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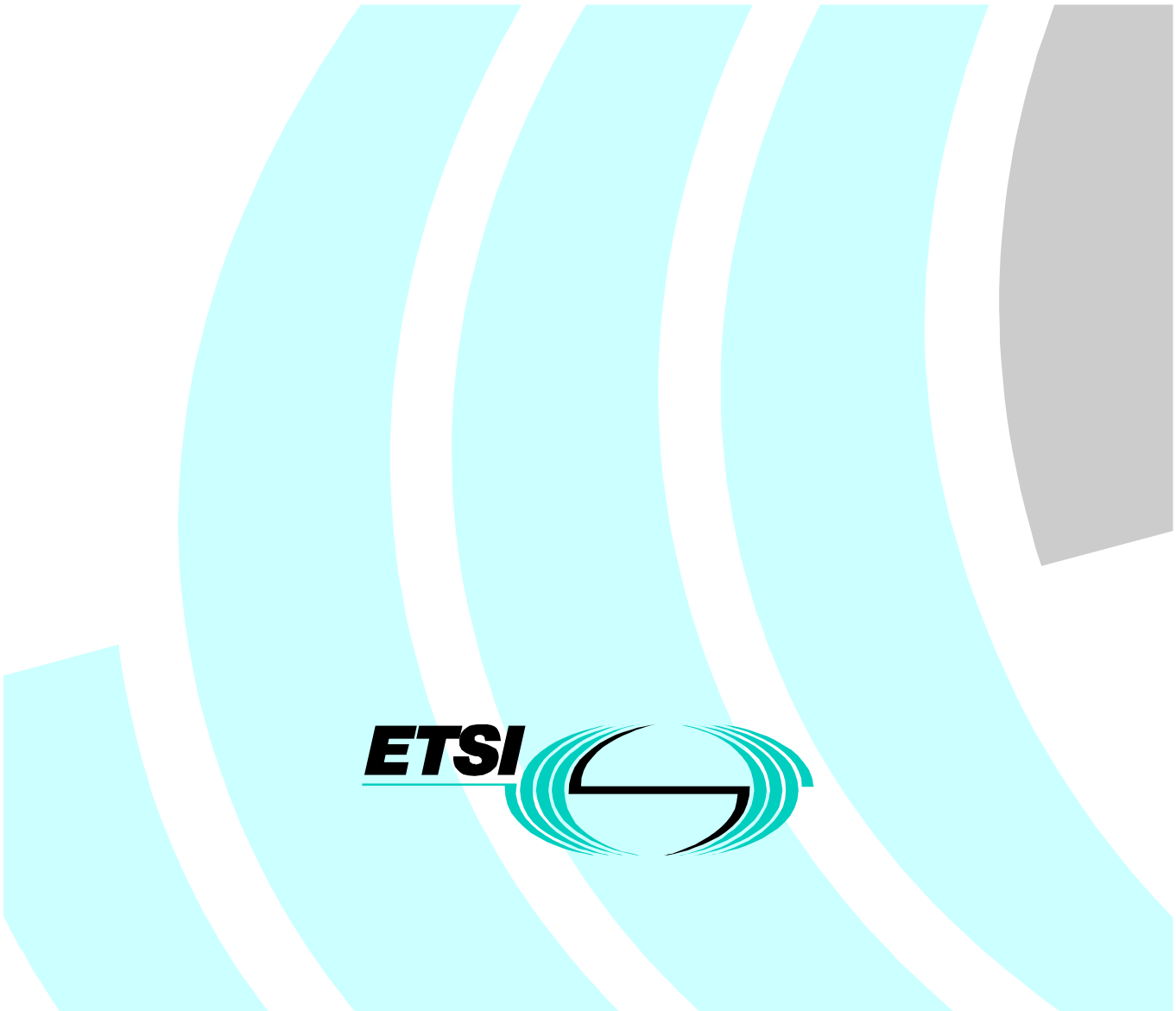

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ETSI

Postal address
F-06921 Sophia Antipolis Cedex - FRANCE

Office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet
secretariat@etsi.fr
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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Telecommunications Management Network (TMN).

1 Scope

The present document addresses the requirements of Network and service providers of Synchronous Digital Hierarchy (SDH) transmission Networks for establishing, maintaining and releasing Virtual Container (VC) connections, which span several administrative SDH domains. These requirements are satisfied by the use of a standardized interface (the "X-interface") between Operation Systems belonging to different Network operators.

The present document contains a general overview describing the different management areas that will be covered in the X-interface ES - path provisioning and fault management - as well as the relationships between them.

The present document describes the configuration management area covering the following aspects:

- a management architecture that shows how the X-interface is to be used between Network providers;
- the management services and functions needed to manage SDH connections, which span several administrative domains. These management services and functions cover the requirements for the X-interface;
- the management information crossing the X-interface. This management information specification uses the GDMO formalism, described in ITU-T Recommendation X.722 [1].

This version includes the first two of the five foreseen management Ensembles (Path Provisioning, Fault Management, Performance Management, Network Resourcing, Administration of the Management Network). Missing Ensembles will be added in future issues of the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ITU-T Recommendation X.722 (1992) | ISO/IEC 10165-4 (1992): "Information Technology; Open Systems Interconnection; Structure of Management Information; Guidelines for the Definition of managed objects".

[2] ITU-T Recommendation M.3100 (1992): "Generic Network Information Model".

[3] EURESCOM Project P.223 Deliverableerable 4: "TMN specification support procedures, EURESCOM; December 1994".

[4] Network Management Forum: "Forum 025; The "Ensemble" Concepts and Format; Issue 1.0; August 1992".

[5] EURESCOM Project P.414 Deliverableerable 3: "Guidelines for TMN development; EURESCOM; August 1996".

[6] I-ETS 300 653: "Telecommunications Management Network (TMN) Generic managed object class library for the network level view".

[7] ITU-T Recommendation G.803 (1992): "Architecture of transport Networks based on the synchronous digital hierarchy (SDH)".

[8] ITU-T Recommendation M.3020 (1992): "TMN interface specification methodology".

[9] ISO/IEC ISP 11183-2 (1992): "Information technology; International Standardized Profiles AOM1n OSI Management; Management Communications; Part 2: CMISE/ROSE for AOM12; Enhanced Management Communications".

[10] ISO/IEC ISP 11183-3 (1992): "Information technology; International Standardized Profiles AOM1n OSI Management; Management Communications; Part 3: CMISE/ROSE for AOM11; Basic Management Communications".

[11] ITU-T Recommendation X.721 (1992): "Information technology; Open Systems Interconnection; Structure of management information; Definition of management information".

[12] ITU-T Recommendation X.710 (1997): "Information technology; Open Systems Interconnection; Common Management Information Service".

[13] ITU-T Recommendation G.805 (1995): "Generic functional architecture of transport networks".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

connection: "transport entity" which is capable of transferring information transparently between "connection points". A "connection" defines the association between the "connection points" and the "connection points" delimit the "connection"

ensemble: result of a particular profiling technique which provides a requirements-based view of a particular solution to a management problem. Ensembles are described in the NM Forum 25 specification document "The Ensemble Concepts and Format"

layer, or transport Network layer: defined as ITU-T Recommendation G.805 [13] a topological component solely concerned with the generation and transfer of characteristic information

link: "topological component" which describes the fixed relationship between a "sub-Network" and another "sub-Network" or "access group"

link connection: "transport entity" provided by the "client/server" association. It is formed by a near-end "adaptation" function, a server "trail" and a far-end "adaptation" function between "connection points". It can be configured as part of the "trail management process" in the associated server layer

network connection: "transport entity" formed by the series of "connections" between "termination connection points"

partitioning: partitioning is defined ITU-T Recommendation G.805 [13] as a framework for defining the Network structure within a Network layer

profile: additional normative text which is required to restrict conditionality (e.g. specifies that a conditional package is or is not present) and specifies additional behaviour which may be required for a given implementation

sub-Network: "topological component" used to effect routing and management. It describes the potential for "sub-Network connections" across the "sub-Network". It can be partitioned into interconnected "sub-Networks" and "links". Each " sub-Network" in turn can be partitioned into smaller "sub-Networks " and "links" and so on. A "sub-Network" may be contained within one physical node

sub-Network connection: "transport entity" formed by a "connection" across a "sub-Network" between "connection points". It can be configured as part of the "trail management process". A SubNetwork connection is capable of transferring information transparently across a SubNetwork. It is delimited by connection points at the boundary of the SubNetwork and represents the association between these connection points. This connection is seen by the I-PNO as a whole, with no details regarding the way the connection is composed inside the involved PNOs domains

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACCD	Available Connections Change Dissemination
ACL	Access Control List
AOM	Application OSI Management
ASN.1	Abstract Syntax Notation 1
ATC	Ability To Connect
ATCCD	Ability To Connect Change Dissemination
BER	Basic Encoding Rules
CMIP	Common Management Information Protocol
CMIS	Common Management Information Service
CMISE	Common Management Information Service Element
CP	Connection Point
CPId	Connection Point Identities
CTP	Connection Termination Point
DLC	Deliverableerable Link Connection
ER	Entity Relationship
ETSI	European Telecommunications Standards Institute
FM	Fault Management
GDMO	Guidelines for the Definition of Managed Objects
GOM	Generic Object Model
HOP	Higher Order Path
ICS	Implementation Conformance Statements
ID	Identification
I-ETS	Intermediate ETSI Standard
INMS	Inter Operator Network Management System
ISO	International Standards Organisation
ISP	International Standardized Profiles
ITU-T	International Telecommunication Union - Telecom.
LC	Link Connection
LOP	Lower Order Path
MF	Management Function
MFS	Management Function Set
MS	Management Service
NMF	Network Management Forum
NWTP	Network Termination Point
OC	Object Class
OSI	Open System Interconnection
PESN	pan-European SDH Network
PNO	Public Network Operator
PP	Path Provisioning
SA log	Sent Alarm Log
SDH	Synchronous Digital Hierarchy
SN	SubNetwork
SNC	SubNetwork Connection
TMN	Telecommunications Management Network
VC	Virtual Container

4 Network and Management Architecture

This clause is informative and describes the Network and functional architecture for SDH transmission Networks.

In the present document, the term X-interface is used for Xcoop, an abbreviation for "co-operative X-interface", term given to the management interface between Public Network Operators (PNOs). The word "co-operative" reflects the understanding that all PNOs provide and receive the same services across that interface and that no PNO co-ordinates activities for others.

The SDH X-interface Management Services detailed in this specification are Path Provisioning and Fault Management. Path Provisioning is needed to set-up and release VC-12 paths when the two end-points lie in different operators' TMN domains. Fault Management is needed to disseminate fault information from the PNO owning the faulty resource to other PNOs using that resource.

4.1 Network Architecture

SDH Networks can be modelled with different Network layers (see figure 1), each of them has a client-server relationship with the contiguous ones, i.e. a server layer offers a transport service to the upper client layer and is the client of the lower layer, of which it uses the transport services. The model defines the circuit layer, which supports the end-to-end transmission of telecommunication services in the SDH Network, the path layer, which supports the transport of Virtual Containers (higher order and lower order path sublayers are defined, according to the order of the Virtual Container) and the Subclause Layer, which guarantees the transmission of SDH frames between the Network nodes.

Each layer is connected to the contiguous layers by means of access points which carry out the necessary adaptation functions to convert the signal formats of the different layers. Each Network can be partitioned in different SubNetworks, which are connected by link connections. The importance of this approach is that each layer can be configured and managed independently of each other and the Network at each layer can be rearranged by changing the association between the connection points.

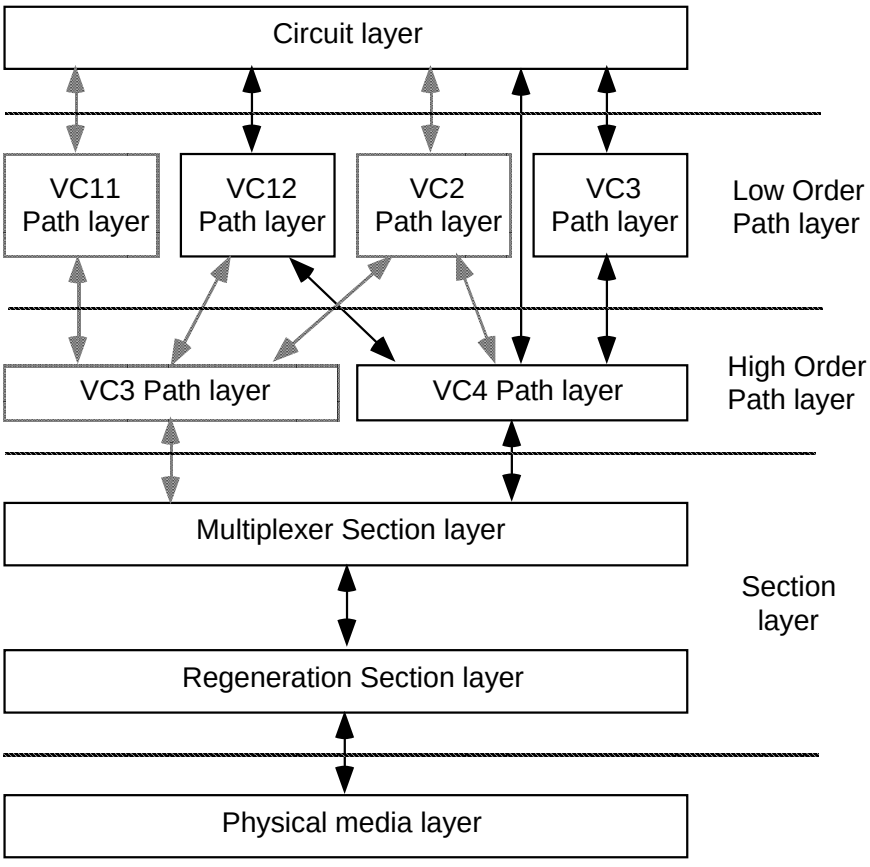


Figure 1: SDH layered model

The server layer (High order path) of the inter-operator SDH Network Network consists uniquely of dedicated VC-4s. The client layer consists of VC-LOW (VC-12,VC-2, and VC-3) which are transported inside the dedicated VC-4s. For reasons of simplicity, a VC-LOW is considered as being a VC-12.

The Network topology consists of gateways (points of access/egress), flexibility locations (cross-connection points) and links between them. The Network topology is known to all PNOs.

A PNO (e.g. PNO A in fig. 3) may request bandwidth on an inter-operator SDH VC-4 link which is owned by another PNO (PNO B, PNO C). PNO A request is always related to a particular VC-4 Link Connection (LC) (it is presumed that all PNOs know the available bandwidth on a VC-4 link). If the responding PNO has bandwidth available he informs the requesting PNO that his request is accepted and also communicates the identity of the VC-12 Deliverableerable Link Connection (DLC) (Path reservation). When all DLCs within a path have been reserved, the requesting PNO may activate the whole Deliverableerable (path) by requests for activation of DLCs and requests for SubNetwork connections (SNCs), within the intermediate flexibility locations (Path activation).

4.2 Management Architecture

The concepts that underpin the functional architecture for the X-interface are:

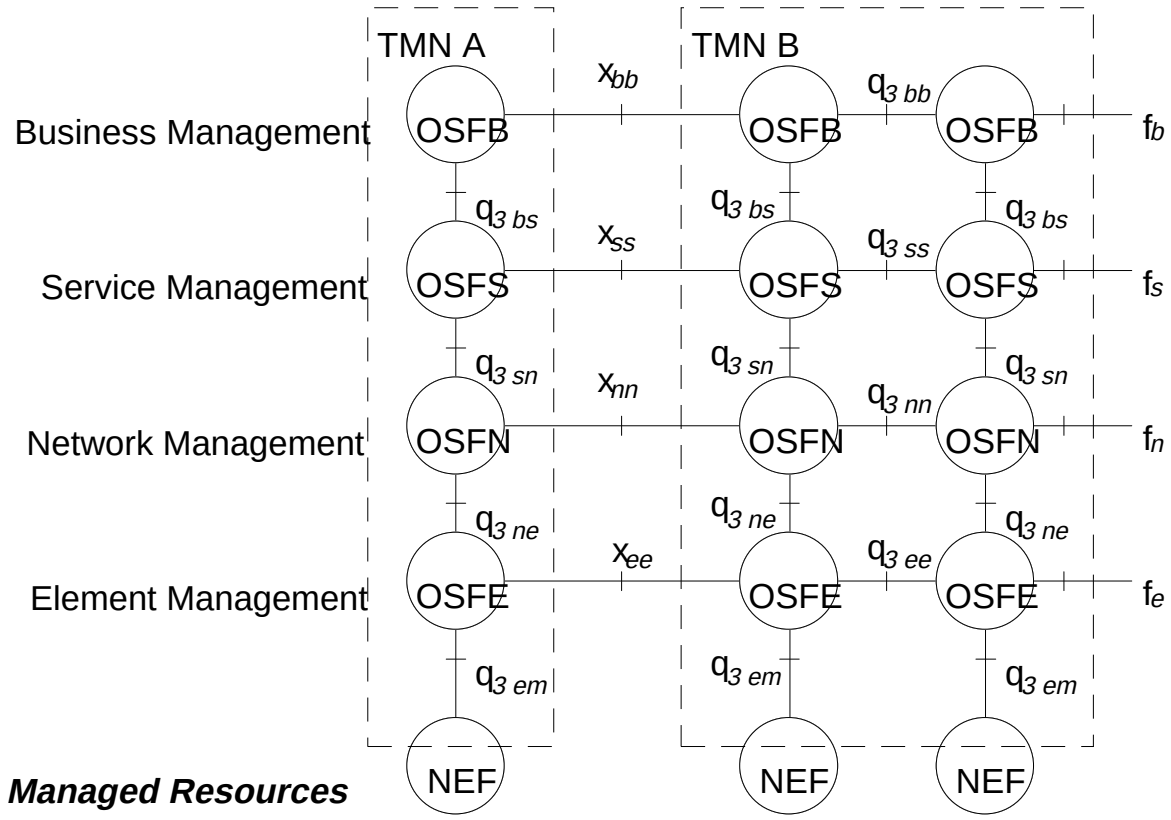
- the X-interface connects two management systems, for the purpose of exchanging service level and/or Network level requests with each other;

- the future use of Star or Cascaded organisational models for communication, or a mixture of both. The choice of the organisational model will be determined by agreements between the PNOs involved in the X-interface.

In order to clarify the position of the X-interface within the layered management architecture outlined in ITU-T Recommendation M.3100 [2], the following definition is adopted within the present document (figure 2):

- the Network Management level is concerned with connections within the Network. This means the control of topological information (SubNetworks and the links between SubNetworks), and SubNetwork connections.

Since Network operators can request other Network operators to Deliverableer a connection with a certain QoS, over the X- interface, this interface could be considered at the Service Management level. However, functionalities described in the present document are allocated to the Network Management level, such as the management of topological information.



q3-em: between NE and EM level
q3-ne: between EM and NM level
q3-sn: between SM and NM level
q3-bs: between BM and SM level

q3/x-nn in between two NM levels
q3/x-ss in between two SM levels
q3/x-bb in between two BM levels
q3/x-ee in between two EM levels

f-e, f-n, f-s, f-b: between OS functionality and workstations

Figure 2: Layers of management (from ITU-T Recommendation M.3100 [2])

4.3 Organisational Model

In order to explain the Path Provisioning and Fault Management mechanisms specified by the two SDH Ensembles, some knowledge of the requirements inherent to the inter-operator Network management rules is necessary [3].

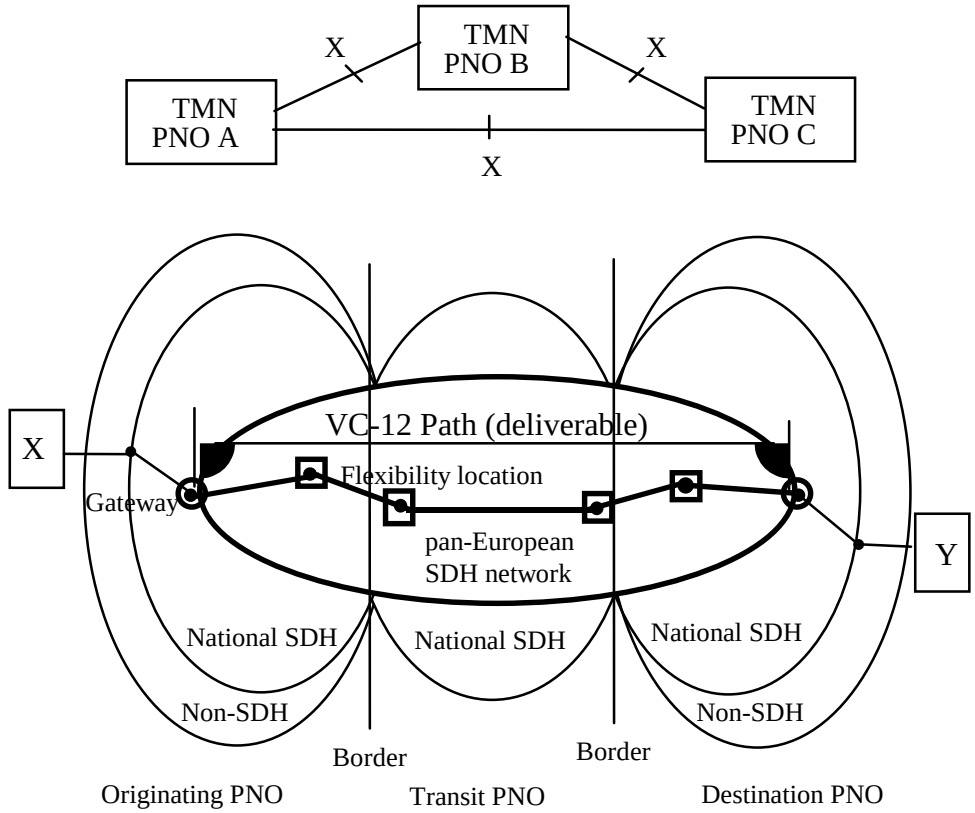


Figure 3: Scope of co-operative Network management

The main purpose of inter-operator SDH Network management is to automate the management of VC-12 paths across the European VC-4 Network. The resources constituting the inter-operator SDH Network across Europe are VC-4 Link Connections (LC) and SubNetworks (SN). SubNetworks are non-partitionable and their cross-connection flexibility can be either VC-12 or VC-4. Cross-border LCs are managed by only one of the two end PNOs and each PNO shall declare to all other PNOs all of its SDH resources it wishes to make available. SNs where VC-12 paths can start or end are called gateways and must be thus identified.

There is no central database for the topology and each PNO maintains its own view of the complete SDH Network. A PNO is therefore responsible for disseminating any change in its part of the Network to all other PNOs. Such changes are, for example, available bandwidth changes in a LC.

The considerable extent of the inter-operator SDH Network has a direct impact on the potential volume of alarms circulated on the X-interface at any time. In order to limit this volume, it is proposed that only LCs (VC-4) and VC-12 connections in SNs are allowed to issue alarms. Furthermore, it has been stipulated that an alarm should only be reported to PNOs that are users of the affected resource, and not to any others.

5 Specification of Ensembles and Information Model

5.1 Methodology

The approach chosen to document the specification of the SDH X-interface for these two management services is the Ensemble approach adapted from the Network Management Forum (NMF) [4]. It is also the approach recommended by other work investigating TMN Guidelines [5].

To specify the selected Management Services (MS), the NMF Ensemble concept adopted has been adapted for the particular needs of the inter-operator SDH scenario, namely the co-existence of both Manager and Agent roles in the same system. An Ensemble is a document containing the complete specification for one MS across one management interface. An Ensemble can be thought as a collection of specific functionalities, called management function sets (MFS). An MFS uses one or more basic management functions (MF). An MF itself describes one self-contained message exchange across the specified management interface. Modularity is found at the MF level since an MF can be used by different MFSs.

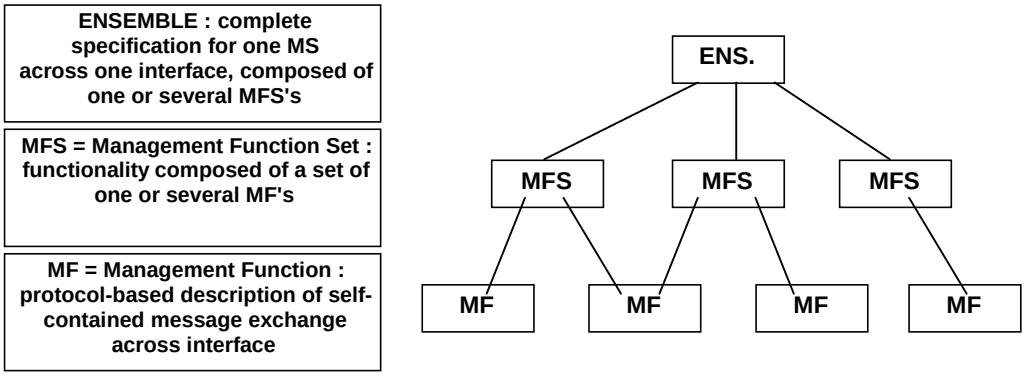


Figure 4: Ensemble Decomposition

Even though all of the information contained in an Ensemble is important, it is interesting to pinpoint that some sections of the document are of essential interest in the Ensemble production phase.

- Subclause 6.8 on Resources, where managed resources are described.
- Subclause 7.1 on Management Service Functions, where MFSs are described, with the help of message sequence charts.
- Subclause 8.3 on Scenarios, where MFs are described.
- Subclause 8.4 on Management Information References, where the Information Model is profiled to the needs of the Ensemble.

The Ensembles are tied to the common Information Model by way of subclauses 8.3 and 8.4. Whereas the Information Model encapsulates the syntax of the message exchanges and how they are subsequently processed (behaviour), it does not however describe the sequence in which messages arrive and how they relate to more global operations. The Ensemble methodology provides that, in addition to other guidelines and heuristics - for example, the minimization of information flow across the interface by way of defining the relevant information to be sent to each PNO, and identifying the least number of parameters that encapsulate such information.

5.2 Path Provisioning Ensemble

When a PNO wishes to establish a VC-12 path across Europe, a VC-12 link connection, or "Deliverableerable Link Connection" (DLC), shall be reserved inside every VC-4 link connection (LC) along the chosen path. Here, the reservation requests are sent by the "origin" PNO to all PNOs on the path. The subsequently received responses contain Ids of the termination points and the Id of the reserved DLC. When all reservations are satisfied, the origin PNO can then activate the path by sending:

- requests for activating the DLCs; and
- requests for setting up the SubNetwork connections (SNC) between DLCs, indicated by the termination points;

to all concerned parties.

There is the possibility to partially or entirely unreserve a path which has not yet been activated. Unreservation is also automatically triggered if a DLC has not been activated within an agreed time-out period.

An LC contains a fixed number of DLCs. Every time a DLC is reserved inside an LC, the available bandwidth of the LC, measured by the number of free DLCs, decreases by one. This change must then be reported to all PNOs. Likewise, changes are reported when a reservation is cancelled, or a DLC released after having been activated. It is also possible for a PNO to inspect the number of available connections of any LC at any time.

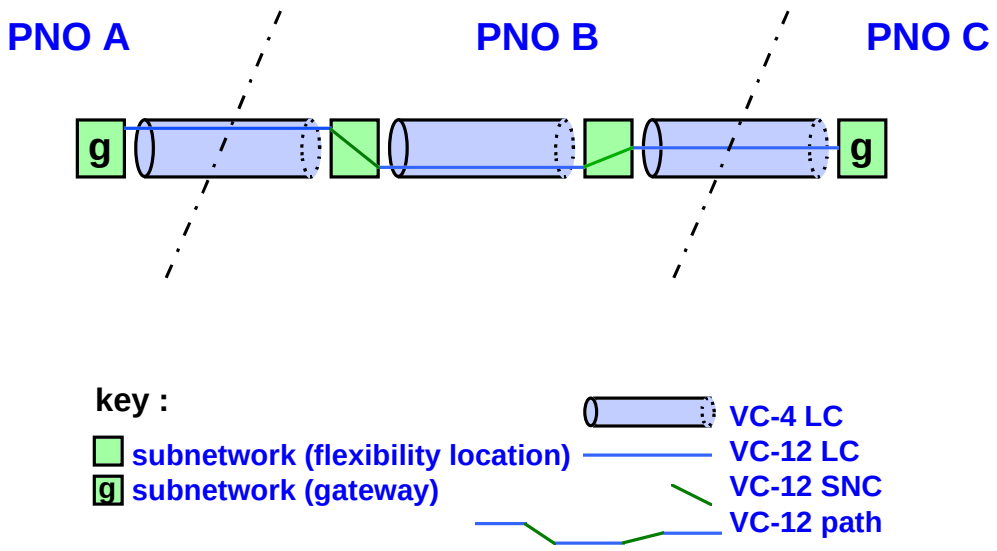


Figure 5: An SDH Path across three PNOs

The MFSs contained in the Path Provisioning Ensemble are:

- **Reserve DLCs**
  (reservation of a set of DLCs within a path);
- **Unreserve DLCs**
  (unreservation of a set of DLCs within a path);
- **Reservation time-out**
  (unreservation of a DLC because of no activation within a limited time);
- **Activate Path**
  (activation of a set of DLCs and SNCs within a path, activation is expected to take place immediately after reservation);
- **Release Path**
  (deactivation and unreservation of a set of DLCs and SNCs within a path);
- **Available Connections Update**
  (internally induced change of available connections (DLCs) within a LC);

- **Ability to Connect Update**
  (notification indicating the ability of a SubNetwork to support establishment of new SNCs).

5.3 Fault Management Ensemble

Alarm events on LCs and SNCs are only transmitted to the PNOs using them. Users of an LC are PNOs who have requested the reservation or activation of DLCs in this LC. Since SNCs are VC-12, there is only one user for an SNC, namely, the PNO which has requested its set-up (there is no reservation process for SNCs).

All PNOs shall maintain a Log of all the alarms they have sent to others. This Log is partially visible to all other PNOs, in order to keep track of accidentally lost alarms: a given PNO "A" is allowed at any time to remotely inspect another PNOs Log, but only the part containing the alarms that were sent to "A" (which it may not have received or may have lost).

When an alarm causes a change in either the available connections of an LC or the ability to connect of an SN, an inter-Ensemble message is sent from Fault Management to Path Provisioning, which will then disseminate to all PNOs (not only the users of the resource) the appropriate topology update message.

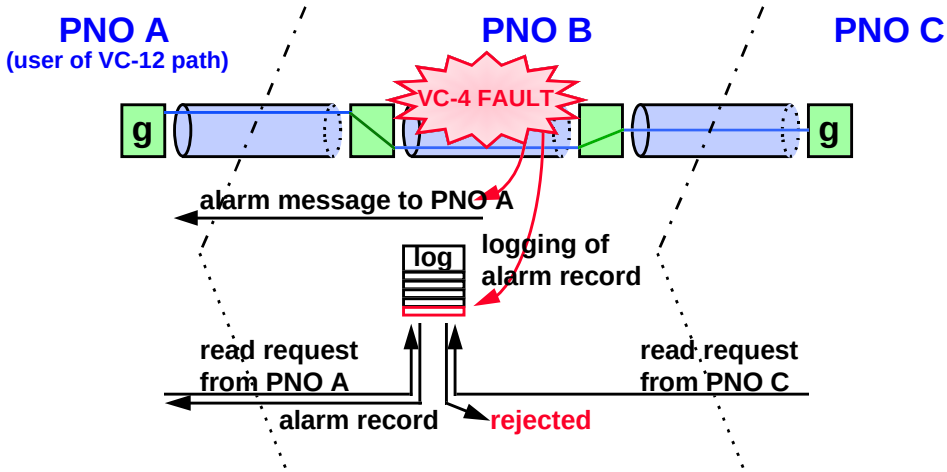


Figure 6: Dissemination of an alarm on an SDH Path

The MFSs contained in the Fault Management Ensemble are:

- **Alarm Processing**
  (alarm reception and dissemination, and topology update);

- **Alarm Event Logging**
  (log inspection).

5.4 Specifying the Information Model

The information model to be used in conjunction with the Ensembles is the inter-operator SDH information model. The inter-operator SDH model has been produced with 6 specific OCs, with names starting with the letter "m" (= managed SDH), all inherited from OCs of I-ETS 300 653 [6].

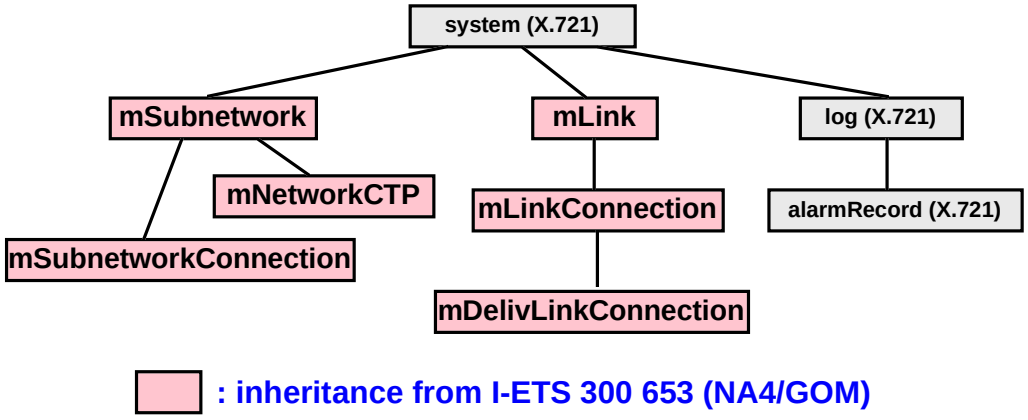


Figure 7: Information Model naming tree

The inter-operator SDH model has a larger scope than the two current Ensembles (it partially covers other MSs), and it is a living document: additional OCs will be added in the future to cover the other MSs (Performance Management, Network Resourcing, Administration of the Management Network).

A quality review of this Information Model was carried out, ensuring that:

- the behaviour part of OCs are comprehensible;
- objects match the requirements expressed in the Ensembles;
- standardized objects are used whenever possible;
- implementation-dependent information is excluded.

Each Ensemble uses a limited part of the Information Model, well defined in terms of restrictions on OCs, and within each of these OCs, on attributes, actions and notifications. These restrictions constitute "profiles" for each of the above items, which are documented in a dedicated subclause of each Ensemble, called "Management Information References" (subclause 8.4).

6 Ensemble Methodology and Features

6.1 Introduction

Ensembles provide a top down view of a particular solution to a management problem. In order to focus on the solution to this management problem, specific restrictions are placed upon particular referenced definitions.

The concepts and format of Ensembles are described in the "NM Forum Ensemble Concepts and Format" [4] specification document.

Each Ensemble contains general text in each subclause that is common to all Ensembles. By convention this common text is portrayed in bold italic characters.

This Ensemble, wherever possible, references documents which define the components of the Ensemble.

The management problem is identified as a set of requirements and constraints. In defining the solution to this management problem, the resources to be managed, the functions to be applied, and the scenarios describing the interactions are all identified. The Ensemble references base standards and International Standardized Profiles (ISPs). It also references libraries containing definitions expressed by GDMO (Guidelines for the Definition of Managed Objects [1]) templates.

The purpose of the present document is to collect management information definitions and profiles, and show how they can be applied to manage the resources identified in this Ensemble.

6.2 General Description of the Ensembles

The Ensembles covered by the present document specify the management functions and the managed objects that define:

The SDH Path Provisioning X-interface between two nodes in a Pan European SDH Network (PESN). The capabilities provided by the managed objects allow a manager to reserve and activate communication resources (links and SubNetwork connections) over the X-interface. The specification is based on collaborative work between a number of European telecommunications operators;

The SDH Fault Management X-interface between two nodes in a Pan European SDH Network (PESN). The capabilities provided by the managed objects allow a manager to send alarm messages concerning communication resources (links and SubNetwork connections), and to read alarm logs, over the X-interface. The specification is based collaborative work between a number of European telecommunications operators.

6.3 Scope and Purpose

Ensembles represent specific solutions to particular problems. Thus, an Ensemble is the complete description of the problem and the solution to that problem.

The Ensembles will be used as a base for the design of management applications within the scope of the Pan European SDH Network. These applications may be regarded as prototypes of Inter Operator Network Management Systems (INMS) needed to manage a future Pan European SDH Network.

The functions covered by the Path Provisioning ensemble are illustrated in figure 8 and the Fault Management ensemble in figure 9.

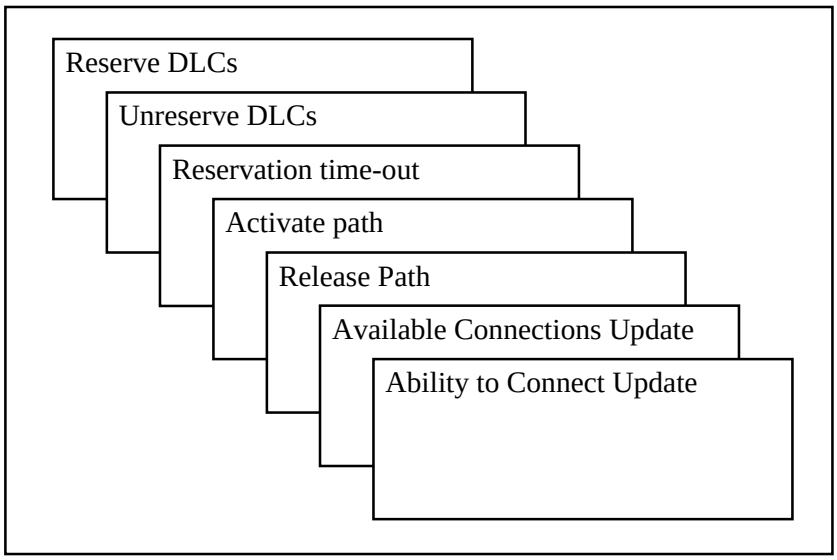


Figure 8: Functions covered by the Path Provisioning ensemble

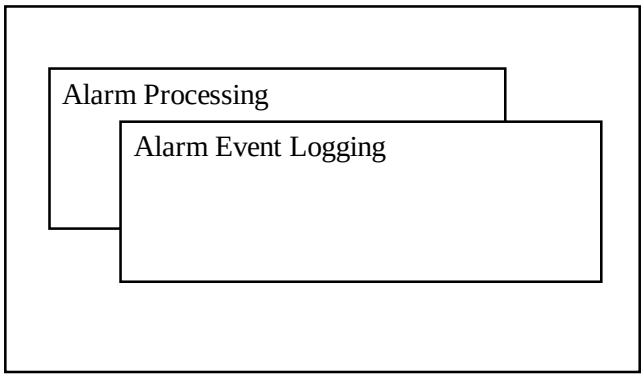


Figure 9: Functions covered by the Fault Management ensemble

6.4 Relationships with Other Ensembles

The Ensembles are closely related to each other and deal partly the same resources and management context.

6.5 Management Context

The "Management Context" describes why an Ensemble is required. The description of the "Management Context" includes the definition of the resources to be managed, the management functions to be performed, the scope of the problem to be solved, and the management view or level of abstraction from which the problem is to be approached. The influence of the Management Context on the Ensemble is shown below in figure 10.

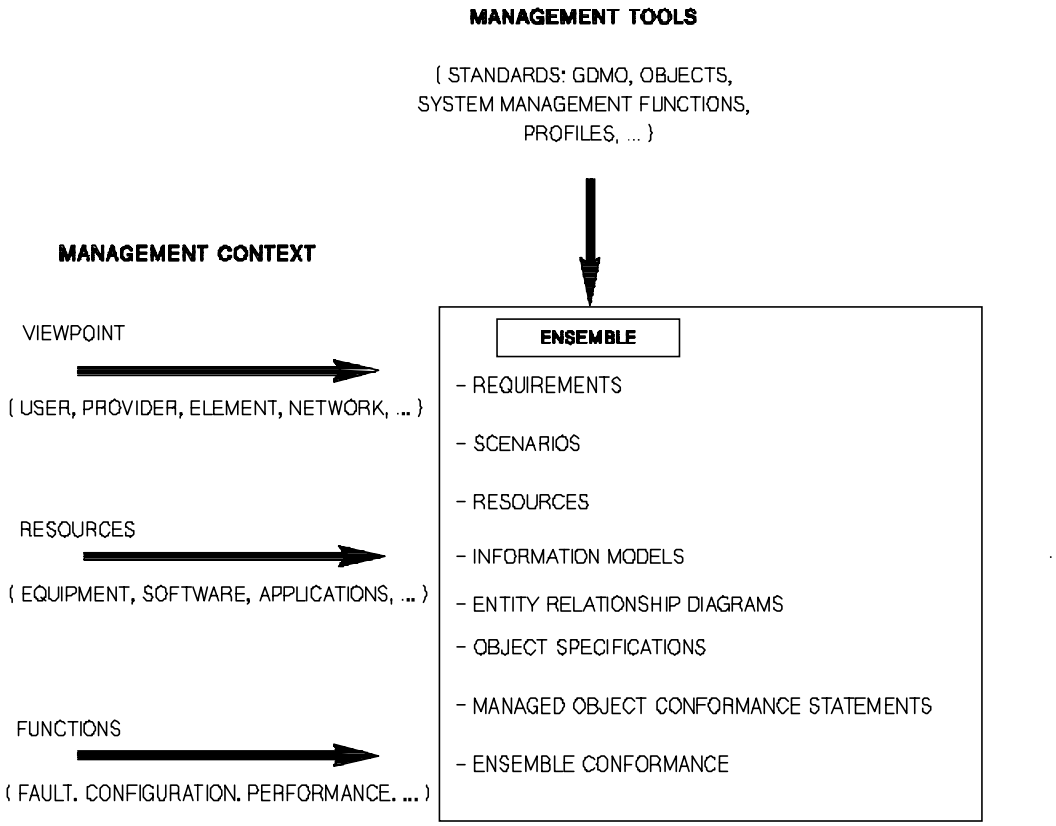


Figure 10: Management context overview

6.6 Management View and Level of Abstraction

This subclause indicates the management view of the Ensembles which includes information on the level of abstraction. For example, in an hierarchically organized system this subclause would indicate if the Ensemble deals with the management of equipment, the management of Networks or the management of services. It may also indicate management perspectives and roles.

The Ensembles address the management views for the X-interface between TMNs of different PNOs according to the inter-operator SDH Network requirements. The management level is the Network-view level. Path Provisioning is a part of Configuration Management whereas SDH Fault Management is a part of overall fault management. All functions described are functions on the Network-view level.

	Fault Management	Configuration Management	Accounting Management	Performance Management	Security Management
Business Management Layer					
Service Management Layer					
Network Management Layer	Fault Man.	Path Prov.			
Network Element Management Layer					
Network Element Layer					

Figure 11: Management view regarding SDH Path Provisioning and Fault Management across the X-interface

6.7 Resources

This subclause defines all the resources or components of resources that are to be the subject of the Ensembles. The definition of the resources contains all the resources and only those resources that are relevant to the Ensembles. The resources are defined by textual descriptions or by reference to other documents containing descriptions of the resources. When other documents are referenced statements are provided to indicate any restrictions and constraints on those source definitions.

The description of manageable resources is based on ITU-T Recommendation G.803 [7] terms (**bold**) and the inter-operator SDH Network interpretation of them, and also extended with inter-operator SDH Network-specific terminology (plain). Resources managed in these Ensembles are underlined.

To describe the dynamics of the resources, two processes in the resource lifecycles are mentioned below; the commissioning process and the provisioning process. The commissioning process contains installation and configuration of resources and exists prior to the provisioning process. The Path provisioning ensemble only deals with activities within the provisioning process. Fault Management deals with monitoring and logging of the status of the resources.

6.7.1 Topological Components

None of the topological components can be created or modified - in terms of characteristics - across the interoperable interface (due to the fact that this ensemble defines the X-interface, i.e. the interface between different PNOs).

Layer Network: transport Network is built up of layer Networks with mutual client/server relationships. A layer Network is defined by its access points. The information transferred through the Network is characteristic (in terms of rate and format) for the layer. A layer Network may be decomposed into links and SubNetworks.

Inter-operator: part of the "global" path layer Network. The inter-operator SDH.

SDH Network: Network consists of a VC-12 (LOP) client layer Network and a VC-4 (HOP) server layer Network. The inter-operator SDH Network consists of flexibility locations, gateways and links between them.

Link: link describes the fixed relationship between SubNetworks within a layer. A link offers capacity which may be used for link connections.

Link: inter-operator SDH Network links can be internal to an operator or linking two operator domains. The latter are managed by one of the involved PNOs.

SubNetwork: SubNetwork describes the potential to interconnect links by means of SubNetwork connections. SubNetworks may be partitioned into lower order SubNetworks and links between them, where the lowest order represent part of the cross-connection matrix in a Network element.

SubNetwork: in the inter-operator SDH Network, a SubNetwork always corresponds to a cross-connection matrix in a Network element, i.e. no partitioning. The inter-operator SDH Network assumes non-blocking equipment, i.e. SubNetwork connections do not have to be reserved before activation. A SubNetwork does not need to be completely dedicated to the inter-operator SDH Network.

Flexibility Location: SubNetwork in the inter-operator SDH Network. A Flexibility Location cannot be partitioned further into SubNetworks and links between them.

Gateway: point of access/egress between the inter-operator SDH Network and an operator's SubNetwork. A gateway may also be a flexibility location. A gateway is assumed to be at the VC-12 level.

6.7.2 Transport Entities

Link Connection: fixed relationship between two connection points which uses some of the transport capacity of a link.

Link Connection: in the inter-operator SDH Network the termLink Connection (LC) denotes a VC-4 link connection. These connections are set up in the commissioning process, i.e. not across the interoperable interface. A VC-4 link connection is always completely dedicated to the inter-operator SDH Network.

Deliverableerable Link Connection: Deliverableerable Link Connection (DLC) is a link connection at the VC-12 level. The inter-operator SDH Network VC-12 path is composed of a set of DLCs and SNCs between two gateways (for now restricted to VC-12 link connections). These connections are set up in the commissioning process, i.e. managed object instances corresponding to the DLCs within a LC exist when the provisioning process starts. They are supported by link connections in the VC-4 layer.

SubNetwork Connection: connection between a number of connection points of a SubNetwork.

SubNetwork Connection: in the inter-operator SDH Network terms: A connection between two connection points of a flexibility location. SubNetwork connections are established in the provisioning process, i.e. managed object instances corresponding to the SNCs are created during provisioning. Constraint: Only point-to-point connections are allowed.

Path/Deliverableerable: in this context the term path is used for the part of a SDH path which belongs to the inter-operator SDH Network, i.e. the same as a inter-operator SDH Network Deliverableerable. It begins and ends in a gateway. The path consists of a number of DLCs with intermediate SNCs. It always starts and ends with a DLC.

6.7.3 Reference Points

The reference points can not be created across the interoperable interface.

Access Point: Point of access/egress of a layer Network.

Connection Point: Point of connection between a link connection and a SubNetwork connection.

7 Ensembles

This clause defines the management functions that can be performed on the resources described in subclause 6.8. These functions may be primitive functions defined for OSI systems management (e.g. event management), higher level functions for general Network management (e.g. alarm surveillance), or other functions unique to the problem the ensemble addresses.

7.1 Path Provisioning

7.1.1 Introduction

The management functions of this Ensemble are described using M.3020 terminology [8]. At the first level (see figure 12), a set of Management Function Sets (MFS) are identified. At the second level these MFS are decomposed into Management Functions (MF). A MF may be used within a set of MFS.

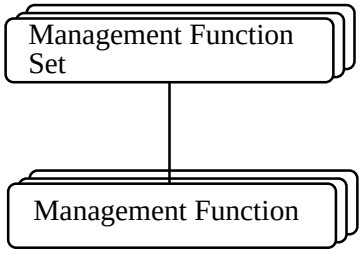


Figure 12: Decomposition hierarchy

The MFS of Path Provisioning are described in terms of Use cases, i.e. sequences of events that are initiated by a TMN user (in this case an inter-operator SDH Network PNO). The following MFSs have been identified.

- **Reserve DLCs**
  (reservation of a set of DLCs within a path);
- **Unreserve DLCs**
  (unreservation of a set of DLCs within a path);
- **Reservation time-out**
  (unreservation of a DLC because of no activation within a limited time);
- **Activate Path**
  (activation of a set of DLCs and SNCs within a path, activation is expected to take place immediately after reservation);
- **Release Path**
  (deactivation and unreservation of a set of DLCs and SNCs within a path);
- **Available Connections Update**
  (internally induced change of available connections (DLCs) within a LC);
- **Ability to Connect Update**
  (notification indicating the ability of a SubNetwork to support establishment of new SNCs).

A DLC *in service* may have one of three different assignment states: *Unreserved, Reserved, Activated.*

The MFS Reserve DLCs changes the state for a set of DLCs from Unreserved to Reserved.

The MFS Unreserve DLCs/Reservation time-out changes the state for a set of DLCs from Reserved to Unreserved.

The MFS Activate DLCs changes the state for a set of DLCs from Reserved to Activated.

The MFS Release DLCs changes the state for a set of DLCs from Reserved/Activated to Unreserved.

A DLC which has become *out of service* can be unreserved or released, but not reserved or activated. Toggling between *in service* and *out of service* is dealt with in the Fault Management Ensemble (annex B). The assignment state is not affected by these transitions.

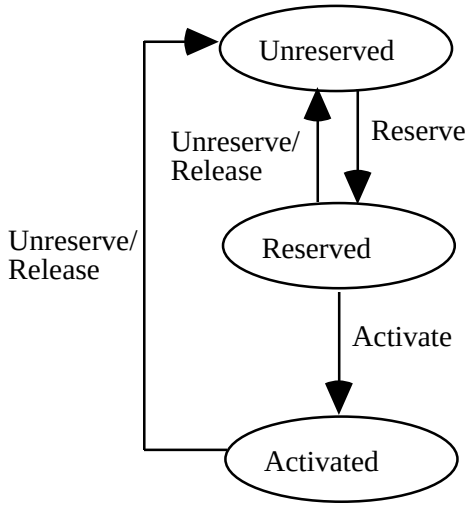


Figure 13: DLC state change diagram

The state changes are further elaborated in table 1.

Table 1: DLC State Change Table

	Unreserved	*Reserved*	*Activated*
Reserve	Reserved	Reserved (note 3)	Activated (note 3)
Unreserve	Unreserved (note 3)	Unreserved (note 2)	Unreserved (note 1)
Activate	Unreserved (note 3)	Activated (note 1)	Activated (note 3)
Release	Unreserved (note 3)	Unreserved (note 1)	Unreserved (note 1)
NOTE 1: The Requesting PNO shall be the same as the Reserving PNO. NOTE 2: The Requesting PNO shall be the same as the Reserving PNO. In case of time-out, the PNO that owns the DLC performs the Unreservation. NOTE 3: Abnormal actions.			

In case the preconditions (1,2) are not met, the request will be denied. Note that these are not the complete set of preconditions for these state transitions.

Each MFS is described by a set of messages that are sent between PNOs. PNO internal activities initiated by incoming messages are also described. The order between different messages are illustrated by Message Sequence Charts. Three types of PNOs are used in these charts:

- the Requesting PNO, i.e. the PNO initiating the sequence of messages;
- the Responding PNOs, i.e. the PNOs responding to messages (reserve, activate etc.) from the Requesting PNO. A Responding PNO may be either a Transit PNO or a Destination PNO;
- third Party PNOs, i.e. PNOs that may receive messages related to actions within the Requesting PNO or a Responding PNO.

It should be noted that only the main parameters are indicated in the Sequence Charts. The full list of parameters per message and the parameter value range are described in tables 2 and 3. It should also be noted that the MFS described here comprise the normal flow of events and the most important error cases. They do not describe all possible error cases.

7.1.2 Reserve DLCs

The MFS Reserve DLCs is initiated when a user within a PNO needs to establish a VC 12 path to a destination located within the domain of another PNO. Before the actual reservation process is initiated, a search for the "best route" (the best route from the starting point to the destination) is carried out within the INMS of the Originating PNO. The result of this search process is a set of VC-4 Link Connections (LCs). These LCs belong to the Originating PNO, the Destination PNO and a set of intermediate Transit PNOs. It is assumed that the different DLCs within the path are reserved in order. The result of each reservation request is an identity of the reserved DLC (DLC Id) and two Connection Point Identities (CPIds) that are to be used during the subsequent path activation. The border between two PNOs are assumed to be located between a DLC and a SubNetwork (SN). This means that the PNO owning the SN has to declare the CPIds corresponding to the incoming DLCs to the PNO owning the DLCs. This declaration is assumed to take place as a part of the commissioning process.

The MFS Reserve DLCs contains all messages over the X-interface needed in order to make reservations of DLCs within the LCs constituting the route. The role of the Responding PNO may for a certain message be played by either a Transit PNO or the Destination PNO. The Third party PNO represent all other PNOs, that for each reservation receive information that the number of available DLCs within that particular LC has been changed (Available Connections Change Dissemination - ACCD).

Reasons for failure of this MFS includes lack of capacity, unknown resource, or LC out of service.

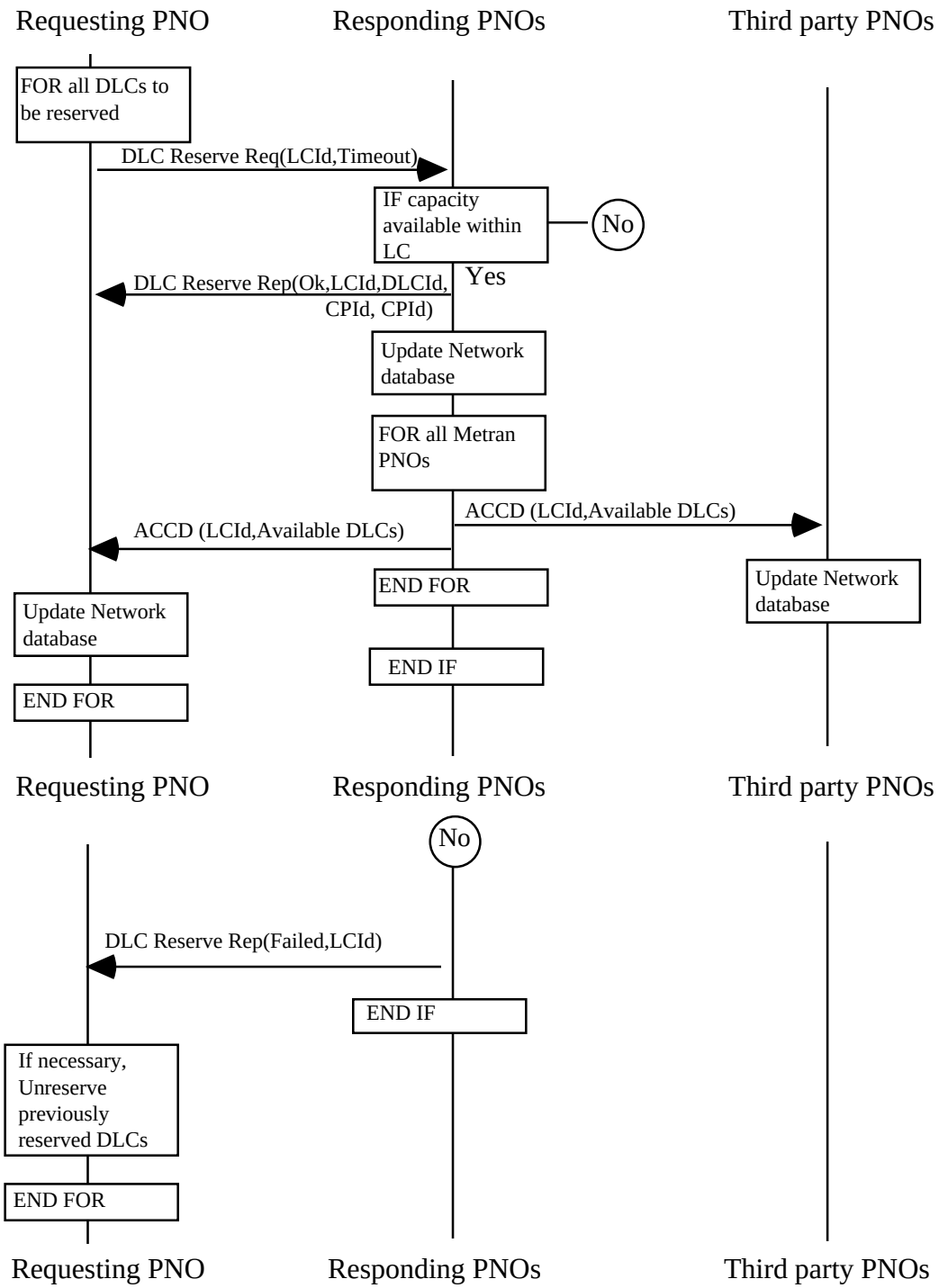


Figure 14: The reservation of a set of DLCs

7.1.3 Unreserve DLCs

The MFS Unreserve DLCs is initiated when the Originating PNO needs to change the state of a single DLC or a set of DLCs to unreserved. The unreservation may for example take place in case it was not possible to reserve a DLC within one of the LCs within the selected route. In this case some of the already reserved DLCs have to be unreserved and a new route or part of route has to be selected. If an unreservation of a DLC fails, it is the responsibility of the Requesting PNO to make a new request for unreservation. The Requesting PNO may also choose not to make a new request. In this case the DLC will be unreserved by the Responding PNO after a certain time-out limit.

The MFS Unreserve DLCs contains all messages over the X-interface needed in order to make unreservations of a set of DLCs within the LCs constituting part of the selected route. The role of the Responding PNO may for a certain message be played by either a Transit PNO or the Destination PNO. The Third party PNO represent all other PNOs, that for each reservation receive information that the number of available DLCs within that particular LC has been changed (Available Connections Change Dissemination - ACCD).

Reasons for failure of this MFS includes trying to unreserve a DLC reserved/activated by another PNO, trying to unreserve an unreserved DLC, or trying to unreserve a by the responder unknown DLC.

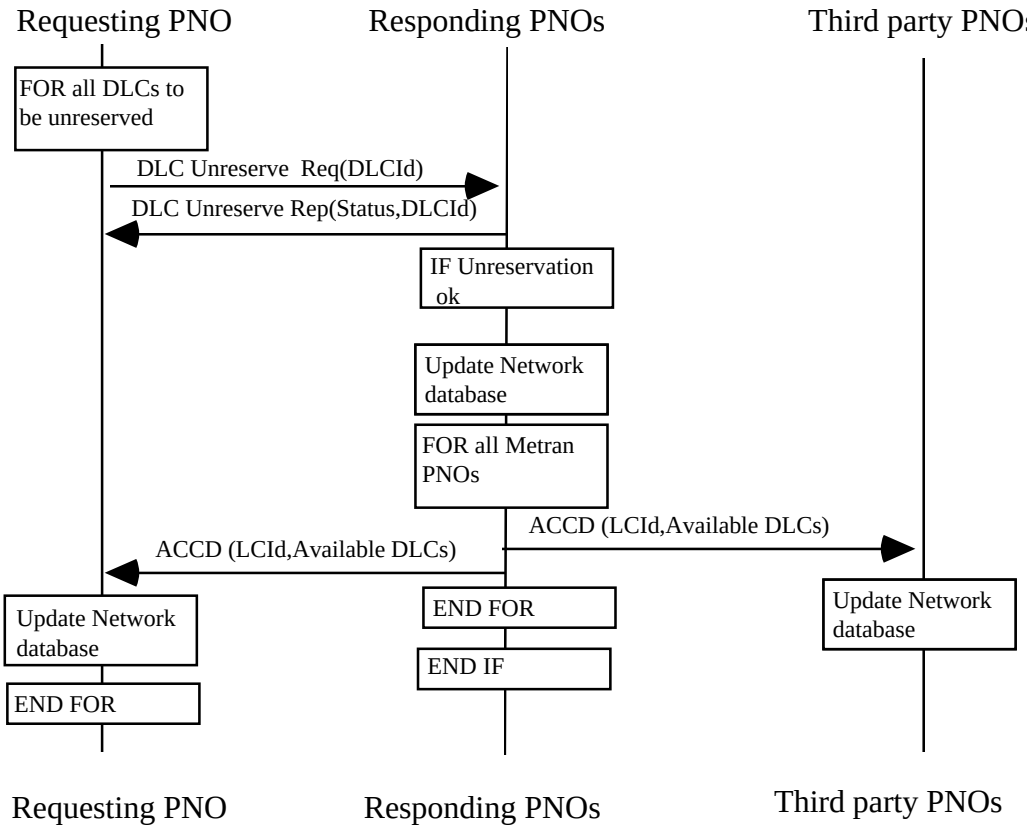


Figure 15: The unreservation of DLCs

7.1.4 Reservation Time-out

The MFS Reservation Time-out is initiated when a DLC within a PNO has been reserved by another PNO but not subsequently activated. In case of time-out the state of the DLC is set to unreserved.

The MFS Reservation Time-out contains the message over the X-interface needed in order to inform a PNO that the number of available DLCs within the LC has been changed (old value plus one). The role of the Responding PNO may be played by either a Transit PNO or the Destination PNO. The Third party PNO represent all other PNOs, that receive information that the number of available DLCs within that particular LC has been changed (Available Connections Change Dissemination - ACCD).

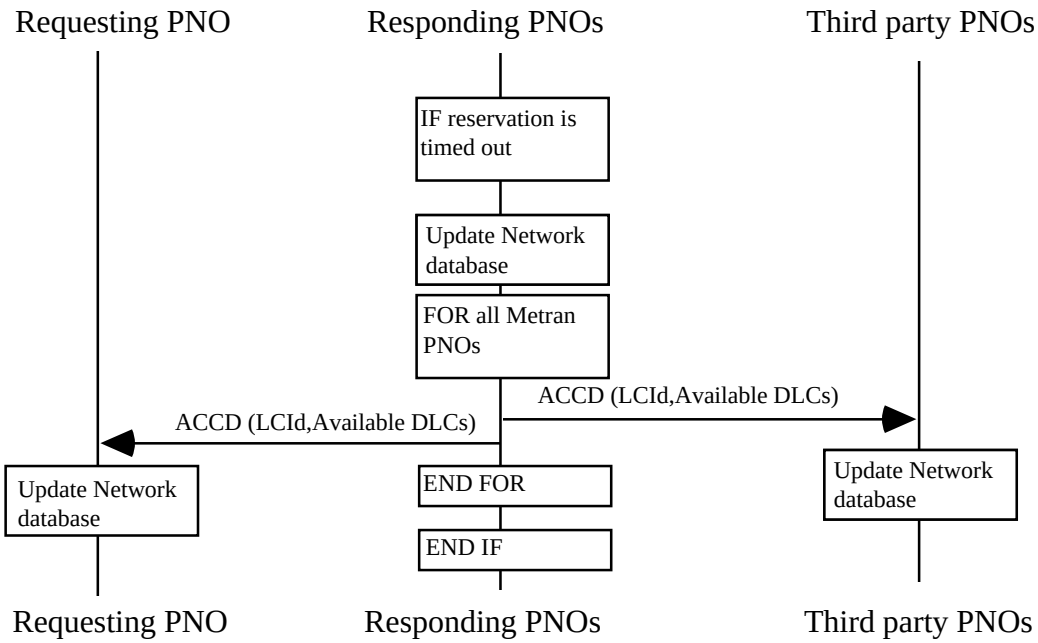


Figure 16: Unreservation after time-out

7.1.5 Activate Path

The MFS Activate Path is initiated when the Originating PNO has succeeded to reserve all DLCs along the selected route. A path consists of at least one DLC and a arbitrary number of SNC-DLC pairs, i.e. the path always starts and stops with a DLC. The border between two PNOs is assumed to be located between a DLC and a SubNetwork (SN). This means that the PNO owning the SN has to declare the Connection Point Identities (CPIds) corresponding to the incoming DLCs to the PNO owning the DLCs. This declaration is assumed to take place as a part of the commissioning process.

The MFS Activate Path contains all messages over the X-interface needed in order to activate the DLCs and the intermediate SNCs that together constitute a path from the Originating PNO to the Destination PNO. The activation takes place in sequence, i.e. DLC(orig)-SNC-DLC-SNC...DLC(term). The role of the Responding PNO may for a certain message be played by either a Transit PNO or the Destination PNO.

The MFS Activate Path may initiate the MFS Ability to Connect Update at the Responding PNO.

Reasons for failure of this MFS includes trying to activate a DLC which has not been reserved by the same PNO, trying to activate an unreserved/activated DLC, trying to activate a by the responder unknown DLC, trying to activate a DLC out of service, trying to set up a SNC between unknown/illegal CPs, lack of SNC capacity, or SN out of service.

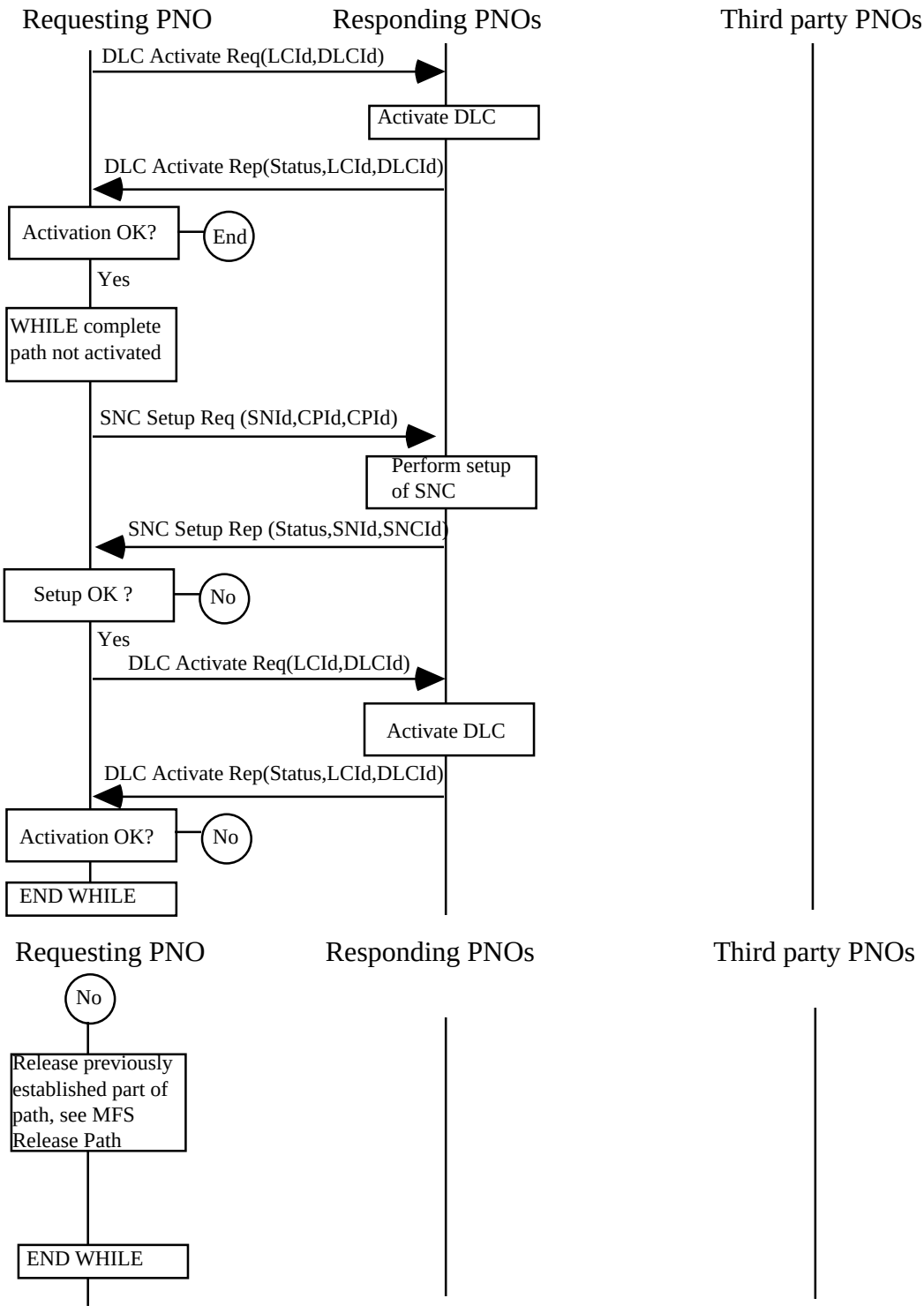


Figure 17: The activation of a path

7.1.6 Release Path

The MFS Release Path is initiated when the Originating PNO does not use the path any more and therefore wants to release the components that together constitute the path. This may take place for example in case the Originating PNO has been notified about an error affecting a SNC or DLC within the path. If a release of a SNC or DLC fails, it is the responsibility of the Originating PNO to make a new request for release.

The MFS Release Path contains all messages over the X-interface needed in order to release the DLCs and the intermediate SNCs that together constitute a path from the Originating PNO to the Destination PNO. The release takes place in sequence, i.e. DLC(orig)-SNC-DLC-SNC...DLC(term). The role of the Responding PNO may for a certain message be played by either a Transit PNO or the Destination PNO. The Third party PNO represent all other PNOs, that for each release of a DLC receive information that the number of available DLCs within that particular LC has been changed (Available Connections Change Dissemination - ACCD).

The MFS Release Path may initiate the MFS Ability to Connect Update at the Responding PNO.

Reasons for failure of this MFS includes trying to release a DLC reserved/activated by another PNO, trying to release an unreserved DLC, or trying to release a by the responder unknown DLC.

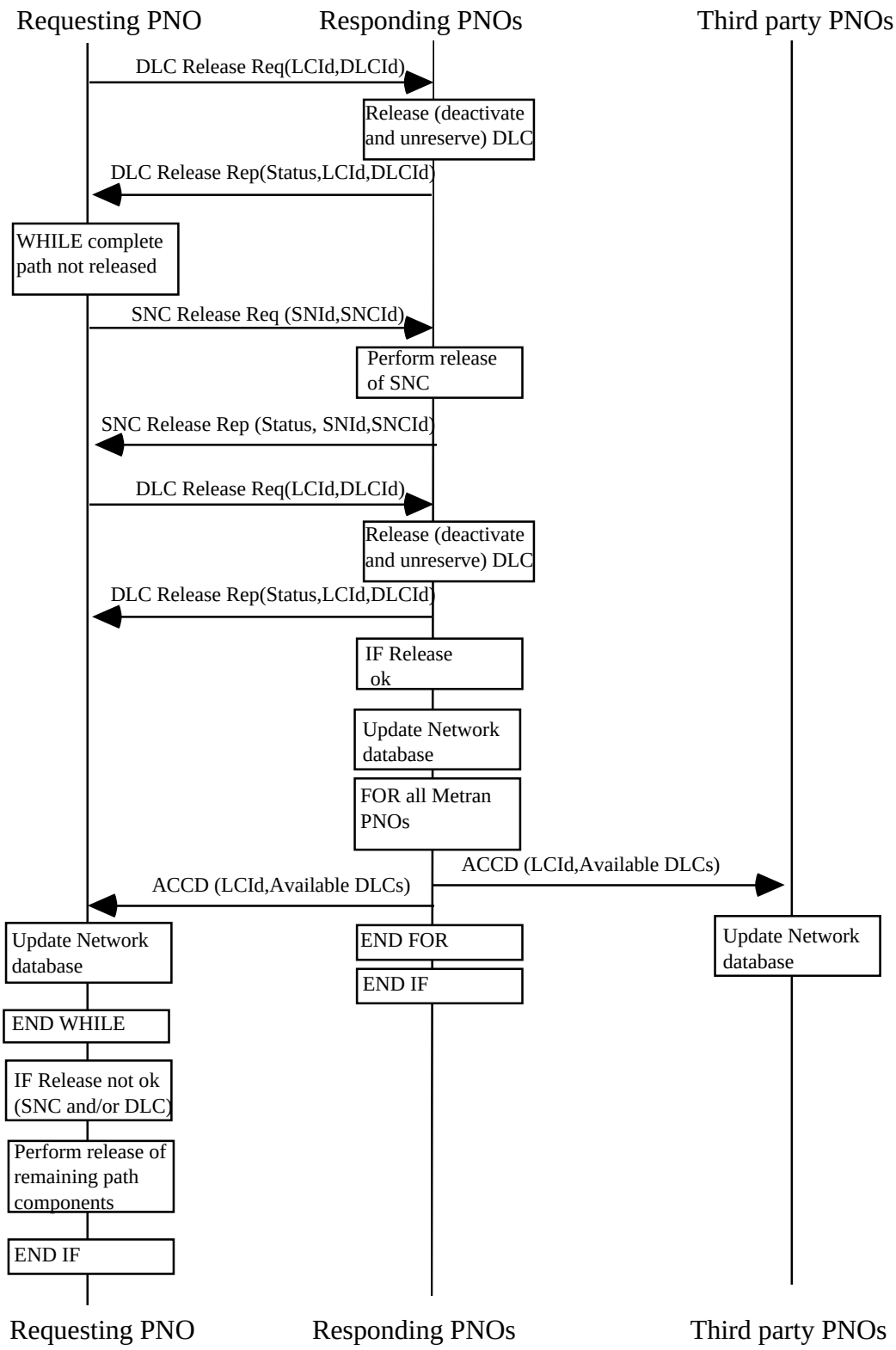


Figure 18: The release of a path

7.1.7 Available Connections Update

This MFS is initiated by a change in a PNOs part of the inter-operator SDH Network that affects the number of available connections (DLCs) within a Link Connection. The change may for example be a result of a fault in a DLC. The MFS emphasizes the fact that the FM Ensemble does have an important interaction with the PP Ensemble in the area of the maintenance of the overall inter-operator SDH Network topology. The MFS may also be initiated by another reason: there are PNO-internal events (maintenance, etc.) that cause capacity to be updated and notifications to be sent but their description is outside the scope of this specification.

The following explanations are indicative, as the exact contents of the inter-ensemble message(s) is left open to PNOs.

The inter-ensemble message concerning a LC indicates an event which can change the number of available connections. It can result from a PESN Communication Alarm on the entire LC, sent or received by the FM Ensemble, in which case the new number of available connections is usually zero. It can also result from a fault concerning a PNO-internal DLC, in which case the new value is usually the old one minus one. Note that this latter kind of fault is not reported on the X-interface because DLCs are not fault monitored in the inter-operator SDH Network, but the resulting change in topology still has to be reported. The message Alarm Indication appears both when the resource becomes faulty/blocked etc. and when the fault/blocking state ceases.

In addition, the MFS comprises messages that makes it possible for one PNO to read the number of available connections within a LC (AC Read and AC Rep).

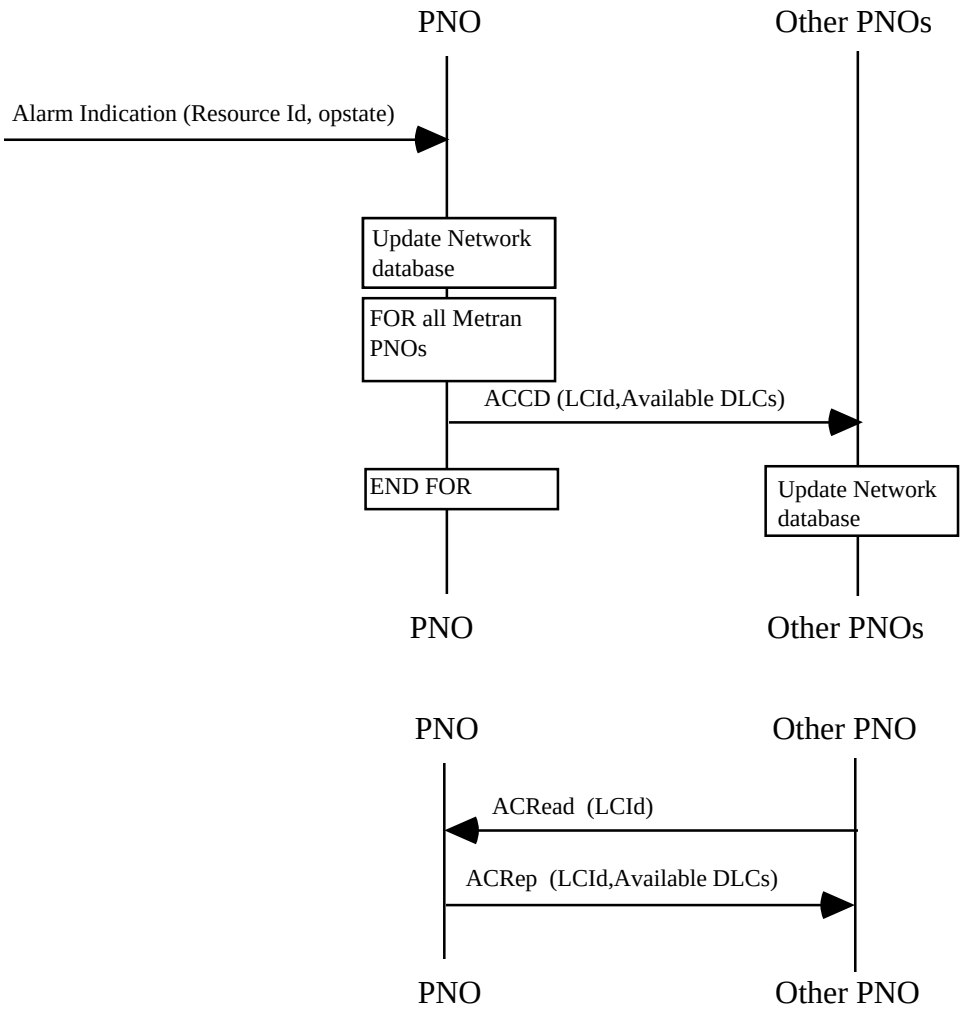


Figure 19: Available Connections Update

7.1.8 Ability to Connect Update

This MFS is initiated by a change in the "ability to connect" within an inter-operator SDH Network SubNetwork, i.e. the ability to establish new SNCs. Possible states are: cannot satisfy any new set-up requests/can satisfy at most N set-up requests/normal situation. The change of the "ability to connect" is triggered by a fault in the SubNetwork that affects the ability to establish new SNCs.

First, an internal message is received from the Fault Management ensemble to indicate the change in the ability to connect of the SubNetwork.

Then, if this results in a change between the possible states of "ability to connect", this is disseminated to all other PNOs by the message ATCCD (Ability To Connect Change Dissemination).

In addition, the MFS comprises messages that makes it possible for one PNO to read the state of the "ability to connect" (ATC Read and ATC Rep).

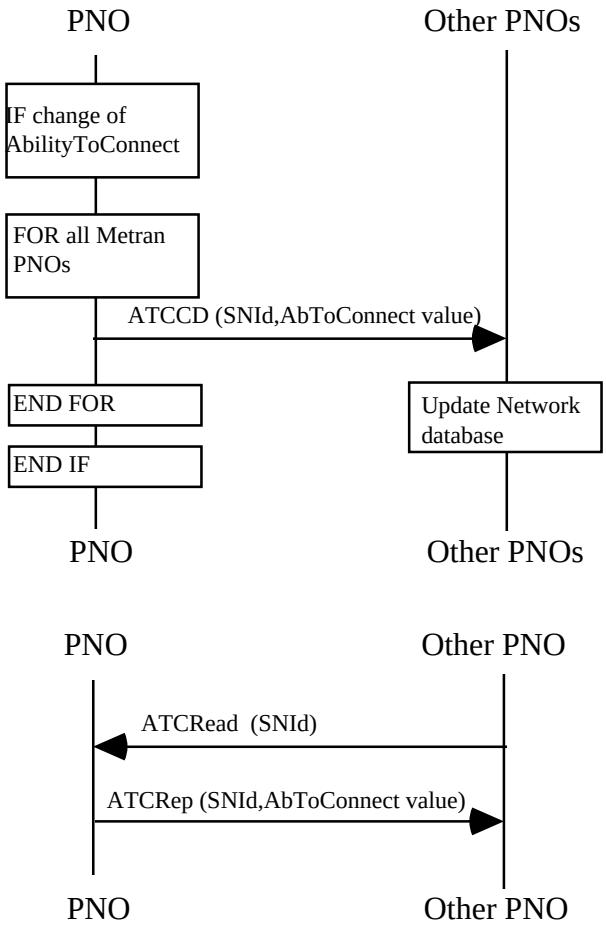


Figure 20: Ability to Connect Update

7.1.9 Database synchronization

NOTE: This is not an MFS.

Although a procedure for complete database synchronization between INMSs is not specified here, it is possible for a PNO to partially examine any other PNO's database by using the MFSs "Available Connections Update" and "Ability to Connect Update". This can be very useful especially in the case where a "Available Connection Change Dissemination" (ACCD) message doesn't reach its destination or if a PNO's database crashes (it is assumed that each PNO has persistent database storage). Indeed, the only correct information at any time for each PNO is the part containing his own resources and therefore, each PNO's database has to be considered as the master database for all resources that are owned by this PNO. Consequently, a partial or complete check with a remote database can be performed via the four following messages: AC Read (LCId), AC Rep (LCId, Available DLCs), ATC Read (SNId) and ATC Rep (SNId, Ab to connect value).

7.1.10 Detailed description of messages

The following table shows name, description and parameters for the messages across the X-interface. Note that PNOId is implicit in the interaction diagrams above.

Table 2: Description of messages

Message	Description	Parameters
DLC Reserve Req	Reservation of a single DLC.	PNOId, LCId
DLC Reserve Rep	Report of reservation.	Status = Ok/Failed, LCId, DLCId (if OK), CPId, CPId (if OK)
DLC Unreserve Req	Unreservation of a single DLC.	PNOId, LCId, DLCId
DLC Unreserve Rep	Report of unreservation	Status = Ok/Failed, LCId, DLCId
DLC Activate Req	Activation of single DLC	PNOId, LCId, DLCId
DLC Activate Rep	Report of activation	Status = Ok/Failed LCId, DLCId
SNC Set-up Req	Request to set up SubNetwork connection	PNOId, SNId, CPId, CPId
SNC Set-up Rep	Report of SNC set-up operation	Status = Ok/Failed SNId, SNCId
DLC Release Req	Request to release DLC	PNOId, LCId, DLCId
DLC Release Rep	Report of DLC release request	Status = Ok/Failed LCId, DLCId
SNC Release Req	Request to release SNC	PNOId, SNId, SNCId
SNC Release Rep	Report of SNC release request	Status = Ok/Failed SNId, SNCId
ACCD	Available Connections Change Dissemination	LCId, Available DLCs

Message	Description	Parameters
AC Read	Available Connections Read	LCId
AC Rep	Available Connections Report	LCId, Available DLCs
ATCCD	Ability To Connect Change Dissemination	SNId, Ab to connect value
ATC Read	Ability To Connect Read	SNId
ATC Rep	Ability To Connect Report	SNId, Ab to connect value
Alarm indication	Inter Ensemble message to indicate start or cease of Alarm	Resource Id, opstate

The following table shows name, description and value range for the parameters within messages sent across the X-interface.

Table 3: Description of parameters

Parameter	Description	Value Range
LCId	Link Connection Identifier	Globally unique.
PNOId	PNO Identifier	Globally unique.
DLCId	Deliverableerable Link Connection Identifier	Unique within LC
SNId	SubNetwork Identifier	Globally unique.
SNCId	SubNetwork Connection Identifier	Unique within SN.
CPId	Connection Point Identifier	Unique within SN.
Status	Result status	Ok/Failed.
Available DLCs	New number of Available DLCs	No of unreserved DLCs.
Ab to connect value	Indicates the "ability to connect" for a SubNetwork	cannot satisfy any new set-up requests/can satisfy at most N set-up requests/can satisfy more than N set-up requests (normal value)
Resource Id	Resource Identifier	Unique within PNO
OpState	Operational State	Enabled/Disabled

7.1.11 Management Functions

An MFS is decomposed into a set of MFs. A certain MF may be used by different MFS. Normally, each MF consists of a Request and a Report message.

MFS Reserve DLCs:

- MF DLC Reservation;
- MF Available Connections Change Dissemination (ACCD).

MFS Unreserve DLCs:

- MF DLC Unreservation;
- MF Available Connections Change Dissemination (ACCD).

MFS Unreserve after time-out:

- MF Available Connections Change Dissemination (ACCD).

MFS Activate Path:

- MF DLC Activation;
- MF SNC Set-up.

MFS Release Path:

- MF DLC Release;
- MF SNC Release;
- MF Available Connections Change Dissemination (ACCD).

MFS Available Connections Update:

- MF Available Connections Change Dissemination (ACCD);
- MF Available Connections Read.

MFS Ability To Connect Update:

- MF Ability To Connect Change Dissemination (ATCCD);
- MF Ability To Connect Read.

7.2 Fault Management

7.2.1 Introduction

The management functions of this Ensemble are described using M.3020 terminology [8]. At the first level (see figure 21), a set of Management Function Sets (MFS) are identified. At the second level these MFS are decomposed into Management Functions (MF). A MF may be used by several MFS's.

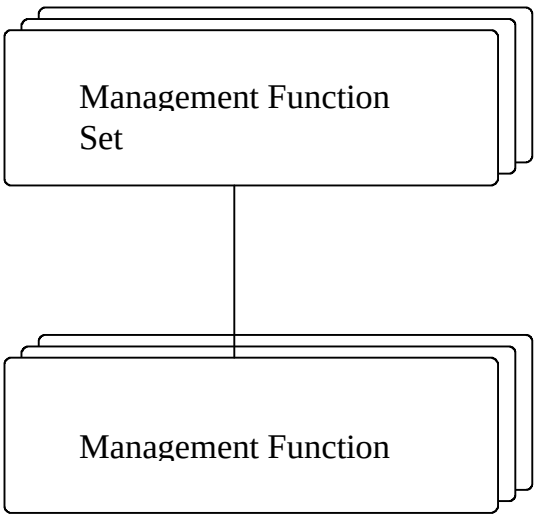


Figure 21: Decomposition hierarchy

These MFS of Fault Management are described in terms of Use cases, i.e. sequences of events that are initiated by a TMN user (in this case an inter-operator SDH Network PNO). The following MFSs have been identified:

- **Alarm Processing**
  (alarm reception and dissemination, and topology update);
- **Alarm Event Logging**
  (log inspection).

7.2.1.1 State changes due to faults

When an alarm is declared for a given resource, its operational state can be set to disabled, depending on the perceived severity of the alarm. Alternatively, when the alarm ends, the operational state of the underlying resource reverts to the value it had before the alarm was declared. This previous value can still be disabled, for instance in the case of successive alarms with different causes on the same resource.

There are 6 different perceived severities, shown in tables 2 and 6. The perceived severity "cleared" is used to indicate the end of an alarm; it forces the operational state of the underlying resource back to the state it had before the alarm started ("enabled" or "disabled").

Of the 5 remaining perceived severities, only "critical" and "major" force the operational state of the underlying resource to become "disabled".

The other perceived severities, "indeterminate", "minor" and "warning" do not change the operational state of the underlying resource (indicated by "-").

Table 4: Perceived severities and operational states

perceived severity	operational state
cleared	previous state (before the alarm started)
indeterminate	-
critical	disabled
major	disabled
minor	-
warning	-

7.2.2 Alarm Processing

The MFS Alarm Processing is initiated when an alarm event message must be disseminated or is received on the X-interface. An alarm event message on the X-interface always contain the following information:

- identifier of the concerned resource;
- time of event;
- probable cause;
- perceived severity;
- estimated time of repair.

The same structure of the alarm event message is used for indicated both the beginning and the end of the alarm event. A perceived severity set to "cleared" is used to indicate the end of an alarm event.

Reception

An alarm event message is received on the X-interface if one remote INMS sends one. The subsequent processing of the message (logging, displaying, etc.) is outside the scope of this ensemble.

Dissemination

An alarm event message is disseminated on the X-interface if one or several alarm event messages have been received beforehand from the INMS own Network (through the Q interface, for example). To be processed into an X-interface alarm event, an alarm event from the INMS own Network has to satisfy the following conditions:

(it concerns a resource dedicated to the inter-operator SDH Network);
and
(it concerns a resource owned by the local PNO);
and
(it concerns a VC-4 Link Connection or a SubNetwork Connection).

The processing also includes the recognition of repeated identical alarm events and their translation into a unique alarm event.

The alarm event message is disseminated to all remote INMS's that are users of the concerned resource, and, in the case of an end-of-alarm message, to all remote INMSs that were users of the resource at the time when the initial alarm event message was sent. In a VC-4 Link Connection, these are all the users of the contained VC-12 Link Connections (Deliverableerable Link Connections). If a remote INMS is the user of more than one Deliverableerable Link Connection, only one alarm event message is sent to it. In a SubNetwork Connection the user is unique, since in this specification Deliverableerable Link Connections are VC-12 and are connected together through SubNetwork Connections which are VC-12 too.

A disseminated alarm event message is always stored in a log which is "visible" across the X-interface (see MFS Alarm Event Logging).

Topology update

In parallel to the dissemination to other INMS's, an Alarm Indication inter-ensemble message must be sent to the Path Provisioning MSC for a possible topology update (see MFSs Available Connection Update and Ability to Connect Update in Path Provisioning Ensemble).

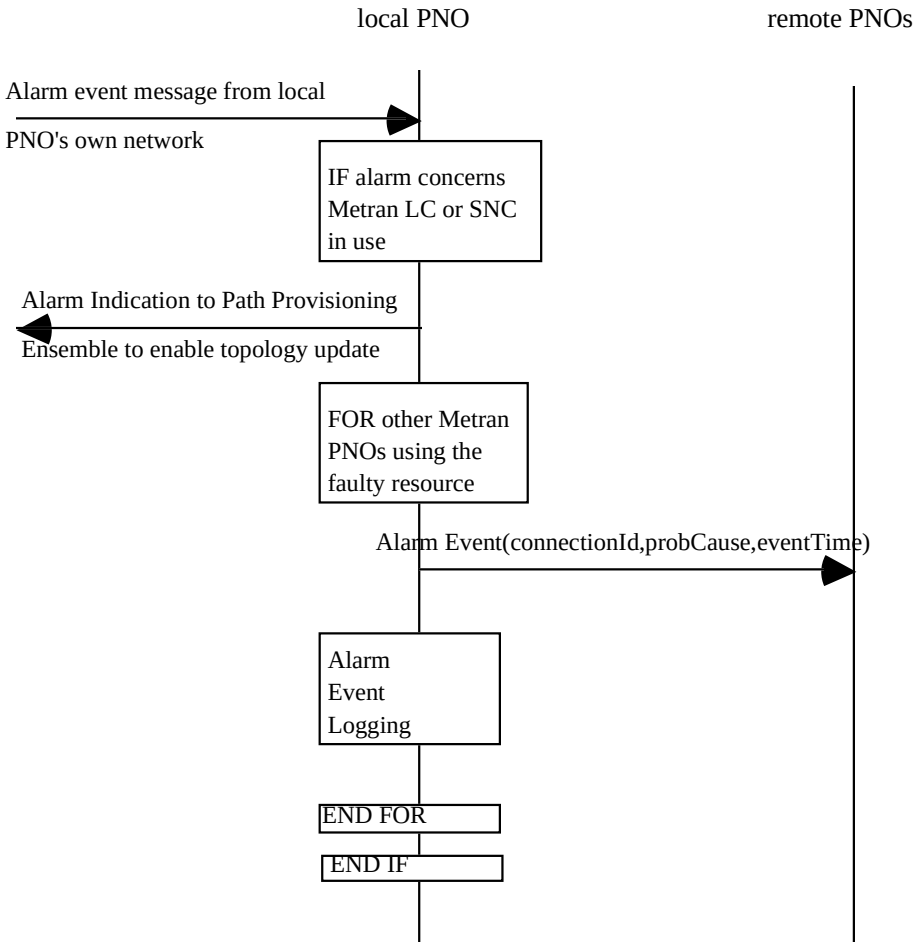


Figure 22: The dissemination/reception of an alarm event message

7.2.3 Alarm Event Logging

Before defining the X-interface functionality of Alarm Event Logging we shall look at the (non X-interface) inter-MFS functionality performed by the logging module. This functionality is shown in figure 23, and illustrates the different actions to be performed upon an "Alarm Processing request". This inter-MFS communication is shown also figure 22 above, where the Alarm Processing MFS calls Alarm Event Logging. Upon reception of this "call", disseminated alarms are taken and placed in the appropriate alarm logs.

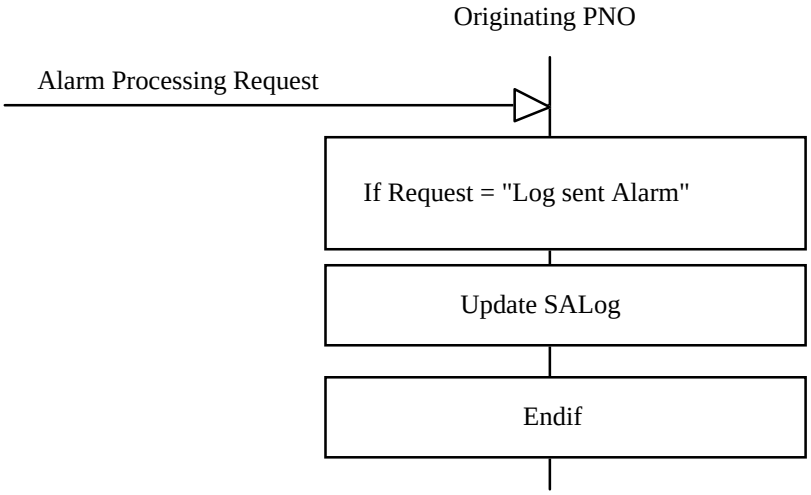


Figure 23: The Inter-MFS communication between Alarm Processing and Alarm Event Logging

Please note that if an Access Control List is used then the updating of the SA log also implies updating this ACL. The use of Access Control Lists will be discussed later under log access control.

In Alarm Event Logging, there is only one Management Function (MF), called the Log Inspection Management Function. Here, we consider this MF, where the alarm logs can be accessed across the X-interface, in particular, where a PNO requests to read the "sent" alarm logs of another PNO. This log, namely the SA log, is the local log that is updated, every time an alarm is disseminated to other PNO's. Based on the validity of the request, a report is returned to the requesting PNO (either a failure, or the alarm log(s) requested to be read). As we can see, this MF can be a "one request-multiple response" operation. It is also assumed that the only logs readable across the X-interface are the SA logs (i.e. those logs that store alarm records that were previously sent to other PNO's).

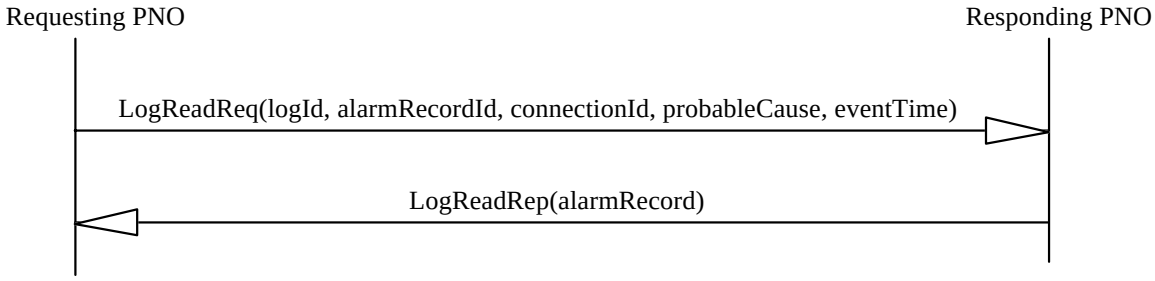


Figure 24: The Log Inspection Message Sequence Chart

There are five parameters given in the request. Of these parameters, "Log Id" is the only one that is mandatory. This is the name of the SA log in the Responding PNO's domain. The other parameters are optional, however, at least one of these parameters shall be specified, otherwise the X-interface can become flooded with responses to the request. The records can be searched for by specifying one or more of the parameters "Connection Id, Probable Cause, Event Time, Perceived Severity". These parameters are passed into a CMISE filter to extract the requested information. If all these parameters are specified, it is understood that they will uniquely identify an alarm record.

7.2.3.1 Log access control

An alarm record contained in SA log must be readable only by the PNO's to whom the corresponding alarm was sent. There is therefore a need to keep track of the PNO's to whom the alarm was originally sent. These PNO's are the only ones having access rights to read the record of that alarm. One way of ensuring that alarm records can only be read by the proper PNO is to keep track of disseminated alarms by the use an Access Control List. Such a list contains an index of every alarm record and the various PNO's to whom that alarm was sent. The Access Control List will thereby only allow read access of alarm records to those PNO's entered in the list under that alarm record. Another way of ensuring that alarm records are only read by the proper PNO is to use separate alarm logs. This means creating and maintaining one "SA log" per remote PNO, and controlling access to these SA logs, rather than controlling access to individual alarm records. This solution however, could result in mass re-production of alarms across several logs.

Table 5 shows a generic ACL where separate users have access to different objects in the system. If the term "User" is replaced with PNO, and the term "Object", replaced with Alarm Record Id, we have an access control list for the logging system. If a new alarm is sent, the alarm is stored (logged) once, and a new corresponding line is added to the Access Control List identifying the PNO's to whom the alarm was sent.

Table 5: A generic ACL. Here Users 1 and n have access to objects 1, and User n has access to object n.

Objects	User 1	User 2	User n
Object 1	X	O	X
Object n	O	O	X

As we see there are two possible solutions to the way in which alarms can be logged, stored and accessed. From here, the choice of solution is really a platform issue, i.e. to choose the solution that best suits the given platform. In view of this, the logging control mechanisms may differ from TMN node to TMN node.

7.2.4 Detailed description of messages

The table shows name, description and most important parameters for the messages across the X-interface.

Table 6: Description of messages

Message	**Description**	**Parameters**
Alarm Event	Message indicating the beginning or the end of an alarm event.	Connection Id, Event Time Probable Cause Perceived Severity ETTR
Log Read Req	Request sent to a PNO to read a log	PNOId, Log Id, Alarm Record Id, Resource Id, Probable Cause, Event Time
Log Read Rep	Alarm Log Report received from a PNO	[Alarm Record(s)]

Table 7: Description of parameters

Parameter	**Description**	**Value Range**
Connection Id	Faulty Resource Identifier	LCId or SNCId
Event Time	Alarm Event Time	Universal time
Probable Cause	Fault Probable Cause	Unique from a list
Perceived Severity	Fault Perceived Severity	Unique from a list
ETTR	Fault Estimated Time To Repair	Number of minutes
PNOId	PNO Identifier	Unique Id from a list
Log Id	Fault Log Identifier	Unique Id from a list
Resource Id	Faulty Resource Identifier	LCId or SNCId

7.2.5 Management Functions

An MFS is decomposed into a set of one or several MF's. In the present case each MFS has only one MF.

MFS Alarm Processing:

- MF Alarm Dissemination.

MFS Alarm Event Logging:

- MF Log Inspection.

8 Basic Ensemble Management Information Models

The Information Model focuses on the real world under study. It contains information about both the elements of the model and their interrelationships. The elements of management information are defined using GDMO templates and their interrelationships are graphically illustrated. This clause details the model specifics for individual management services.

8.1 General Introduction

8.1.1 Overview of the Managed Object Classes

The inter-operator SDH Information Model consists of managed objects which support the implementation of this Path Provisioning Ensemble and the related Fault Management Ensemble. The model is derived from the Generic Object Model (GOM) for the Network Level View [6]. The resources described in subclause 6.8 are mapped onto managed object classes according to table 8.

Table 8: Mapping of managed resources onto managed object classes

Resource	Managed Object Class
Link	mLink
Link Connection	mLink Connection
Deliverableerable Link Connection	m Deliverable Link Connection
SubNetwork	m SubNetwork
SubNetwork Connection	m SubNetwork Connection
Connection Point	m Network CTP

A short introduction to the key characteristics of these managed object classes:

mLink: this class is in this ensemble merely used as a container object for mLink Connections. The intended use of this class is to group link connections with the same routing criteria. However, routing criteria are not used within the scope of inter-operator SDH Network specification.

mLink Connection: instance of this class contains a number of m Deliverable Link Connections. Reservation, activation and release of these DLCs is performed by actions on instances of this class. Objects of this class are characterized by an attribute to count available DLCs. A notification is emitted if the value of this attribute changes. Alarms are emitted if the connection becomes faulty.

m Deliverable Link Connection: instance of this class represents a DLC. It is characterized by its operational and assignment state and, if used, by the identity of the using PNO. It is also characterized by pointers to the associated m Network CTPs.

m SubNetwork: instance of this class contains a number of m Network CTPs. Set up and release of SubNetwork Connections (SNC) between m Network CTPs is performed by actions on this instance. The m SubNetwork is characterized by its ability to connect. Degraded ability causes a notification to be emitted.

m SubNetwork Connection: instance of this class represents a SNC. It is characterized by its operational and assignment state and, if used, by the identity of the using PNO. It is also characterized by pointers to the connected m Network CTPS.

m Network CTP: instance of this class represent the point of connection between link connections and SubNetwork connections. It is characterized by pointers to the associated m Deliverable Link Connection and the connected m SubNetwork Connection.

8.1.2 Mapping of the States of the DLC (Path Provisioning)

The states of the DLC are mapped to the combination of two attributes of managed object class m Deliverable Link Connection; assignment state and operational state. The assignment state is changed by operations over the X-interface. The operational state changes are caused by PNO-internal actions or problems. The operational state of a DLC is dictated by the operational state of the LC that contain the DLC. The following table shows the states and the corresponding attribute values.

Table 9: Mapping between DLC state and state attributes of MOC m Deliverable Link Connection

DLC state	assignment state	operational state
unreserved	free	enabled
reserved	reserved	enabled
activated	assigned	enabled
out of service	free/reserved/assigned	disabled

(The two attributes used as state attributes, assignment state and operational state, are a subset of five state attributes defined in the GOM [6]. The reason for only using two attributes is that the other three are fixed, and therefore not very interesting in the functions defined in this ensemble. The DLC states can be mapped to status conditions from the list in Appendix A of the GOM. Unreserved is mapped to condition number 2 (In Service, Not Allocated), Reserved to 4 (In Service, Reserved), Activated to 8 (In Service with no spare capacity), Out-of-service/Unreserved to 10 (Resource Failed), O-o-s/Reserved to 10a (Resource Failed, Reserved) and O-o-s/activated to 10c (Resource Failed, with no spare capacity)).

The normal state transitions are shown in figure 25.

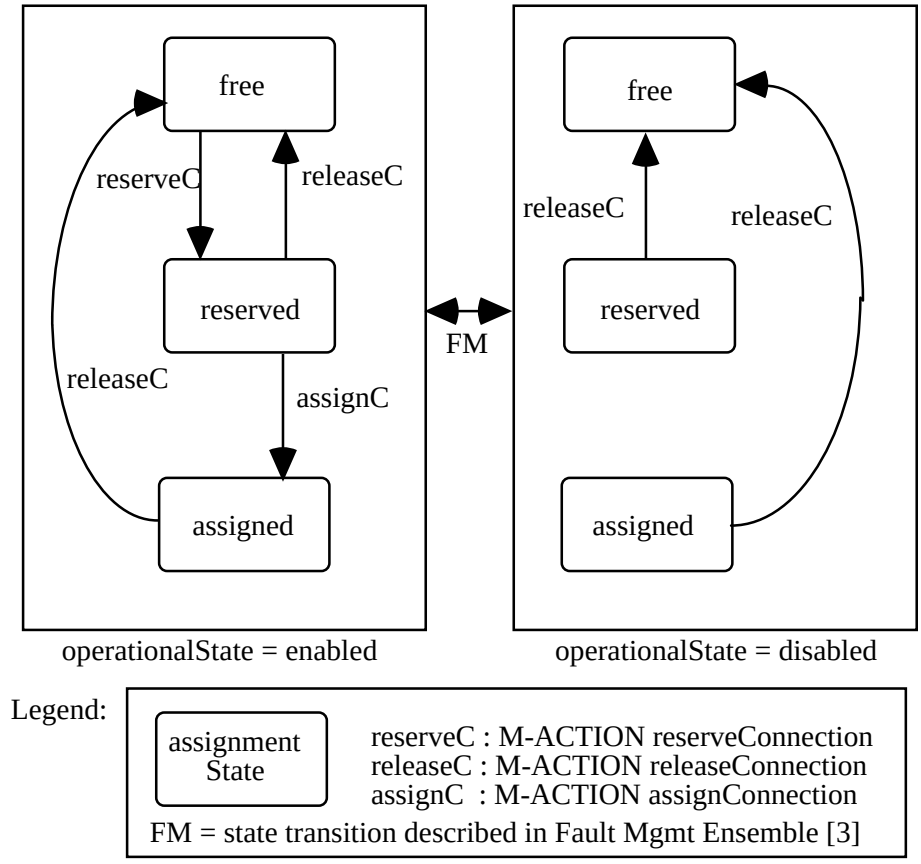


Figure 25: The states of the m Deliverable Link Connection

A complete state transition table is shown below. The transitions between operational state *enabled* and *disabled* shall not affect the value of the assignment state.

Table 10: m Deliverable Link Connection assignment state transitions

operational state	*enabled*		
assignment state	*free*	*reserved*	*assigned*
reserve connection	reserved	reserved[3]	assigned[3]
assign connection	free[3]	assigned[1]	assigned[3]
release connection	free[3]	free[2]	free[1]

operational state	*disabled*		
assignment state	*free*	*reserved*	*assigned*
reserve connection	free[3]	reserved[3]	assigned[3]
assign connection	free[3]	reserved[3]	assigned[3]
release connection	free[3]	free[1]	free[1]

Preconditions and remarks:

a) the Requesting PNO shall be the same as the Reserving PNO;

b) the Requesting PNO shall be the same as the Reserving PNO. In case of time-out, the PNO that owns the DLC performs the release;

c) illegal (or impossible) operation request, which will return an error.

8.1.3 The States of the SNC

The m SubNetwork Connection (mSNC) uses the same state attributes as the m Deliverable Link Connection, i.e. assignment state and operational state. However, since the mSNC is created when a SubNetwork connection is set-up and deleted when it is released, the assignment state will have a fixed value, *assigned*, during the entire lifetime of a mSNC.

8.1.4 Unsuccessful Actions

Action-specific errors are defined for all actions used in this ensemble. The errors are included as part of the reply syntax of each action. The same ASN.1 syntax (type Failed from GOM [6]) is used for the error part of all reply syntaxes. Only the branch *logical Problem* of the Failed syntax will be used. A problem cause will indicate the nature of the problem.

General CMIS errors for M-ACTION according to Recommendation X.710 [12] are returned in case of non-action-specific errors. The same applies for the M-GET and M-EVENT-REPORT service.

The table below assigns integer values to the problem causes needed. The values 0 to 8 are comments in the GOM ASN.1 body (only 0 and 3 are used in this ensemble). This set can be augmented with additional specific values if required, as was used within EURESCOM for the actions of Path Provisioning. We let the numbering start at 20 in order not to infringe on the existing values.

Table 11: Problem causes for unsuccessful actions

Problem Cause	*integer Value*
no such TP Instance	0
no such SNC Instance	3
no such DLC Instance	**20**
use Conflict	**21**
resourceful	**22**
resource disabled	**23**
no reservation	**24**
no effect	**25**

Integer values 26 to 39 are reserved for unforeseen problem causes.

8.1.5 Mapping of the States of the resources (Fault Management)

In the present specification set, there is no Performance Management and the operational state of a LC must govern the operational state of its contained DLC's. The other resource that has an operational state is the SNC.

Alarms are of the type "PESN communications alarm" can be either communication, equipment, or software alarms. ITU-T Recommendation M.3100 provides the list of probable causes for communications alarm, equipment alarms and software alarms (the latter is called "processing error alarms" in M.3100) [2].

The following table contains the assignment of severities to probable causes, and the consequence on the operational state of the underlying resource. The severities other than "warning" are used only for communications alarms. The use of the "critical", "major" and minor" severities attempts to conform to reality.

Table 12: Possible mapping of the states of the resources

probable cause	**perceived severity**	**operational state**
indeterminate	indeterminate	-
communication alarms		
aIS Probable Cause	warning	-
call Set-Up failure	warning	-
degraded signal	warning	-
far end receiver failure	minor	-
framing error	warning	-
loss of frame	critical	disabled
loss of pointer	major	disabled
loss of signal	critical	disabled
payload type mismatch	warning	-
transmission error	warning	-
remote alarm interface	warning	-
excessive BER	warning	-
path trace mismatch	critical	disabled
equipment alarms		
backplane failure	warning	-
data set problem	warning	-
equipment identifier duplication	warning	-
external IF device problem	warning	-
line card problem	warning	-
multiplexer problem	warning	-
ne identifier duplication	warning	-
power problem	warning	-
processor problem Pro	warning	-
protection path failure	warning	-
receiver failure	warning	-
replaceable unit missing	warning	-
replaceable unit type mismatch	warning	-
synchronization source mismatch	warning	-
terminal problem	warning	-
timing problem	warning	-
transmitter failure	warning	-
trunk card problem	warning	-
replaceable unit problem	warning	-
software alarms		
storage capacity problem	warning	-
memory mismatch	warning	-
corrupt data	warning	-
out of CPU cycles	warning	-
sfwr environment problem	warning	-
sfwr download failure	warning	-

8.1.6 Transfer of the PNO Identity

The authority to perform most of the actions mentioned below is based on the identity of the requesting PNO. As an example, only the PNO which reserved a DLC may later on activate it. However, this information is not part of the action information of a certain action. Instead, the Access Control field of all CMISE requests will contain a string identifying the PNO.

The abstract syntax for the access control field is specified using ASN.1. The permitted values for access control are values of the ASN.1 data type PESN defined types module origin PNO, which is defined in clause 10.

The ASN.1 object identifier value **{PESN standard specific extensions(0) access control(0) version1(1)}** is assigned as an abstract syntax name (see clause 10 for definition). This value can be used to identify the abstract syntax in the access control field, which is of ASN.1 type EXTERNAL.

The basic encoding rules (BER) for ASN.1 should be used as transfer syntax.

8.2 Relationships

This subclause defines the relationships between the components of the model. These may be expressed in Entity Relationship (ER) diagrams or other similar graphical representations.

Three types of diagrams are used:

- one for the relationships inherent in the underlying resources;
- one for the relationships among the classes representing these resources;
- and one for the naming schema.

8.2.1 Entity Relationship Diagrams

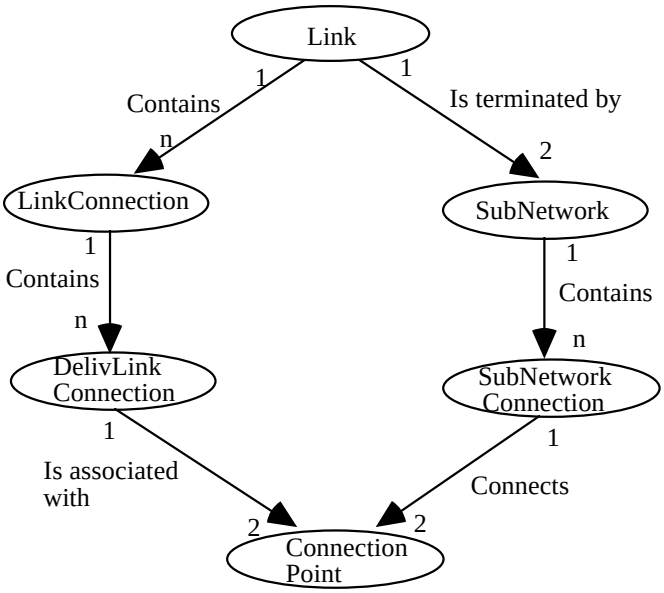


Figure 26: Relationships between resources subject to management

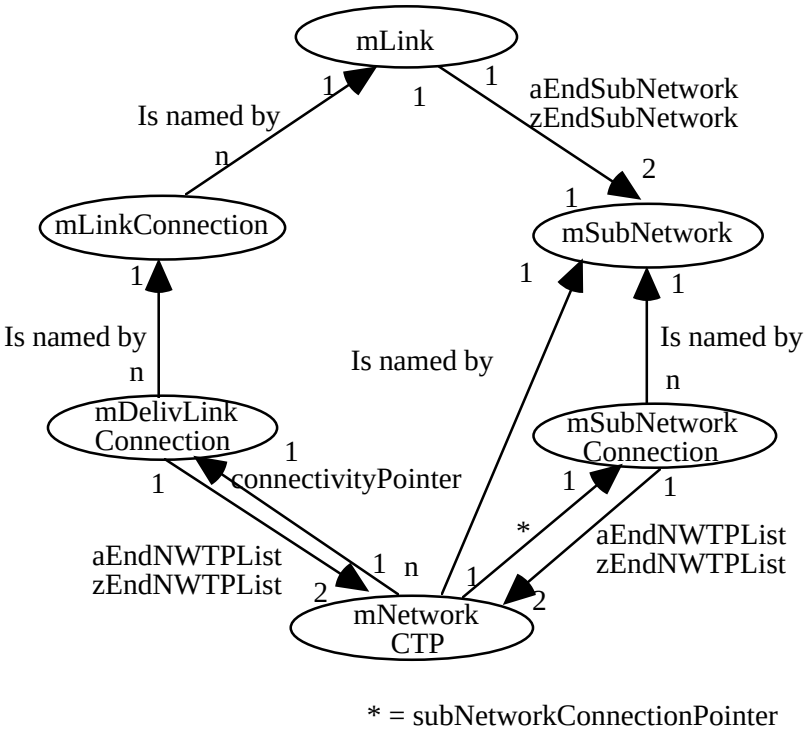


Figure 27: Relationships between managed objects subject to management

8.2.2 Object Naming

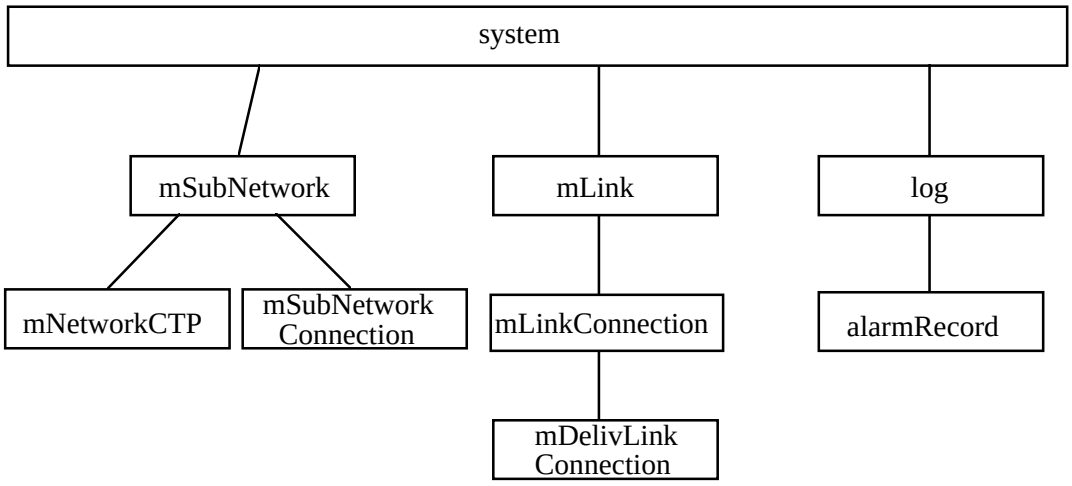


Figure 28: Naming tree

8.3 Scenarios

This subclause defines the Ensemble scenarios. Each of these definitions consists of a brief textual descriptions and message flow diagrams.

The scenarios are used to show how the managed objects in the information model can be used to accomplish the function listed in subclause 7.1.

In the scenarios that follow, CMIP flows between (and corresponding CMIS primitives within) manager and agent systems are indicated by arrows with a three character abbreviation for request, indicate, response and confirm primitives shown at the head and tail of the arrow. For example:

o-- Req ---------- Ind -->
CMIS request
<-- Cnf ---------- Rsp --o
CMIS response

NOTE: CMIS information in italics denotes parameters described in the sequence charts. No OPTIONAL parts are included.

Although the management functions and scenarios are not exhaustive in terms of M-GET messages, all the object class instances and their attributes are visible across the X-interface. However, some instances might not be visible due to access control restrictions.

8.3.1 Path Provisioning

8.3.1.1 MF DLC Reservation

A manager can request reservation of a DLC by sending an M-ACTION request for operation reserve connection to an instance of managed object class mLink Connection. The PNO identity of the requester is input to the action. The result, if success, contains the identities of the reserved m Deliverable Link Connection and associated m Network CTPs.

Preconditions: The operational state of the mLink Connection must be *enabled*. The value of available connections must be greater than zero.

Post conditions: If successful, this action changes the assignment state attribute in the affected m Deliverable Link Connection to *reserved*. The value of attribute Available connections of the invoked mLink Connection is decreased. The current origin PNO attribute of the reserved m Deliverable Link Connection is set to the identity of the invoking PNO. An attribute value change notification according to MF ACCD (see subclause 8.3.1.2) is emitted.

Manager **Agent**

o-Req----------Ind->

M-ACTION

Mode	confirmed
Base Object Class	mLink Connection
Base Object Instance	connection Id *(LCId)*
Action Type	reserve connection

<-Cnf----------Rsp-o

M-ACTION

Managed Object Class	mLink Connection	
Managed Object Instance	connection Id	*(LCId)*
	Reserve connection reply	
	passed	
	Connection Id =	*DLCId*
	a Network CTP Id =	*CPId*
	z Network CTP Id =	*CPId /*
	failed	
	logical Problem	
	problem cause = (see table below)	

Types of problems for the action **reserve connection**:

No free DLC in LC	resource full
LC disabled	resource disabled

8.3.1.2 MF Available Connections Change Dissemination

An agent reports that the number of available DLCs in a certain LC has changed by sending an M-EVENT-REPORT of type attribute value change. This is caused by a notification from an instance of class mLink Connection, which is emitted in the event of a change in attribute available connections. The M-EVENT-REPORT should be sent to all PNOs.

Manager Agent

<-Ind----------Req-o

M-EVENT-REPORT

Mode	non confirmed	
Managed Object Class	mLink Connection	
Managed Object Instance	connection Id	*(LCId)*
Event Type	attribute value change	
Event Information	attribute value change info	
	attribute value change definition	
	attribute ID = available Connections	
	new attribute value =	*Available DLCs*

8.3.1.3 MF DLC Unreservation & MF DLC Release

These two MFs are implemented in the same way. The only difference between them is the precondition.

A manager can request the unreservation (release) of a DLC by sending an M-ACTION request for operation release connection to an instance of managed object class mLink Connection. The identity of the requesting PNO, and the identity of the m Deliverable Link Connection (m DLC) are input to the action.

Preconditions: The assignment state of the affected m DLC must be reserved (released). The value of the current origin PNO shall be the same as the input PNOId.

Post conditions: If successful, this action changes the assignment state attribute of the affected m DLC to *free*, the value of available connections is increased, and an attribute value change notification according to MF ACCD (see 8.3.1.2) is emitted.

Manager **Agent**

o-Req----------Ind->

M-ACTION

Mode	confirmed	
Base Object Class	mLink Connection	
Base Object Instance	connection Id	*(LCId)*
Action Type	release connection	
Action Information	Release connection info	
	Connection Id =	*DLCId*

<-Cnf----------Rsp-o

M-ACTION

Managed Object Class	mLink Connection	
Managed Object Instance	Connection Id	*(LCId)*
Action Reply	Release connection reply	
	passed /	
	failed	
	logical Problem	
	Problem cause = (see table below)	

Types of problems for the action **Release Connection**:

DLC not recognized by responding PNO	no such DLC Instance
DLC not assigned to requesting PNO	use Conflict
DLC not reserved by requesting PNO	use Conflict
DLC already free	no effect

8.3.1.4 MF DLC Activation

A manager can request the activation of a DLC by sending an M-ACTION request for operation assign connection to an instance of managed object class mLink Connection. The PNO identity of the requesting PNO and the identity of the m Deliverable Link Connection (m DLC) are input to the action.

Preconditions: The assignment state of the m DLC must be *reserved*. The operational state of the m DLC must be *enabled*. The value of Current origin PNO of the m DLC shall be equal to the input PNOId.

Post conditions: If successful, this action changes the assignment state attribute of the affected m DLC to *assigned*.

Manager **Agent**

o-Req----------Ind->

M-ACTION

Mode	confirmed	
Base Object Class	mLink Connection	
Base Object Instance	Connection Id	*(LCId)*
Action Type	assign connection	
Action Information	Assign connection info	
	Connection Id =	*DLCId*

<-Cnf----------Rsp-o

M-ACTION

Managed Object Class	mLink Connection	
Managed Object Instance	Connection Id	*(LCId)*
Action Reply	Assign connection reply	
	passed/	
	failed	
	logical Problem	
	Problem cause = (see table below)	

Types of problems for the action **assign connection**:

DLC not recognized by responding PNO	no such DLC Instance
DLC not reserved by requesting PNO	no reservation
DLC already assigned to other PNO	use Conflict
DLC already assigned to requesting PNO	no effect
DLC disabled	Resource disabled

8.3.1.5 MF SNC Set-up

A manager can request the setting up of a SubNetwork connection by sending an M-ACTION request for operation set-up SubNetwork connection to an instance of managed object class m SubNetwork. The end points, in terms of m Network CTP identities, are input to the operation. If successful, identity of the set-up m SubNetwork Connection is returned.

Preconditions: The operational state of the m SubNetwork must be *enabled*. The ability "To Connect/nb of Possible New Set-ups" must be greater than zero.

Post conditions: If the action is successful, an instance of m SubNetwork Connection (mSNC) contained in the m SubNetwork is created and its identity is returned. The a end NWTP list and the z end NWTP list of the mSNC will point to the involved m Network CTP objects. The SubNetwork connection pointer of the m Network CTPs are set to point to the new mSNC. The value of operational state is set to *enabled*. The value of assignment state is set to *assigned*.

Manager Agent

o-Req----------Ind->

M-ACTION

Mode	confirmed	
Base Object Class	m SubNetwork	
Base Object Instance	SubNetwork Id	*(SNId)*
Action Type	Set-up SubNetwork connection	
Action Information	Set-up SubNetwork connection information	
	SNC directionality	
	pToP Bidirectional	
	a End NWTP =	*CPId*
	z End NWTP =	*CPId*

<-Cnf----------Rsp-o

M-ACTION

Managed Object Class	m SubNetwork	
Managed Object Instance	SubNetwork Id	*(SNId)*
Action Reply	Set-up SubNetwork connection result	
	point to point result	
	connection =	*SNCId* /
	general failure	/
	problem = (see table below)	

Types of problems for the action **set-up SubNetwork connection**:

NWCTP not recognized by responding PNO	no such TP Instance
NWCTP already used	use Conflict
SNC already set up by requesting PNO	no effect
SN disabled	Resource disabled

8.3.1.6 MF SNC Release

A manager can request the clearing down of a SNC by sending an M-ACTION request for operation release SubNetwork connection to an instance of managed object class m SubNetwork. The identity of the PNO and the identity of the M SubNetwork Connection is input to the operation. The identity of the M SubNetwork Connection is output of the operation.

Preconditions: The operational State of the M SubNetwork must be *enabled*. The ability To Connect/no of Possible Set-ups must be greater than zero.

Post conditions: If the action is successful, the m SubNetwork Connection is deleted. The SubNetwork connection pointer attributes of the involved m Network CTPs are reset.

Manager Agent

o-Req----------Ind->

M-ACTION

Mode	confirmed	
Base Object Class	m SubNetwork	
Base Object Instance	SubNetwork Id	*(SNId)*
Action Type	release SubNetwork Connection	
Action Information	release SubNetwork Connection Information	
	SNC =	*SNCId*

<-Cnf----------Rsp-o

M-ACTION

Managed Object Class	M SubNetwork	
Managed Object Instance	SubNetwork Id	*(SNId)*
Action Reply	release SubNetwork Connection Result	
	point To Point Result	
	connection =	*SNCId*
	failure = (see table below)	

Types of problems for the action **Release SubNetwork connection**:

SNC not recognized by responding PNO	no such SNC Instance
SNC not set-up by requesting PNO	use Conflict

8.3.1.7 MF Available Connections Read

A manager can request to read the value of the Available connections attribute of an instance of class mLink Connections by sending a M-GET request. The value shows the number of DLCs within this LC which are free.

Manager Agent

o-Req----------Ind->

M-GET

Base Object Class	mLink Connection	
Base Object Instance	Connection Id	*(LCId)*
Attribute Identifier List	Available connections	

<-Cnf----------Rsp-o

M-GET

Managed Object Class	mLink Connection	
Managed Object Instance	Connection Id	*(LCId)*
Attribute List	Available connections = *Available DLCs*	

8.3.1.8 MF Ability to Connect Dissemination

An agent reports that the ability to set up SubNetwork connections in a certain SubNetwork is degraded by sending an M-EVENT-REPORT of type Attribute value change. This is caused by a notification from an instance of class m SubNetwork, whose ability to connect attribute has changed from normal to another value or vice versa, i.e. when the value has been reset to normal.

Manager Agent

<-Ind----------Req-o

M-EVENT-REPORT

Mode	non confirmed	
Managed Object Class	m SubNetwork	
Managed Object Instance	SubNetwork Id	*(SNId)*
Event Type	Attribute value change	
Event Information	Attribute value change info	
	Attribute value change definition	
	Attribute ID = ability to connect	
	New attribute value = *Ab to connect*	

8.3.1.9 MF Ability to Connect Read

A manager can request to read the value of the ability to connect attribute of an instance of class m SubNetwork by sending a M-GET request. This attribute either has the value normal, or, in case of degraded performance, the number of possible new set-ups of the SubNetwork.

Manager Agent

o-Req----------Ind->

M-GET

Base Object Class	m SubNetwork	
Base Object Instance	SubNetwork Id	*(SNId)*
Attribute Identifier List	ability to connect	

<-Cnf----------Rsp-o

M-GET

Managed Object Class	m SubNetwork	
Managed Object Instance	SubNetwork Id	*(SNId)*
Attribute List	ability to connect = *Ab to connect*	

8.3.2 Fault Management

8.3.2.1 MF Alarm Dissemination

The alarm event notification is sent to remote PNOs which are users of the concerned resource, to indicate that the local PNO has detected an alarm event on it.

Manager Agent

<-Ind----------Req-o

M-EVENT-REPORT

Mode	non confirmed
Managed Object Class	(mLC/mSNC)
Managed Object Instance	*Connection Id or SubNetwork Connection Id*
Event Type	PESN communications alarm
Event Time	*event time*
Event Information	alarm info(*probable Cause,* perceived Severity, additional Text = (ETTR))

8.3.2.2 MF Log Inspection

Here, a manager (PNO) requests to read the local log of an agent (PNO). In this example, the manager corresponds to the requesting PNO and the agent to the responding PNO. It is also assumed that the requesting PNO only has access to the SA log. Furthermore, there are quite a number of filter requests that a manager can make, but for the purpose of clarity this ensemble will specify those filters that are deemed mandatory for this management function. Before these mandatory filters are specified, the generic log inspection management function looks like the following.

Generic CMIS

Manager Agent

o-Req----------Ind->

M-GET Invoke

Mode	confirmed
Base Object Class	Log
Base Object Instance	*log Id "SA log"*
Attribute Id List	{ *managed Object Instance,* *event Time,* *probable Cause,* *perceived Severity,* *additional Text = (ETTR)* }
Scope	whole Subtree
Filter	Inspection Filter

Inspection Filter CMIS Filter: = item Event Time <bin_op> {Generalized Time}
<operator> item Probable Clause equality {INTEGER}
<operator> item managed Object Instance equality {Object Instance}

Where <operator> stands for a logical AND, or logical OR and <bin_op> stands for greater Orequal, less Orequal or equality, and where Managed Object Instance replaces "connection Id or SubNetwork Connection Id".

Manager Agent

<-Cnf----------Rsp-o

M-GET Result

Managed Object Class	Alarm Record
Managed Object Instance	Log Id = "SA log", Alarm Record Id = "..."
Attribute List	{ Alarm Record Id, Managed Object Instance, Event Time, probable Cause, Perceived Severity, additional Text = (ETTR) }
Errors	- as in ITU-T Recommendation X.710 [12] (CMISE)

Mandatory filters

The syntax used here is the same as the generic CMISE message syntax above with the exception that the fields Mode, Base Object Class, Base Object Instance attribute, scope and filter are omitted. These fields will be exactly the same in each case, i.e. the generic CMISE message. If the request succeeds, all filters will return the same responses as given in the first case, i.e. one or multiple responses with all the attribute fields filled in. If the request fails, the errors for each filter request will be of the same type.

Filter 1:

This filter extracts all alarm records between two specified times Ta and Tb. This filter should also have the facility for the manager to specify just one time say Ta and request all alarm records of alarms; that occurred at that time; that occurred on or before that time; and lastly that occurred on or after that time. Ta and Tb are 2 different values of Generalized Time.

M-GET invoke

Inspection Filter

CMIS Filter: = item Event Time greater Orequal {Ta}:

AND item event Time less Orequal {Tb}.

Other possibilities

1) Inspection Filter CMIS Filter: = item event Time equality{Ta}.

2) Inspection Filter CMIS Filter: = item event Time greater Orequal {Ta}.

3) Inspection Filter CMIS Filter: = item Event Time less Orequal {Ta}.

M-GET Result (One or multiple response)

Base Object Class	Log
Base Object Instance	log ID = "SA log"
Attribute List	{ alarm Record Id, managed Object Instance, Event Time, probable Cause, perceived Severity, additional Text = (ETTR) }

Filter 2:

This filter allows the manager to extract all alarm records that relate to one particular resource.

M-GET invoke

Inspection Filter

CMIS Filter: = item managed Object Instance equality {Object Instance}.

M-GET Result (One or multiple response)

Same as Filter 1.

Filter 3:

This filter allows the manager to extract all alarm records that have the same Probable Clause

M-GET invoke

Inspection Filter

CMIS Filter: = item Probable Clause equality {INTEGER}.

M-GET Result (One or multiple response)

Same as Filter 1

Filter 4:

This filter allows the manager to extract all alarm records of alarms that occurred between event Times Ta and Tb on a specific resource.

M-GET invoke

Inspection Filter

CMIS Filter: = item Event Time greater Orequal {Ta}:

AND item Event Time less Orequal {Tb};

AND item managed Object Instance equality {Object Instance}.

M-GET Result (One or multiple response)

Same as Filter 1.

Filter 5:

This filter allows the manager to extract all alarm records of alarms that occurred between event Times Ta and Tb with a specific probable Clause

M-GET invoke

Inspection Filter

CMIS filter: = item Event Time greater Orequal {Ta}:

AND item Event Time less Orequal {Tb};

AND item Probable Clause equality {INTEGER}.

M-GET Result (One or multiple response).

Same as Filter 1.

Filter 6:

This filter allows a manager to extract all alarm records of alarms that occurred on a specific resource with a specific probable cause.

M-GET invoke

Inspection Filter

CMIS Filter: = item Managed Object Instance equality {Object Instance}:

AND item Probable Clause equality {INTEGER}.

M-GET Result (One or multiple response)

Same as Filter 1.

Filter 7:

This filter allows a manager to extract the alarm records that occurred between times Ta and Tb on a specific resource with a specific probable cause. Note that when the connection Id and Probable Clause fields are specified, and the filter specifies just one Event Time and requests all alarms that occurred at (exactly) that given time, then one unique alarm log will be returned to the manager.

M-GET invoke

Inspection Filter

CMIS Filter: = item Event Time Greater Orequal {Ta}:

AND item Event Time less Orequal {Tb};

AND item Probable Clause equality {INTEGER};

AND item Managed Object Instance equality {Object Instance}.

M-GET Result (One or multiple response)

Same as Filter 1.

Filter 8:

This filter allows a manager to extract the alarm records of a given perceived severity.

M-GET invoke

Inspection Filter

CMIS Filter: = item perceived Severity equality {INTEGER}.

M-GET Result (One or multiple response)

Same as Filter 1.

8.4 Management Information References

This subclause references all the definitions of management information relevant to the Ensemble. The definitions will be provided entirely by references to other documents which contain GDMO specifications.

- I-ETS 300 653.
- ITU-T Recommendation M.3100 (1992).
- ITU-T Recommendation X.721 (1992).
- ITU-T Recommendation X.710 [12] (1991).

This subclause contains only references to definitions that are relevant to the Ensemble. Thus, this subclause also contains statements about any additional restrictions or constraints to those definitions.

8.4.1 Restrictions on Inter-operator SDH Network Object Classes

8.4.1.1 Profile for m Deliverable Link Connection Object Class

The mode and the directionality attributes are always positioned to point to point and bi-directional. signalled will be positioned to characteristic Info 14 (VC-12).

None of the conditional packages inherited from GOM are to be used. They are:

- "M.3100": attribute Value Change Notification P, "M.3100": state Change Notification P, tmn Network Communication P;
- "M.3100": alarm Severity Assignment Pointer P, supported by P, administrative State P, assignment State P;
- "X.721": availabilityStatusP, lifecycle State P, "M.3100": operational State P, quality of Connectivity Service P, server Trail P, layer Trail P, user Label P).

The user Label is GET only for security reason.

The create and delete notifications will not be used in this specification.

8.4.1.2 Profile for mLink Object Class

Signalid will be positioned to characteristic Info 12 (VC-4).

Routing Criteria will be fixed with: tariff set to "secret", quality of service set to "unknown", dedicated protection set to "false" and additional Info set to an empty string.

The user Label is GET only for security reason.

The internal Link P is not to be used.

The actions Reserve Connection, assign connection and Release Connection will not be used in the inter-operator SDH Network, since only VC-12 DLCs are managed (and not VC-4s).

8.4.1.3 Profile for mLink Connection Object Class

The mode and the directionality attributes are always positioned to point to point and bi-directional.

Signalid will be positioned to characteristic Info 12 (VC-4).

None of the conditional packages inherited from GOM are to be used. They are:

- "M.3100": state change Notification P, tmn Network Communication P, supported by P, administrative State P, assignment state P, "X.721":availabilityStatusP, lifecycle state P;
- "M.3100": operational state P, alarm severity Assignment Pointer P, quality of connectivity Service P, server trail P, layer trail P, user label P).

Routing Criteria will be fixed with: tariff set to "secret", quality Of service set to "unknown", dedicated protection set to "false" and additional info set to an empty string.

The user label is GET only for security reason.

The create and delete notifications will not be used in this specification.

8.4.1.4 Profile for Network CTP Object Class

None of the conditional packages inherited from GOM are to be used. They are:

- Reassignment P, tmn Network communication alarm information P, Network TTP Pointer P;
- "M.3100": attribute value change notification P, user label P, administrative State P, assignment state P;
- "X.721": availability Status P, lifecycle state P;
- "M.3100": operational state P;
- "M.3100": state change notification P, supported by P, server TTP Pointer P, Network CTPP).

It is proposed not to use the channel Number package in the inter-operator SDH Network.

The user label is GET only for security reason.

The create and delete notifications will not be used in this specification.

8.4.1.5 Profile for SubNetwork Object Class

None of the conditional packages inherited from GOM are to be used, they are:

- "M.3100": state change notification P;
- "M.3100": user label P, administrative State P, assignment state P;
- "X.721": availability Status P, lifecycle state P;
- "M.3100": operational state P, supported by P, contained NWTTP List P, contained NWCTP List P, contained Link List P, contained SubNetwork List P, contained in SubNetwork list P, link Pointer List P, link Pointer P.

The create and delete notifications will not be used in this specification.

8.4.1.6 Profile for SubNetwork Connection Object Class

The mode and the directionality attributes are always positioned to point to point and bi-directional.

None of the conditional packages inherited from GOM are to be used, they are:

- "M.3100": create Delate Notifications P;
- "M.3100": attribute Value Change Notification P;
- "M.3100": state change notification P, tmn Network Communication P, supported by P, administrative State P, assignment state P;
- "X.721": availabilityStatusP, lifecycle state P;
- "M.3100": operationalStateP, quality of connectivity Service P, alarm Severity Assignment Profile Pointer P, composite Pointer P, component Pointer P).

The user label is GET only for security reasons.

The create and delete notifications will not be used in the present document.

8.4.2 Restrictions on X.721 Object Classes

8.4.2.1 Profile for system Object Class

None of the conditional packages of system will not be supported (they are administrative State Package and supported Features Package).

8.4.2.2 Profile for alarm record Object Class

Only event Time Package and additional Text Package, both inherited from event Log Record, will be supported. No other conditional packages are to be supported (they are: notification identifier P, correlated Notification P, additional Information P, specific Problems P, backed Up Status P, backup object P, trend indication P, threshold info P, state change definition P, monitored attributes P, proposed repaired action P).

8.4.2.3 Profile for log Object Class

None of the conditional packages of log will be supported (they are finite Log Size P, log alarm P, availability status P, duration, daily scheduling P, weekly scheduling P and external scheduler P).

3 attributes are to be GET only (instead of GET-REPLACE) for P408/T8: log full action, administrative state and discriminator construct. Log full action is fixed to "wrap".

8.4.3 Restrictions on NA4/GOM Actions

8.4.3.1 Profile for set-up SubNetwork connection Action

Within the inter-operator SDH Network, this action is sent to a m SubNetwork instance in order to establish a connection between 2 m Network CTPs. As a result of it, a m SubNetwork Connection instance is created with the assignment state equal to assigned. There is no create notification report emitted. Regarding the action syntax, none of the conditional parameters of the GOM action is to be used. Regarding the action reply syntax in case of failure, only the CHOICE logical problem should be supported for Failed. In this case the action reply indicates one of the reasons listed as Problem Cause in subclause 10.11.1.

8.4.3.2 Profile for release SubNetwork Connection Action

Within the inter-operator SDH Network, this action is sent to a m SubNetwork instance in order to disconnect an already established connection between 2 M Network CTPs. As a result of it, the required m SubNetwork Connection instance is deleted. There is no delete notification report emitted. Regarding the action reply syntax in case of failure, only the CHOICE logical problem should be supported for Failed. In this case the action reply indicates one of the reasons listed as Problem Cause in subclause 10.11.1.

8.4.4 Constraints on CMIS syntax

8.4.4.1 GET requests

For confidentiality reason, some attributes cannot be read by all the PNO's but only by the PNO who uses (and pays for) the underlying resource. In order to be able to identify which PNO is sending a GET request, the parameter access control defined in ITU-T Recommendation X.710 [12] (CMISE) will be used in all GET requests.

For confidentiality reason, the alarm records cannot be read by all the PNO's. In order to be able to identify which PNO is sending a GET request, the parameter access control defined in ITU-T Recommendation X.710 [12] (CMISE) will be used in all GET requests.

8.4.4.2 ACTION requests

For security reason, it is necessary to identify which PNO is asking for an action. For example, the release of a connection should not be accepted if it is not the connection's Current origin PNO which is asking for the release. In order to be able to identify which PNO is sending an ACTION request, the parameter access control defined in ITU-T Recommendation X.710 [12] (CMISE) will be used in all ACTION requests.

9 Ensemble Conformance Requirements

9.1 General Conformance Requirements

Clause 9 specifies the conformance requirements for the ensembles, in terms of communication profile, functional conformance and managed object class conformance.

The Ensemble Conformance Requirements support the interworking of different implementations by enabling the interoperability between two systems providing the manager and agent implementations. It is a means to prove that an implementation of the Path Provisioning Ensemble is conformant to:

- all object classes representing the resources of the Ensemble;
- all Functions requirements, as specified in the functions subclauses of the, which represent the management of the resources;
- any specified management communications specified in the Ensemble.

The Ensemble Conformance Requirements describe the Implementation Conformance Statement (ICS) proformas. The ICS proformas specify the conformance requirements of the Ensemble in a tabular format. They identify which role (manager/agent) the implementation of the Ensemble adopts.

9.2 Specific Conformance Requirements

This subclause presents the specific conformance requirements for the Ensemble.

9.2.1 OSI Communications Profiles Conformance

The table below lists all the current ISPs and identifies which profiles are required to be supported when the implementation adopts a manager or an agent role.

The following notation convention has been used:

- m: defines a mandatory requirement;
- i: stands for out of scope.

Table 13: Supported ISPs

ISP Supported	Manager Role	Agent Role
AOM11 [9], Basic Management Communications	m	m
AOM12 [10], Enhanced Management Communications	m (note)	m (note)
NOTE: m Scoped and filtered operations are required to implement the FM Ensemble (Annex B). No scoped operations are specified in the PP ensemble.		

9.2.2 Ensemble Functions Conformance

All of the management functions in subclause 7.1 are required by each implementation of these Ensembles. Both the manager and agent roles shall be implemented by each PNO.

10 The Inter-operator SDH Network Information Model

10.1 Introduction

History of the Inter-operator SDH Network Information Model

Collaborative work in a number of EURESCOM projects has been in progress for several years to develop and specify the TMN X-interface for inter-operator SDH Network management. As a result of the specification activity an early information model was generated. This model has subsequently been developed through a number of iterations to the current version which is presented in the present document. The current version has been refined to cover Path Provisioning and Fault Management and has been validated via testing in a multi node laboratory environment representing interconnected INMSs.

Further enhancements to the model are in progress through definition of further ensembles for additional Network management services e.g. Performance Management, Network Resourcing, Administration of the Network Management Capability etc.

10.2 Inheritance tree

The Managed Object Classes of the inter-operator SDH Network are derived from I-ETS 300 653 [6]. Figure 29 shows the inheritance tree.

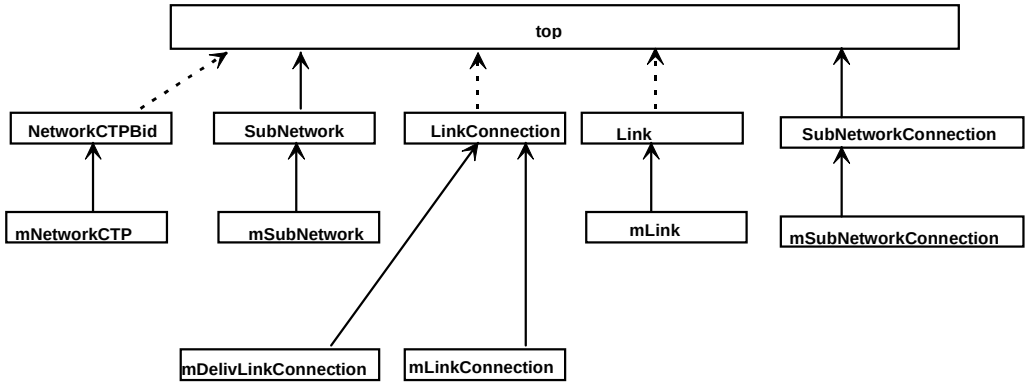


Figure 29: Inheritance tree

Object Classes starting with the letter "m" are managed SDH Object Classes. All other Object Classes except "top" are GOM Object Classes. Dotted lines in the tree indicate that the derivation is not directly obtained from "top" and that other Object Classes were not shown for simplicity.

10.3 Naming tree

Figure 30 shows the naming tree.

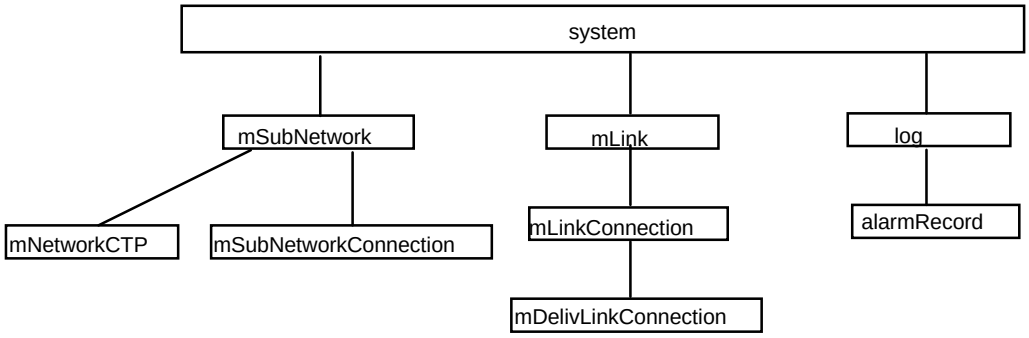


Figure 30: Naming tree

Most Name Bindings are documented in GOM. Those used in the inter-operator SDH Network are specifically referred to in subclause 10.10.

10.4 Inter-operator SDH Network Object Classes

10.4.1 m Deliverable Link Connection

```
m Deliverable Link Connection MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653 ": link connection;
CHARACTERIZED BY:
    "Recommendation M.3100:1992": create delete notifications package;
    "I-ETS 300653": z End NWTP list package;
    m Deliverable link connection package, PACKAGE;
        BEHAVIOUR;
        m Deliverable link connection behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents a capacity between 2 m Network CTPs. This capacity,
which can be equivalent to a VC-12, a VC-2, a VC-3 or a VC-4, is a subclause of an inter-operator
SDH Network Deliverableerable.
All the instances of this class are created during the commissioning process with an assignment
state attribute set to free. The states of the DLC are mapped to the combination of two attributes
of managed object class m Deliverableerable link connection, assignment state and operational state.
```

```
The assignment state is changed by operations over the X-interface. The operational state changes
are caused by PNO-internal actions or problems. The operational state of a DLC is dictated by the
operational state of the LC that contains the DLC. The following table shows the states and the
corresponding attribute values.
DLC state              assignment state operational state
unreserved             free                    enabled
reserved               reserved                enabled
activated              assigned                enabled
out of service         free/reserved/assigned  disabled
    ATTRIBUTES;
    "Recommendation M.3100:1992": user label        GET;
    "Recommendation X.721:1991": operational state  GET;
    Current origin PNO                              GET;
    "I-ETS 300653": assignment state                GET.
REGISTERED AS {PESN defined types module PESN object class 1}.
```

10.4.2 mLink

```
mLink MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653": link;
CHARACTERIZED BY:
    "I-ETS 300653": external link package;
    mLink package, PACKAGE;
        BEHAVIOUR;
        mLink behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents a topological description of capacity sharing the
same routing criteria between two m SubNetworks.
A mLink Connection inside a mLink is assigned (released) using the Reserve Connection and Assign
Connection (using the Release Connection) actions, which as a result, change the mLink Connection's
assignment state attribute.
The a and z End Points attributes point to the 2 m SubNetworks terminating the mLink. In case of a
cross-border link these 2 m SubNetworks belong to separate PNOs, but the mLink belongs to only one
of them.
The Attribute value change notification is sent to all PNOs only when attribute no of connections or
Available connections changes. Available Connections changes when capacity is used but also when
underlying resources are out of order, or added / removed from the inter-operator SDH Network. No of
connections changes when underlying resources are added/removed from inter-operator SDH Network ".
    ATTRIBUTES;
    routing criteria                                GET;
    "Recommendation M.3100:1992": user label        GET;
    ACTIONS;
    Reserve Connection;
    Assign connection;
    Release Connection.
REGISTERED AS {PESN defined types module PESN object class 2}.
```

10.4.3 mLink Connection

```
mLink Connection MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653": link connection;
CHARACTERIZED BY:
    "Recommendation M.3100:1992": create delete notifications package;
    "Recommendation M.3100:1992": attribute value change notification package;
    "I-ETS 300653": z End NWTP list Package;
    mLink connection package, PACKAGE;
        BEHAVIOUR;
        mLink connection behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents a capacity equivalent to a VC-4 between 2 m Network
CTPs and is used for managing the Set-up and release of m Deliverable link connections.
All the contained m Deliverable link connections have the same routing criteria as the mLink
connection.
The Available connections attribute gives the number of m Deliverable link connections which are
still possible to Set-up inside the mLink Connection. All changes of its value should be reflected
by an Attribute value change notification to all the PNOs.
All the instances of this class are created during the commissioning process with an assignment
state attribute set to free. The assignment state changes to assigned when all the possible m
Deliverable link connections are set up and the Available connections reaches the null value. There
is no Attribute value change notification for the assignment states change.
The operational state is either enabled or disabled, depending on the presence/absence of a defect
on the underlying resource. There is no Attribute value change notification for this change, but a
PESN communication alarm is sent (once) to the Current origin PNO of all the contained m Deliverable
link connections.
A m Deliverable Link Connection can be set up (can be released) inside a mLink Connection at a PNO's
request using the Reserve Connection and Assign connection actions (using the Release Connection
action). These actions change the value of Available connections attribute and an Attribute value
change notification is sent to all PNOs".
    ATTRIBUTES;
    "Recommendation X.721:1991": operational state  GET;
    "I-ETS 300653": Available connections   GET;
    "Recommendation M.3100:1992": user label    GET;
    routing criteria    GET;
    "I-ETS 300653": assignment state    GET;
```

```
    ACTIONS;
    Reserve Connection;
    Assign connection;
    Release Connection;
    NOTIFICATIONS;
    PESN communications alarm.
REGISTERED AS {PESN defined types module PESN object class 3}.
```

10.4.4 m Network CTP

```
m Network CTP MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653":NetworkCTPBidirectional;
CHARACTERIZED BY:
    "I-ETS 300653.3": connectivity pointer package;
    "I-ETS 300653": SNC pointer package;
    "Recommendation M.3100:1992": CTP instance package;
    m Network CTP package, PACKAGE;
        BEHAVIOUR;
        m Network CTP behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents the point where the input-output of a m Deliverable
Link Connection or of a mLink Connection is bound to the input-output of a m SubNetwork Connection,
or vice-versa".
    ATTRIBUTES;
    "Recommendation M.3100:1992": user label    GET.
REGISTERED AS {PESN defined types module PESN object class 4}.
```

10.4.5 m SubNetwork

```
m SubNetwork MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653": SubNetwork;
CHARACTERIZED BY:
    "I-ETS 300653": SubNetwork Id package;
    "I-ETS 300653": signalid package;
    "I-ETS 300653": basic connection performer package;
    "Recommendation M.3100:1992": attribute value change notification package:
    m SubNetwork package, PACKAGE.
        BEHAVIOUR.
        m SubNetwork behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents a logical collection of m Network CTPs and is used
for managing the Set-up and release of m SubNetwork connections.
According to G.803 definition of sub-Network, all termination points can be connected together, in
addition an inter-operator SDH Network assumption says that there is no blocking situation.
Consequently it is not possible/required to reserve in advance a m SubNetwork Connection and the
only actions supported by the m SubNetwork are for immediate activation/release of m SubNetwork
connections.
An attribute value change notification is sent only when the value of ability to connect attribute
becomes null, ceases to be null or crosses a threshold".
    ATTRIBUTES;
    ability to connect  GET.
REGISTERED AS {PESN defined types module PESN object class 5}.
```

10.4.6 m SubNetwork Connection

```
m SubNetwork Connection MANAGED OBJECT CLASS
DERIVED FROM "I-ETS 300653": SubNetwork connection;
CHARACTERIZED BY:
    "I-ETS 300653": z End NWTP list Package;
    m SubNetwork connection package, PACKAGE;
        BEHAVIOUR.
        m SubNetwork connection behaviour, BEHAVIOUR.
DEFINED AS "An instance of this class represents a connection across a m SubNetwork between 2
Network CTPs.
An instance is created as the result of a set-up SubNetwork connection action sent to the containing
m SubNetwork.
The assignment state attribute value is set to assigned during the entire lifetime of an instance.
The operational state is either enabled or disabled, depending on the presence/absence of a defect
on the underlying resource. There is no Attribute value change notification for this change, but a
PESN communication alarm is sent to the current Origin PNO.
An instance is deleted as the result of a release SubNetwork Connection action sent to the
containing m SubNetwork".
    ATTRIBUTES;
    "Recommendation M.3100:1992": user label    GET;
    "Recommendation X.721:1991": operational state  GET;
    Current origin PNO  GET;
    "I-ETS 300653": assignment state    GET;
    NOTIFICATIONS:
    PESN communications alarm.
REGISTERED AS {PESN defined types module PESN object class 6}.
```

10.5 Standard Object Classes

10.5.1 Alarm Record

This Object Class is defined in [X.721] [11].

10.5.2 log

This Object Class is defined in [X.721] [11].

10.5.3 system

This Object Class is defined in [X.721] [11].

10.6 Packages

There is no inter-operator SDH Network -specific Packages to be implemented.

10.7 Attributes

10.7.1 Ability to connect

```
Ability to connect ATTRIBUTE:
    WITH ATTRIBUTE SYNTAX   PESN defined types module ability to connect;
    MATCHES FOR EQUALITY;
    BEHAVIOUR:
        ability to connect behaviour, BEHAVIOUR.
DEFINED AS "This attribute refers to the ability of the m SubNetwork to operate new m SubNetwork
connections changes. Possible values are: cannot satisfy any new Set-up requests (normal parameter
is false), cannot satisfy requests for more than N set-ups (nb of possible new Set-ups gives the
value of N), or normal capability (normal parameter is true). A change of the value of this
attribute generates an Attribute value change notification".
REGISTERED AS {PESN defined types module PESN attribute 1}.
```

10.7.2 Current origin PNO

```
Current origin PNO ATTRIBUTE:
    WITH ATTRIBUTE SYNTAX   PESN defined types module origin PNO;
    MATCHES FOR EQUALITY;
    BEHAVIOUR:
        current origin PNO behaviour.
DEFINED AS "This attribute identified the PNO who requested the associated m Deliverable Link
Connection or m SubNetwork Connection. A change of the value of this attribute does not generate an
Attribute value change notification".
REGISTERED AS {PESN defined types module PESN attribute 2}.
```

10.7.3 Routing criteria

```
Routing criteria ATTRIBUTE:
    WITH ATTRIBUTE SYNTAX   PESN defined types module routing criteria;
    BEHAVIOUR:
        routing criteria behaviour.
DEFINED AS "This attribute is a place holder for giving the routing criteria shared by all mLink
connections belonging to the referred mLink (or all the M Deliverable link connections contained in
a mLink Connection). The routing criteria could be expressed in terms of performance
characteristics, cost, length, availability, etc. The exhausted list of criteria and the way to
model them are for further study as they will depend largely on agreements for the inter-operator
SDH Network. For the purposes of this model the syntax is reduced to the following:
tariff, which is expressed in terms of normal, discount, high or secret;
quality of service which indicates a contractual level of performance expected from the contained
mLink connections (or M Deliverable Link connections), it is expressed in terms of low, medium, high
or unknown;
dedicated protection, a boolean which indicates if the mLink is protected or not;
additional info, which is a free text.
It is not expected that any of these criteria changes during the mLink lifetime".
REGISTERED AS {PESN Defined types module PESN attribute 3}.
```

10.8 Actions

10.8.1 Assign Connection

```
Assign Connection ACTION:
    BEHAVIOUR;
    assign connection behaviour BEHAVIOUR.
DEFINED AS:
"This action activates an already reserved m Deliverable Link Connection. As a result of it, the
assignment state of the mDLC changes to assigned. No other attribute is affected, no Attribute value
change notification is generated.
If this action fails, the action reply indicates one of the following reasons:
    DLC unknown to responding PNO:              no such DLC Instance;
    DLC not reserved by requesting PNO:         no reservation;
    DLC already assigned to other PNO:          use Conflict;
    DLC already assigned to requesting PNO:     no effect;
    DLC disabled:                               Resource disabled";
        MODE                                    CONFIRMED;
        WITH INFORMATION SYNTAX                 PESN defined types module assign connection info;
        WITH REPLY SYNTAX                       PESN defined types module assign connection reply.
REGISTERED AS {PESN defined types module PESN action 1}.
```

10.8.2 Release Connection

```
Release Connection ACTION
    BEHAVIOUR;
    release connection behaviour BEHAVIOUR.
DEFINED AS:
"This action discontinues an active m Deliverable Link Connection. As a result of it, the assignment
state of the mDLC changes to free. The value of the Available connections attribute changes and an
Attribute value change notification is generated.
If this action fails, the action reply indicates one of the following reasons:
    DLC unknown to responding PNO:              no such DLC Instance;
    DLC not assigned to requesting PNO:         use Conflict;
    DLC not reserved by requesting PNO:         use Conflict;
    DLC already free:                           no Effect".
MODE CONFIRMED:
    WITH INFORMATION SYNTAX                     PESN defined types module release connection info;
    WITH REPLY SYNTAX                           PESN defined types module release connection reply.
REGISTERED AS {PESN defined types module PESN action 2}.
```

10.8.3 Reserve Connection

```
Reserve Connection ACTION:
    BEHAVIOUR;
    reserve connection behaviour BEHAVIOUR.
DEFINED AS:
"This action reserves a m Deliverable Link Connection contained in a given mLink Connection. As a
response to this action, the identity of the reserved m Deliverable Link Connection is received with
the corresponding a and z Network CTP identities. As a result of it, the assignment state of the
mDLC changes to reserved. The value of the Available connections attribute changes and an Attribute
value change notification is generated.
If this action fails, the action reply indicates one of the following reasons:
    no free DLC in LC:                          Resourceful
    LC disabled:                                Resource disabled
        MODE CONFIRMED;
        WITH REPLY SYNTAX                       PESN defined types module reserve connection reply.
REGISTERED AS {PESN defined types module PESN action 3}.
```

10.9 Notifications

10.9.1 PESN communications alarm

```
PESN communications alarm NOTIFICATION
    BEHAVIOUR;
    PESN communications alarm behaviour BEHAVIOUR.
DEFINED AS
"This notification type is used to report when an alarm concerning the referred object occurs. The
list of probable cause and their associated perceived severity will be fixed for P408 experiment.
The alarm can be either a communication, an equipment, or a software alarm. An estimated time of
repair can be indicated in additional text parameter".
    WITH INFORMATION SYNTAX                     PESN defined types module alarm info.
REGISTERED AS {PESN defined types module PESN notification 1}.
```

10.10 Name bindings

10.10.1 log-system

```
smi2NameBinding2
```

10.10.2 Alarm Record-log

```
Alarm Record-log NAME BINDING:
SUBORDINATE OBJECT CLASS                        Alarm Record AND SUBCLASSES;
NAMED BY:
    SUPERIOR OBJECT CLASS                       log AND SUBCLASSES.
WITH ATTRIBUTE                                  "Recommendation X.721: 1991": log record Id.
REGISTERED AS {PESN defined types module PESN name binding 7}.
```

10.10.3 mSubNetwork-system

```
mSubNetwork-system NAME BINDING
SUBORDINATE OBJECT CLASS                        m SubNetwork AND SUBCLASSES;
NAMED BY:
    SUPERIOR OBJECT CLASS                       "Recommendation X.721: 1992":system AND SUBCLASSES;
WITH ATTRIBUTE                                  "I-ETS 300653": SubNetwork Id.
REGISTERED AS {PESN defined types module PESN name binding 5}.
```

10.10.4 m SubNetwork Connection-m SubNetwork

```
m SubNetwork Connection-m SubNetwork NAME BINDING
SUBORDINATE OBJECT CLASS                        mLink AND SUBCLASSES;
NAMED BY:
    SUPERIOR OBJECT CLASS                       m SubNetwork AND SUBCLASSES;
WITH ATTRIBUTE                                  "Recommendation M.3100: 1992": Connection Id;
REGISTERED AS {PESN defined types module PESN name binding 6}.
```

10.10.5 M Network CTP-M SubNetwork

```
M Network CTP-M SubNetwork NAME BINDING
SUBORDINATE OBJECT CLASS                        M Network CTP AND SUBCLASSES;
NAMED BY:
    SUPERIOR OBJECT CLASS                       m SubNetwork AND SUBCLASSES;
WITH ATTRIBUTE                                  "Recommendation M.3100: 1992": cTPId.
REGISTERED AS {PESN defined types module PESN name binding 4}.
```

10.10.6 mLink-system

```
mLink-system NAME BINDING:
SUBORDINATE OBJECT CLASS                        mLink AND SUBCLASSES.
NAMED BY:
    SUPERIOR OBJECT CLASS                       "Recommendation X.721: 1992":system AND SUBCLASSES;
WITH ATTRIBUTE                                  "I-ETS 300653": link Id.
REGISTERED AS {PESN Defined types module PESN name binding 2}.
```

10.10.7 mLink Connection-mLink

```
mLink Connection-mLink NAME BINDING:
SUBORDINATE OBJECT CLASS                        mLink Connection AND SUBCLASSES.
NAMED BY:
    SUPERIOR OBJECT CLASS                       mLink AND SUBCLASSES;
WITH ATTRIBUTE                                  "Recommendation M.3100: 1992": Connection Id.
REGISTERED AS {PESN Defined types module PESN name binding 3}.
```

10.10.8 m Deliverable Link Connection-mLink Connection

```
m Deliverable Link Connection-mLink Connection NAME BINDING:
SUBORDINATE OBJECT CLASS                        m Deliverable Link Connection AND SUBCLASSES.
NAMED BY:
    SUPERIOR OBJECT CLASS                       mLink Connection AND SUBCLASSES;
WITH ATTRIBUTE                                  "Recommendation M.3100: 1992": Connection Id.
REGISTERED AS {PESN Defined types module PESN name binding 1}.
```

10.11 Supporting ASN.1 Productions

10.11.1 Inter-operator SDH Network defined types module

```
PESN defined types module { ITU-T(0) identified-organization(4) ETSI(0) ETS(PESN) information
model(2) asn1Module(2) PESN(0)}.
DEFINITIONS IMPLICIT TAGS: = BEGIN.
IMPORTS.
Alarm info.
FROM Notification-ASN1Module { joint-iso-ccitt ms (9) smi (3) part2 (2) asn1Module (2) 2}.
Object Instance.
FROM CMIP-1 { joint-iso-ccitt ms (9) cmip (1) version1 (1) protocol (3)}.
Failed, Problem Cause.
FROM PrETSx {ccitt(0) identified-organization(4) ETSI(0) ETS(653) Information model(0) asn1Module(2)
prETSx(0)}.
PESN model OBJECT IDENTIFIER: = {{ ITU-T(0) identified-organization(4) ETSI(0) ETS(PESN) Information
model(0)}.
PESN object class OBJECT IDENTIFIER: = {PESN model managed object class(3)}.
PESN attribute OBJECT IDENTIFIER: = { PESN model attribute(7)}.
PESN name binding OBJECT IDENTIFIER: = {PESN defined types module PESN name binding(6)}.
PESN action OBJECT IDENTIFIER: = { PESN model action(9)}.
PESN notification OBJECT IDENTIFIER: = { PESN model notification (10)}.
The following value assignment are specific extension for Problem Cause within the inter-operator
SDH Network context.
No such DLC instance                    Problem Cause: = integer value: 20.
Use conflict                            Problem Cause: = Integer value: 21.
Resource full                           Problem Cause: = Integer value: 22.
Resource disabled                       Problem Cause: = Integer value: 23.
No reservation                          Problem Cause: = Integer value: 24.
No effect                               Problem Cause: = Integer value: 25.
The following value assignments are mentioned as comments in GOM and shall be used within the inter-
operator SDH Network context.
No such TP instance Problem Cause: = Integer value: 0.
No such SNC instance                    Problem Cause: = Integer value: 3.
Integer values 26 to 39 are reserved for unforeseen problem causes that could be encountered during
the course of the validation experiments.
Ability to connect: = CHOICE:
normal                              BOOLEAN;
nb of possible new Set-ups          INTEGER.
Assign connection info: = Object Instance.
Assign connection reply: = CHOICE:
passed [0]                          NULL;
failed [1]                          Failed.
Origin PNO: = graphic string.
Quality of service: = ENUMERATED:
low (0);
medium (1);
high (2);
unknown(3).
Release connection info: = SEQUENCE:
Connection Id   Object Instance.
Release connection reply: = CHOICE:
passed [0]                          NULL;
failed [1]                          Failed.
Reserve connection reply: = CHOICE:
passed [0] SEQUENCE:
Connection Id                       Object Instance;
A Network CTP Id                    Object Instance;
Z Network CTP Id                    Object Instance.
failed [1]                          Failed.
Routing criteria: = SEQUENCE:
tariff                              Tariff;
quality of service                  Quality of service;
dedicated protection                BOOLEAN;
additional info                     Graphic string.
Tariff: = ENUMERATED:
discount (0);
normal (1);
high (2);
secret (3).
END
```

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