Section 1:

Introduction

In the emerging field of high speed virtual networking, Asynchronous Transfer Mode (ATM) is a key component. ATM is a telecommunications concept defined by ANSI and ITU (formally CCITT) standards for carriage of a complete range of user traffic, including voice, data, and video signals, on any User-to-Network Interface (UNI). As such, ATM is extremely well suited to high speed networking in the 1990s. ATM technology can be used to aggregate user traffic from existing applications onto a single UNI (e.g. PBX tie trunks, host-to-host private lines, video conference circuits), and to facilitate multi-media networking between high speed devices (e.g. workstations, supercomputers, routers or bridges) at multi-megabit speeds (e.g. 150 Mbit/s).

On the basis of its numerous strengths, ATM has been chosen by standards committees (e.g. ANSI T1, ITU-T SG13) as an underlying transport technology within many Broadband Integrated Services Digital Network (B-ISDN) protocol stacks. In this context, "transport" refers to the use of ATM switching and multiplexing techniques at the data link layer (i.e., OSI Layer 2) to convey end-user traffic from source to destination within a network.

While B-ISDN is a definition for public networks, ATM can also be used within private networking products. In recognition of this fact, and for clarity, this document defines two distinct forms of ATM UNI:

1. Public UNI - which will typically be used to interconnect an ATM user with an ATM switch deployed in a public service provider's network,

2. Private UNI - which will typically be used to interconnect an ATM user with an ATM switch that is managed as part of the same corporate network (e.g., MIS department responsible for the user device is also responsible for the private ATM switch).

The primary distinction between these two classes of UNI is physical reach. There are also some functionality differences between the public and private UNI due to the applicable requirements associated with each of these interfaces. Both UNIs share an ATM layer specification, but may utilize different physical media. Facilities that connect users to switches in public central offices must be capable of spanning long distances. In contrast, private switching equipment can often be located in the same room as the user device (e.g. computer, PBX), and hence can use limited distance technologies.

The term "ATM user" represents any device that makes use of an ATM network, via an ATM UNI, as illustrated in Figure 1-1.

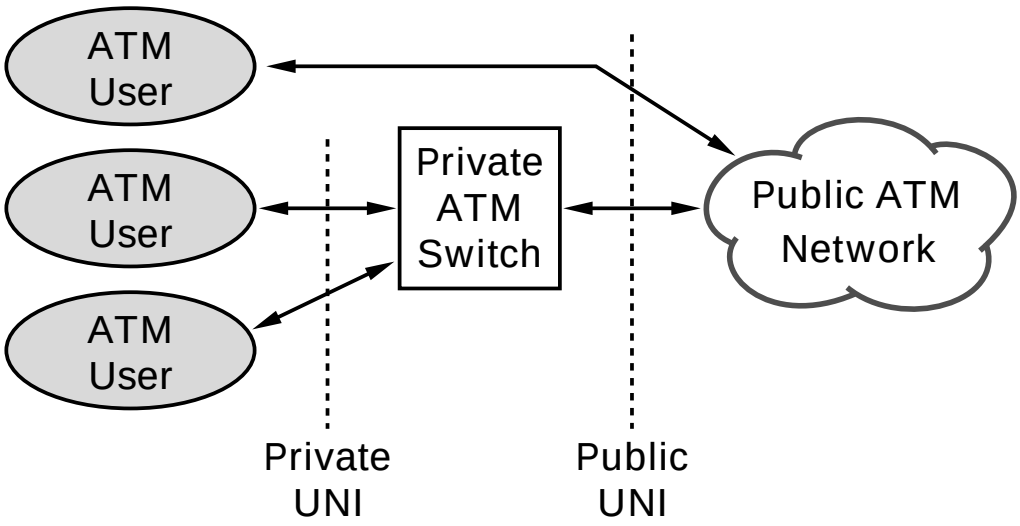


Figure 1-1 Implementations of the ATM UNI

For example, an ATM user device may be either of the following:

- An Intermediate System (IS), such as an IP router, that encapsulates data into ATM cells, and then forwards the cells across an ATM UNI to a switch (either privately owned, or within a public network),

- A private network ATM switch, which uses a public network ATM service for the transfer of ATM cells (between public network UNIs) to connect to other ATM user devices.

The carriage of user information within ATM format cells is defined in standards as the "ATM Bearer Service". Implementation of an ATM bearer service involves the specification of both an ATM protocol layer (Layer 2) and a compatible physical media (Layer 1).

1.1 Purpose of Document

This document is a specification of the interface(s) to be used between:

- ATM user devices and private ATM network equipment (operating as Customer Premises Equipment (CPE)
- ATM user devices and public ATM network equipment
- Private ATM network equipment and public ATM network equipment.

It defines "standards based" (when possible) Layer 1 and Layer 2 protocols needed for early interoperability. Layer 3 protocol is also defined for UNI signalling.

This document does not specify upper layer protocols to ensure multi-vendor compatibility of end-user devices[1] (e.g. method of encapsulating application data within network layer PDUs, choice of ATM adaptation layer for segmenting application PDUs into ATM format cells).

1.2 Scope of Document

The scope of the document includes the following:

- Background information on ATM technology and protocols used for broadband networking.
- The initial service attributes defined at the User-Network Interface.
- The set of physical layer specifications supported for the carriage of ATM cells.
- The ATM Layer specification which is common for all the physical layer interfaces specified.
- The Interim Local Management Interface (ILMI) specification.
- The signalling protocols and procedures used across the UNI for call control.

1.3 Structure of Document

This document is structured as follows:

- Section 1 constitutes the Introduction. It first describes the purpose, scope and structure of this document. It also introduces some basic ATM network concepts and provides a description of the initial service capabilities offered at the User-Network interfaces. Finally it describes the equipment configuration and protocol layers involved at the interfaces.
- Section 2 provides the specification of the physical layer interfaces for connecting ATM equipment (user or network).
- Section 3 specifies the ATM layer requirements common to all physical layer interfaces.
- Section 4 contains the Interim Local Management Interface (ILMI) specification.
- Section 5 contains the UNI Signalling specification.
- Annexes A through E contains additional signalling requirements.
- Appendix A contains the Quality of Service guidelines.

[1] Except to support ILMI across the UNI.

- Appendix B contains the Conformance Examples in a Traffic Contract
- Appendix C contains explanatory information for multipoint signalling state machines.
- Appendix D contains examples of signalling codlings.
- Appendix E contains a listing of differences with draft recommendation Q.2931.
- Appendix F is a glossary of terms and acronyms.

1.4 Terminology

In the context of this document, the term “UNI” is used generically to indicate interfaces to both public or private ATM networks. In the same manner, the generic term “ATM switch” refers to public or private switches. The terms “private ATM switch” and “public ATM switch” are used when a specific requirement or definition applies to only a private or public ATM switch. The definitions of “ATM user”, “Public UNI”, and “Private UNI” are as provided in the Introduction (Section 1). Additionally, two more terms are defined as follows:

- Public Network Interface, which is synonymous with “Public UNI”
- Private Local Interface, which is synonymous with “Private UNI”

This document uses three levels for indicating the degree of compliance necessary for specific functions/procedures/coding associated with the UNI:

- **Requirement (R)** : functions, procedures and coding necessary for operational compatibility.
- **Conditional Requirement (CR)** : functions, procedures and coding necessary providing the specified optional function is implemented.
- **Option (O)** : functions, procedures and coding that may be useful, but are not necessary for operational compatibility.

This document also uses the term “byte” (8-bit byte) which is synonymous with “octet”.

1.5 ATM Bearer Service Overview

The concept of service as described in this section mainly applies to the Public Network Interface. However, in most cases the same service attributes are available at the Private Local Interface too.

The ATM bearer service, as defined by ANSI and ITU standards, provides a sequence-preserving, connection-oriented cell transfer service between source and destination with an

agreed Quality of Service (QoS) and throughput. The ATM bearer service[2] involves at a minimum the two lower protocol layers (ATM, Physical) of the B-ISDN protocol stack as described in section 1.7. These two layers are service-independent and contain functions applicable to all upper layer protocols (i.e. they are independent of user applications). Additionally, the ATM bearer service may involve the C-Plane adaptation layer and signalling protocol for SVC service. U-Plane adaptation layers, which reside above the ATM layer, have been defined in standards to adapt the ATM bearer service to provide several networking classes of service including Constant Bit-Rate (CBR) and Variable Bit-Rate (VBR) services.

An ATM bearer service at a Public UNI is defined in this document to offer point-to-point, bi-directional or point-to-multipoint uni-directional virtual connections at either a virtual path (VP) level and/or a virtual channel (VC) level. Networks can provide either a VP or VC (or combined VP and VC) level service. For ATM users that desire only a VP service from the network, the user will be able to allocate individual VCs (which are not reserved or allocated for ILMI) within the VP connection (VPC) as long as none of the VCs is required to have a higher QoS than the VP connection. QoS of a VPC can be either explicitly specified at subscription time or implicitly specified (through a variety of mechanisms) and is selected to accommodate the most demanding QoS of any VC to be carried within that VPC. For VC level service at the UNI, the QoS and throughput are configured for each virtual channel connection (VCC) individually. The virtual connection (VPC or VCC) will be established or released via the signalling protocol or on a subscription basis.

The ATM bearer service attributes to be supported by network equipment conforming to this UNI specification are shown in Figure 1-2. Figure 1-2 indicates implementation requirements and does not imply services provided.

[2] Also referred to as the B-ISDN Class X service.

ATM Bearer Service Attribute	Private UNI	Public UNI
Support for point-to-point VPCs	Optional	Optional
Support for point-to-point VCCs	Required	Required[1]
Support for point-to-multipoint VPCs	Optional	Optional
Support for point-to-multipoint VCCs, SVC	Required	Required[1]
Support for point-to-multipoint VCCs, PVC	Optional	Optional
Support of Permanent Virtual Connection	Required[2]	Required[2]
Support of Switched Virtual Connection	Required[2]	Required[2]
Support of Specified QoS Classes	Optional	Required[3]
Support of an Unspecified QoS Class	Optional	Optional
Multiple Bandwidth Granularites for ATM Connections	Optional	Required
Peak Rate Traffic Enforcement via UPC	Optional	Required
Sustainable Cell Rate Traffic Enforcement via UPC	Optional	Optional
Traffic Shaping	Optional	Optional
ATM Layer Fault Management	Optional	Required
Interim Local Management Interface	Required	Required

Note 1: Public ATM network equipment conforming to this interface specification shall be capable of providing ATM users with either a VPC service, or VCC service, or combined VPC/VCC service.

Note 2: ATM network equipment conforming to this interface specification shall be capable of providing ATM users with either support for PVC or SVC capability or both.

Note 3: Only one of the specified QoS connection categories is required at the Public UNI (see §4.1).

Figure 1-2 ATM Bearer Service Attributes

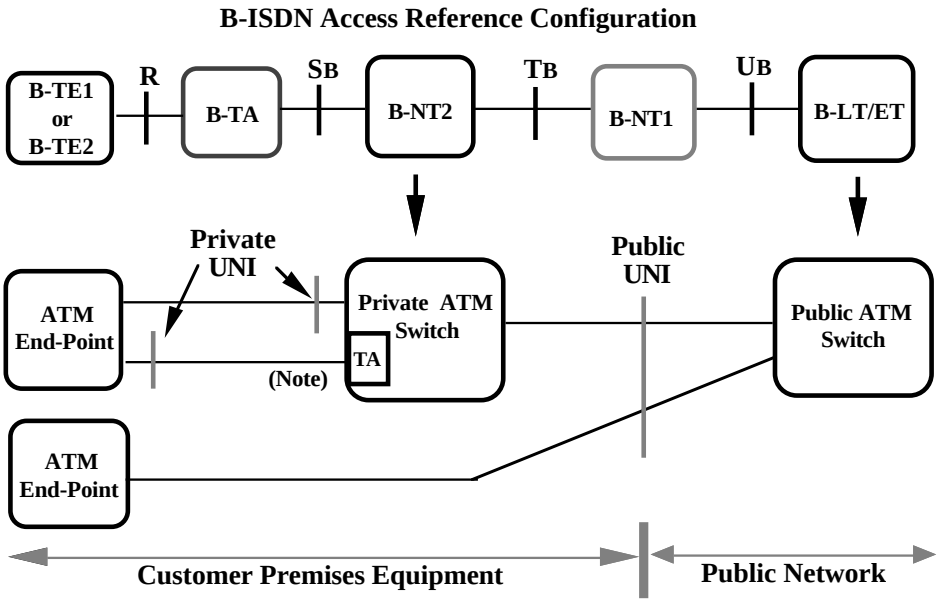
Two categories of QoS classes are defined initially, Specified QoS classes and an Unspecified QoS class. The specified QoS classes are initially aligned with the types of service defined for the ATM Adaptation Layers. The detailed definitions of the QoS classes are given in section 4 of Appendix A.

1.6 User-Network Interface Configuration

Figure 1-3 illustrates how equipment at both the Private UNI and Public UNI, as defined in this document, map into the B-ISDN access reference configuration shown in standards. The B-ISDN access configuration and interface definition at each reference point as well as the complete description of the functional entities can be found in ANSI T1E1.2/92-020, ITU-T Recommendation I.413.

The Public UNI is modeled after the B-ISDN User-Network interface defined in ITU Recommendations and ANSI Standards. It embraces the physical characteristics corresponding to both U_B and T_B reference points. The Public UNI defined in this document specifies the criteria for connecting Customer Premises Equipment (e.g. ATM end-points and private ATM switch) to a public service provider's ATM switch.

The Private UNI is an interface that is optimized for local campus or "on premises" applications. It provides an alternative physical layer interface for short distance links with reduced operation and management complexity. The Private UNI, defined in this document, specifies criteria for connecting User equipment (e.g. workstation, router) to a private (on-premises) ATM switch.



Note: The "R" reference point indicates a non-B-ISDN standard interface (e.g. Both block coded interfaces). In this case, the TA functionality is limited to physical layer conversion.

Figure 1-3 User-Network Interfaces Configuration

1.7 User-Network Interface Protocol Architecture

The B-ISDN protocol reference model defined in ITU-T Recommendation I.121 is shown in Figure 1-4. The reference model is divided into multiple planes as follows:

U-plane: The User plane provides for the transfer of user application information. It contains Physical Layer, ATM Layer and multiple ATM Adaptation Layers required for different service users (e.g. CBR service, VBR service).

C-plane: The Control plane protocols deal with call establishment and release and other connection control functions necessary for providing switched services. The C-plane structure shares the Physical and ATM layers with the U-plane as shown in Figure 1-4. It also includes ATM adaptation layer (AAL) procedures and higher layer signalling protocols.

M-plane: The Management plane provides management functions and the capability to exchange information between U-plane and C-plane. The M-plane contains two sections: Layer Management and Plane Management. The Layer Management performs layer-specific management functions while the Plane Management performs management and coordination functions related to the complete system.

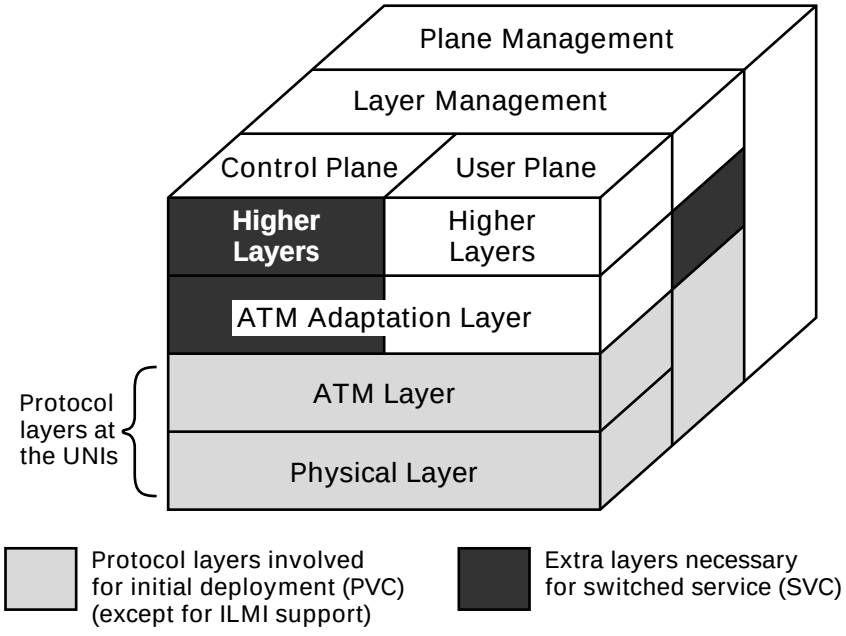


Figure 1-4 B-ISDN Protocol Reference Model

The UNI specification involves those protocols which are either terminated or manipulated at the user-network interfaces. Based on the ATM bearer service capabilities defined in Section 1.5, the protocol layers involved at both UNIs are limited to the Physical and ATM layers, C-plane higher protocol layers for SVC support and other protocols required for UNI management. Many physical layers (e.g. SONET, DS-3) can be specified at both the private or public User-Network Interfaces. Additional physical layers (e.g. block-coded) are specified for the private UNI. The applicability of any physical layer at a given interface will depend on technology limitations (e.g. maximum reach) or cost effectiveness (e.g. complexity). The UNIs may also contain Physical Layer Management functions (e.g. SONET-OAM) and ATM Layer Management functions. Since the initial ATM bearer service will support PVC only, no C-plane protocol layers are involved at the UNI.