data from the ingress device.

8 Protocol reference model

The protocol reference model for IP transport network is composed of a user-plane (U-plane), a control-plane (C-plane) and a management-plane (M-plane) similar to that of ITU-T I.321 [3]. Figure 5 shows the model for the IP-based network.

The user-plane provides user information flow transfer on the IP-based network. In the layer architecture model, it consists of TCP/UDP layer, IP layer and lower transport layers. To meet the IP-based service features; the user-plane network capabilities include among others, connection types and IP transfer capabilities and ATM transfer capabilities in the case of ATM.

The control-plane performs the call and connection control functions to support connection-oriented (e.g. MPLS) as well as connectionless services. It provides necessary signalling between the user and the network. To provide the IP-based services, the control-plane network capabilities include on-demand control capabilities of user-plane transfer functions, call/connection signalling, traffic negotiation, addressing, routing functions and user, terminal, and/or service identification.

The management-plane has two types of management functions namely layer management and plane management. The layer management performs management functions on resources and parameters of lower layer transport protocol entities. It handles the general operation and maintenance of each protocol layer to meet the QoS requirements on user information flows. The plane management performs system management functions with coordination with the U-plane and the C-plane capabilities. With the help of plane management capabilities, the IP network provides the high-level client/server applications and user, terminal and/or service interaction. It also provides network-related and service-oriented high layer capabilities such as naming, information searching, data storing, information transaction, etc.

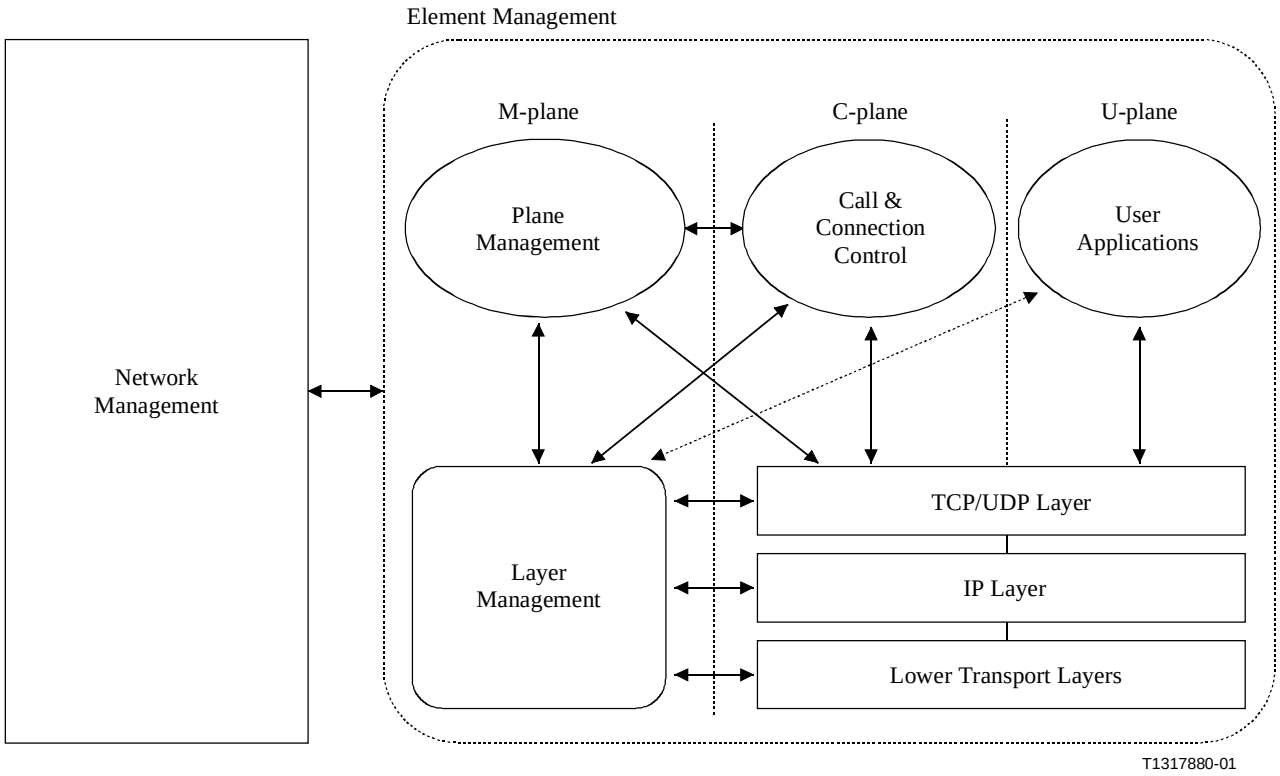


Figure 5/Y.1241 – Protocol reference model for IP-based networks

9 Functional architecture

In this Recommendation the functional architecture of IP-based networks is explained in a similar manner as in ITU-T I.327 [4].

9.1 Applications of functional groups

IP-based networks are comprised of two functional groups: the IP-network element (IP-NE) and the IP terminal equipment (IP-TE). The IP-NE functional group has the network intelligence to configure, register, control and manage the IP-based services. It may be interfaced to the Internet Service Provider's network. The functional groups can be categorized in three groups where each can be sub-categorized again. The following provides a list of these categories with a brief explanation for each one:

– IP-Terminal Equipment (IP-TE): IP Interface Functional Group and IP Client Functional Group;

– IP-Router: IP Interface Functional Group and IP Routing and Forwarding Functional Group (and IP Server Functional group optionally);

– IP-Interworking Unit (IP-IWU): IP Interface Functional Group and IP Conversion Functional Group (and IP Server Functional group optionally).

The list of functions for each functional group is not exhaustive. Also, not all specific functions in a functional group need to be present in all implementations.

9.1.1 IP interface functional group

This functional group includes interface functions to generate and receive IP messages for the specific Internet applications. Examples of IP interface functions are:

- generation and extraction of IP messages specific to end user applications;
- buffering and resource allocation;
- multiplexing and de-multiplexing;
- provisioning of virtual circuits with or without signalling protocol handling;
- traffic flow handling including usage parameter control;
- physical transmission interface and adaptation functions;
- transmission control including OAM functions.

Additional functions specific to the transmission system or high-level services and applications may be required.

9.1.2 IP routing and forwarding functional group

This functional group includes forwarding and routing functions to transfer IP messages to the destinations. Examples of IP routing and forwarding functions are:

- storing and forwarding of IP messages;
- routing information handling for static or dynamic routing;
- topology information handling;
- provisioning of QoS assured path.

9.1.3 IP server functional group

This functional group includes the server-side functions for configuration and registration procedure of IP network. Examples of IP server functions are:

- server-side functions for registration procedure of IP address and name;
- server-side functions for registration procedure of IP multicast and broadcast group;
- directory service with efficient and distributed storage;
- response to the query of IP address and name;
- maintenance of mapping between IP address and IP domain name.

9.1.4 IP client functional group

This functional group includes the client-side functions for configuration and registration procedure in IP networks. Examples of IP client functions are:

- client-side functions for registration procedure of IP address and name;
- client-side functions for registration procedure of IP multicast and broadcast group;
- query of IP address and name.

9.1.5 IP conversion functional group

This functional group includes the functions for protocol conversion and format translation in IP network for the specific Internet applications. Examples of IP conversion functions are:

- translation of IP protocol functionality, for example, to convert the UDP messages to the TCP messages or vice versa (e.g. transport gateway, signalling);
- mapping of IP versions (e.g. IPv4, and IPv6, etc.);

- conversion of connection types, for example, to translate one point-to-multipoint connection to multiple point-to-point connections;
- change of transfer mode, for example, to translate the connectionless transfer mode to the connection-oriented transfer mode;
- conversion of QoS provisioning, for example, to deliver the best effort service to the guaranteed service with high priority;
- IP traffic control and management handling.

10 Support of IP-based services by ATM

ITU-T Y.1310 [7] specifies transport of IP over ATM in public networks and ITU-T Y.1401 [9] provides general requirements for Interworking with IP-based networks. For a detailed discussion regarding these subjects, the aforementioned and other relevant Recommendations should be consulted. This clause provides examples of IP performance attributes mapped to ATM QoSs to support IP-based services.

10.1 Relationship with ATM transfer capabilities

ITU-T I.371 [5] provides ATM transfer capability. Transfer capabilities carry varying QoS objectives. QoS objectives for IP-based services, like in ATM, are dependent on the sensitivity of transferred data to loss and delay. Hence, in this clause, loss, delay variation and delay attributes are chosen as a means to relate performance attributes for IP-based services to the ATM QoS classes as specified in ITU-T I.356.

Clause 5.2 identifies IP-based services as to belong to two categories and five classes based on their performance attributes. Table 2 provides examples of how performance attributes of IP-based services can be related to ATM QoS classes.

Table 2/Y.1241 – Examples of relationship between performance attributes for IP-based services and ATM QoS classes

Guaranteed performance attribute(s) for IP-based service	Possible mapping (s) to ATM QoS
Loss, delay and delay variation	QoS class 1 (stringent class) or QoS class 5 (stringent bi-level class) for CLP = 0 cells
Loss	QoS class 2 (tolerant class) or QoS class 3 (bi-level class) for CLP = 0 cells
None	QoS class 4 (U class) or QoS class 3 (bi-level class) for CLP = 1 cells

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	**Global information infrastructure and Internet protocol aspects**
Series Z	Languages and general software aspects for telecommunication systems

Geneva, 2001