Module 4: Broadband Network Management

4.1 Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN
4.2 ATM Network Management – ATM network reference model, integrated local management interface. ATM management information base, role of SNMP and ILMI in ATM management.
4.3 M1, M2, M3, M4 interface. ATM digital exchange interface management

4.1 Broadband networks and services

As new technologies emerge, service providers offer new services to commercial and residential communities using those technologies. In turn, offerng of new services by service providers is propelling information technology to new heights.

The broadband network and the narrowband Integrated Services Digital Network (ISDN) are multimedia networks that provide integrated analog and digital services over the same network. Narrowband ISDN is low -bandwidth network that can carry two 56 kilobaud rate channel. The broadband network can transport very high data rate signals. The narrowband ISDN is also known as Basic ISDN.

There are three types of information technology services: voice, video and data. In the traditional terminology, voice and video services are transported over the telecommunication network. The information may be transported over telecommunication facilities in either an analog or a digital mode. The telecommunication network can be topologically separated into a wide area network (WAN) and local loops. The former serves transportation over long distance between switching offices, and the latter coves the “last mile” from the switching office to the customer premises.

Data services are transported over the computer network, which is made up of LANs and WANs. The switches are multiplexers in the telecommunication network, which is made up of LANs and WANs. The switches and multiplexersin the telecommunication ntwork are replaced with bridges, routers and gateways. The computer network uses the facilities of the telecommunication network for transportation over WAN.

The broadband network has several interpretations. One of the chief characteristics of broadband service is the integration of voice, video and data services over the same transportation medium; in other words, it is multimedai transportation networking. Sometimes, the broadband network is confused with high-speed data network, either dedicated or combined with real-time voice or video, especially in the data traffic arena. However, we limit our defination of the broadband network to those that can handle multimedia service of voice, video and data. The broadband network is also called the Broadband Integrated Services Digital Network (B-ISDN).

The early form of the integrated services network is the Basic ISDN. It consists of two basic channels: B-channels, 56- Kilobaud rate each, combined with an 8- kilobaud signalling channel, D-channel. Together, they are refered to as 2B+D.

It is called narrowband ISDN. However, online video requires a much larger bandwidth. Besides, voice and video require low latency and latency fluctuations, which are achieved by ATm technology. They necessities have led to the early implementation of broadband ISDN, more succinctly referred to as the broadband network.

The broadband network and services have contibuted significantly to advances in three network segments of WAN, access network, and home/customer premises equipment (CPE) network. In the WAN segment, protocols used in addition to IP are the asynchronous transfer mode(ATM), the Synchronous Optical Network (SONET) , the Synchronous Digital Hierarchy (SDH), and Multiprotocol Label Switching (MPLS). The ATM technology can be viewed as a hybrid of circuit- and packet- switched transmission modes. As a switch, the ATM switch makes a physical connection of a virtual circuit. However, the data are transmitted as cells (or packets) unlike in a circuit-switched connection.
The data rate of SONET/SDH WAN is an integral multiple of basic OC-1 (Optical carrier-1) STS (Synchronous Transport Signal), which is 51.84 Mbps. MPLS, evolved as the broadband protocol and takes advantage of the high performance of ATM and the richness in features of IP and Ethernet.

Broadband access technology is implemented using one of five technologies. Hybrid fiber coax (HFC) or cable modem technology is a two-way interactive multimedia communication system using fiber and coxial cable facilities and cable modems. The second technology uses a digital subscriber line (DSL). There are several variations of implementing this, generically referred to as xDSL. For example,ADSL stands for Asymmetric DSL.

The third and fourth technologies use wireless transmission from the switching office or the head end to the customer premises. Transmission in the two cases is either terestrial or via a satellite. The fifth technology is the mobile wireless technology.

Mobile wireless technology is deployed as either access technology using GSM (Global System for Mobile Communications)/ GPRS (General packet Radio Service) or CDMA (Code Division Multiple Access) or as a home/CPE network using WiFi (IEEE 802.3) protocol.

Figure 1 shows a broadband network. The WAN is MPLS/IP/ATM. The WAN is linked to the customer premises using either optical links, OC-n (Optical Carrier-n) /STS (Synchronous Transport Signal), or a broadband link with emerging access technology (HFC, xDSL, or wireless).

The customer network consists of two classes, residential customers and corporate customers with campus-like network. The residential customers are either residential customers and corporate customers with campus-like network. The residential customers are either residential homes or small corporations that use broadband services, but do not require the high-speed access network to WAN. Corporate customers need high-speed access and connect opticl or synchronous (E1/T1) links

Radio, video(television), Internet Service Provider (ISP) and other service providers constitute the service providers. Multiple services are multiplexed at the central office or the multiple Service Operator (MSO) head end and are piped to the customer premises via common facilities. The service providers interface with wan via gateways.

The management of a broadband network is more complex than that of either the conventional computer network, which is mostly based on IP or the telecommunication network. It is based on MPLS and ATM WAN technology and broadband access technology.

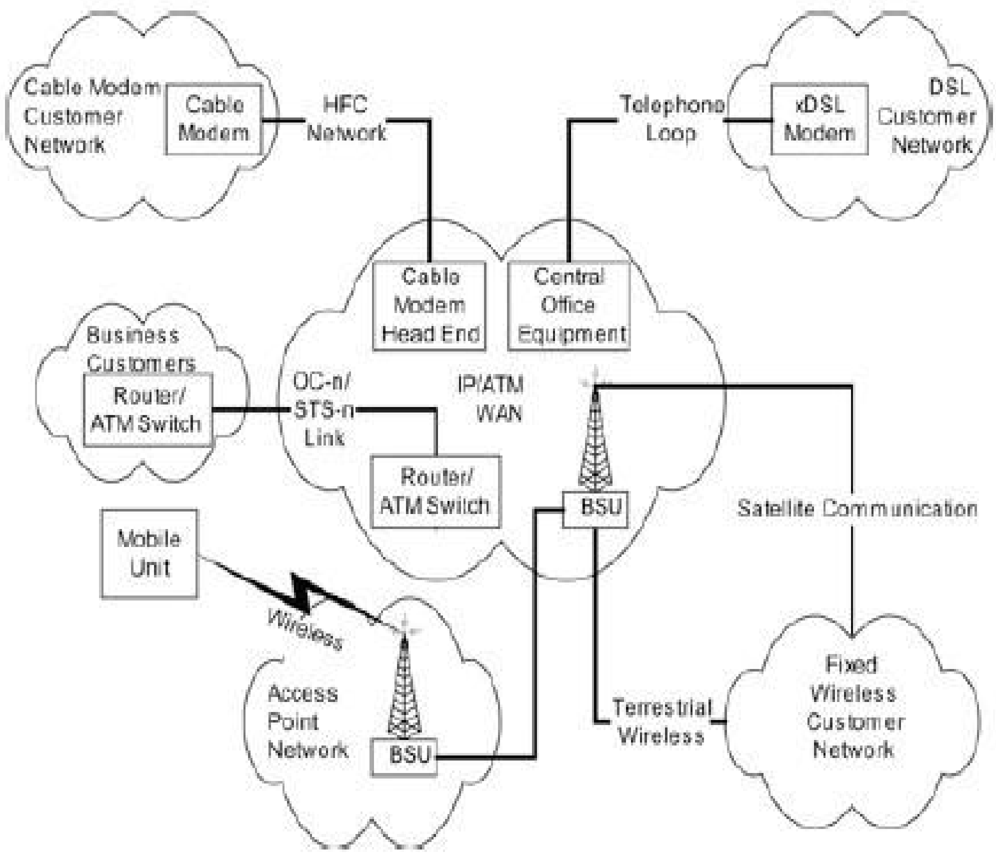


Figure 1: Broadband Service Networks

An ATM network is based on switches with point -to-point connections (in contrast to one-to-many connections as in broadcast/multicast protocols). It is also a connection-oriented protocol and needs to be integrated in the connectionless Internet environment. These provide challenges to the management of an ATM network. The ATM network is slowly migrating to the MPLS network. However ,it is still in extensive use .The MPLS protocol can be used with either ATM or IP and the management requirements and the management information bases(MIBs) are still evolving.

ATM Technology

The ATM has helped bring about the merger of computer and telecommunication networks. There are five important concepts comprising ATM technology. They are :
1] virtual path-virtual circuit (VP-VC)
2] fixed packets size or cells
3] small packet size
4] statsitical multiplexing
5] integrated services

The implementation of these concepts in a network that is made up of ATM switches achieves high-speed network that acan transport all three services (voice, video, and data). The desired quality of service is provided to individual streams (unlike the current Internet) at the same time. The network is also easily scaleable. The ATM Forum, an organization that specifies standards for ATM implementation, has also provided a framework for network management.

4.1.1 Virtual Path- Virtual Circuit-switched

Cell transmission mode:

It combines the best of the circuit and packet switched modes of transmission as shown in figure 2. The packets are all of the same size and are small in size. Each cell has the full bandwidth of the medium, and the cells are statistically multiplexed. The packets all take the same path using the VP-VC concept. This mode of transmission is called the aynchronous transfer mode (ATM) and is one of the fundamental concepts of ATM technology.

Figure 2 : Cell Transmission (ATM)

Figure 3.a and 3.b shows the distinction between the datagram and the virtual circuit configuration.

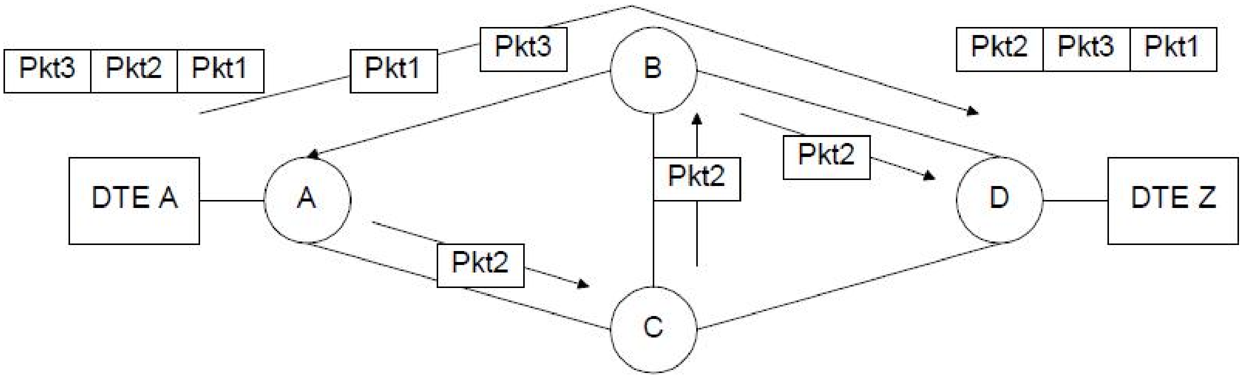
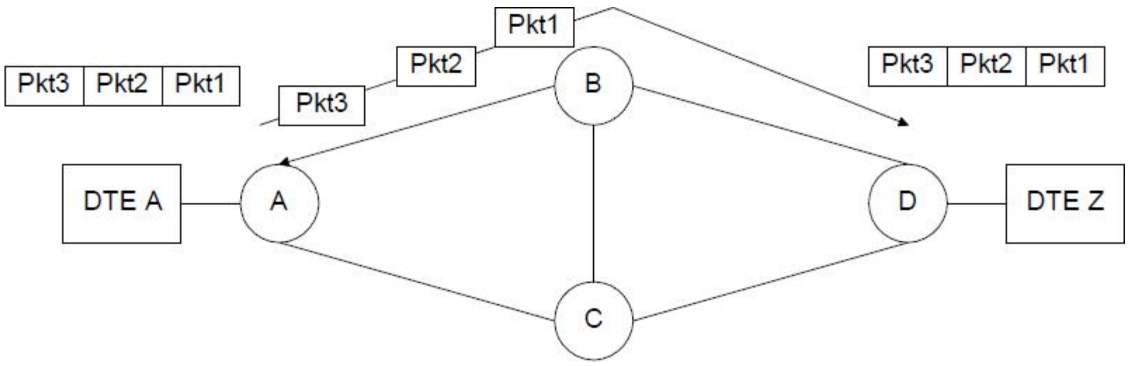


Figure :3.a Datagram Configuration



3.b :Virtual Circuit Configuration

Figure 3 :Packet Switched Configuration

In ATM technology, the virtual circuit configuration is used. A virtual circuit that has been established between two stations A and Z is shown in figure 4. The routing tables in the ATM switches, A, B,and D associated with this virtual circuit is shown in the table. The virtual circuit is first established prior to sending the data. In our example, the virtual circuit is the combination of virtual circuits links VCI-1, VCI-2, VCI-3 and VCI-4. Once the virtual circuit is established, all packets are transported in the sequence in which they were transmitted by the source along the same path for a given session. Thus, packets 1, 2 and 3 transmitted by Station A arrive at Station Z in the correct sequence traversing the same links. Since the path is fixed for the entire session, the transmission rate is considerably increased just as in circuit-switched TDM transmissions.

Although there is enhanced speed of tranmsission of packets, there is delay associated with pre-establishing the links for the virtual circuit. This delay is reduced by pre-assigning links to a virtual circuit. This is done by grouping a number of virtual circuits between two switches into a virtual path. A virtual path identifier (VPI) comprises virtual circuit identifeirs (VCIs). Thus establishing the route from Station A to Station Z in our example is to do a lookup of the VPI-VCI tables. The price that we pay for adopting this mechanism is that some VCIs may remain idle during non-busy traffic period, and thus waste the bandwidth. However, this waisted bandwidth is a lot less than that for dedicated physical links in a circuit switched transmission mode.

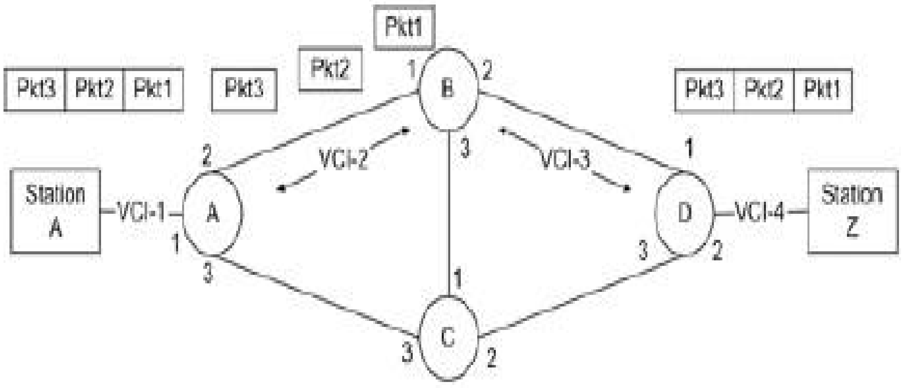


Figure 4: Virtual circuit Configuration

Table: A-Z Virtual circuit routing table

Switch	Input VCI/Port	Output VCI/Port
A	VCI-1/Port-1	VCI-2/Port-2
	VCI-2/Port-2	VCI-1/Port-1
B	VCI-2/Port-1	VCI-3/Port-2
	VCI-3/Port-2	VCI-2/Port-1
D	VCI-3/Port-1	VCI-4/Port-2
	VCI-4/Port-2	VCI-3/Port-1

The VP-VC can be established on a per session basis or on a permanent basis between a pair of end stations that carry large volumes of traffic. In the former case, the circuit is established as and when the connection is established for long periods of time and not switched between sessions, a permanent Virtual circuit (PVC) is established.

ATM packet Size

ATM packets are of fixed size, each 53 bytes long. A fixed-size packet was chosen so that fast and efficient switches can be built. Many switches can operate in parallel if they all perform switching on the same-size packets.

The ATM packet size of 53 bytes has a header of 5 bytes and a payload of 48 bytes. This size was arrived at by optimizing between two factors. The packet size should be as small as possible to reduce the delay in switching and packetization. However, it should be large enough to reduce the overhead of the header relative to the payload.

Header	**Payload**
5 bytes	48 bytes

Integrated Service

The main challenge in integrating the three services is to meet the diffeent requirements of each. Voice and video traffic require low tolerance on variations in delay and low end-to-end (roundtrip) delays for good interactive communication. Once voice data are lost or delayed, real-time communication is garbled and we cannot reproduce it. Thus, it has to be given the highest priority of service in transmission. This is true with the voice portion of the information in video transmission. Further, the voice and video have to be synchronized. Otherwise, it will be like watching a movie with the conversation lagging behind the mouth motion due to wrong threadings of the film. Pure video without sound can have less priority than audio.

Data traffic can have a much higher tolerance on latency. It is primarily a store and forward technology and the traffic itself is inherently bursty in nature. However, data speed is important for large data transmission applications, although it has the lowest priority in transmission.

It is possible to set the priority in ATM switches by assigning priority to the different services. This is accomplished by guaranteeing a quality of service (QoS) for each accepted call setup. A traffic descriptor is specified by the user of the service, and the system ensures that the service requested could be met by the virtual circuit that is set up.
There are four main classes of traffic defined to implement quality of service. They are the constant bit rate (CBR), the real-time variable bit rate (VBR-rt), the non-real-time variable bit rate (VBR-nrt), and the available bit rate (ABR). Voice is assigned CBR. Streaming video such as real-time video on the Internet is assigned VBR-rt. The VBR-nrt is applicable to transmission of still images. The IP data traffic gets the lowest bandwidth priority with ABR.
There are two markets for ATM switches using ATM technology, public and private. A public network is the network that is established by the service prividers. A private network is primarily a campus network.

ATM LAN Emulation

It was once considered posible that ATM would be at all desktop workstations. However, this has not been the case and IP over Ethernet has become the most used LAN.

The services provided by ATM differ from conventional LAN in three ways. First, ATM is connection oriented. Second, ATM makes one-to-one connection between pairs of workstations in contrast to the broadcast and multicast mode in conventional LAN. Third, a LAN MAC address is dedicated to the physical network interface card and is independent of network topology. The 20-byte ATM address is not.
In order to use ATM in the current LAN environment, it has to fit into the current TCP/IP LAN environment. Because of the basic differences mentioned in the previuos paragraph, although the ATM Forum has developed ATM specifications for LAN emulation (LE or LANE) that emulates services of the current LAN network across an ATM network, it has been discontinued.

4.2 ATM Network Management

Broadband network management consists of managing the WAN using ATM technology as well as access networks from the central office to the home.

WAN facilities are provided by public service providers, who perform the following management functions: Operation, Adminstration, Maintenance and Provisioning (OAPM). Typically, a large enterprise or corporation services its private network. However, they too use the public service providers' facilities to transport information over a long distance. This is referred to as public network.

ATM networks are classified as private and public networks as shown in figure 5. The standards for the management of each and the interactions between them have been addressed by the ATM Forum, which is an international organization accelerating cooperation on ATM technology.

The user interface to the private network is the private user-network interface (UNI) and the interface to the public network is the Public UNI.

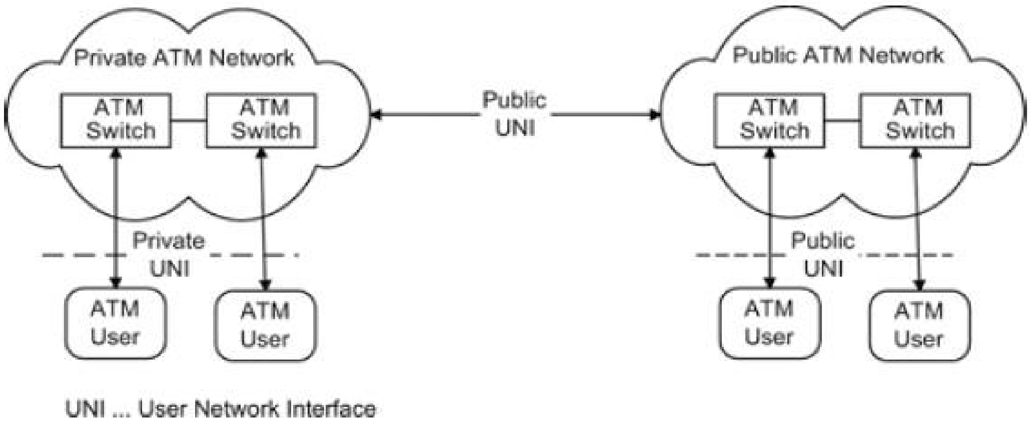


Figure 5: Private and Public ATM Network user Network Interfaces

ATM Network Reference Model

The ATM Forum has defined a management interface architecture, ATM network reference model, as shown in Figure 6. Private networks are managed by private network managers or private network management systems (NMss). Public network managers or public network management systems manage the public networks.

There are five interfaces between systems and netwoks. M1 and M2 are, respectively, the interfaces between private NMS and either end user or private network. The end user can be a workstation, ATM switch or any ATM device. A private ATM network is an enterprise network.

A private NMS can access is own network-related information in a public network via an M3 interface to the public NMS. The public NMS, which manages the public network, responds to the private NMS via the M3 interface with the relevant information or takes the appropriate action requested.
M4 is the interface between a public NMS and a public network. M5 is the interface between NMSs of two service providers.

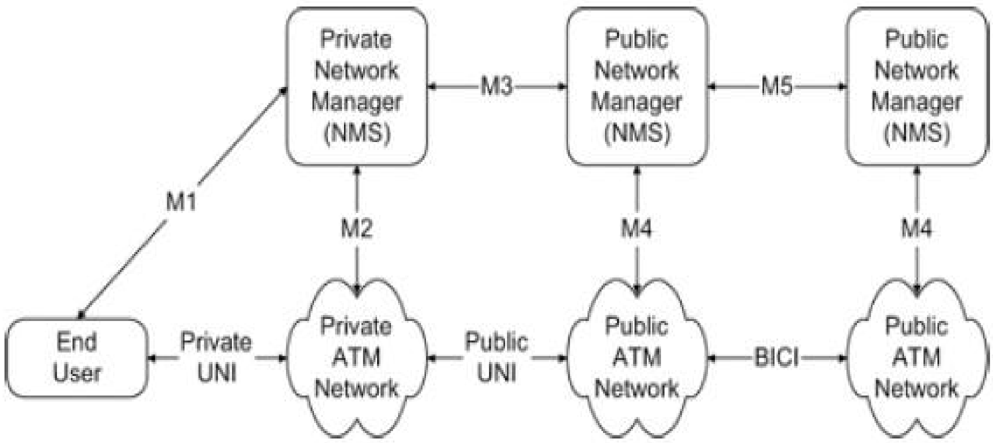


Figure 6: ATM Forum Management Interface Reference Architecture

Integrated Local management Interface

Beside the M-interfaces, Figure 6 also shows interfaces between an ATM end user or device and an ATM network, as well as interfaces between ATM networks. These are distinct from the M-interfaces between NMSs and networks or end users. While the M-interfaces provide a top-down management view of network or devices, the ATM Forum defines the ATM link-specific view of configuration and fault parameters across a UNI. These are the UNI interfaces presented in Figure 5 and 6.

The “ I” in ILMI originally stood for “Interim,” not “Integrated”. Its specifications were supposed to have been replaced by IETF specification. However, it turned out that some were and others were not. Hence, “I” in ILMI now designates Integrated. The ILMI fits into the overall model for anATM device , as shown in Figure 7. The ATM management information is communicated across the UNI or the network-to-network interface (NNI). These interfaces are with ATM devices (end-systems, switches, etc.) that belong to either a private or a public network.

Any interface with the public ATM netwrok is a public UNI or a public NNI. Any interface with a private ATM network is a private UNI or a private NNI. The devices communicates across UNI and NNI avia an ATM interface management entity (IME) mudule in the entity. There are three versions of IME- user, network and system based on where it is used.

Figure 7 shows the various physical connections, virtual connections and the ILMI communication links between the devices and the networks. The ILMI communication occurs over both physical and virtual links using SNMP or AAL5 protocols.

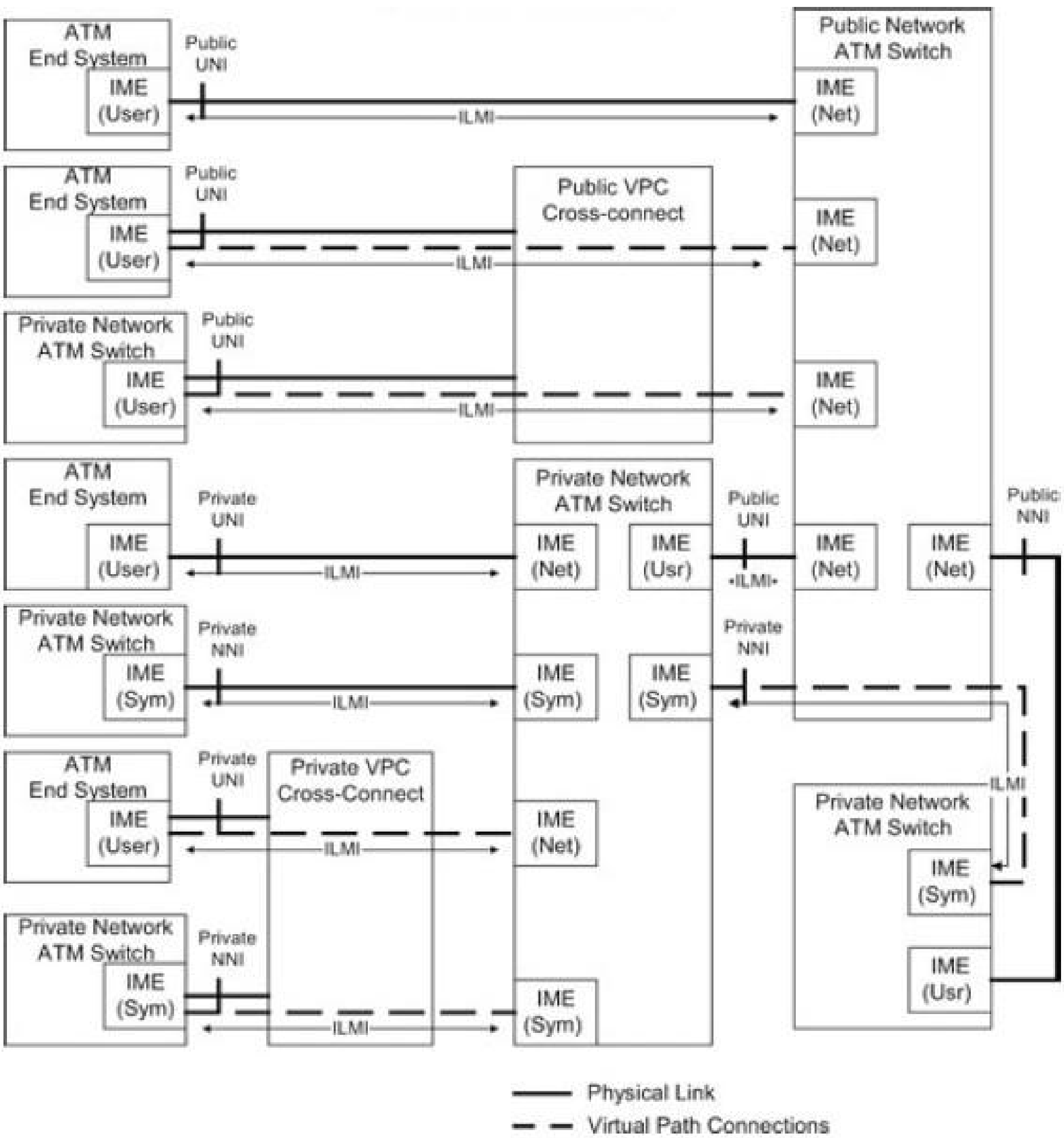


Figure 7: Definitions and context of ILMI

Reference: Network Management Principles and Practice by Mani Subramanian, Publication : Pearson.

Two public carrier networks interface with each other via a broadband intercarrier interface (BICI) as shown in Figure 6. BICI is also known as network-to-network interface (NNI).

ATM Management Information Base

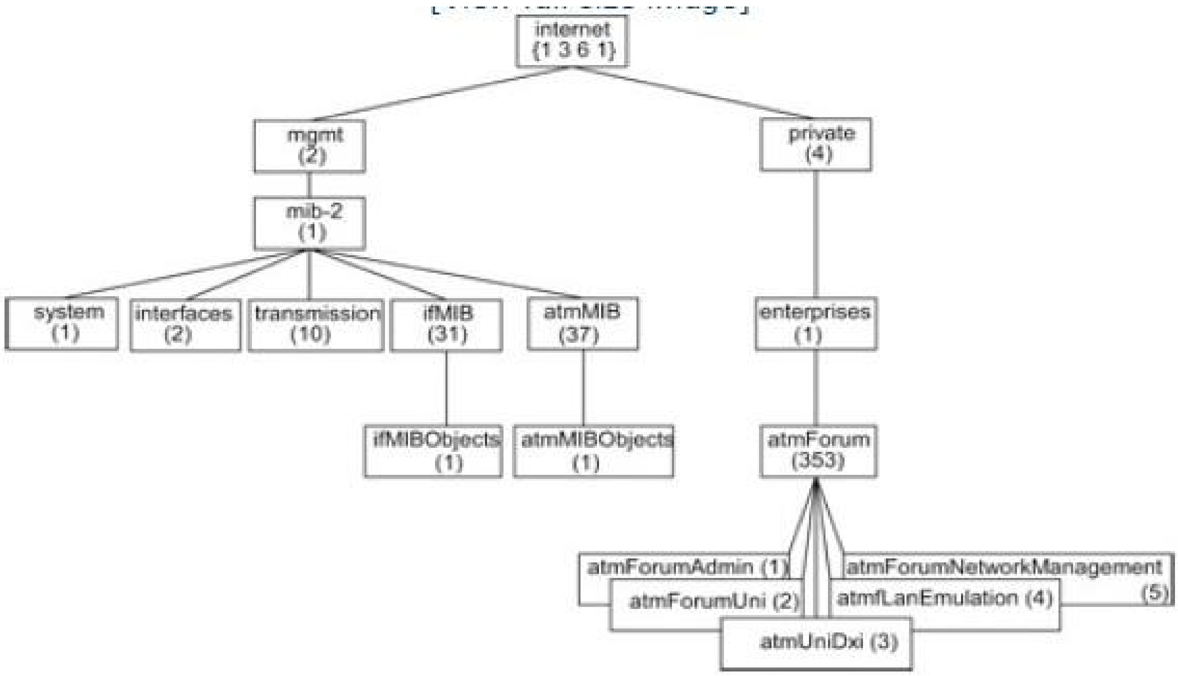


Figure 8 : Internet ATM MIB

Role of SNMP and ILMI in ATM Management

Although ILMI was conceived as interim specifications, it has become permanent. The ATM network management uses both SNMP MIB and ATM Forum MIB. Figure 9 and 10 conceptually present the role of the two network management protocols. Figure 9 presents the M1 interface. An SNMP agent is shown embedded in an ATM device, and the NMS communicates with it using SNMP protocol and IETF MIB modules. RFC 2863 specifies the interface parameters and types, including the additional tables to manage the ATM sublayer. RFC 1695 specifies the ATM objects. The transport MIB module is dependent on the transmission medium.

Figure 10 , which shows the M2 interface, comprises the network of two ATM devices. The NMS manages the network with an interface to device A. The ILMI protocol is used for communication between the agent management entity (AME) in device A and the AME in device B. A proxy agent theat resides in device A does the translation between ILMI MIB and SNMP MIB.

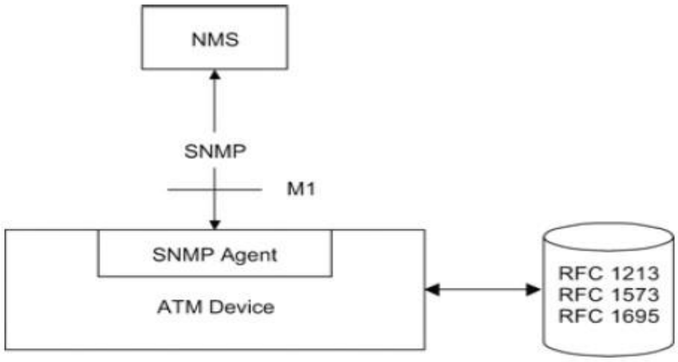


Figure 9: SNMP ATM Management (M1 Interface)

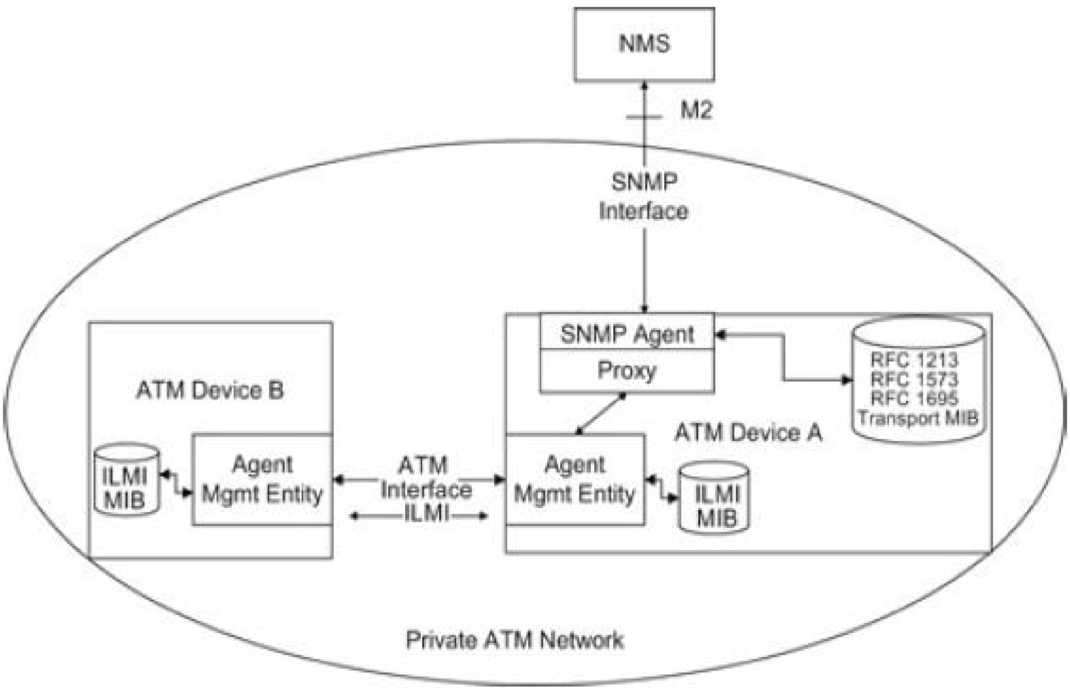


Figure 10 : Role of SNMP and ILMI in ATM Management(M2 Interface)

4.3 M1 Interface : Management of ATM Network Element.

The M1 interface is between an SNMP management system and an SNMP agent in an ATM device. Four entities, *ifInNUcastPkts*, *ifOutNUcastPkts*, *ifOutQLen*, and *ifSpecific* have been deprecated.

The interfaces and ifMIB (IF MIB) groups under the mgmt node . Four tables have been added to handle sublayers. They are shown in Figure 11 under *ifMIBObjects*. Table 1 below gives a brief description of the functions that each table performs.

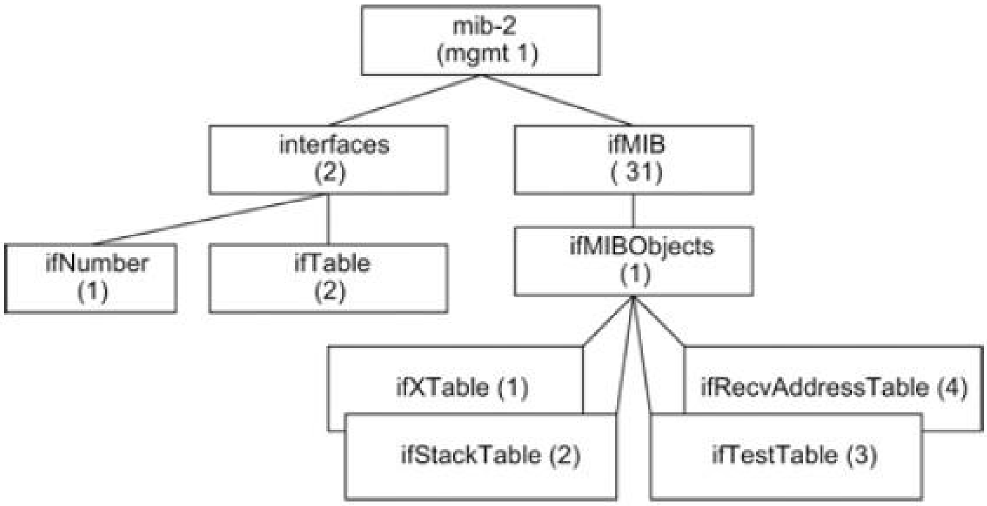


Figure 11 : Interface Group Tables for Sublayers

Table 1: Interface Group Tables for Sublayers

Entity	OID	Description (brief)
ifXTable	ifMIBObjects 1	Additional objects for the interface table
ifStackTable	ifMIBObjects 2	Information on relationship between sublayers
ifTestTable	ifMIBObjects 3	Tests that NMS instructs agent to perform
ifRecvAddressTable	ifMIBObjects 4	Information on type of packets / frames accepted on an interface

Figure 12 shows the three transmission modes that are used for the ATM. They are DS1(1.544Mbps twisted -pair cable), DS3 (44.736- Mbps coaxial cable), and SONET (nx155.52- Mbps optical fiber). DS1 and DS3 are transmitted ove T1 and T3 carriers, respectively. Only one of these MIBs needs to be implemented in the agent based on which transmission medium is used.

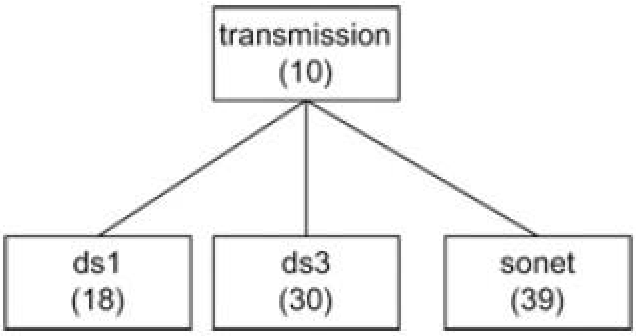


Figure 12: Transmission Groups for ATM

Figure 13 and the table 2 shows the ATM MIB objects group. This group contains information to manage the ATM sublayer entities : traffic descriptors, DS3 physical-layer convergence parameters (PLCP), transmission convergence (TC) sublayer parameters, virtual path link/ virtual channel link and their associated cross-connect tables, and performance parameters for AAL5 (ATM adaptaion layer).

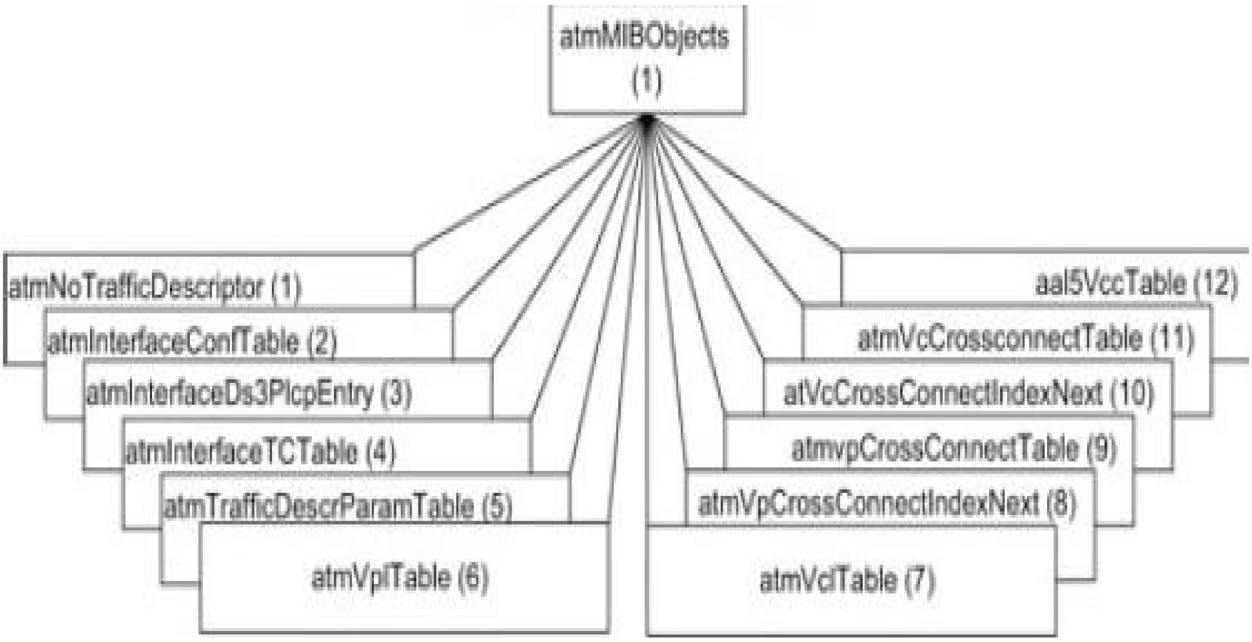


Figure 13: ATM Managed OBjects Group

Table 2 : ATM Managed Objects Group

Entity	OID	Description (brief)
atmNoTrafficDescriptor	atmMIBObjects 1	ATM traffic descriptor type
atmInterfaceConfTable	atmMIBObjects 2	ATM local interface configuration parameter table
atmInterfaceDs3PlcpEntry	atmMIBObjects 3	ATM interface DS3 PLCP parameters and state variables table
atmInterfaceTCTable	atmMIBObjects 4	ATM TC sublayer configuration and state parameters table
atmTrafficDescrParamTable	atmMIBObjects 5	ATM traffic descriptor type and associated parameters
atmVplTable	atmMIBObjects 6	Virtual path link table
atmVclTable	atmMIBObjects 7	Virtual channel link table
atmVpCrossConnectNext	atmMIBObjects 8	Index for virtual path cross-connect table
atmVpCrossConnectTable	atmMIBObjects 9	Virtual path cross-connect table
atmVcCrossConnectNext	atmMIBObjects 10	Index for virtual channel cross-connect table
atmVcCrossConnectTable	atmMIBObjects 11	Virtual cross-connect table
aal5VccTable	atmMIBObjects 12	AAL VCC performance parameters table

M2 Interface : Management of a Private Network

The M2 interface for ATM management is shown in Figure 10. The management information on ATM links between devices is gathered from ILMI MIB. The relative roles of each are shown in Figure 11.

The ILMI specifications define the adminstrative and UNI groups of the ATM Forum MIB. The adminstrative group defines a general-purpose registry for locating ATM network services such as the ATM name answer server (ANS). Other subgroups under the adminstrative group have been deprecated and handled by IETF specifications.

Figure 14 and Table 3 shows the ATM UNI MIB object group. They define the management objects associated with the ATM layer and the physical layer.
The statistics group is deprecated. The parameters associated with virtual path/ virtual connections as well as the adjustable bandwidth rate (ABR) and QoS are covered.

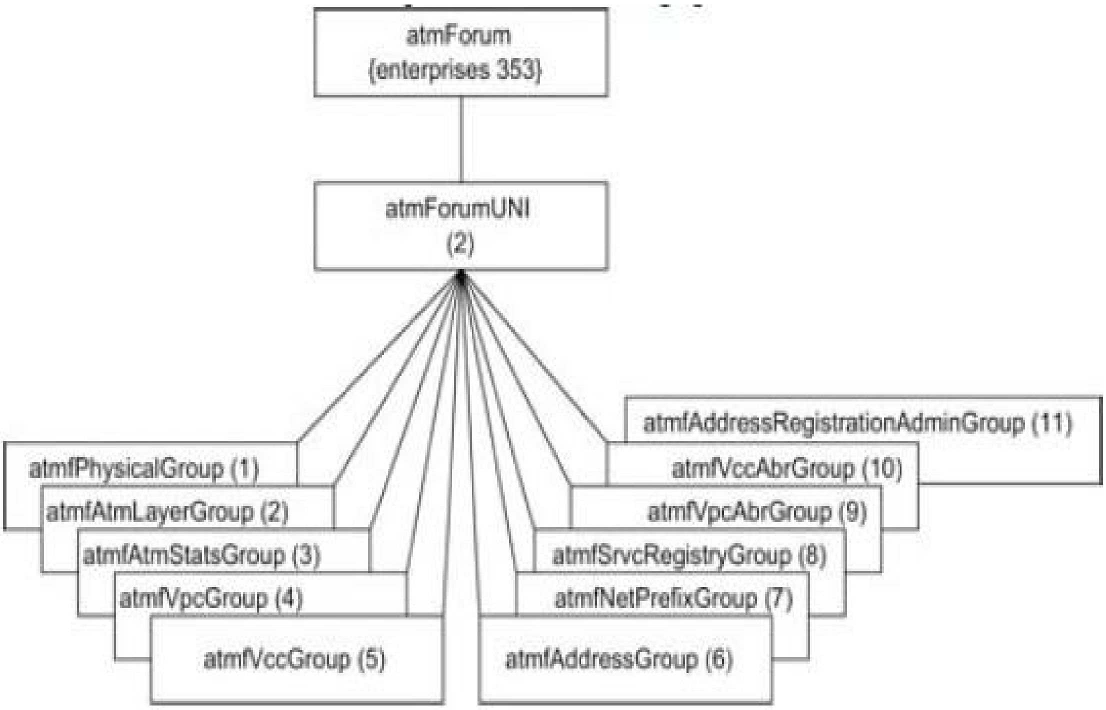


Figure 14 : ATM UNI MIB Object Group

Table 3 : ATM UNI MIB Object Group

Entity	OID	Description (brief)
atmfPhysicalGroup	atmForumUni 1	Defines a table of physical layer status and parameter information
atmfAtmLayerGroup	atmForumUni 2	Defines a table of ATM layer status and parameter information
atmfAtmStatsGroup	atmForumUni 3	Deprecated
atmfVpcGroup	atmForumUni 4	Defines a table of status and parameter information on the virtual path connections
atmfVccGroup	atmForumUni 5	Defines a table of status and parameter information on the virtual channel connections
atmfAddressGroup	atmForumUni 6	Defines the network-side IME table containing the user-side ATM-layer addresses
atmfNetPrefixGroup	atmForumUni 7	Defines a user-side IME table of network prefixes
atmfSrvcRegistrryGroup	atmForumUni 8	Defines the network-side IME table containing all services available to the user-side IME
atmfVpcAbrGroup	atmForumUni 9	Defines a table of operational parameters related to ABR virtual path connections
atmfVccAbrGroup	atmForumUni 10	Defines a table of operational parameters related to ABR virtual channel connections
AtmfAddressRegistrationAdminGroup	atmForumUni 11	

M3 Interface : Customer Network Management of a Public Network

M3 is the management interface between the private NMS and the public service provider NMS. It allows the customer to monitor and configure their portion of the public ATM network. The M3 interface specifications are defined in the ATM Forum document af-nm-0019.000. Networks show the typical configuration, how a customer would interact with the public service provider network via the carrier management system. There are two classes of M3 requirements in the figure-- status and configuration monitoring (Class I) and virtual configuration control (Class II).

Class I requirements are those which a public network service provider offers to the customer. These include the customer performing monitoring and management of configuration, fault and performance management of a specific customer's portion of a public ATM network. This service is offered only for PVC configuration. Examples of this service are (a) retrieving performance and configuration information for a UNI link and (b) public service NMS reporting an alarm or trap message to the user NMS on a UNI-link failure.

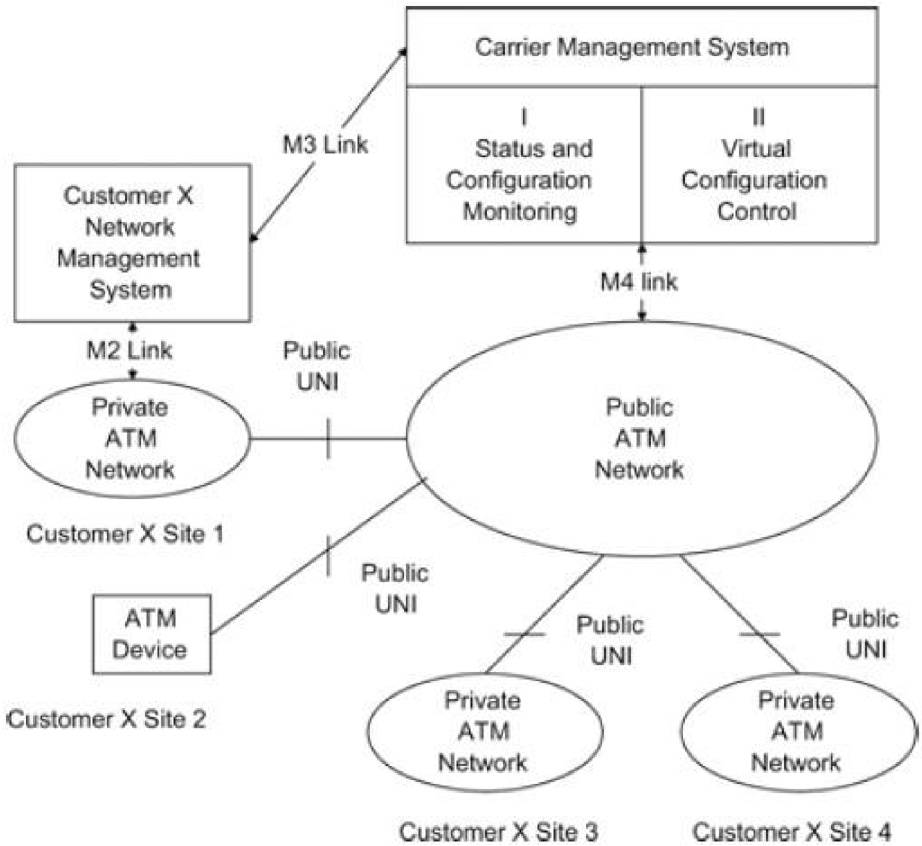


Figure 15 : Customer Management of Private and Public Networks

Class II service provides greater capability to the user. The user can request the service provider to add, delete or change virtual connections between a pair of customer's UNIs. An example of this would be the customer wanting to establish a new virtual path or increase the number of virtual

circuits in a given virtual path.
A customer network management (CNM) agent residing in the private service providers NMS provides the M3 service. The service is limited to the portion of the public service providers network that the user's circuit traverses. If the user's circuit traverses multiple service providers, a separate interface with each providers is needed. The CNM sends requests to the carrier management system as shown in Figure 15 ,which acts as an agent to the CNM. The carrier management system then invokes the request on the network elements (NE) or other NMS and returns the responses to CNM. The requirements for M3 and M4 are specified as mandatory or required, conditionally required and optional. Class I requirements are mandatory and Class II requirements are optional.

Class I Interface Management Functions
Table 4 presents M3 Class I requirements and the MIB groups that are used to obtain the information. The request has SNMP 'read-only" capability. The public network service provider should give the CNM customer the ability to retrieve all the information listed in table 4.

General UNI Protocol Stack information	system group (RFC 1213), interfaces group, including ifTable and ifStackTable (RFC 1213, RFC 1573), SNMP group (RFC 1213)
ATM Performance information on customer's UNI	ifTable (RFC 1573)
Physical-layer performance and status information	all tables except dsx3ConfigTable (RFC 1407), all tables except dsx1ConfigTable (RFC 1406), all tables except the configuration tables and VT tables of SONET MIB (RFC 1595), atmInterfaceDs3PlcpTable / atmInterfaceTCTable of ATM MIB (RFC 1695)
ATM-Level information configuration information	atmInterfaceConfTable of ATM MIB (RFC 1695)
Physical-layer configuration information	dsx3ConfigTable (RFC 1407) dsx1ConfigTable (RFC 1406) all configuration tables except the sonetVtConfigTable of SONET MIB (RFC 1595)
ATM-layer virtual path link configuration and status information	atmVplTable of ATM MIB (RFC 1695)
ATM-layer virtual channel link configuration and status information	atmVclTable of ATM MIB (RFC 1695)
ATM-layer virtual path connection configuration and status information	atmVpCrossConnectTable and atmVpCrossConnectIndexNext of ATM MIB (RFC 1695)
ATM layer virtual channel connection configuration and status information	atmVcCrossConnectTable and atmVcCrossConnectIndexNext of ATM MIB (RFC 1695)
ATM-layer traffic characterization (traffic descriptors for customer's UNIs) information	atmTrafficDescrParamTable of ATM MIB (RFC 1695)
Event notifications on ATM link going up or down	warmStart, coldStart, linkUp, linkDown of SNMP group (RFC 1695)

Table 4 : M3 Class I Interface Requirements and MIB

Class II Interface Management Functions

M3 Class II functionality is divided into three groups so that the provider can implement one or more subgroups. They are (1) ATM-level subgroup, (2) VPC/ VCC-level subgroup and (3) traffic subgroup.

The ATM—level subgroup should provide the CNM the ability to modify the ATM Level Information Configuration Information.

The VPC/VCs-level subgroup provides the CNM the ability to modify:

1. Virtual path link configurationand status information.
2. Virtual channel link configuration and status information.
3. Virtual path connection configuration and status information
4. Virtual channel connection configuration and status information

The traffic subgroup shall provide the CNM the ability to modify:

1. Traffic descriptors and information objects doe virtual channel connections.
2. Traffic descriptors and information objects for virtal path connections.

Table 5 presents the M3 Class II requirements and the MIB objects in the ATM MIB group.

Table 5: M3 Class II Interface Requirements and MIB

ATM level information configuration information	atmInterfaceConfTable in ATM MIB (RFC 1695)
Virtual path link configuration and status configuration information	atmVplTable in ATM MIB (RFC 1695)
Virtual channel link configuration and status information	atmVclTable in ATM MIB (RFC 1695)
Virtual path connection configuration and status information	atmVpCrossConnectTable and atmVpCrossConnectIndexNext of ATM MIB (RFC 1695)
Virtual channel connection configuration and status information	atmVcCrossConnectTable and atmVcCrossConnectIndexNext of ATM MIB (RFC 1695)
Traffic descriptors and information objects for virtual path and channel connections	atmTrafficDescrParamTable in ATM MIB (RFC 1695)

M4 Interface : Public Network Management

The management of public ATM network is primarily the responsibilty of network service providers- carriers and Postal Telephone and Telegraph (PTT) companies. They have the challenge of not only managing the public network, but also keeping up with new technology. To help this process, ITU-T has defined M. 3010, a five-layer model of operations, telecommunications management network (TMN). The relationshipof ATM to TNM is shown in Figure 16.

The top two layers, the business management layer and the service management layer, deal with the business and service aspects of TNM and are not addressed by the ATM Forum.

The element layer (EL) contains NEs. The NEs specific to ATM technology are components, such as ATM workstation, ATM switches, ATM transport devices (cross-connect systems and concentrators), etc. The element management layer (EML) manages NEs. The network management layer (NML) has the responsibilty to manage the network either directly or via the EML

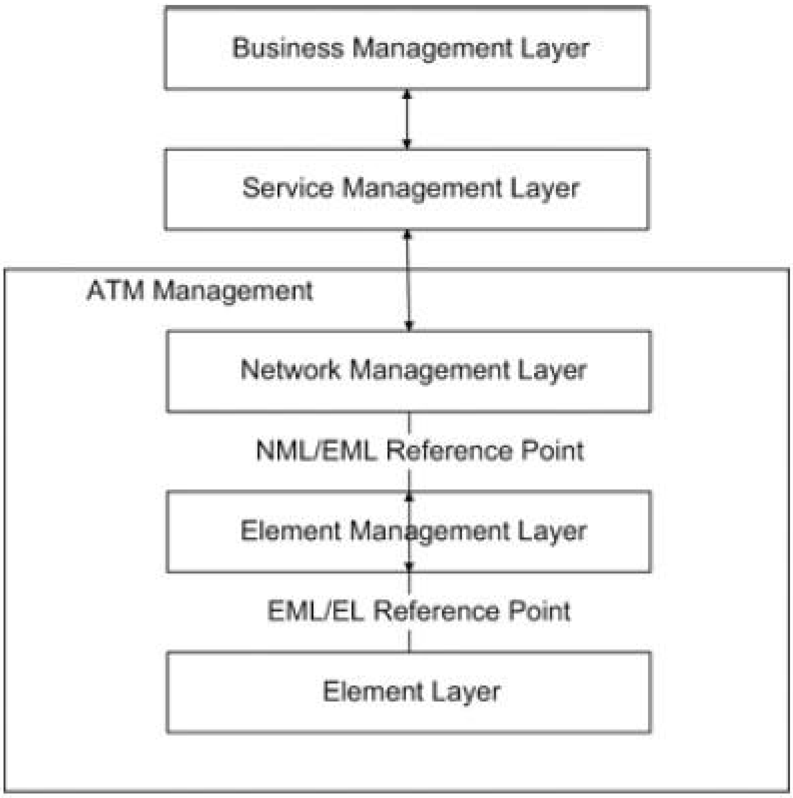


Figure 16 : ATM Relationship to TNM-Layered Architecture

Figure 17 shows the dual view of M4 interface. Both views are present in the architecture across the M4 interface plane. It should be noted that is a conceptual view and the the physical connections can be the same for both views.

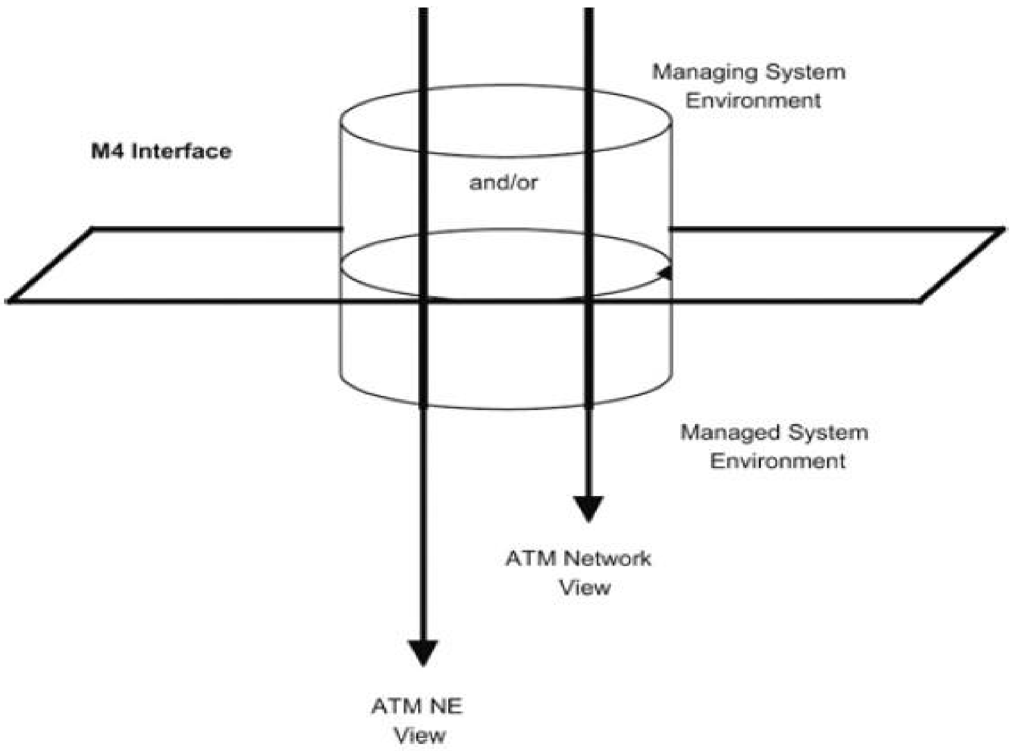


Figure 17 : Dual views of the M4 Interface

In the NE- level management architecture,thye NMS environment, consisting of one or more NMSs ,directly interfaces with the ATM NE and manages them.

In the NE-level management architecture, the NMS environment, consisting of one or more NMSs, directly interfaces with the ATM NE and manages them. There is a single M4 interface between ATM NE and the NMS environment.

The figure shows links between NE, but the NMS directly communicates with each ATM network element. In an actual implementation, it is likely that the NMS is intefacing with another NMS, which is managing the NE, but can still present a network view to the higher-level management system.

The Figure 18 shows links between NE, but the NMS directly communicates with each ATM network element. In an actual implementation, it is likely that the NMS is intefacing with another NMS, which is managing the NE, but can still present a network view to the higher-level management system.

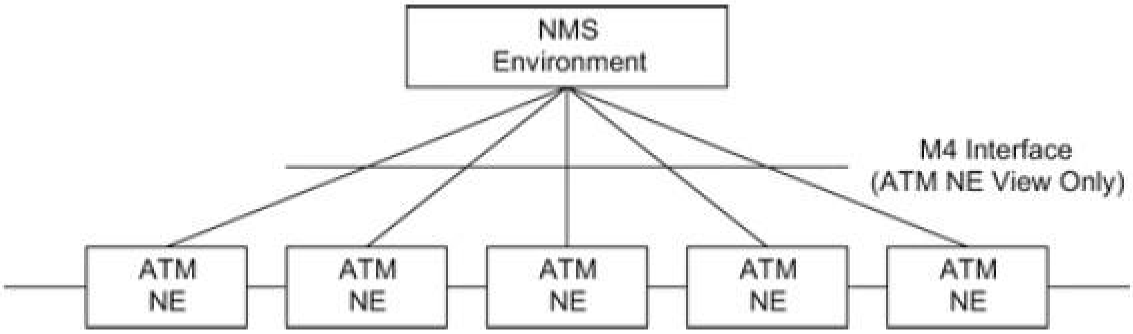


Figure 18 : NE- View Management Architecture

Figure 19 presents am example of network-view management physical configuration.

It consists of two ATM networks, one a single -supplier subnetwork and the other a multi-supplier subnetwork.

Each subnetwork has its own subNMS managing its NE.

In a single-supplier subnetwork shown on the right side, the subNMS has only an ATM NE view.

In the multi-supplier subnetwork environment shown on the left side, the subNMS is presented only an ATM NE view, although it may actually be communicating to lower-level NMSs of each supplier.

This is similar to Manager -of- Manager architecture.

Figure 19 presents an example of network-view management physical configuration.

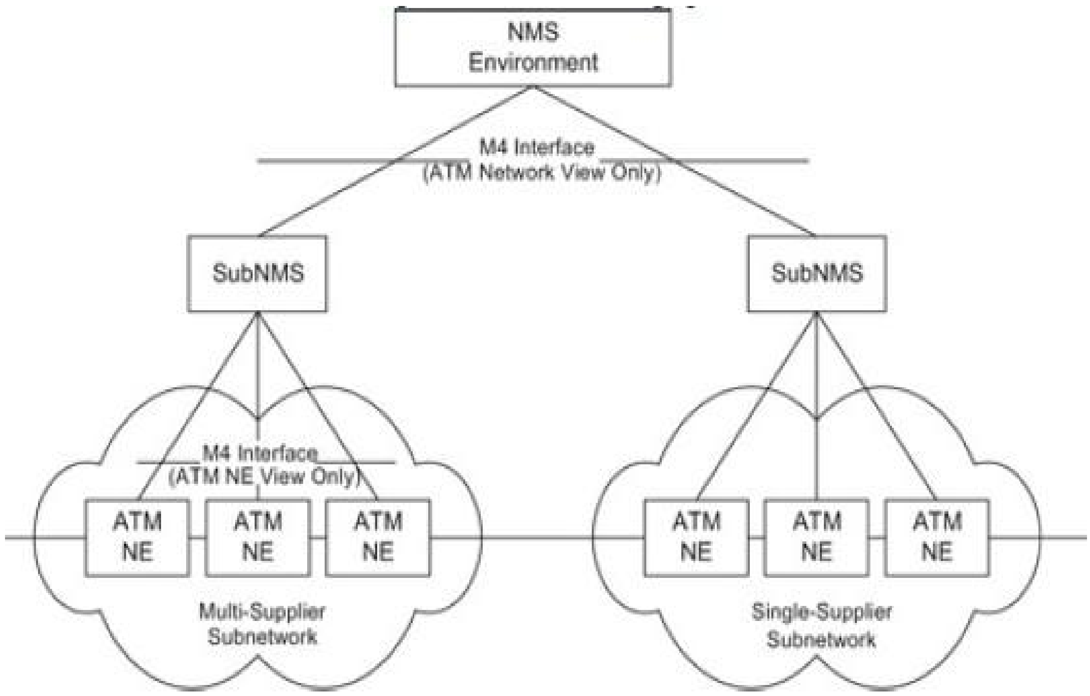


Figure 19 : Example of Network-View Management Physical Configuration

Configuration Management. Configuration management provides the following list of functions to manage NEs:

1. ATM NE configuration identification and change reporting, which involves

a) Operations performed over the craft interface
b) Human intervention (removal/insertion of equipment modules)
c) Customer control channels (e.g. ILMI)
d) Network failures
e) Protection switching events
f) Sub- ATM NE component initialization
g) Secondary efffects of atomic operations performed by the management systems

2. Configuration of UNIs, BICIs and BISSIs.
3. Configuration of VPL/VCL termination points and cross -connections.
4. Configuration of VPC and VCC OAM segment end-points.
5. Event flow control- event forwading discriminator function.

Fault Management. The following set of functions is specified to detect, isolate and correct abnormal operation:

1. Notifying the NMS of a detected failure
2. Logging failure reports
3. Isolating faults va demand testing

The specific functions are:

1. Failure reporting of the various alams. The generic troubles that cause the alarm.
2. Operations, adminstration and maintenance (OAM) cell loopback testing.

Performance Management. The functions of performance monitoring for an ATM network are:

1. Performance monitoring
2. Traffic management
3. UPC (use parameter control)/NPC (network parameter control) disagreement monitoring
4. Performance management controllingNetwork data collection

To accomplish these general functions, the following specific functions are specified:

1. Physical-layer performance monitoring
2. ATM cell-level protocol monitoring
3. UPC?NPC disagreement monitoring

Network-view requirements and logical MIB

The M4 network view for the management of an ATM public network is concerned with NML information. It addresses the different perspectives of the service providers, each of whom need both network management and service management capabilities. The functional areas addresses in the specifications are:

1. **Transport network configuration provisioning**(including subnetwork provisioning and link provisioning).
2. **Transport network connection management** (including set up/reservation/ modification for subnetwork connection, link connection, trails and segments)
3. **Network fault management** (including congestion monitoring and connection and segment monitoring)
4. **Network security management**

Managed entities have not been defined in the MIB for meeting all the above requirements.

Transport network Provisioning

The transport network provisioning includes subnetwork provisioning of network nodes and links.

1. Subnetwork provisioning: addition and monitoring information on addition, deletions and changes in NEs and their configuration
2. Link provisioning: set up, modify and release subnetwork links.

Subnetwork connection management

The M4 network-view managed entities support subnetwork management of reservation and modification of subnetwork connections, link connections, trials and segment.
Specifically, this involves:

1. Point -to-point subnetwork connection: VP-VC subnetwork connection betweeen pair of end points.
2. Multipoint subnetwork connection: Multipoint VP-VC connections between pair-wise end points.
3. Link connection set up : VP-VC segment termination end points.
4. Segment setup : Set up and support VP-VC segment termination end points.
5. Trail setup : support and set up trails containing information on subnetwork connections and links.

Subnetwork state management

The NMS needs to be aware of the operational status of the subnetworks with regard to the network being ready to perform its intended functions, including link connections, trail operational changes and network components.

Transport Network Fault Management

The MS interface managementis required to report network-view alarms and provide testing capability to isolate the problems.Specifically , this include:

1.l og network alarms withn a subnetwork to be retrieved by the NMS.
2. Autonomously notify failures such as termination point failures.
3. Provide loopback-testing capability that supports OAM cell loopback along a subnetwork connection or a segment of it.

Network security Management
It addresses the security concerns from the perspectives of customers, public communities and network operators. The main security of objectives are

1) confidentiality
2) data integrity
3) accountability
4) availability

Seven generic threats are considered in the threat analysis of an ATM network.
They are 1) masquerade or spoofing, 2) eavesdropping, 3) unauthorized access, 4) loss or corruption of information, 5) repudiation, 6) forgery, 7) denial of service.

ATM Digital Exchange Interface Management

The Digital Exchange Interface (DXI) is an interface between a Digital Terminal Equipment (DTE) and a Digital Circuit Equipment (DCE) that connects to a public data network.

In the ATM network, the public data network is anetwork of ATM switches. Figure 20 shows a high -level view of the DXI interface. Typically, a DTE will be ahub or the router and the DCE is a Digital Service Unit (DSU). Which interfaces to anATM switch.

Figure 20 : The ATM DXI Interface

Figure 21 shows the ATM DXI Local Management Interface (LMI). The ATM LMI defines the protocol for exchange of information across the DXI interface and supports DXI, AAL and UNI-specific management information. The LMI protocol supports the SNMP management system and the ILMI management Entity (IME) running on an ATM switch. The ATM DXI LMI MIB supports IETF ATM MIB and the ATM Forum UNI MIB.

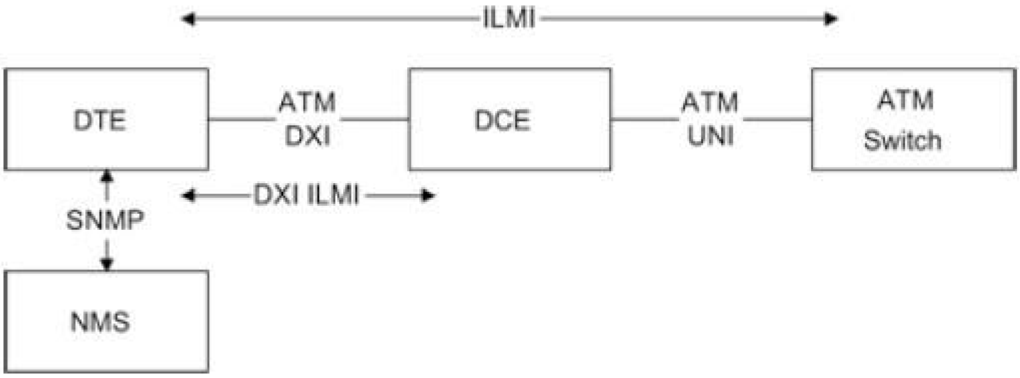


Figure 21: ATM DXI Local Management Interface

Reference: Network Management Principles and Practice by Mani Subramanian, Publication : Pearson.