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OF ITU

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SERIES Y: GLOBAL INFORMATION  
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS  
AND NEXT GENERATION NETWORKS

Internet protocol aspects – Transport

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## Transport of IP over ATM in public networks

ITU-T Recommendation Y.1310

ITU-T Y-SERIES RECOMMENDATIONS

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GENERATION NETWORKS**

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# ITU-T Recommendation Y.1310

## Transport of IP over ATM in public networks

### Summary

With the rapid growth of IP-based networks and applications in both private and public networks, it is necessary to consider arrangements to transport IP services over ATM in the public network environment.

For the private network environment, the ATM Forum has specified Multi-Protocol Over ATM (MPOA) [ATM\_MPOA]. The Internet Engineering Task Force (IETF) has specified Classical IP Over ATM (C-IPOA) [CIP\_ATM] and Next Hop Resolution Protocol (NHRP) [NHRP] and Multi-Protocol Label Switching (MPLS) [MPLS\_ARCH]. To ensure that public networks will interwork with each other supporting a set of services defined in this Recommendation, and to ensure the interworking of public and private networks, it is necessary to recommend the preferred approach for transporting IP over ATM in public networks.

The approach adopted in this Recommendation is to identify generic requirements, key IP services and determine which IP over ATM approach is preferred for each service. It is preferable that the same approach is used for all services considered. This approach is recommended for all identified services using IP over ATM transport in public networks.

### Source

ITU-T Recommendation Y.1310 was approved on 15 March 2004 by ITU-T Study Group 13 (2001-2004) under the ITU-T Recommendation A.8 procedure.

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# ITU-T Recommendation Y.1310

## Transport of IP over ATM in public networks

### 1 Scope

This Recommendation addresses the transport of IP services over ATM. IP services in this Recommendation are defined as services provided at the IP layer. IP services in this Recommendation do not include those at the application layer (e.g., network banking).

This Recommendation identifies the IP over ATM approach for public networks adopting ATM technology, including service provider networks and carrier networks, but does not preclude the same approach where applicable in access networks, private networks and end systems. Approaches taken into account include classical IPOA, MPOA, and MPLS. These approaches are described briefly in Appendix I.

### 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. The 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

##### 2.1.1 ITU-T

- [I.321] ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application*.
- [I.326] ITU-T Recommendation I.326 (2003), *Functional architecture of transport networks based on ATM*.
- [I.356] ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.
- [I.361] ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification*.
- [I.364] ITU-T Recommendation I.364 (1999), *Support of the broadband connectionless data bearer service by the B-ISDN*.
- [I.371] ITU-T Recommendation I.371 (2004), *Traffic control and congestion control in B-ISDN*.
- [I.432] ITU-T Recommendations I.432.1 (1999), I.432.2 (1999), I.432.3 (1999) and I.432.4 (1999), *B-ISDN user-network interface – Physical layer specification*.
- [Q.2931] ITU-T Recommendation Q.2931 (1995), *Digital Subscriber Signalling System No. 2 – User-Network Interface (UNI) layer 3 specification for basic call/connection control*.
- [Q.2941] ITU-T Recommendation Q.2941.2 (1999), *Digital Subscriber Signalling System No. 2 – Generic identifier transport extensions*.
- [Y.1311.1] ITU-T Recommendation Y.1311.1 (2001), *Network-based IP-VPN over MPLS architecture*.

### 2.1.2 ISOC/IETF

|               |                                                                                                                        |
|---------------|------------------------------------------------------------------------------------------------------------------------|
| [ATM_MULTI]   | IETF RFC 2684 (1999), <i>Multiprotocol Encapsulation over ATM Adaptation Layer 5</i> .                                 |
| [ATM_VCID]    | IETF RFC 3038 (2001), <i>VCID Notification over ATM Link for LDP</i> .                                                 |
| [CIP_ATM]     | IETF RFC 2225 (1998), <i>Classical IP and ARP over ATM</i> .                                                           |
| [CONTROL_SER] | IETF RFC 2211 (1997), <i>Specification of the Controlled-Load Network Element Service</i> .                            |
| [CR_LDP]      | IETF RFC 3212 (2002), <i>Constraint-Based LSP Setup using LDP</i> .                                                    |
| [DIFF_AF]     | IETF RFC 2597 (1999), <i>Assured Forwarding PHB Group</i> .                                                            |
| [DIFF_ARCH]   | IETF RFC 2475 (1998), <i>An Architecture for Differentiated Services</i> .                                             |
| [DIFF_HEADER] | IETF RFC 2474 (1998), <i>Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers</i> . |
| [DIFF_EF]     | IETF RFC 2598 (1999), <i>An Expedited Forwarding PHB</i> .                                                             |
| [GUAR_SER]    | IETF RFC 2212 (1997), <i>Specification of Guaranteed Quality of Service</i> .                                          |
| [IP_V4]       | IETF RFC 791 (1981), <i>Internet Protocol</i> .                                                                        |
| [IP_V6]       | IETF RFC 2460 (1998), <i>Internet Protocol, Version 6 (IPv6) Specification</i> .                                       |
| [LDP]         | IETF RFC 3036 (2001), <i>LDP Specification</i> .                                                                       |
| [MPLS_ARCH]   | IETF RFC 3031 (2001), <i>Multiprotocol Label Switching Architecture</i> .                                              |
| [MPLS_ATM]    | IETF RFC 3035 (2001), <i>MPLS using LDP and ATM VC Switching</i> .                                                     |
| [MPLS_DIFF]   | IETF RFC 3270 (2002), <i>Multi-Protocol Label Switching (MPLS) Support of Differentiated Services</i> .                |
| [MPLS_ENCAPS] | IETF RFC 3032 (2001), <i>MPLS Label Stack Encoding</i> .                                                               |
| [NHRP]        | IETF RFC 2332 (1998), <i>NBMA Next Hop Resolution Protocol (NHRP)</i> .                                                |
| [RSVP_AGG]    | IETF RFC 3175 (2001), <i>Aggregation of RSVP for IPv4 and IPv6 Reservations</i> .                                      |
| [RSVP_FUN]    | IETF RFC 2205 (1997), <i>Resource Reservation Protocol (RSVP) – Version 1 Functional Specification</i> .               |
| [RSVP_REFR]   | IETF RFC 2961 (2001), <i>RSVP Refresh Overhead Reduction Extensions</i> .                                              |
| [RSVP_TE]     | IETF RFC 3209 (2001), <i>RSVP-TE: Extensions to RSVP for LSP Tunnels</i> .                                             |
| [TCP]         | IETF RFC 793 (1981), <i>Transmission Control Protocol</i> .                                                            |
| [UDP]         | IETF RFC 768 (1980), <i>User Datagram Protocol</i> .                                                                   |

### 2.1.3 ATM Forum

|            |                                                                                        |
|------------|----------------------------------------------------------------------------------------|
| [ATM_MPOA] | ATM Forum AF-MPOA-0087.000 (1997), <i>Multi-Protocol Over ATM Specification v1.0</i> . |
|------------|----------------------------------------------------------------------------------------|

## 2.2 Informative references

### 2.2.1 ISOC/IETF

|           |                                              |
|-----------|----------------------------------------------|
| [BGP_VPN] | IETF RFC 2547 (1999), <i>BGP/MPLS VPNs</i> . |
|-----------|----------------------------------------------|

### 3 Terms and definitions

This clause lists alphabetically the acronyms of the key terms used in this Recommendation and the references to their sources of definitions. Refer to clause 4 for the acronyms and to clause 2 for the references:

|         |             |
|---------|-------------|
| CR-LDP  | [CR_LDP]    |
| DS      | [DIFF_ARCH] |
| DSCP    | [DIFF_ARCH] |
| FEC     | [MPLS_ARCH] |
| LIB     | [MPLS_ARCH] |
| LSR     | [MPLS_ARCH] |
| MPLS    | [MPLS_ARCH] |
| PHB     | [DIFF_ARCH] |
| RSVP    | [RSVP_FUN]  |
| RSVP-TE | [RSVP_TE]   |
| VPN     | [BGP_VPN]   |

### 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

|        |                                   |
|--------|-----------------------------------|
| AAL    | ATM Adaptation Layer              |
| ABR    | Available Bit Rate                |
| ABT    | ATM Block Transfer                |
| AESA   | ATM End System Address            |
| ARP    | Address Resolution Protocol       |
| ATC    | ATM Transfer Capability           |
| ATM    | Asynchronous Transfer Mode        |
| ATMARP | ATM Address Resolution Protocol   |
| BGP    | Border Gateway Protocol           |
| BUS    | Broadcast and Unknown Server      |
| CE     | Customer Edge                     |
| CE     | Customer Equipment                |
| C-IPOA | Classical IP over ATM             |
| CLP    | Cell Loss Priority                |
| CLS    | Controlled Load Service           |
| CoF    | Coordination Function             |
| CR-LDP | Constraint-based Routing LDP      |
| DBR    | Deterministic Bit Rate            |
| DS     | Differentiated Services           |
| DSCP   | Differentiated Service Code Point |
| ER     | Explicit Routing                  |
| ES     | End System                        |
| FEC    | Forwarding Equivalence Class      |
| FIB    | Forwarding Information Base       |

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|         |                                                   |
|---------|---------------------------------------------------|
| GFR     | Guaranteed Frame Rate                             |
| GS      | Guaranteed Service                                |
| ILMI    | Integrated Local Management Interface             |
| IP      | Internet Protocol                                 |
| IPOA    | IP Over ATM                                       |
| IPSF    | IP Service Functions                              |
| IP-SSCS | IP-Service Specific Convergence Service           |
| IS      | Integrated Service                                |
| ISP     | IP Service Provider                               |
| LANE    | Local Area Network Emulation                      |
| LDP     | Label Distribution Protocol                       |
| LEC     | LANE Client                                       |
| LECS    | LANE Configuration Server                         |
| LER     | Label Edge Router                                 |
| LES     | LANE Server                                       |
| LIB     | Label Information Base                            |
| LIS     | Logical Internet Subnet                           |
| LLC     | Logical Link Control                              |
| LSP     | Label Switched Path                               |
| LSR     | Label Switching Router                            |
| MAC     | Medium Access Control                             |
| MBS     | Maximum Burst Size                                |
| MCR     | Minimum Cell Rate                                 |
| MPC     | MPOA Client                                       |
| MPLS    | Multi-Protocol Label Switch                       |
| MPOA    | Multi-Protocol Over ATM                           |
| MPS     | MPOA Server                                       |
| NAT     | Network Address Translation                       |
| NHC     | NHRP Client                                       |
| NHRP    | Next Hop Resolution Protocol                      |
| NHS     | NHRP Server                                       |
| NNI     | Network to Network Interface                      |
| OSPF    | Open Shortest Path First                          |
| PCI     | Protocol Control Information                      |
| PCR     | Peak Cell Rate                                    |
| PDR     | Peak Data Rate                                    |
| PE      | Provider Edge                                     |
| PHB     | Per Hop Behaviour                                 |
| PIM     | Protocol Independent Multicasting                 |
| PPP     | Point-to-Point Protocol                           |
| PSC     | Per Hop Scheduling                                |
| QoS     | Quality of Service                                |
| RSVP    | Resource Reservation Protocol                     |
| RSVP-TE | Resource Reservation Protocol-Traffic Engineering |
| SBR     | Statistical Bit Rate                              |
| SLA     | Service Level Agreement                           |

|        |                                       |
|--------|---------------------------------------|
| SNAP   | Subnet Attachment Point               |
| SSCS   | Service Specific Control Service      |
| TCP    | Transmission Control Protocol         |
| TMN    | Telecommunications Management Network |
| UDP    | User Data Protocol                    |
| UNI    | User Network Interface                |
| VPN    | Virtual Private Network               |
| VPN-ID | VPN Identifier                        |
| xDSL   | x-Digital Subscriber Loop             |

## 5 Generic requirements

This Recommendation places a number of generic requirements on IP over ATM approaches. Such requirements are applicable to all identified IP services. The mandatory generic requirements are as follows:

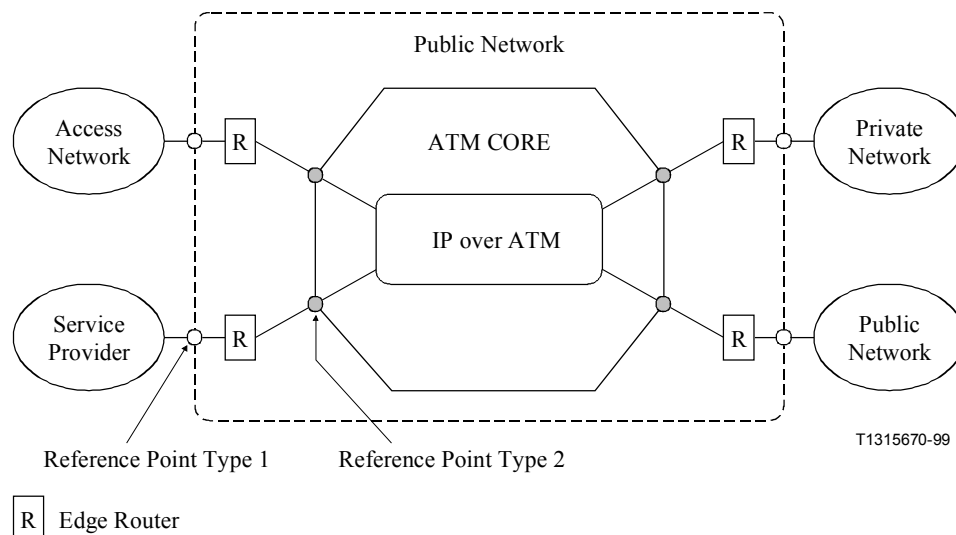
- The recommended approach must be independent of the IP version supported.
- The recommended approach must have sufficient scalability to support large networks. Items to be taken into account regarding scalability include:
  - use of VCI and VPI values;
  - complexity of routing calculation at Layer 2 and Layer 3;
  - complexity of address resolution mechanism;
  - control messaging load (e.g., frequency of setup and teardown of ATM connections, frequency of IP-related signalling messages);
  - complexity of the packet classification mechanism needed to support QoS. The less granularity in the QoS (e.g., from per IP flow, to per IP flow aggregation, to per service, as in Diffserv) the simpler the packet classification mechanism.
- The recommended approach must include the capability for efficient and scalable solutions to support IP multicasting over ATM networks.
- The recommended approach must have sufficient robustness to support large networks. Items to be taken into account include:
  - capability to support restoration systems.

## 6 Framework architecture

The framework architecture to support IP layer services over ATM is defined as comprising the network architecture and the protocol architecture to support the IP services required.

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## 6.1 Network architecture



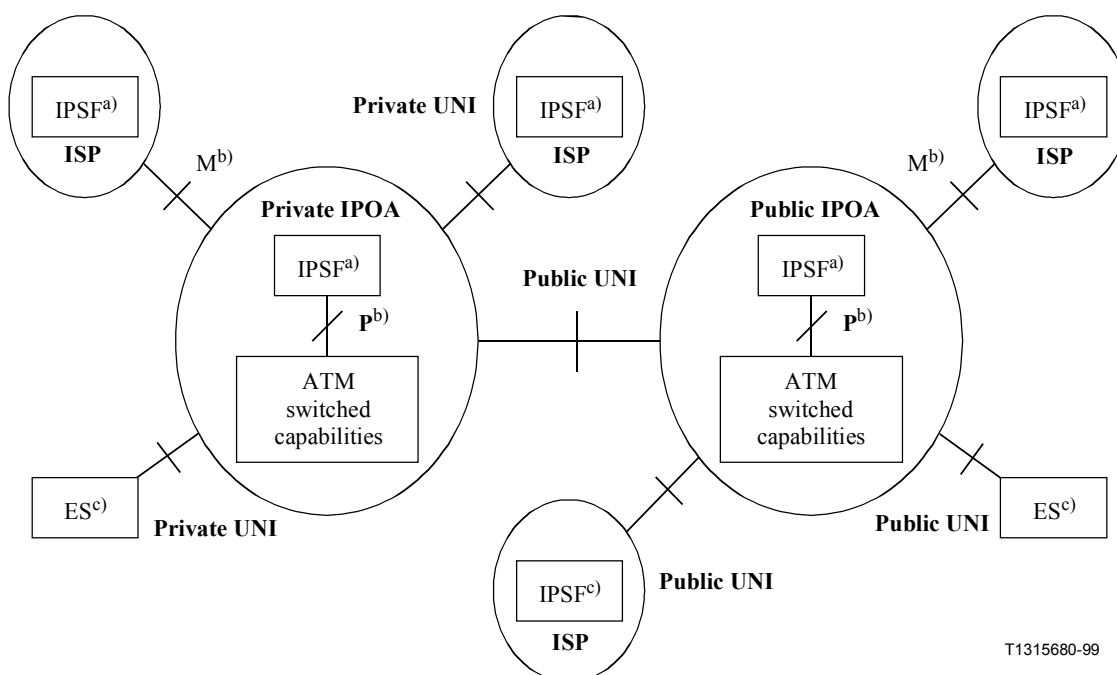
NOTE 1 – Internet service providers may also provide the ATM core.

NOTE 2 – Reference point types 1 and 2 can be a standardized reference point such as an ISDN S, T interface or a non-standardized interface.

**Figure 6-1/Y.1310 – Reference network architecture for IP over ATM**

The reference network architecture for IP over ATM is shown in Figure 6-1. This configuration illustrates possible scenarios to support IP services over ATM identified in this Recommendation. The dotted rectangle indicates a public network on which we focus. Note that the public network in this Recommendation is restricted to one which has an ATM core. The boxes inside the dotted rectangle describe the generic arrangement inside the public network. It includes an ATM core, IP over ATM capabilities, and edge routers. A number of different kinds of networks are described outside the dotted rectangle, with each identifying a scenario in which the public network provides a certain identified IP service to a certain type of a network. From the viewpoint of the public network, these networks are regarded as subscriber networks.

In this figure, two types of distinct reference points are described. The reference point type 1 is the boundary between the public network and subscriber networks, and the reference point type 2 is the interface to the IP over ATM network inside the public network. The arrangement of the reference point type 1 may depend on the facilities of subscriber networks, and the definition of IP services provided. Interworking functions and/or adaptation functions may be required in edge routers. This Recommendation primarily focuses on the reference point type 2, and on the approach adopted inside the public network.



- a) IPSF: IP Service Functions.
- b) P or M: on the basis of ITU-T Recommendation I.364.
- c) ES: End System has a full IPOA protocol stack.

**Figure 6-2/Y.1310 – Reference configuration for IP services over ATM**

Figure 6-2 illustrates the reference configuration for IP services over public and private ATM networks. In the private and public IPOA networks, the provision of IP services is realized by means of ATM switched capabilities and IP Service Functions (IPSF). In this case, interfaces between ATM switched capability and IPSF shall be defined at the P or M reference points [I.364]. The IP Service Functions (IPSF) are those functions necessary to enable IP over ATM. A typical example of IPSF is address resolution service. As an end system, the IPSF is essentially a router with an ATM interface.

The IPSF function can be implemented in the same equipment together with the ATM switched capabilities. In this case, there is no need to define the interface at the P reference point. The IPSF function and ATM switched capabilities can be also implemented in separate equipment. In this case, interfaces shall be defined at the M or P reference points depending whether the IPSF is located outside or inside the core ATM network.

ISPs and End Systems (ES) outside the ATM networks may be connected to the private or public ATM networks. Each ES has a full IPOA protocol stack and is connected by way of private UNI for the private IPOA, or public UNI for the public IPOA.

### 6.1.1 Network and service interworking

In network interworking scenario the IP Protocol Control Information (PCI) and payload data are transferred transparently across the ATM network to another IP-based network by means of an interworking function (IWF) between the two networks. Typically the IWF simply encapsulates the IP packet by means of an adaptation function and transfers it transparently to the remote IWF. For current IP and ATM interworking, network interworking is the typical case, with ATM providing a backbone or core network for transport of Internet protocol. In this scenario, the ATM network may be viewed as an underlay transport for the Layer 3 (and above) protocols.

For the case of service interworking, the IWF terminates the IP protocol and translates the PCI to the ATM network PCI for transfer, control and management functions. Since in general not all functions may be supported in one or other of the networks, the service interworking scenario may only be able to provide a "best fit" conversion between the two different technologies. However, this should not result in any loss of user data since this is not affected by the PCI conversion at the service interworking IWF.

Figures 6-1 and 6-2 illustrate network interworking associated with IP over ATM.

## 6.2 Protocol architecture

### 6.2.1 General description of IPOA protocol reference model

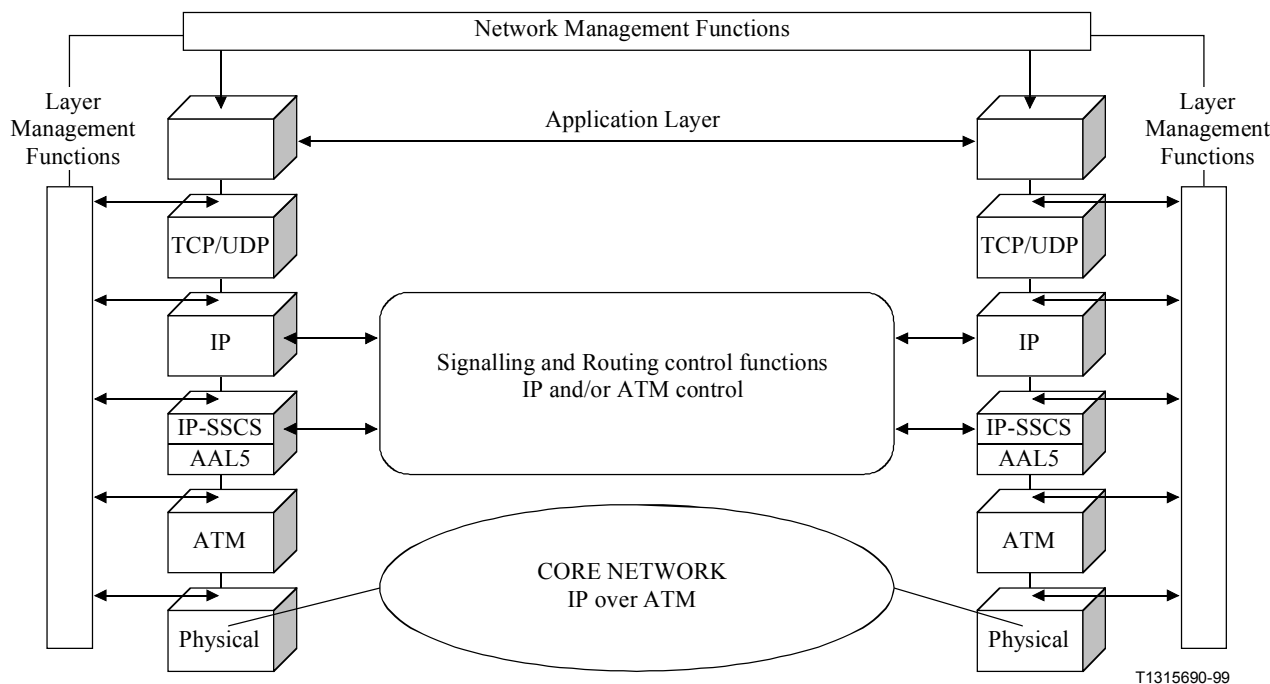


**Figure 6-3/Y.1310 – Protocol reference model for IP over ATM**

Figure 6-3 generalizes the protocol reference model for IP transport over ATM in public networks. It may be noted that the underlying protocol reference model concepts of layer management, network management and signalling and routing control are extended to include the Layer 3 and above functional blocks. It should be noted that the blocks shown in Figure 6-3 correspond to logical representations of the functions and therefore do not signify or constrain any particular network implementation.

The interfaces between the functional blocks may either be internal, non-standardized communication between the sub-layers, or external, standardized protocols. Each layer in the general model has its associated layer management functional block. The layer management blocks are responsible for processing of management and Protocol Control Information (PCI) for that layer only. Communication of information between the layers may only occur through the network management function. This is performed via the Coordination Function (CoF) of the network management.

All functional blocks do not need to be present in all network applications of IPOA. Thus, the blocks may be viewed as basic "building blocks" to enable any given network application of IPOA. However, the basic relationships and ordering between the different blocks must be maintained to ensure consistent interoperability.

## 6.2.2 Functional description of IPOA protocol reference model

This clause describes only the IPOA-related functional blocks, since detailed descriptions of the physical, ATM and ATM control layer functions are dealt with in other Recommendations [I.321], [I.326], [I.361], [I.432] and [Q.2931]. The application layer block is outside the scope of this Recommendation.

### 6.2.2.1 IP-SSCS/AAL5 functions

The IP-SSCS/AAL5 incorporates transfer functions required to map the IP packet onto the AAL5. The IP-SSCS/AAL5 functional block provides the encapsulation and multi-protocol multiplexing functions defined by the IEEE 802.2-based Link Layer Control/Subnetwork Attachment Point (LLC/SNAP) protocol as adopted by the IETF in [ATM\_MULTI].

### 6.2.2.2 IP layer functions

IP layer functions provide IP forwarding (IP datagram delivery) from a source to a destination over an interconnected system. IP forwarding is the process of receiving a packet and using a very low overhead decision process determining how to handle the packet. The packet may be delivered locally or forwarded externally. For traffic that is forwarded externally, the IP forwarding process also determines which interface the packet should be sent out on, and if necessary, either removes one media layer encapsulation and replaces it with another, or modifies certain fields in the media layer encapsulation.

IPOA protocol architecture must be independent of IP version. Currently, there are two versions: IPv4 (IP version 4) and IPv6 (IP version 6). IP layer functions are equal to those defined by IETF in [IP\_V4] and [IP\_V6] according to IPv4 and IPv6, respectively.

The IP layer function does not provide a reliable communication facility. There are no acknowledgements either end-to-end or hop-by-hop.

Note that IP layer functions should not be changed to use IP-SSCS/AAL5 functions over ATM.

### 6.2.2.3 IP layer management functions

IP layer management function has two basic functions: addressing and fragmentation. IP layer functions use the addresses carried in the IP header to transmit IP datagrams toward their destinations. The selection of a path for transmission is resolved as using signalling and routing functions block. IP layer functions use fields in the IP header to fragment and reassemble IP datagrams when necessary for transmission.

IPv4 protocol uses four basic key mechanisms in providing its service: type of service, time to live, options, and header checksum. IPv6 is a new version of the Internet protocol, designed as the successor to IPv4. The changes from IPv4 to IPv6 fall primarily into the following categories: expanded addressing capabilities, header format simplification, improved support for extensions and options, flow labelling capability and authentication and privacy capabilities. The IP layer management function does not provide error control for data, only a header checksum. There are no retransmissions. There is no flow control.

### 6.2.2.4 Transport layer functions

Transport layer includes connection-oriented type TCP functions and connectionless type UDP functions respectively. These depend on application programme type.

TCP functions provide reliable connection service between pairs of processes. TCP functions are equal to those defined by IETF in [TCP]. TCP functions include the following facilities: basic data transfer, reliability, flow control, multiplexing, connections and precedence and security.

UDP functions provide datagram transfer. UDP functions are equal to those defined by IETF in [UDP]. The UDP is transaction oriented, and delivery and duplicate protection are not guaranteed.

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Note that transport layer functions should not be changed to use IP layer functions over ATM.

#### **6.2.2.5 Application layer functions**

The application layer and its associated layer management functional blocks include user or network-specific applications such as HTTP, FTP, TELNET, etc. The description of application layer functions is outside the scope of this Recommendation.

Note that in the TCP/IP protocol architecture, the application layer function is generally taken to include the session and presentation layer functions.

#### **6.2.2.6 Network management functions**

The network management functions depend on the specific network application for IPOA. In general, they include the TMN (Telecommunications Management Network) functions associated with: fault management, performance management, configuration management, security management, etc.

#### **6.2.2.7 Signalling and routing control functions**

This includes the signalling and routing functional blocks in IP and/or ATM control. IP control and signalling encompasses various aspects of IP control including routing. ATM control includes ATM signalling and routing.

### **7 IP services**

A range of IP services is included in this Recommendation as a means to determine the preferred IP over ATM approach in public networks. Initially, mapping of IP QoS with ATM and VPN services are addressed. Additional services are for further study.

#### **7.1 Mapping of IP QoS with ATM**

##### **7.1.1 Introduction**

Two major approaches for the support of QoS differentiation at the IP level are documented in the IETF: the Intserv paradigm, aimed at supporting per IP flow QoS differentiation, and the Diffserv paradigm, aimed at supporting "coarse" QoS differentiation for aggregations of IP flows.

##### **7.1.1.1 The IP Intserv paradigm**

The Intserv paradigm relies on explicit per IP flow QoS requests carried by the RSVP protocol and on flow admittance control at the RSVP capable routers along the path of the flow. In the Intserv paradigm, two services are defined: the Guaranteed Service – GS [GUAR\_SER] and the Controlled Load Service – CLS [CONTROL\_SER]. In GS the maximum queuing delay for the flow is controlled. To compute the maximum delay a datagram will experience, the latency of the path must be determined and added to the maximum queuing delay [GUAR\_SER]. CLS does not provide firm delay guarantees, but the service provided to the flow should be comparable to what the flow would experience in a lightly loaded network, even when it is not the case [CONTROL\_SER]. In practice, CLS requires long-term available bandwidth.

Both services require that the characteristics of the flow be specified by means of a token bucket specification [RSVP\_FUN] and that excess traffic be treated as best effort.

### 7.1.1.2 The IP Diffserv paradigm

The IETF Diffserv model is based on the concept of Per Hop Behaviours (PHB) [DIFF\_HEADER] and [DIFF\_ARCH]. The Diffserv PHBs are defined by a set of forwarding behaviours that each local router along the path adheres to. IETF has identified two main PHBs so far:

- Expedited Forwarding (EF) PHB [DIFF\_EF]:  
The EF-PHB is characterized by a configurable amount of bandwidth that is not impacted by the other traffic sharing the link. The EF-PHB can be used to build an end-to-end service that requires low loss, low delay and low delay variation through Diffserv domains.
- Assured Forwarding (AF) PHB group [DIFF\_AF]:  
The AF-PHB group is characterized by four AF classes, and each AF class is allocated a certain amount of forwarding resources such as buffer and bandwidth in a Diffserv node. Within each AF class, IP packets are marked with one of three possible drop precedence values. In case of congestion, the drop precedence of a packet determines the relative importance of the packet within the AF class. However, there is no standardized relationship between the relative performance of the four AF classes. The AF-PHB group can be used to ensure that the subscribed information rate of a service is guaranteed with high probability.

### 7.1.2 Network model to support QoS-aware IP services

This clause describes a network model to support QoS-aware IP services in IPOA networks. In the IETF framework, the end-to-end QoS is provided by coupling Intserv regions at the edge of the network with Diffserv regions in the core of the network. The network model proposed here, however, considers additional possibilities. Moreover, the link layer in this case is always assumed to be ATM.

#### 7.1.2.1 Model description

The possible network models to support QoS-aware IP services are illustrated in Figures 7-1, 7-2 and 7-3. In each case, the shaded area indicates the active function used.

#### Case 1 – Intserv over ATM networks

In this model, communication between two Intserv stub networks is supported over IPOA core networks. The IPOA devices in the core networks may provide both Intserv and Diffserv capabilities. However, only Intserv functionality of the IPOA devices will be activated to support end-to-end integrated services. Both service level agreements (SLA 1 and SLA 2) require that the requirements for Intserv service are satisfied.

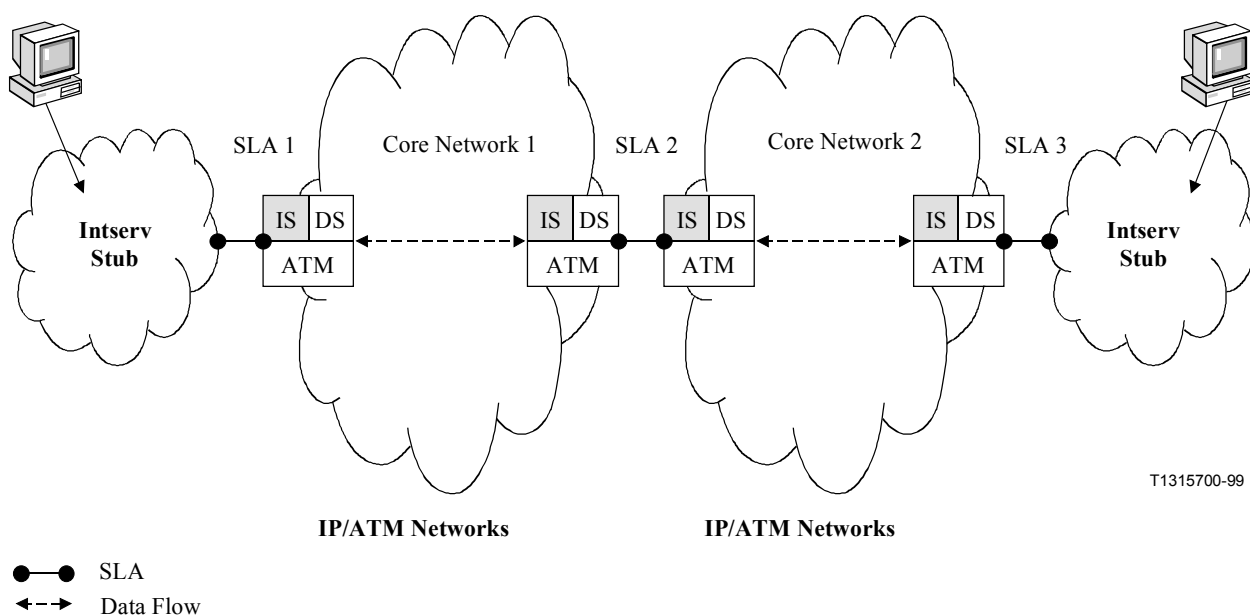


**Figure 7-1/Y.1310 – Network model to support Intserv over ATM**

### Case 2 – Diffserv over ATM networks

In this model, communication between two Diffserv stub networks is supported over IPOA core networks. The IPOA devices in the core networks may provide both Intserv and Diffserv capabilities. However, only Diffserv functionality of the IPOA devices will be activated to support end-to-end differentiated services. Both service level agreements (SLA 1 and SLA 2) require that the requirements for Diffserv service are satisfied.

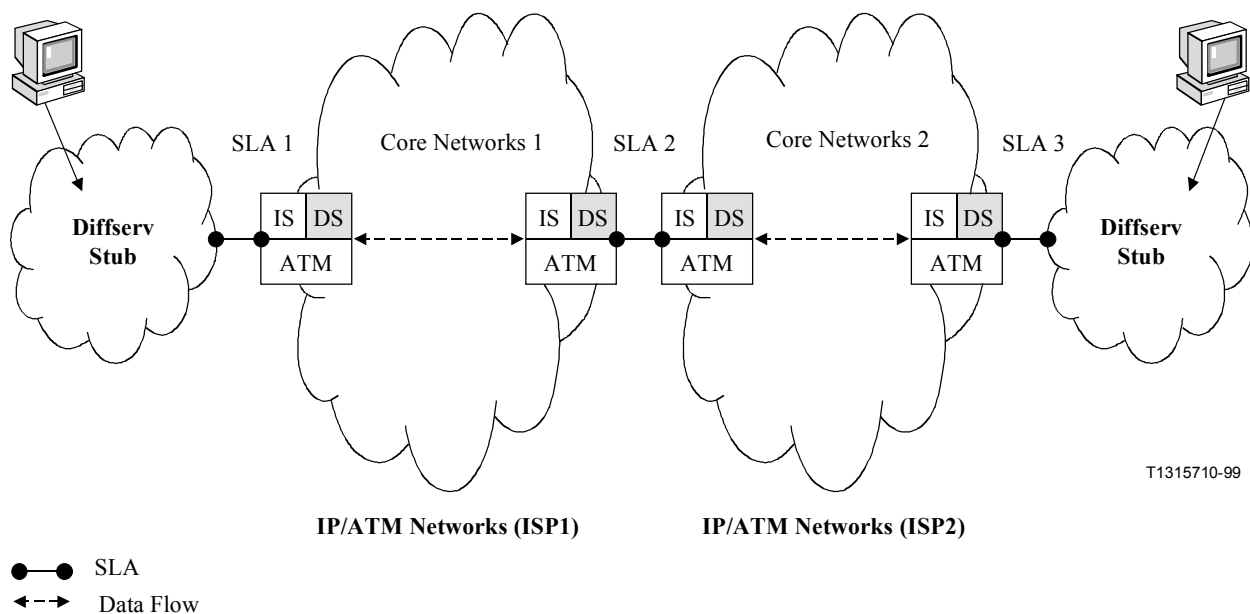


**Figure 7-2/Y.1310 – Network model to support Diffserv over ATM**

### Case 3 – Intserv through Diffserv domains over ATM networks

In this model, communication between two Intserv stub networks is supported over IPOA core networks. In the IPOA core networks, some domains may provide only Diffserv, and the others may provide both Intserv and Diffserv capabilities. In this case, the Intserv may be transparently transported over Diffserv only domains. In this case there are two types of service level agreement.

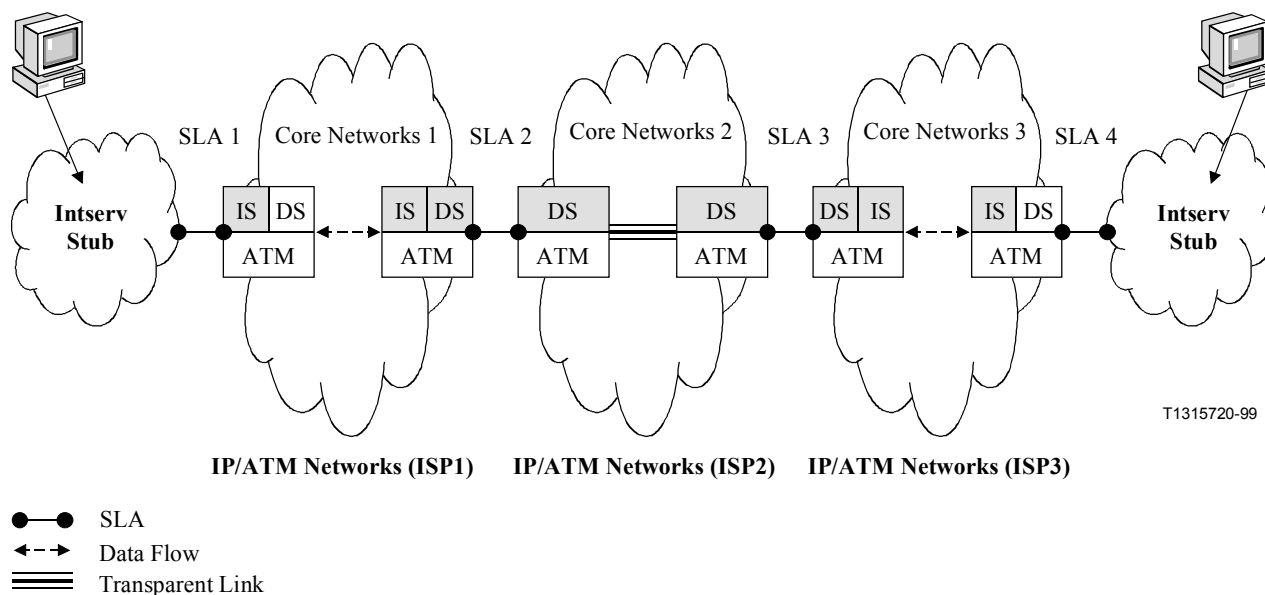


**Figure 7-3/Y.1310 – Network model to support Intserv through Diffserv domains over ATM**

#### 7.1.3 List of service mapping functions

The service mapping functions do not depend on the architecture of the surrounding network but only on the way IP and ATM QoS is supported on both sides of the interface where the mapping is needed. Figure 7-4 thus displays the necessary set of possible IP services to ATM services mappings of the considered framework architecture (refer to clause 6).

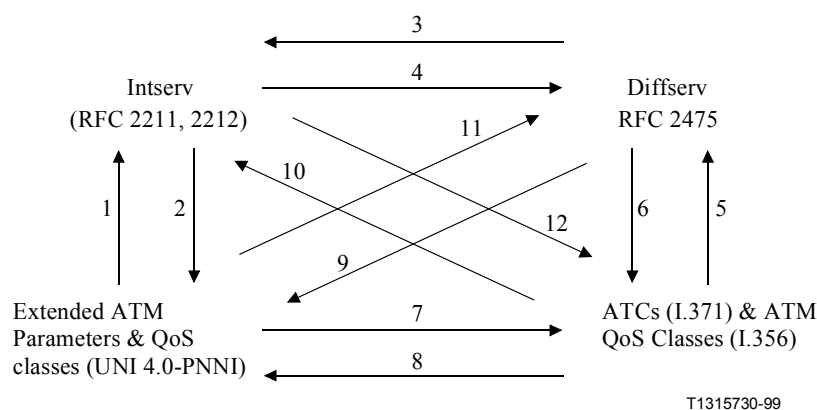


**Figure 7-4/Y.1310 – List of service mapping functions**

Among all these mappings, only mappings 6 and 12 are addressed in this Recommendation. Note that in this case at the egress of this ATM portion, there is no need of a mapping function of type 5 or 10, as in the destination IP network the support of QoS is totally based on the IP level information which is transparently carried by the ATM portion. Mappings 5 and 10 might be

required in the case of native ATM traffic having to cross or reach a pure IP network, and are for further study.

Mappings 3 and 4 pertain to the IP domain only and are part of activity within the IETF, whereas all the mapping originating/terminating into the extended ATM parameters and QoS classes (supported in private ATM networks) is part of ATM Forum's work.

#### **7.1.4 Mapping of IP integrated services to ATM services**

The issue of Intserv to ATM mapping arises whenever an IP flow requesting Guaranteed Services (GS) [GUAR\_SER] or Controlled Load Services (CLS) [CONTROL\_SER] must be supported by an ATM connection linking two Intserv capable routers, and it is independent from the specific approach to support IP over ATM.

Two different kinds of mapping are foreseen: one to one mapping and many to one mapping.

##### **7.1.4.1 One to one mapping**

One to one mapping occurs when a single ATM connection is entirely devoted to the support of a single IP flow. Specifically, the mapping process consists of the choice of an ATM service (i.e., ATC and associated QoS class) that can satisfy the QoS commitments of the IP service (GS or CLS), and in that view, several mappings are possible. More generally, however, the mapping process can be additionally thought as a way to communicate to the ATM level additional information regarding the characteristics of the carried flow, so that the downstream ATM network can make use of this information to efficiently carry the connection (e.g., multiplex it with others). In that view, one can rank all the possible mappings, and some mappings are better than others.

##### **7.1.4.2 Many to one mapping**

Many to one mapping occurs when a single ATM connection can carry more than one IP flow. In that case the mapping process consists in the choice of an ATM service that can satisfy the QoS commitments of a set of IP flows. As IP flows normally start and end asynchronously, this mapping can be viewed as an aggregation process which on the basis of the flow's IP level characteristics (e.g., token bucket and requested QoS), decides on the possibility of carrying the flow together with others on an already existing ATM connection (while still meeting the QoS constraints of the IP flow), or on the need of re-negotiating the connection's parameters.

Rules on how to take such a decision are outside the scope of this Recommendation.

##### **7.1.4.3 Mapping of Guaranteed Service (GS) to ATM**

ATM does not require any extensions to perform these mappings. However, the mapping scheme chosen should satisfy the following requirements:

- The chosen ATC must be one able to support delay requirements.
- The chosen ATC must be one able to reserve some bandwidth for the flow.

Appendix II provides suggestions on guidelines for implementation of the mappings.

##### **7.1.4.4 Mapping of Controlled Load Service (CLS) to ATM**

ATM does not require any extensions to perform these mappings. Appendix II provides suggestions on guidelines for implementation of the mappings. However, the mapping scheme chosen should satisfy the following requirement:

- The chosen ATC must be one able to reserve some bandwidth for the flow.

##### **7.1.4.5 Impact on ATM traffic management**

For further study.