Technical Report
TR-035

Protocol Independent
Object Model for
ADSL EMS-NMS Interface

March 2000

ABSTRACT:

This document specifies the management information model to be used at the interface between Element Management Systems (EMS) and Network Management Systems (NMS) managing ADSL Network Elements in the Access Subnetwork. The model specification is independent of the management protocol.

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1 INTRODUCTION

This document specifies the management information object model to be used at the EMS (Element Management System) to NMS (Network Management System) interface for managing ADSL Access Subnetworks. The model specification is independent of the management protocol.

2   SCOPE and REFERENCE

2.1   The Management Framework

The ADSL Forum Network Management framework is based on the TMN (Telecommunications Management Network) model specified by ITU-T recommendation M.3010 [1]. A key concept of the TMN model is a layered approach to managing various components that comprise the network. Figure-1 below shows the various layers defined, and the relevant interface for this document.

Figure-1: TMN Logical Layered Architecture
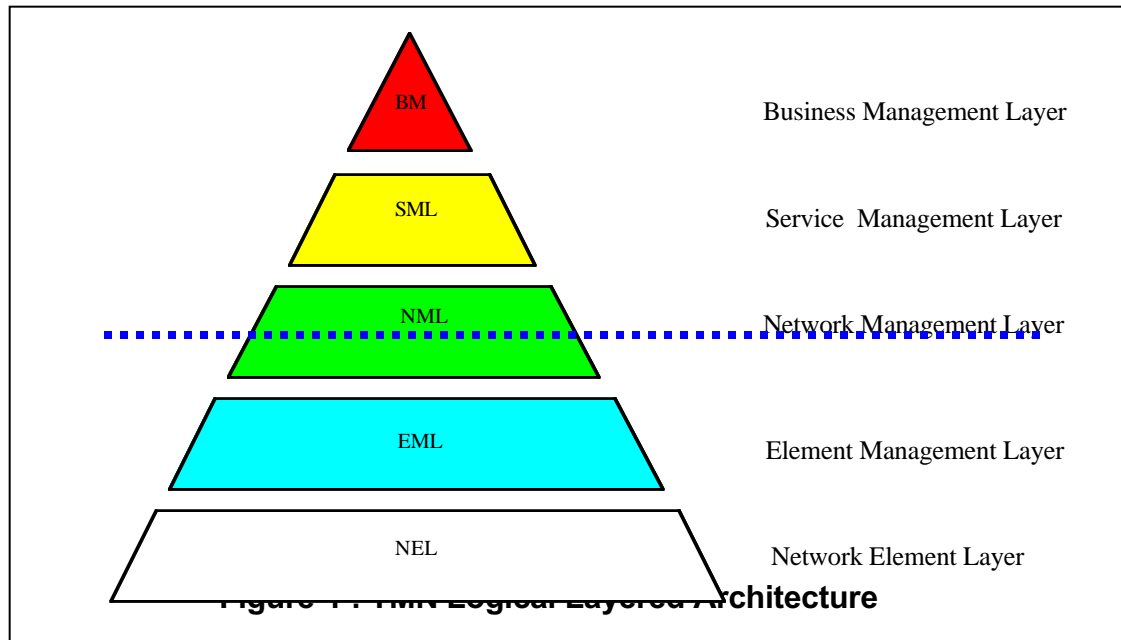
This document specifies the interface between the EMS and NMS, which respectively embody the EML and NML layer functionality as per the TMN model (see Figure-2 below).

ADSL Forum WT-041 [4] outlines the general requirements to be met by the EMS-NMS interface.
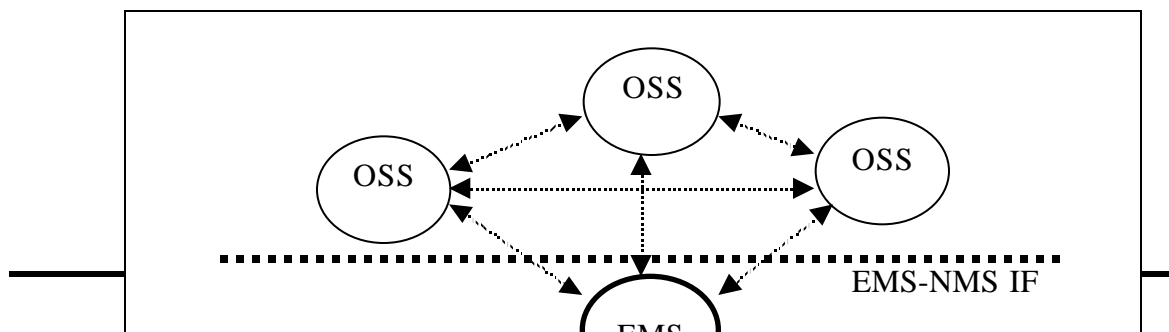
Figure-2 : Interfaces between the NE, EMS and NMS

2.2   The End-to-End Service Network

Figure-3 shows an example of a typical end-to-end service network deploying ADSL, and the various Subnetworks comprising it. Note that configuration of individual networks may vary depending on the scope and operating practices of the network operator.
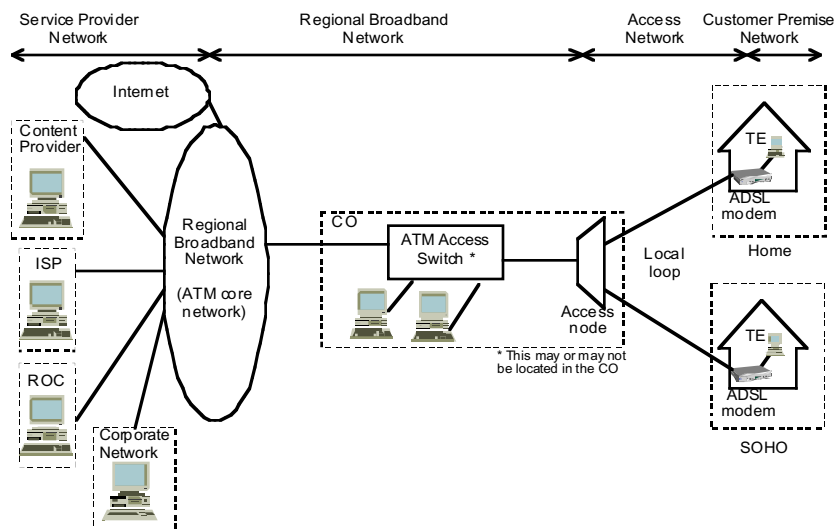
Figure-3 : Typical Architecture of an ADSL Service Network [7]

The main focus of the interface specified in this document is the Access Subnetwork, however, the basic principles are equally applicable to other Subnetworks in the end-to-end ADSL service network shown in Figure-3.

2.3   The Access Subnetwork

The Access Subnetwork covers the portion of the end-to end network connecting the customer to the central office (see Figure-3). It includes the ADSL copper loop and the Access Node (DSLAM : Digital Subscriber Line Access Multiplexor) housing the ATU-C (ADSL Termination Unit – Central). It may include the ATU-R (ADSL Termination Unit – Remote) depending on the network operator.

2.4 The Transport Protocols

A number of communication protocols are deployed in the end-to-end service network. This document primarily focuses on the two main protocols used in the Access Subnetwork – ADSL, and ATM. It is assumed that other protocols may be deployed in the Access Subnetwork. However, the management of other protocols is presently not covered by this document.

2.4.1 ADSL in the Access Subnetwork

ADSL transport protocol operates between the ATU-C in the Access Node in the central office and the ATU-R at the customer premise. The ADSL Forum has defined a management information model for ADSL transport in TR-005[5].

2.4.2 ATM in the Access Subnetwork

The ATM connections are transported over ADSL through the Access Subnetwork. The connections may be cross-connected one or more times for access concentration in the Access Nodes and transported via higher speed interfaces like DS1/DS3/OC3 to the Regional Broadband Network. In some cases ATM connections may be terminated within the Access Subnetwork to offer special services. The ATM connections may be Virtual Channel Connections (VCC) or Virtual Path Connections (VPC). They may be Permanent Virtual Connections (PVC) or Switched Virtual Connections (SVC).

The ATM Forum has defined two models – one for the NE-EMS interface called M4 Network Element View, and the other of the EMS-NMS interface called the M4 Network View [3]. This specification makes use of the latter model.

3 MANAGEMENT INFORMATION MODEL

The management information model to be used at the EMS-NMS interface is based on existing management information models defined by various standards bodies including ITU-T, ANSI T1.M1, Telcordia (formerly Bellcore), ATM Forum, and ADSL Forum.

This document limits the scope of the model to only cover those elements that are needed to meet the limited requirements for the EMS-NMS interface for managing the Access Subnetwork as defined by the ADSL Forum.

3.1 Access Subnetwork Managed Entities

This section outlines the primary entities (managed object classes) in the Access Subnetwork that are managed by the NMS.

NOTE: Name of the predefined managed object class from the M4 model used as the basis for each Access Subnetwork is provided in parenthesis.

3.1.1 Access Subnetwork (network)

The Access Subnetwork class represents the complete Access Subnetwork (as defined in section 2.3) itself. It is modeled after the *network* class in the M4 model. The Access Subnetwork class represents the top-level domain of the management system. It is primarily used as a container for all other managed entities.

KEY ATTRIBUTES:
- Access Subnetwork ID : Unique identification for the Access Subnetwork. (read-only)

KEY OPERATIONS:
- Retrieve list of Element Management Systems involved in the management of this Access Subnetwork.
- Retrieve list of Layered Network Domains in this Access Subnetwork.

3.1.2 Layer Network Domain (atmLayerNetworkDomain)

The Layer Network Domain class represents the part of the VC or VP Layer which is available to a managing system through the M4 interface. It is modeled after the atmLayerNetworkDomain class in the M4 model. An atmLayerNetworkDomain is defined to support the requirement for independent layer management of either the VC Layer or the VP Layer. The atmLayerNetworkDomain class represents part of an administration's portion of the VC or VP Layer, which is available to a managing system through the M4 interface. In this model, an ATM Layer Network Domain is associated with one and only one top ATM Subnetwork, which can be further decomposed. There may be several Layer Network Domains within a single network.

An atmLayerNetworkDomain is defined to support the requirement for independent layer management of the VC and VP Layers.

KEY ATTRIBUTES:
- Signal Identification (read-only)
- User Label (read-write)

KEY OPERATIONS:
- Make External vcLinkEnd

3.1.3 Element Management System (EMS)

The Element Management System class represents the logical management system managing network elements of one or more types, from one or more vendors.

KEY ATTRIBUTES:
- Element Management System ID : Unique identification for the Element Management System. (read-only)

KEY OPERATIONS:
- Retrieve list of Network Elements managed by this EMS.
- Retrieve list of active alarms associated with this EMS.
- Reserve an ADSL Line.
- Free an ADSL Line.

3.1.4 Network Element (managedElement)

The Network Element is a logical class representing a single managed unit comprising one or more pieces of equipment functioning together.

KEY ATTRIBUTES:
- Network Element ID : Unique identification for the Network Element. (read-only)
- Vendor Name : Name of the equipment vendor. (read-only)
- Model Number : Type of this equipment. (read-only)

KEY OPERATIONS:
- Retrieve list of Equipment comprising this Network Element.
- Retrieve list of ADSL lines supported by this Network Element.

3.1.5 Equipment (equipment)

The Equipment class represents physical components of a Network Element that could be fixed or replaceable that are not modeled as a Plug-in Unit.

KEY ATTRIBUTES:
- Equipment ID : Unique identification for this Equipment. (read-only)
- Administrative State (read-write)
- Operational State (read-only)
- Vendor Name (read-only)
- Version (read-only)
- User Label (read-write)

KEY OPERATIONS:

-- None --

3.1.6 Equipment Holder (equipment)

The Equipment Holder class represents those physical components of a Network Element that hold/contain other pieces of equipment or plug-in units. Equipment Holders may contain other Equipment. Example racks containing shelves containing drawers containing slots.

KEY ATTRIBUTES:
* Equipment Holder ID : Unique identification for this Equipment Holder. (read-only)
* Equipment Holder Type (read-only)
* Equipment Holder Location (read-only)
* Allowed Plug-in Unit Types – Slots Only (read-write)
* Slot Status – Slots Only (read-only)

KEY OPERATIONS:
-- None –

3.1.7 Plug-in Unit (circuitPack)

The Plug-in Unit class represents those physical components of a Network Element that can be inserted and removed from slots in the Equipment Holder.

KEY ATTRIBUTES:
* Plug-in Unit ID : Unique identification for this Plug-in Unit. (read-only)
* Administrative State (read-write)
* Availability Status (read-only)
* Operational State (read-only)
* Plug-in Unit Type eg. CLEI code (read-only)
* Vendor Name (read-only)
* Version (read-only)

KEY OPERATIONS:
-- None --

3.2 ADSL Transport Managed Entities

The entities for managing the ADSL transport in the Access Subnetwork are based on the model defined by the ADSL Forum for the Network Element management (TR-005).

3.2.1 ADSL Line (adslLine)

The ADSL Line represents the ADSL transport facility, including the ATU-C and ATU-R.

KEY ATTRIBUTES:
* ADSL Line ID : Unique identification for this ADSL Line. (read-only)
* Administrative State (read-write)
* Operational State (read-only)
* User Label (read-write)

- ADSL Configuration Profile (read-write)
- Line Coding (read-only)
- Supported Channel Types (read-only)
- Current SNR Margin – ATU-C & ATU-R (read-only)
- Current Attenuation – ATU-C & ATU-R (read-only)
- Current Output Power – ATU-C & ATU-R (read-only)
- Current Attainable Rate – ATU-C & ATU-R (read-only)

KEY OPERATIONS:
- Retrieve associated ADSL Channel(s)
- Retrieve associated Equipment entity

3.2.2 ADSL Channel (adslChannel)

The ADSL Channel represents a bearer channel supported by the ADSL Line. Two types of channels are defined – Fast and Interleaved.

KEY ATTRIBUTES:
- ADSL Channel ID : Unique identification for this ADSL Channel. (read-only)
- Administrative State (read-write)
- Operational State (read-only)
- Channel Type (read-only)
- Current Channel Rate – ATU-C & ATU-R (read-only)
- Current Channel Interleave Delay – Interleaved Channel Only – ATU-C & ATU-R (read-only)
- Current CRC Block Length – ATU-C & ATU-R (read-only)
- Current Line Rate – ATU-C & ATU-R (read-only)
- Previous Line Rate – ATU-C & ATU-R (read-only)

KEY OPERATIONS:
- Retrieve associated ADSL Line entity.

3.2.3 ADSL Configuration Profile (adslConfigurationProfile)

The ADSL Configuration Profile is a complete set of configuration parameters for configuring the ADSL Line as well as ADSL Channels at both the ATU-C and ATU-R.

KEY ATTRIBUTES:
- Profile ID : Unique identification for this ADSL Configuration Profile. (read-only)
- Profile Name : Unique name identifying this Profile. (read-write)
- Rate Adaptation Mode – ATU-C & ATU-R (read-write)
- Rate Channel Ratio – ATU-C & ATU-R (read-write)
- Min SNR Margin – ATU-C & ATU-R (read-write)
- Max SNR Margin – ATU-C & ATU-R (read-write)
- Target SNR Margin – ATU-C & ATU-R (read-write)
- Downshift SNR Margin – ATU-C & ATU-R (read-write)
- Upshift SNR Margin – ATU-C & ATU-R (read-write)
- Min Upshift Time – ATU-C & ATU-R (read-write)
- Min Downshift Time – ATU-C & ATU-R (read-write)

- Min Fast Channel Rate – ATU-C & ATU-R (read-write)
- Max Fast Channel Rate – ATU-C & ATU-R (read-write)
- Min Interleaved Channel Rate – ATU-C & ATU-R (read-write)
- Max Interleaved Channel Rate – ATU-C & ATU-R (read-write)
- Max Interleaved Channel Delay – ATU-C & ATU-R (read-write)

KEY OPERATIONS:
-- None --

3.3   ATM Transport Managed Entities

The entities for managing the ATM transport in the Access Subnetwork are based on the M4 Network View model defined by the ATM Forum.

The ATM Forum M4 specification defines an extensive model to cover all intricacies associated with ATM networks. This document only identifies a minimal sub-set required to meet the limited requirements defined by the ADSL Forum for the EMS-NMS interface for the Access Subnetwork.

3.3.1 ATM Subnetwork (atmSubnetwork)

An ATM Subnetwork is a logical portion of a VC or VP layer network. Connections across ATM Subnetworks are termed Subnetwork Connections, while connections between ATM Subnetworks are termed Link Connections. ATM Subnetworks may be Topological, or Atomic. Topological ATM Subnetworks span multiple Network Elements, while Atomic ATM Subnetworks span a single Network Element.

Since the EMS is only responsible for managing Network Elements individually, it will only support Atomic ATM Subnetworks and ATM Subnetwork Connections. The NMS shall support Topological ATM Subnetworks and Link Connections.

KEY ATTRIBUTES:
- Subnetwork ID : Unique identification for the Subnetwork. (read-only)
- User Label : User definable name for this Subnetwork. (read-write)
- Availability Status : Indication of the current status of the Subnetwork. (read-only)

KEY OPERATIONS:
- Retrieve list of other ATM Subnetworks contained within this ATM Subnetwork.
- Retrieve list of ATM Link Ends delineating this ATM Subnetwork.
- Retrieve list of ATM Subnetwork Connections in this ATM Subnetwork.
- Create an ATM Subnetwork Connection.
- Delete an ATM Subnetwork Connection.

3.3.2 ATM Subnetwork Connection (atmSubnetworkConnection)

An ATM Subnetwork Connection represents a connection across an ATM Subnetwork. It is responsible for transporting cells across the ATM Subnetwork. It is always bi-directional, and is terminated by ATM Network CTPs.

KEY ATTRIBUTES:
- Subnetwork Connection ID : Unique identification for this Connection. (read-only)
- User Label : User definable name for this Connection. (read-write)
- Administrative State (read-write)
- Availability Status : Indication of the current status of this Connection. (read-only)

KEY OPERATIONS:
- Retrieve list of any ATM Subnetwork Connections contained within this ATM Subnetwork Connection (for composite Subnetwork Connections only).
- Retrieve the terminating ATM Network CTP instances.

3.3.3 ATM Link End (atmLinkEnd)

An ATM Link End represents an end-point of an ATM Link Connection between ATM Subnetworks in a VC or VP layer network. It also represents a demarcation point in the ATM Subnetwork. The ATM Link End also embodies the underlying transport facility interface in the VP layer network.

KEY ATTRIBUTES:
- Link End ID : Unique identification for the ATM Link End. (read-only)
- User Label (read-write)
- Administrative State. (read-write)
- Availability Status (read-only)
- Ingress and Egress Assignable Bandwidth (read-only)
- Ingress and Egress Available Bandwidth (read-only)
- Link TP Type : UNI / inter-NNI etc. (read-write)

KEY OPERATIONS:
- Retrieve associated ATM Subnetwork.

3.3.4 ATM Network CTP (atmNetworkCTP)

The ATM Network CTP (Connection Termination Point) is used to represent the termination of a VP or VC connections in ATM Subnetworks.

KEY ATTRIBUTES:
- CTP ID : Unique identification for the CTP. (read-only)
- VPI/VCI Value (read-write)
- User Label (read-write)

KEY OPERATIONS:
- Associate this Network CTP with a Network TTP.
- Retrieve any associated Network TTP.
- Retrieve any associated ATM Subnetwork Connections.

3.3.5   ATM Network TTP (atmNetworkTTP)

The ATM Network TTP (Trail Termination Point) is used to represent the termination of a VPC or VCC.
NOTE: This entity is only used for connections terminated within the Access Subnetwork.

KEY ATTRIBUTES:
- TTP ID : Unique identification for the TTP. (read-only)
- Availability Status (read-only)

KEY OPERATIONS:
- Retrieve associated Network CTP

3.3.6 ATM Network Access Profile (atmNetworkAccessProfile)

An ATM Network Access Profile contains information that describe the maximum ingress and egress bandwidth, along with the range of VPI or VCI values that are applied to the ATM Link or ATM Link End class instances that point to it.

KEY ATTRIBUTES:
- Network Access Profile ID : Unique identification for the Access Profile. (read-only)
- Total Ingress Bandwidth (read-write)
- Total Egress Bandwidth (read-write)
- Number of Allowed Connections (read-write)
- VPI/VCI Range (read-write)

KEY OPERATIONS:
-- None --

3.3.7 ATM Traffic Descriptor (atmTrafficDesc)

The ATM Traffic Descriptor class represents traffic management parameters associated with a Network CTP.

KEY ATTRIBUTES:
- Traffic Descriptor ID : Unique identification for this Traffic Descriptor. (read-only)
- Ingress and Egress Peak Cell Rate for CLP=0+1 traffic (read-write)
- Ingress and Egress Peak Cell Rate for CLP=0 traffic (read-write) -- optional
- Ingress and Egress CDV Tolerance for CLP=0+1 traffic (read-write)
- Ingress and Egress CDV Tolerance for CLP=0 traffic (read-write) -- optional
- Ingress and Egress Sustainable Cell Rate for CLP=0 and CLP=0+1 traffic (read-write) -- optional
- Ingress and Egress Burst Tolerance for CLP=0 and CLP=0+1 traffic (read-write) -- optional

KEY OPERATIONS:
-- None –

4 REFERENCES

[1]   ITU-T Recommendation M.3010: "Principles for a Telecommunications
         Management Network".

[2]   ITU-T Recommendation M.3100: "Generic Network Information Model".

[3]   ATM Forum af-nm-0058.001: "M4 Interface Requirements and Logical
         MIB: ATM Network View", version 2, May 1999.

[4]   ADSL ForumWT-041: "ADSL EMS to NMS Functional Requirements",
         August 1999.

[5]   ADSL Forum TR-005: "ADSL Network Element Management".

[6]   ADSL Forum adslf99_198: "Protocol Independent Model for ADSL EMS-
         NMS Interface", August, 1999.

[7]   ADSL Forum TR-012: " Broadband Service Architecture for Access to
         Legacy Data Networks over ADSL".
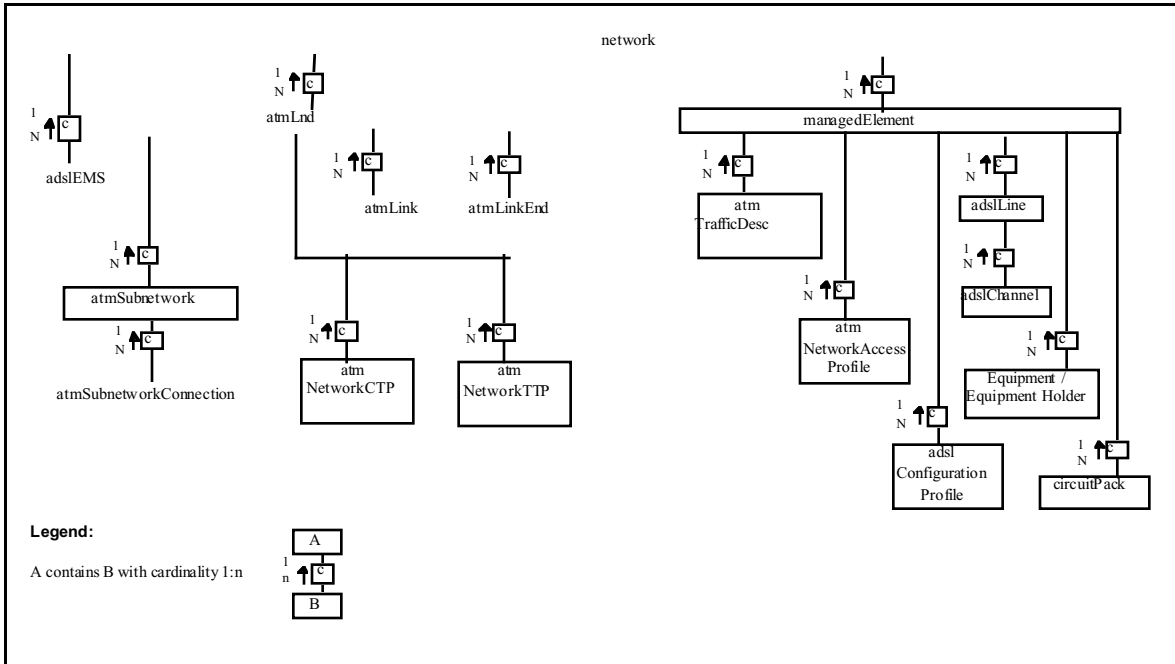
5   APPENDIX-A : Entity Relationships

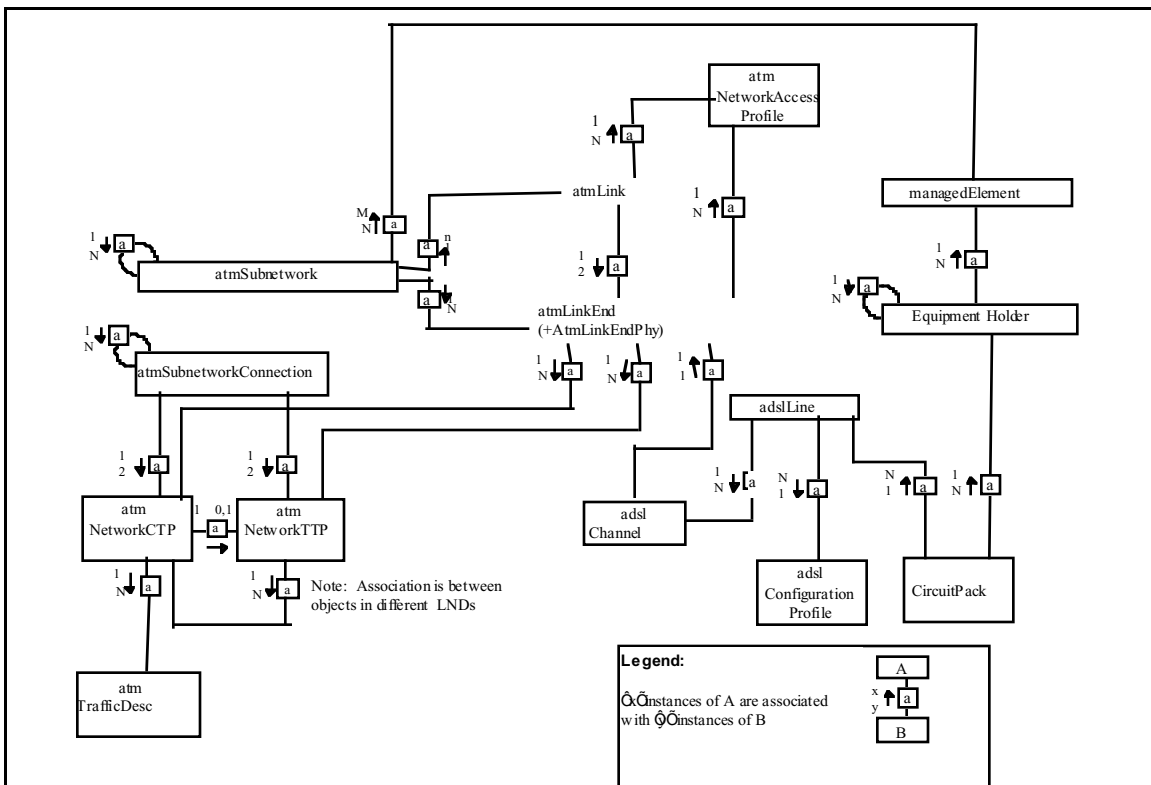**Figure-4 : Entity Containment Relationships**

Figure-5 : Entity Associations

APPENDIX-B : M4 Model Applicability Matrix

This section outlines the applicability of the ATM Forum M4 Network View Model [3] to the EMS-NMS interface specified in this document.

Following conventions are used:
(R) -   This section is fully applicable and is required to implement this interface.
(O) -   This section may be applicable depending on actual implementation.
(N) -   This section is not required to implement this interface.

5.1   network (R)

ATTRIBUTES
- Network ID (R)

5.2   vcLayerNetworkDomain (R)

ATTRIBUTES
- Signal Identification (R)
- User Label (R)

OPERATIONS
- Query vcLayerNetworkDomain for delimiting vcTTPs (N)
- Query vcLayerNetworkDomain for existing vcTrails (N)
- Query vcLayerNetworkDomain for component vcSubnetwork (N)
- Set up vcTrail set-up (N)
- Setup vcTrailRequest (N)
- Add TPs to Multipoint Trail: (N)
- Release vcTrail (N)
- Make external vcLinkEnd (R)
- Remove external vcLinkEnd (O)
- Setup vcTopologicalLink (N)
- Release vcTopologicalLink (N)

5.3   vcLinkConnection (N)

5.4   vcLinkEnd (R)

ATTRIBUTES
- VcLinkEnd ID (R)
- Administrative State (R)
- Availability Status (R)
- Egress Maximum Assignable Bandwidth (R)
- Ingress Maximum Assignable Bandwidth (R)
- Egress available Bandwidth (R)
- Ingress available Bandwidth (R)
- User Label (R)
- Link TP Type (R)

OPERATIONS
- Query vcLinkEnd for terminated vcTopologicalLink (O)

- Query vcLinkEndTP for delineated vcSubnetwork (N)
- Query vcLinkEnd for associated vpTTP (R)
- Associate vcLinkEnd with supporting vpTTP (N)
- vcLinkEnd PVC trace (N)

5.5   VcLogicalLinkTP (N)

5.6   VcNetworkAccessProfile (R)

ATTRIBUTES
- vcNetworkAccessProfile ID (R)
- total Egress Bandwidth (R)
- total Ingress Bandwidth (R)
- maximum Number of Active Connection Allowed (R)
- VPI or VCI ID Range (R)

5.7   VcRoutingProfile (N)

5.8   vcSubnetwork (R)

ATTRIBUTES
- Subnetwork ID (R)
- Signal Identification (R)
- user Label (R)
- availability Status (R)
- Supported by Object List (R)

OPERATIONS
- Query vcSubnetwork for existing vcSubnetworkConnections (R)
- Query vcSubnetwork for component vcSubnetworks (O)
- Query vcSubnetwork for vcTopologicalLinks between its
          component vcSubnetworks (O)
- Query vcSubnetwork for delineating vcLinkEnds and
          vcLogicalLinkTPs (R)
- Set up vcSubnetworkConnection (R)
- Modify vcSubnetworkConnection (N)
- Add TPs to subnetworkConnection: (O)
- Release vcSubnetworkConnection (R)

5.9   vcSubnetworkConnection (R)

ATTRIBUTES
- vcSubnetworkConnection ID (R)
- Directionality (R)
- availability Status (R)
- Administrative State (R)

- User Label (R)
- restorableIndicator (N)
- retainedResource (N)
- provisionType (N)

OPERATIONS
- Query subnetworkConnection for terminating networkCTPs (R)
- Query vcSubnetworkConnection for component
    vcSubnetworkConnections (N)
- vcSubnetworkConnection connection trace (N)

5.10 vcTopologicalLink (O)

ATTRIBUTES
- vcTopologicalLink ID (R)
- Signal Identification (R)
- Directionality (R)
- Operational State (R)
- Provisioned Bandwidth (R)
- Available Bandwidth (R)
- RestorationMode (N)
- Customer Identification (N)
- Weight (N)

OPERATIONS
- Query vcTopologicalLink for contained vcLinkConnections (N)
- Query vcTopologicalLink for terminating vcLinkEnds or
    vcLogicalLinkTPs (R)
- Query vcTopologicalLink for delineated vcSubnetworks (N)
- Set up vcLinkConnection (N)
- Modify vcLinkConnection (N)
- Release vcLinkConnection (N)
- vcTopologicalLink PVC trace (N)

5.11 vcTrail (N)

5.12 vcTrailRequest (N)

5.13 vpLayerNetworkDomain (R)

ATTRIBUTES
- Signal Identification (R)

OPERATIONS
- Query vpLayerNetworkDomain for delimiting vpTTPs (N)
- Query vpLayerNetworkDomain for existing vpTrails (N)
- Query vpLayerNetworkDomain for component vpSubnetwork (N)
- Set up vpTrail set-up (N)

- Setup vpTrailRequest (N)
- Add TPs to Multipoint Trail: (N)
- Release vpTrail (N)
- Setup vpTopologicalLink (O)
- Make external vpLinkEnd (R)
- Remove external vpLinkEnd (O)
- Release vpTopologicalLink (N)

5.14 vpLinkConnection (N)

5.15 vpLinkEnd (R)

ATTRIBUTES
- vpLinkEnd ID (R)
- Administrative State (R)
- Availability Status (R)
- Egress Maximum Assignable Bandwidth (R)
- Ingress Maximum Assignable Bandwidth (R)
- Egress available Bandwidth (R)
- Ingress available Bandwidth (R)
- User Label (R)
- Link TP Type (R)
- Loopback Location Identifier (O)
- ILMI Virtual Identifier (N)
- Supporting NE Location (N)
- Supporting Circuit Pack Location (N)
- Server TTP Name (N)
- Server TTP Characteristic Information Type (N)
- Server TTP Port Id (N)
- Server TTP Operational State (N)
- Server TTP Technology Specific Additional Information (N)
- Cell Scrambling Enable (R)
- Subscriber Address (N)
- Prefered Carrier (N)

OPERATIONS
- Query vpLinkEnd for terminated vpTopologicalLink (O)
- Query vpLinkEnd for delineated vpSubnetwork (N)
- Query vpLinkEnd for associated serverTTP (N)
- Associate vpLinkEnd with supporting serverTTP (N)
- vpLinkEnd PVC trace (N)

5.16 vpLogicalLinkTP (N)

5.17 vpNetworkAccessProfile (R)

ATTRIBUTES
- vpNetworkAccessProfile ID (R)
- total Egress Bandwidth (R)
- total Ingress Bandwidth (R)
- maximum Number of Active Connection Allowed (R)
- VPI/VCI Range (R)

5.18 vpRoutingProfile (N)

5.19 vpSubnetwork (R)

ATTRIBUTES
- Subnetwork ID (R)
- Signal Identification (R)
- user Label (R)
- availability Status (R)
- Supported by Object List (R)

OPERATIONS
- Query vpSubnetwork for delimiting vpNetworkCTPs (N)
- Query vpSubnetwork for existing vpSubnetworkConnections (R)
- Query vpSubnetwork for component vpSubnetworks (O)
- Query vpSubnetwork for vpTopologicalLinks between its
        component vpSubnetworks (O)
- Query vpSubnetwork for connecting vpLinkEnds or
        vpLogicalLinkTPs (O)
- Set up vpSubnetworkConnection (R)
- Modify vpSubnetworkConnection (N)
- Add TPs to SubnetworkConnection: (O)
- Release vpSubnetworkConnection (R)

5.20 vpSubnetworkConnection (R)

ATTRIBUTES
- vpSubnetworkConnection ID (R)
- Directionality (R)
- availability Status (R)
- Administrative State (R)
- User Label (R)
- restorableIndicator (N)
- retainedResource (N)
- provisionType (N)

OPERATIONS
- Query subnetworkConnection for terminating networkCTPs (R)
- Query vpSubnetworkConnection for component
        vpSubnetworkConnections (N)
- vpSubnetworkConnection connection trace (N)

5.21 vpTopologicalLink (O)

ATTRIBUTES
- vpTopologicalLink ID (R)
- Signal Identification (R)
- Directionality (R)
- Operational State (R)
- provisioned Bandwidth (R)
- available Bandwidth (R)
- restorationMode (N)
- Customer Identification (N)
- Weight (N)

OPERATIONS
- Query vpTopologicalLink for contained vpLinkConnections (N)
- Query vpTopologicalLink for terminating vpLinkEnds or
        vpLogicalLinkTPs (R)
- Query vpTopologicalLink For Delineated vpSubnetworks (R)
- Set up vpLinkConnection (N)
- Modify vpLinkConnection (N)
- Release vpLinkConnection (N)
- vpTopologicalLink PVC trace (N)

5.22 vpTrail (N)

5.23 vpTrailRequest (N)

5.24 vcNetworkCTP (R)

ATTRIBUTES
- vcCTP ID (R)
- VPI/VCI Value (R)
- User Label (R)
- Segment Endpoint (R)
- Ingress Tagging Indicator (R)
- Egress Tagging Indicator (R)
- PM OAM Method (N)
- PM OAM Direction (N)
- PM OAM Block Size (N)
- PM OAM Forward Active (N)
- PM OAM Backward Active (N)

OPERATIONS
- Associate vcNetworkCTP with vcNetworkTTP (O)
- Query vcNetworkCTP for associated vcNetworkTTP (R)
- Query vcNetworkCTP for associated subnetworkConnections (R)
- Loopback vcTrail at vcNetworkCTP (N)

5.25 vcNetworkTTP (O)

ATTRIBUTES
- vcTTP ID (R)
- availability Status (R)
- PM OAM Method (N)
- PM OAM Direction (N)
- PM OAM Block Size (N)
- PM OAM Forward Active (N)
- PM OAM Backward Active (N)

OPERATIONS
- Query vcNetworkTTP for associated vcNetworkCTP (R)
- Query vcTTP For terminated vcTrail (N)
- Loopback vcTrail at vcTTP (N)

5.26 vpNetworkCTP (R)

ATTRIBUTES
- vpCTP ID (R)
- VPI Value (R)
- User Label (R)
- Segment Endpoint (R)
- Ingress Tagging Indicator (R)
- Egress Tagging Indicator (R)
- PM OAM Method (N)
- PM OAM Direction (N)
- PM OAM Block Size (N)
- PM OAM Forward Active (N)
- PM OAM Backward Active (N)

OPERATIONS
- Associate vpNetworkCTP with vpNetworkTTP (R)
- Query vpNetworkCTP for associated vpNetworkTTP (R)
- Query vpNetworkCTP for associated subnetworkConnections (R)
- Loopback vpTrail at vpNetworkCTP (N)

5.27 vpNetworkTTP (R)

ATTRIBUTES
- VP TTP ID (R)
- availability Status (R)
- PM OAM Method (N)
- PM OAM Direction (N)
- PM OAM Block Size (N)
- PM OAM Forward Active (N)
- PM OAM Backward Active (N)

OPERATIONS
- Query vpNetworkTTP for associated vpNetworkCTP (R)
- Query vpTTP For terminated vpTrail (N)
- Loopback vcTrail at vcTTP (N)