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Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Study on alignment of 3GPP generic Network Resource Model (NRM) Integration Reference Point (IRP) and the TeleManagement Forum (TMF) Shared Information/Data (SID) model (Release 10)

Keywords
NRM, IRP, TMF, SID

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Foreword

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The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

3GPP WG SA5 has specified detailed Network Resource Models (NRMs) for the management of mobile networks, including a Generic NRM.
TMF has done the same for the management of various kinds of fixed networks, as well as a Shared Information Data (SID) model providing common and generic definitions for network and service management aspects.
Both sets of specifications have been developed independently. As a consequence the models are different.

Though there will always be a part in the NRMs and SID which are different due to the different network technologies modelled, there are numerous modelling aspects which do not have to be different between the two models for the different network technologies.
Examples of these aspects are the top part of the NRMs and SID, modelling of resource inventory information, modelling of security aspects, modelling techniques and how vendor specific resource model extensions are managed using NRMs and SID.

Because both sets of specifications have been developed independently, the management of the mobile part and the fixed part is currently structured along silos with different management interfaces, resource models, management architectures, and management workflows.
Aligned management interfaces, management models, management architectures, and management workflows would greatly benefit the industry. Advantages include:

- CAPEX reduction (less development cost, less integration cost);
- OPEX reduction (configuration and re-configuration of mobile and fixed networks can be handled in the same manner and with the same work flows);
- Enhanced management capabilities (e. g. consistent management of dependant configurations for mobile part and fixed part aspects).

1 Scope

The present document studies how to allow the two organizations (3GPP and TMF) to evolve their respective NRMs and SID in a manner that they would become aligned to support consistent and integrated management of mobile and fixed networks. This study:

- identifies the non-aligned, contradicting or overlapping parts between NRMs and SID
- identifies the non-aligned, contradicting or overlapping parts regarding specification methodology
- proposes possibilities to align the parts identified above;
- ensures that the proposal allows usage of the 3GPP Generic NRM IRP independently of SID
- ensures that the proposal allows usage of mobile specific NRMs to be used as they are
- drives the alignment process with TMF
- identifies any required changes in the 3GPP specifications
- identifies required changes in the TMF specifications to be communicated to the TMF
- ensures that 3GPP remains full owner of the aligned part of the NRM specifications
- defines a procedure how aligned specifications can be maintained and updated in a consistent manner

Special emphasis has been given to the borderline between generic and harmonized part and the network technology specific parts of the models. In case new requirements had been identified during the alignment process, they have been taken into account as well.

It is not intended to add the mobile specific parts of the 3GPP Network Resource Models to the TMF SID.

These model aspects are published by 3GPP only. Interface aspects (e. g. the Alarm IRP) are outside of the scope of this Study.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] TMF RN306: "MTOSI 2.0 Release Notes", Version 2.1

[2] MTOSI 2.0: Framework - DDP IA, TMF612_FMW, Version 1.0

[3] MTOSI 2.0: Network Resource Basic – DDP, IA, TMF612_NRB, Version 1.0

[4] MTOSI 2.0: Network Resource Fulfillment DDP IA, TMF612_NRF, Version 1.0

[5] MTOSI 2.0: Network Resource Assurance - DDP IA, TMF612_NRA, Version 1.0

[6] 3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".

[7] 3GPP TS 32.69x: "Telecommunication management; Inventory Management (IM) network resources Integration Reference Point (IRP); ...".

[8] Guide Book GB922 "Shared Information/Data (SID) Model", Release 8, Telemanagement Forum, http://www.tmforum.org

[9] ITU-T Recommendation X.680: "OSI networking and system aspects – Abstract Syntax Notation One (ASN.1)".

[10] 3GPP TS 32.642: "Telecommunication management; Configuration Management (CM); UTRAN network resources Integration Reference Point (IRP); Network Resource Model (NRM)".

[11] ATM Forum, Technical Committee, Network Management, M4 Network View CMIP MIB Specification: CMIP Specification for the M4 Interface, Sep, 1995

[12] 3GPP TR 32.833: "Study on Management of Converged Networks".

[13] 3GPP TS 32.622: "Telecommunication management; Configuration Management (CM); Generic network resources Integration Reference Point (IRP); Network Resource Model (NRM)".

[14] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[15] ITU-T X.680 OSI networking and system aspects – Abstract Syntax Notation One (ASN.1)

[16] 3GPP TS 32.642: "Telecommunication management; Configuration Management (CM); UTRAN network resources Integration Reference Point (IRP): Network Resource Model (NRM)"

[17] ATM Forum; Technical Committee; Network Management; M4 Network View; CMIP MIB; Specification; Version 1.0; af-nm-0073-000; January, 1997; http://www.broadband-forum.org/ftp/pub/approved-specs/af-nm-0073.000.pdf

[18] ATM Forum; Technical Committee; CMIP Specification for the M4 Interface; af-nm-0027.000; September, 1995; http://www.broadband-forum.org/ftp/pub/approved-specs/af-nm-0027.000.pdf)

[19] 3GPP TS 32.622: "Telecommunication management; Configuration Management (CM); Generic network resources Integration Reference Point (IRP); Network Resource Model (NRM)"

[20] MEF Technical Specification MEF 7.1, Phase 2 EMS-NMS Information Model, October 2009

[21] 3GPP2 S.S0028-E “OAM&P for cdma2000 (Overview, 3GPP R7 Delta Specification, 3GPP2 Network Resource Model IRP)”

[22] 3GPP TS 32.300: "Telecommunication management; Configuration Management; Name convention for Managed Objects"

[23] S5-102610 S5vTMFa033 E NSN Proposed enhancement of Generic NRM IOCs v3

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [14] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [14].

3.1.1 Definition of TMF Terminology

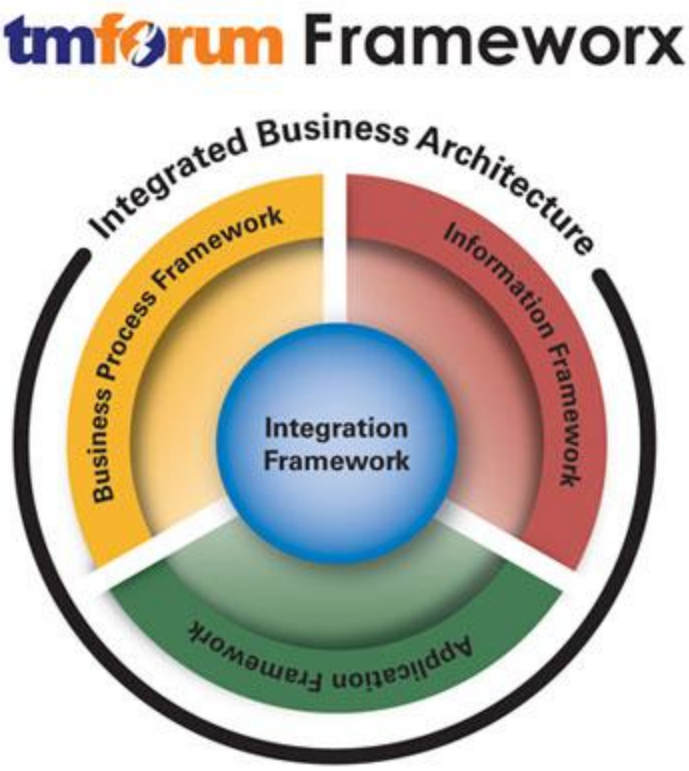


Figure 3.1.1.1: TMF Frameworx

TMF Frameworx defines the mechanism by which the TMF's existing NGOSS standard Framework components are integrated into a comprehensive enterprise IT and process architecture that also embraces major IT industry standards such as ITIL and TOGAF. Its components are:

- Business Process Framework (eTOM) is the TMF's common process architecture for both business and functional processes
- Information Framework (SID) provides a common reference model for Enterprise information that service providers, software providers, and integrators may use to describe management information
- Application Framework (TAM) provides a common language between service providers and their suppliers to describe systems and their functions, as well as a common way of grouping them
- Integration Framework provides a service oriented integration approach with standardized interfaces and support tools

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [14] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [14].

BA	Business Agreement
CCV	Common Communication Vehicle
CMIP	
CORBA	
DDP	Document Delivery Package
FMC	Fixed Mobile Convergence
FMW	Framework
FNM	Federated Network Model
IA	Information Agreement
IF	
IIS	Interface Implementation SpecificationIRP Integration Reference Point
IS	Information Service
MTOSI	Multi-Technology Operations System Interface
NM	Network Management
NRA	Network Resource Assurance
NRB	Network Resource Basic
NRF	Network Resource Fulfilment
NRM	Network Resource Model
NW	Network
RTM	Resource Trouble Management
SOA	
SOAP	
SS	
TIP	TMF Interface Program
TMF	TeleManagement Forum
UML	Unified Modeling Language
XML	

4 Comparison of 3GPP and TMF Generic Model Definitions

4.1 Reference Architectures and Specification Overview

4.1.1 3GPP

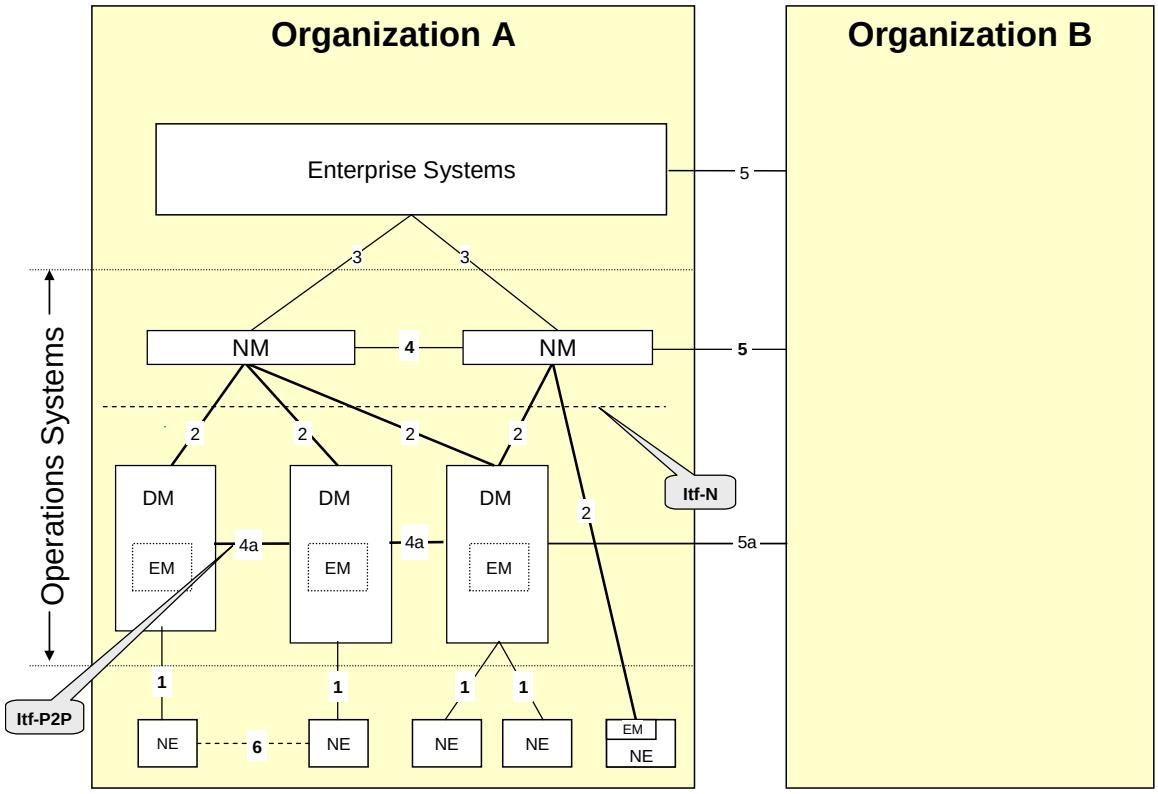


Figure 4.1.1.1: 3GPP Management Reference Model (3GPP TS 32.101 [6])

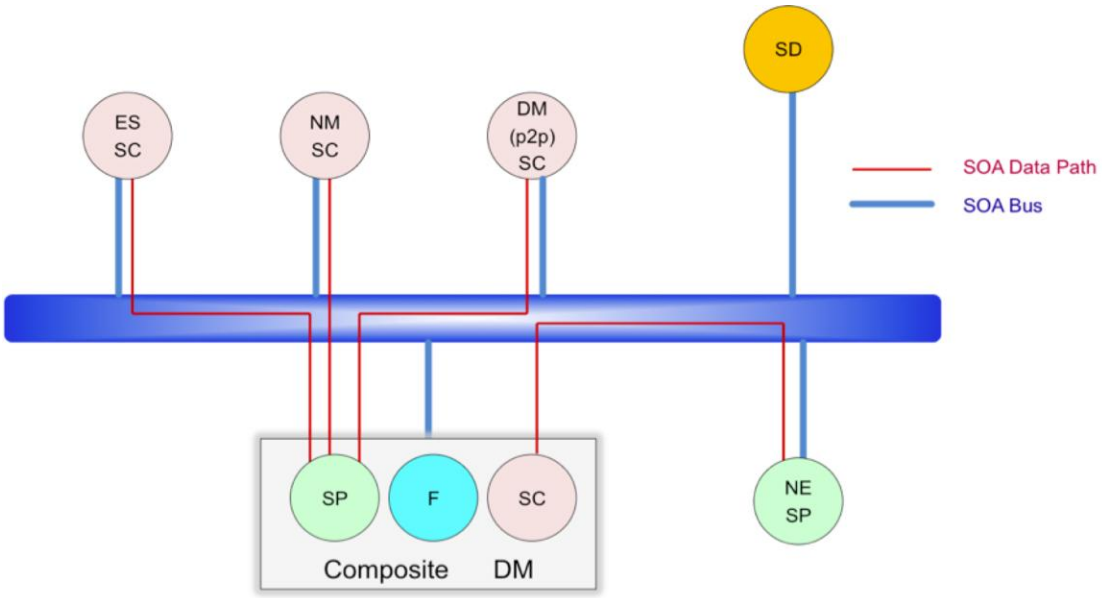


Figure 4.1.1.2: SOA-based Representation of the 3GPP Management Reference Model (3GPP TS 32.101 [6])

IRP Framework Methodology Specifications:

- 3GPP TS 32.150: Integration Reference Point (IRP) Concept and definitions
- 3GPP TS 32.151: IRP Information Service (IS) template
- 3GPP TS 32.152: IRP IS Unified Modeling Language (UML) repertoire
- 3GPP TS 32.153: IRP technology specific templates, rules and guidelines
- 3GPP TS 32.154: Backward and Forward Compatibility Concept and definitions
- 3GPP TS 32.155: Requirements template

IRP Specification Structure (up to and including 3GPP Release 9):

- xx1: xyz IRP Requirements
- xx2: xyz IRP IS
- xx3: xyz IRP CORBA SS
- *xx4: xyz IRP CMIP SS (retired)*
- xx5: xyz IRP XML Definitions *(applicable for NRM IRPs & notification emitting IF IRPs)*
- xx7: xyz IRP SOAP SS *(applicable only for IF IRPs)*

IRP Specification Structure (from 3GPP Release 10 onwards):

- xx1: xyz IRP Requirements
- xx2: xyz IRP IS
- xx6: xyz IRP SS

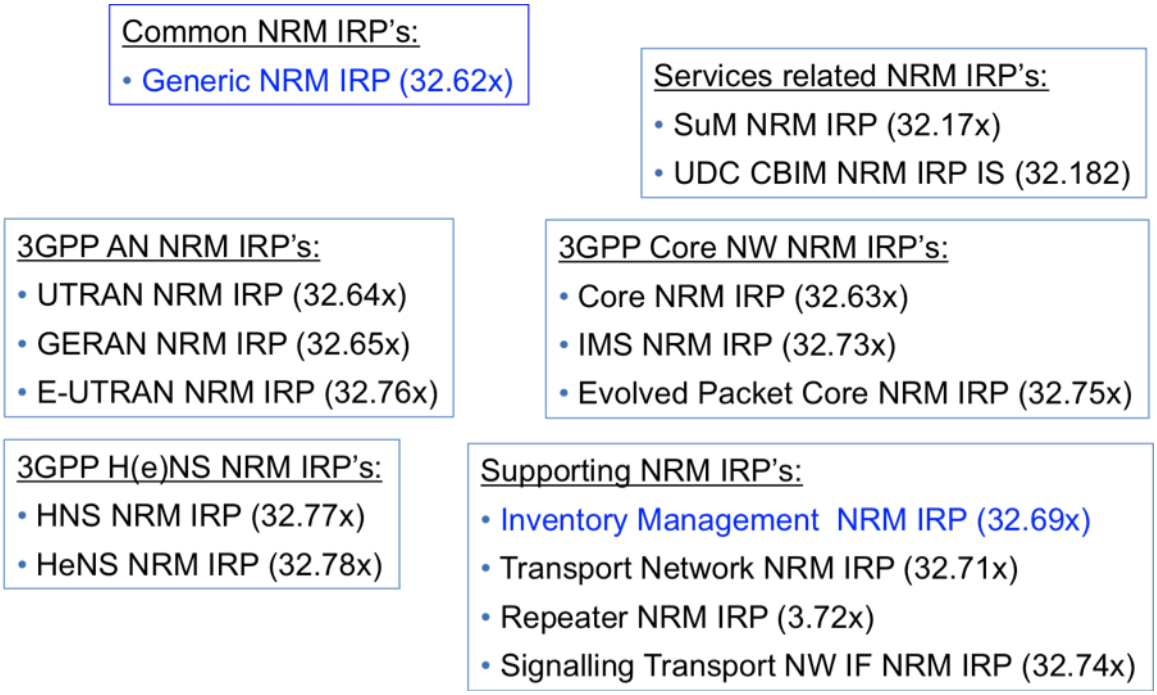


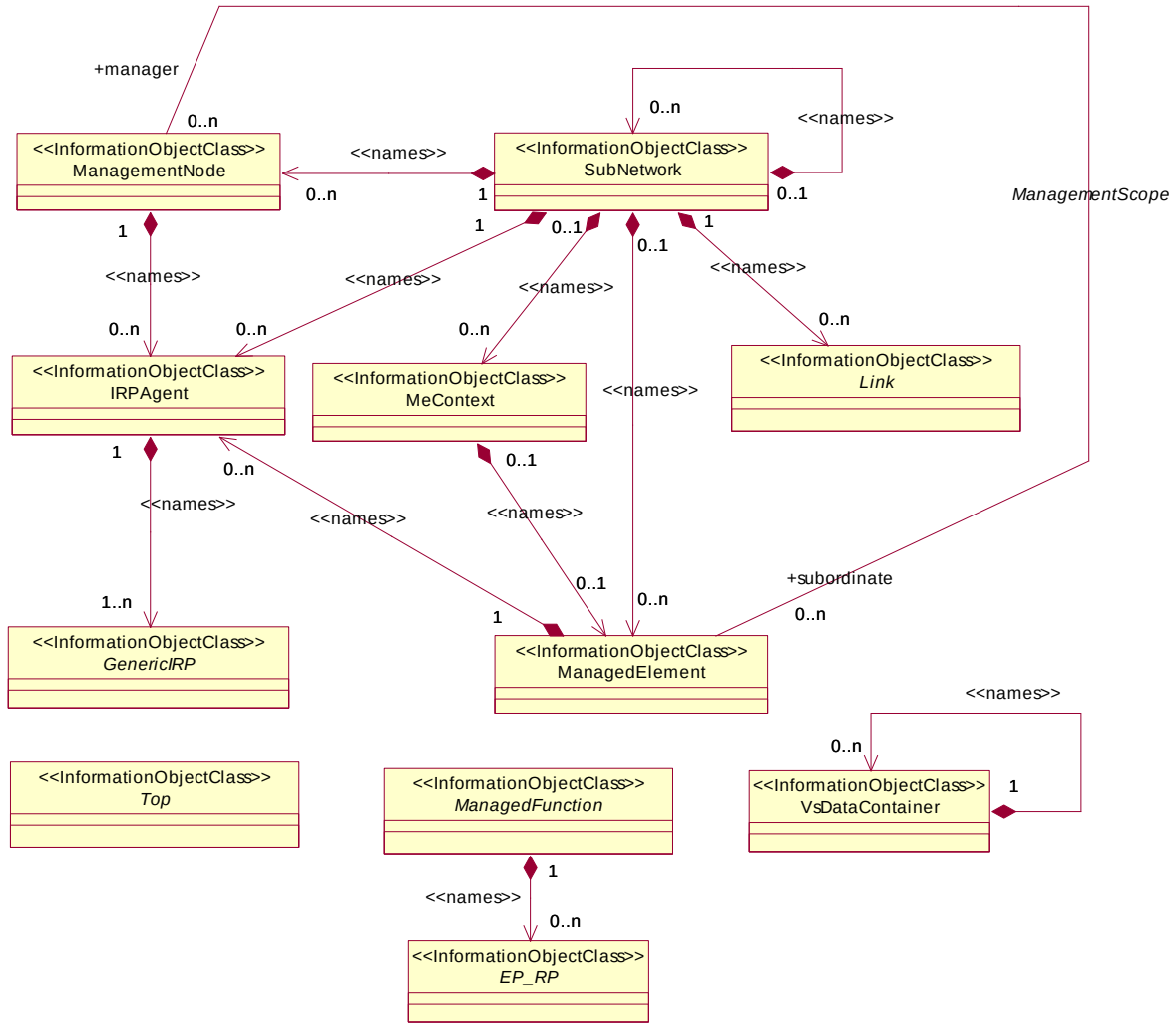
Figure 4.1.1.3: 3GPP Release 9 NRM IRP Overview

4.1.2 TMF TIP

4.2 Common/Relevant Generic Definitions

4.2.1 3GPP

3GPP defines its top model as well as generic definitions in 3GPP TS 32.622 "Generic NRM IRP" [13].



NOTE 1: `ManagedElement` may be contained in either a `SubNetwork` or a `MeContext` instance (also shown by the {xor} constraint), or have no parent instance at all.
NOTE 2: Void
NOTE 3: Each instance of the `VsDataContainer` shall only be contained under one IOC. The `VsDataContainer` can be contained under IOCs defined in other NRMs.
NOTE 4: If the configuration contains several instances of `SubNetwork`, exactly one `SubNetwork` instance shall directly or indirectly contain all the other `SubNetwork` instances.
NOTE 5: The `SubNetwork` instance not contained in any other instance of `SubNetwork` is referred to as "the root `SubNetwork` instance".
NOTE 6: `ManagementNode` shall be contained in the root `SubNetwork` instance.
NOTE 7: If contained in a `SubNetwork` instance, `IRPAgent` shall be contained in the root `SubNetwork` instance.
NOTE 8: For a clarification on the choice of containment of the `IRPAgent` (since it has three possible parents), see the def. of `IRPAgent`.

Figure 4.2.1.1: Generic NRM Containment/Naming and Association diagram (3GPP TS 32.622 [13])

It is assumed that the following 3GPP information objects may have to be "aligned" with equivalent SID information objects:

- Subnetwork
- ManagedElement
- ManagedFunction
- ManagementNode (tbd)
- Top (tbd)

SUBNETWORK

This IOC represents a set of managed entities as seen over the Itf-N.

There may be zero or more instances of a `SubNetwork`. It shall be present if either a `ManagementNode` or multiple `ManagedElements` are present (i.e. `ManagementNode` and multiple `ManagedElement` instances shall have `SubNetwork` as parent).

The `SubNetwork` instance not contained in any other instance of `SubNetwork` is referred to as "the root `SubNetwork` instance".

Attributes of `SubNetwork`

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
`subNetworkId`	M	M	-
`dnPrefix`	M	M	-
`userLabel`	M	M	M
`userDefinedNetworkType`	M	M	-
`setOfMcc`	M	M	-

MANAGED ELEMENT

This IOC represents telecommunications equipment or TMN entities within the telecommunications network that performs Managed Element (ME) functions, i.e. provides support and/or service to the subscriber.
An ME communicates with a manager (directly or indirectly) over one or more interfaces for the purpose of being monitored and/or controlled. MEs may or may not additionally perform element management functionality.
An ME contains equipment that may or may not be geographically distributed. An ME is often referred to as a "Network Element".

A `ManagedElement` may be contained in either a `SubNetwork` or in a `MeContext` instance. A single `ManagedElement` seen over the Itf-N may also exist stand-alone with no parent at all.

The `ManagedElement` IOC may be used to represent combined ME functionality (as indicated by the `managedElementType` attribute and the contained instances of different functional IOCs).

Single function `ManagedElement` IOC instances will have a 1..1 containment relationship to a function IOC instance (in this context a function IOC instance is an instance of an IOC derived from the `ManagedFunction` IOC). Multiple function `ManagedElement` instances will have a 1..N containment relationship to function IOC instances.

NOTE: For some specific functional IOCs a 1..N containment relationship is permitted. The specific functional entities are identified in the NRMs that define subclasses of `ManagedFunction`.

Attributes of ManagedElement

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managedElementId	M	M	-
dnPrefix	M	M	-
managedElementType	M	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedBy	M	M	-

MANAGEDFUNCTION

This IOC is provided for sub-classing only. It provides attribute(s) that are common to functional IOCs. Note that a ManagedElement may contain several managed functions. The ManagedFunction may be extended in the future if more common characteristics to functional objects are identified.

Attributes of ManagedFunction

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
userLabel	M	M	M

MANAGEMENTNODE (TBD)

This IOC represents a telecommunications management system (EM) within the TMN that contains functionality for managing a number of ManagedElements (MEs). The management system communicates with the MEs directly or indirectly over one or more interfaces for the purpose of monitoring and/or controlling these MEs.

This class has similar characteristics as the ManagedElement. The main difference between these two classes is that the ManagementNode has a special association to the managed elements that it is responsible for managing.

Attributes of ManagementNode

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managementNodeId	M	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedElements	M	M	-

TOP (TBD)

This IOC is introduced for generalisation purposes. All information object classes defined in all TS shall inherit from Top.

Attributes of Top

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
objectClass	M	M	-
objectInstance	M	M	-

4.2.2 TMF Information Framework (SID)

The TMF has an ongoing program of work under the Information Framework that is developing and refining an Information and Data model known as the SID (Shared Information / Data Model) [8]. The SID provides a framework within which all information objects can be described that are of interest for operator business processes and also provides the information/data objects that are exchanged over the TMF Interfaces (MTOSI/MTNM). The TMF teams are working on tooling that will take the SID and produce interfaces. This work is part of the TMF Interface Program (TIP).

Due to the flexibility required to meet the goals, the SID provides a rich set of interrelationships. Parts of the model have been tuned for transfer over a management interface of information related to Network Devices. In these parts the SID provides a strong composition (containment) model.. In some areas the model has not been focussed on interface transfer and in these areas the containment model is intentionally weakened to aggregation (recognising the lack of lifecycle dependency) and on occasions to a general association.. Examples of aggregation are: "EquipmentInHolder", "EquipmentInEquipment" where clearly each part has an independent life,. Also, SID uses the "Composite-Atomic" pattern to model Items that can contain other items. Examples of this pattern are "HolderComposite" / "HolderAtomic" with the Association "HasHolders" that allow to model EquipmentHolders which may contain other EquipmentHolders, and "SoftwareComposite" / "SoftwareAtomic" with "HasSoftwareComponents" that allows to hierarchically structure software.

It is clear that when developing a model representation to be passed across a Management Interface the relevant viewpoint at the interaction point between the applications needs to be represented and that this will lead to strengthening some relationships from aggregation to composition. For example, when the context is narrowed to that of a Network Device the view of the Equipment-Holder relationship could be strengthened to Composition/Containment. So when mapping from the SID generalised model to the SID model for interface transfer (for MTOSI/MTNM for example) relationships may change in strength. The same treatment would be appropriate when interrelating the 3GPP model to the SID.

Until recently the SID did not incorporate the MTNM/MTOSI model. In SID 9 the Resource model from MTNM/MTOSI, which is a large majority of the MTNM/MTOSI model, has been incorporated in the SID. There are still some areas to incorporate and there is also a need for some restructuring of the SID to improve accessibility, interpretation and application..

Some SID Objects potentially relevant for harmonizing generic model aspects are:

- RootEntity
- ManagedEntity
- ManagementDomain
- EquipmentHolder
- Equipment
- SubNetwork
- Pipe
- TerminationPoint (including PhysicalTerminationPoint, ConnectionTerminationPoint and FloatingTerminationPoint)
- DeviceInterface (including MediaInterface and LogicalInterface)
- FlowDomainFragment
- SubNetworkConnection
- TopologicalLink

Where SID model has been applied to interfaces specific documentation has been developed to assist the implementer of the interfaces. This documentation comes in two forms (MTNM and MTOSI). The focus in this document will be the MTOSI form of documentation.

4.2.3 Comparison of Common Definitions

TMF MTOSI has a similar document/specification structure than 3GPP IRPs. MTOSI specifications have three kinds of Document Data Packages (DDP) (Chapter 1.2 DDP Structure in [1]):

- The FrameWork DDP (FMW) – this DDP contains the generic artefacts that are applicable to all the other DDPs.
- Data Model DDP (DM-DDP) – a DDP that concerns a data model (entities, data structures, attributes, state, but no operations)
- Operation Model DDP (OM-DDP) – a DDP that concerns a computational model (operations, notifications, transactions) for a given functional area (such as resource inventory management)

And in more detail, the resource management related data models are captured in following DDPs (additional to FrameWork DDP):

- NetworkResourceBasic (NRB)
- NetworkResourceFulfilment (NRF)
- NetworkResourceAssurance (NRA)

The generic object definitions for resource management functions are captured in FMW and NRB DDPs. Additionally some objects in NRF and NRA can also be considered as generic when object models and object definitions are compared to 3GPP Generic NRM IRP. Thus some objects from those DDP are captured in this chapter as well.

MTOSI naming tree as per FMW DDP [2]:

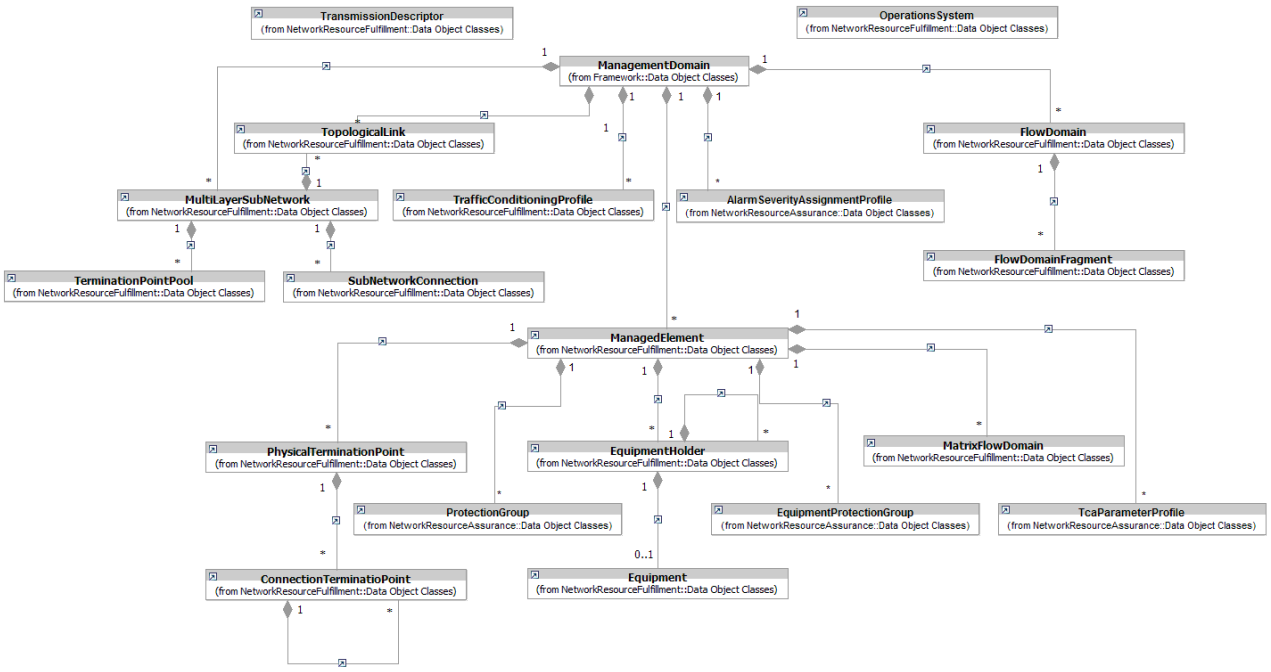


Figure 4.2.3.1: MTOSI naming tree as per FMW DDP [2]

4.2.3.1 Object definitions in FMW

MTOSI FMW defines following objects, [2]

Object name	Description
CommonObjectInfo	CommonObjectInfo defines the common attributes for all addressable object classes
ManagementDomain	One or more ManagementDomains are used to represent the managed network of a service provider (i.e., a portion of a network) in the context of a given CCV. Each network resource is contained under exactly one ManagementDomain. Each OS on the CCV may store part or whole inventory associated with one or more ManagementDomains. A top-level OS may manage part or all of one or more ManagementDomains

The relevance of these objects for this study is to be verified.

CommonObjectInfo, attributes [2]

Attribute name	Description
name	This attribute represents a unique identifier of the object on the CCV within the context of the OS that creates the object.
discoveredName	This attribute contains the name of the object when its existence is first published on the CCV but only in the case where the OS that publishes the object on the CCV is not the naming OS.
namingOsRef	This attribute represents an identifier for the steward of the object, intended as the OS that sets the name of the object. The namingOS attribute is set by the OS that is responsible for setting the "name" of the object.
nativeEmsName	This attribute contains the native EMS Name of the object. It represents how an EMS user addresses an object on the EMS GUI. Its aim is to provide a "nomenclature bridge" for relating information presented on NMS displays and EMS displays (via GUI cut through). The EMS may or may not support changing this value. This attribute contains a list of aliases for the entity.
aliasNameList	This attribute contains a list of aliases for the entity.
userLabel	This attribute represents a provisionable, user friendly name for the object. The userLabel attribute is owned and may be set by the requesting OS or the naming OS. The difference between the userLabel and the name is that the userLabel is an attribute of the object that may be "set" by the requesting OS or the naming OS. This attribute may be unique amongst all instances of this object in the target OS.
owner	This attribute represents an identifier for the owner of the object.
additionalInfo	This is a vendor specific attribute that contains additional specific information about the object. This list can be empty. The attribute, when present, can be used to convey information from the target OS to the requesting OS, and vice versa, of additional information that isn't explicitly modelled, except that some parameter names and values may be predefined. Any information encoded in the additionalInfo is optional: the target OS need not fill out this information and the requesting OS need not interpret this information.

MANAGEMENTDOMAIN, ATTRIBUTES:

Attributes are inherited from CommonObjectInfo.

4.2.3.2 Object definitions in NRB

MTOSI NRB defines following object [3]

Object name	Description
CommonResourceInfo	This object class defines the attributes that are common to all resource objects

CommonResourceInfo, attributes [3]

Attribute name	Description
source	this attribute shall indicate whether the object was discovered from the network, or was entered into the OS's inventory. The possible values for this attribute are, i.e., • network ME – the object was discovered directly from an NE. • network OS – the object was discovered from an OS communicating directly with an NE. • OS – the object was entered into an OS on the CCV, that was not communicating directly with an NE, e.g., OS GUI or file transfer to the OS from some other system. • Unknown – the source of the object is not available or known by the OS.
resourceState	this attribute shall represent the lifecycle state of a physical resource. The possible values for this attribute are: • planning – the resource is scheduled for deployment in accordance with a specific plan. • installing – the resource undergoes a full commissioning process until it is finally ready for work and support services. • working – the resource has been physically installed and all necessary firmware and software have been installed, all commissioning tests have been performed, • retiring – the resource undergoes all necessary procedures for its decommissioning and phasing out. • unknown - the resource state is not known.
networkAccessDomain	This attribute contains a free-format string used to associate the resource to a Network Access Domain
ituStateAndStatusList	This attribute allows an object that represents a managed resources across the Interface to support the ITU-T state and status values (as defined in the ITU-T X.731 and M.3100).

4.2.3.3 Object definitions in NRF

Network resource fulfillment DDP contains definitions that are applicable to fulfilment applications. Thus the objects are not generic in a sense the definitions FMW and NRB. Anyhow, NRF defines objects that may not be directly tight to a specific domain or technology thus considered here as potential generic objects. Objects and object descriptions as per [4]:

Object name	Description
ManagedElement	represents an abstraction of a set of co-located physical resources managed as a single entity
OperationsSystem	This object class represents the Operations System (OS) itself (an EMS, NMS or SMS). In the context of the MTOSI product, there are top-level OSs which are attached to the CCV and subordinate OSs which are known to a given top-level OS but not attached to the CCV
Equipment	This object class represents the manageable physical components of a network element

ManagedElement, attributes [4]

Attribute name	Description
Location	This attribute identifies the location of the Network Element represented by the Managed Element
softwareVersion	The version attribute identifies the version of the Managed Element as a whole. Changes in the value of this attribute lead to an AVC notification.
productName	This attribute identifies the Managed Element vendor's name/designation for the product.
communicationState	This attribute identifies the state of communication between the target OS and the Managed Element.
supportedConnectionLayerRateList	This attribute identifies the supported connection layer rates of the Managed Element. There is a standardised list of LayerRates
isInSyncState	This attribute identifies whether the target OS is able to keep its data synchronized with the Network Element data. The target OS sets this attribute to False to indicate that it requires resynchronization with the Network Element data and that it is not able to generate the appropriate notifications (such as OCs/ODs/AVCs) while doing so. The target OS sets this attribute back to True when the resynchronization is completed and when notifications can start being generated as appropriate.
manufacturer	This attribute identifies the Managed Element manufacturer name.
manufactureDate	This attribute identifies the production date of the Managed Element in the format of YYYYMMDD where YYYY = the 4-digit year of manufacture, MM is the 2-digit month, and DD is the 2-digit date.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the Managed Element.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.
source, resourceState, networkAccessDomain, ituStateAndStatusList	Inhereted from CommonResourceInfo
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo	Inhereted from CommonObjectInfo

OperationsSystem, attributes [4]

Attribute name	Description
softwareVersion	This attribute identifies the software version of the OS.
productName	This attribute identifies the product name for the OS.
manufacturer	This attribute identifies the name of the OS supplier.
resourceFulfillmentState	This attribute indicates the current resource fulfillment state of the OS.
isSubordinateOS	This attribute identifies if the OS is a subordinate OS or not.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the Operations System.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.
source, resourceState, networkAccessDomain, ituStateAndStatusList	Inhereted from CommonResourceInfo
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo	Inhereted from CommonObjectInfo

4.2.3.4 Object definitions in NRA

Information source: Network Resource Assurance DDP IA, TMF612_NRA, Version 1.0

Network resource assurance DDP contains definitions that are applicable to assurance applications. Thus the objects are not generic in a sense the definitions FMW and NRB. Anyhow, NRA defines objects that are not directly tight to a specific domain or technology thus considered here as potential generic objects. Objects and object descriptions as per [5]:

Object name	Description
AlarmSeverityAssignmentProfile	This object class models the (flexible) severity assignment to specified probable causes. So the ASAP object includes a table, with each row specifying the probable cause (plus optionally the probableCauseQualifier and / or the nativeProbableCause) and the assigned severity for "service affecting", "non service affecting" and "service independent or unknown" alarms
EquipmentProtectionGroup	This object class represents the information about an equipment protection in a Managed Element
PerformanceMonitoringPoint	This object class represents one Performance Monitoring Point (PMP). There always exists one PMP for every triple of layer rate, PM location and granularity for which the containing TP is capable to monitor performance. Thus, its existence reflects the TP's PM capabilities.

The relevance of these objects for this study is to be verified.

4.3 Common/Relevant Inventory Definitions

4.3.1 3GPP

3GPP defines an Inventory Information in 3GPP TS 32.692 [7], and further inventory-related data are included in 3GPP TS 32.622 [13]. In addition, vendor specific data can be put into a vsDataContainer structure.

INVENTORY UNIT DEFINITION IN 3GPP TS 32.692 [7]

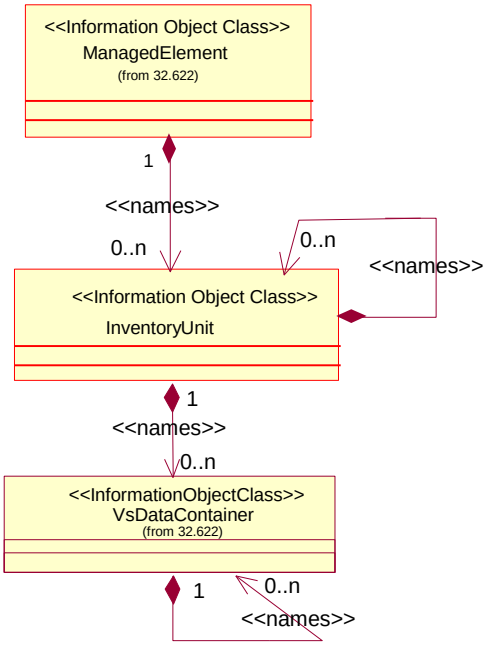


Figure 4.3.1.1: Inventory Unit definition in 3GPP TS 32.692 [7]

Attributes (Table 6.5.1 from 3GPP TS 32.692x [7])

Attribute Name	Definition	Legal Values
dateOfManufacture	Date of Manufacture of inventory unit.	
dateOfLastService	Date of last service or repair of inventory unit.	
inventoryUnitId	An attribute whose 'name+value' can be used as an RDN when naming an instance of this object class. This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	
inventoryUnitType	Type of inventory unit (see TS 32.690 [11])	
manufacturerData	Manufacturer specific data of inventory unit.	
serialNumber	Serial number of inventory unit.	
unitPosition	Position of inventory unit (e.g. Rack, shelf, slot, etc.). Depending on the implementation of the inventory unit in the managed system, the value and meaning of this attribute may vary. For example, if a system has three levels and types of inventory units representing Rack, Shelf and Slot respectively (i.e. the Managed Element contains multiple Rack inventory units, each Rack inventory unit contains multiple Shelf inventory units and each Shelf inventory unit contains multiple Slot inventory units), then for this example: – for the Inventory Unit representing a Rack, the Frame Identification code may be used as the value of this attribute; – for the Inventory Unit representing a Shelf, the Rack Shelf code may be used as the value of this attribute; – for the Inventory Unit representing a Slot, the position code may be used as the value of this attribute.	
vendorName	Name of inventory unit vendor.	
vendorUnitFamilyType	Mnemonic of inventory unit family type (e.g. Fan, PSU) assigned by vendor.	
vendorUnitTypeNumber	A vendor/manufacturer defined and assigned number which uniquely identifies the unit type and optionally for backward compatibility reasons only, also version (used for replacing HW units, spares).	
versionNumber	The version information related to vendorUnitTypeNumber.	

INVENTORY-RELATED DEFINITIONS IN TS 32.622 [13]

Attributes of ManagedElement

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managedElementId	M	M	-
dnPrefix	M	M	-
managedElementType	M	M	-
userLabel	M	M	M
vendorName	**M**	**M**	**-**
userDefinedState	M	M	M
locationName	**M**	**M**	**-**
swVersion	**M**	**M**	**-**
managedBy	M	M	-

Attributes of ManagementNode

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managementNodeId	M	M	-
userLabel	M	M	M
vendorName	**M**	**M**	**-**
userDefinedState	M	M	M
locationName	**M**	**M**	**-**
swVersion	**M**	**M**	**-**
managedElements	M	M	-

Attributes

Attribute Name	Definition	Legal Values
locationName	The physical location of this entity (e.g. an address).	
swVersion	The software version of the ManagementNode or ManagedElement (this is used for determining which version of the vendor specific information is valid for the ManagementNode or ManagedElement).	
vendorName	The name of the vendor.	

4.3.2 TMF SID

Besides many others, the SID [8] defines information objects that are applicable to physical and logical resources. Among those, there are objects that contain information, which is relevant in the context of Inventory. These are defined in the SID Domain Addenda 5PR (Physical Resources) and 5LR (Logical Resources). The information objects in the SID are organized in so-called "Aggregate Business Entities" (ABE). For Inventory, the ABEs "PhysicalResource", "Hardware", "Equipment", "EquipmentHolder" and "Software" are relevant.

The following attributes contain information that may be relevant for hardware inventory:

- RootEntity.objectID
- RootEntity.commonName
- RootEntity.description
- RootEntity.version
- PhysicalResource.manufactureDate
- PhysicalResource.otherIdentifier
- PhysicalResource.serialNumber
- PhysicalResource.versionNumber
- Hardware.depth
- Hardware.height
- Hardware.width
- Hardware.measurementUnits
- Hardware.weight
- Hardware.weightUnits
- Hardware.replacable
- ManagedHardware.additionalInfo

The location of a resource is not modelled by an attribute, but by the association PhysicalResource.ResourceIsAtPlace which links to an instance of the abstract class "LocalPlace". This class is part of the Location ABE which provides very complex and powerful mechanisms to model location.

To provide an extension mechanism for this set of values, SID has defined a mechanism called "PhysicalResourceSpec" that allows assigning attributes of arbitrary type and value to physical resources. This mechanism is powerful but also very complex. Information about HardwareVendors could be modelled using the Information object "Vendor" which inherits from "PartyRole". But again, for a few attributes about the vendor of a particular piece of hardware or software, this modelling approach is by far too complex.

The following associations model containment relationships that may be relevant to structure hardware inventory information:

- Hardware.ContainsHardware
- Equipment.EquipmentInHolder
- Equipment.EquipmentInEquipment
- EquipmentHolder and its subclasses model Equipment that has been designed to contain other Equipment.

The following attributes contain information that may be relevant for software inventory:

- RootEntity.objectID
- RootEntity.commonName
- RootEntity.desctiption
- RootEntity.version
- Software.buildNumber
- Software.majorVersion
- Software.minorVersion
- Software.maintenanceVersion
- Software.targetPlatform
- Resource.usageState
- LogicalResource.serviceState
- LogicalResource.isOperational

The following associations model containment relationships that may be relevant to structure software inventory information:

- SoftwareComposite.HasSoftwareComponents

The mapping between Hardware and Software is represented by PhysicalContainer.ContainerHasSoftware and is inherited by Equipment and all derived classes like Equipment or EquipmentHolder (but not present in Hardware).

Software Licensing is not covered in SID as it would be appropriate for inventory purposes. Instead, under a very limited scope, licenses for Operating Systems are covered in the PartyRoleLicenseOSDetails information object.

The diagram below graphically depicts the part of the SID that may be relevant for Inventory. Note that only those classes in the inheritance hierarchy are depicted which contribute inventory-related information. Some non-abstract classes are provided, but in practical deployments probably more of these classes need to be derived.

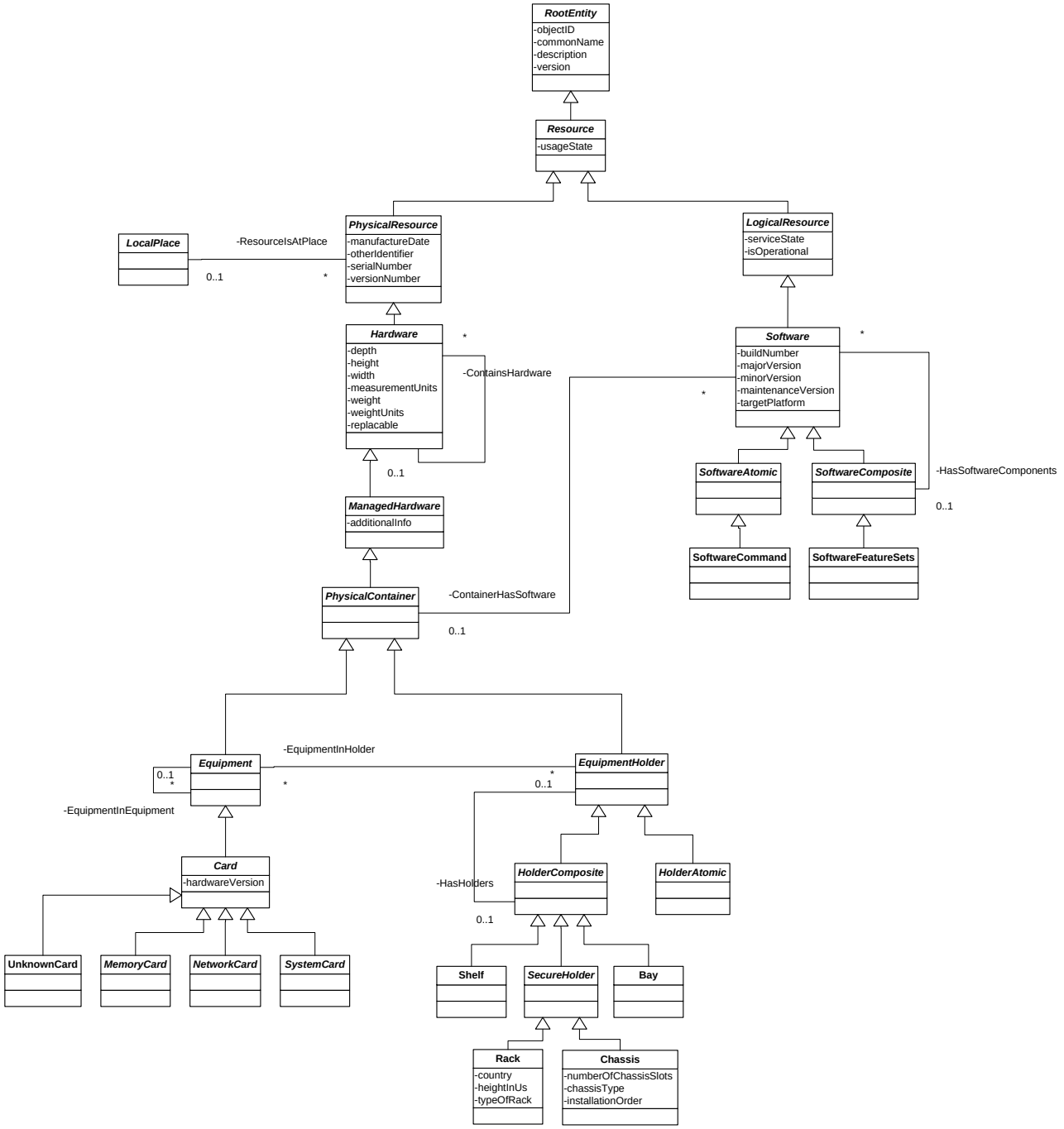


Figure 4.3.2.1: Inventory related classes of SID

4.3.3 TMF MTOSI

The Manage Resource Inventory BA covers requirements and use cases concerning the management of resource inventory. The following management capabilities are covered:

- General Management such as (among others):
  - Bulk inventory retrieval (retrieving selected information in a single operation)
  - Multi-Object Inventory Update
- Inventory Management of Connection Oriented Technologies
- Inventory Management of Connectionless Technologies
- Inventory Notifications

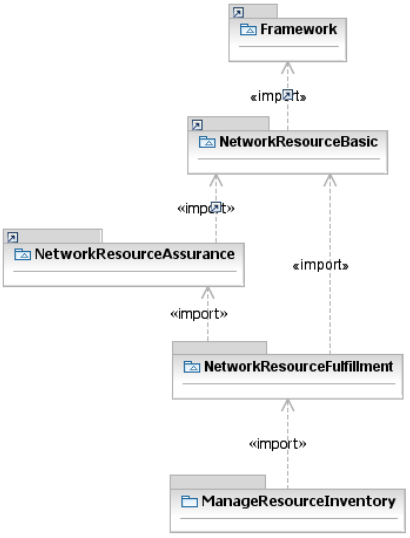


Figure 4.3.3.1: DDP relationship diagram for Resource Inventory

- The Data Model is defined in
  - Framework
  - NetworkResourceBasic
  - NetworkResourceAssurance
  - NetworkResourceFulfillment
- The Interfaces and Operations Model is defined in
  - ManageResourceInventory

Relevant documents for inventory model are

- TMF518 Manage Resource Inventory DDP BA
- TMF612 Manage Resource Information DDP IA
- TMF612 Network Resource Fulfillment DDP IA
- SD2-12 Resource Inventory Layout
- SD2-20 Equipment Model

The MTOSI Equipment Model represents the various manageable physical components of the Network Element (circuit packs or field replaceable units or also, fan, fuse panel, power supply, etc.) and is described in Network Resource Fulfillment SD2-20 Equipment Model: The Equipment Holder Class represents an abstraction of Rack, Shelf, Subshelf, Slot and Subslot. Figure 4.3.3.2describes the containment and support/supporting relationship of the equipment model. Some of the equipment may be protected in case of failure with alternative equipment that is modeled under EquipmentProtectionGroup.

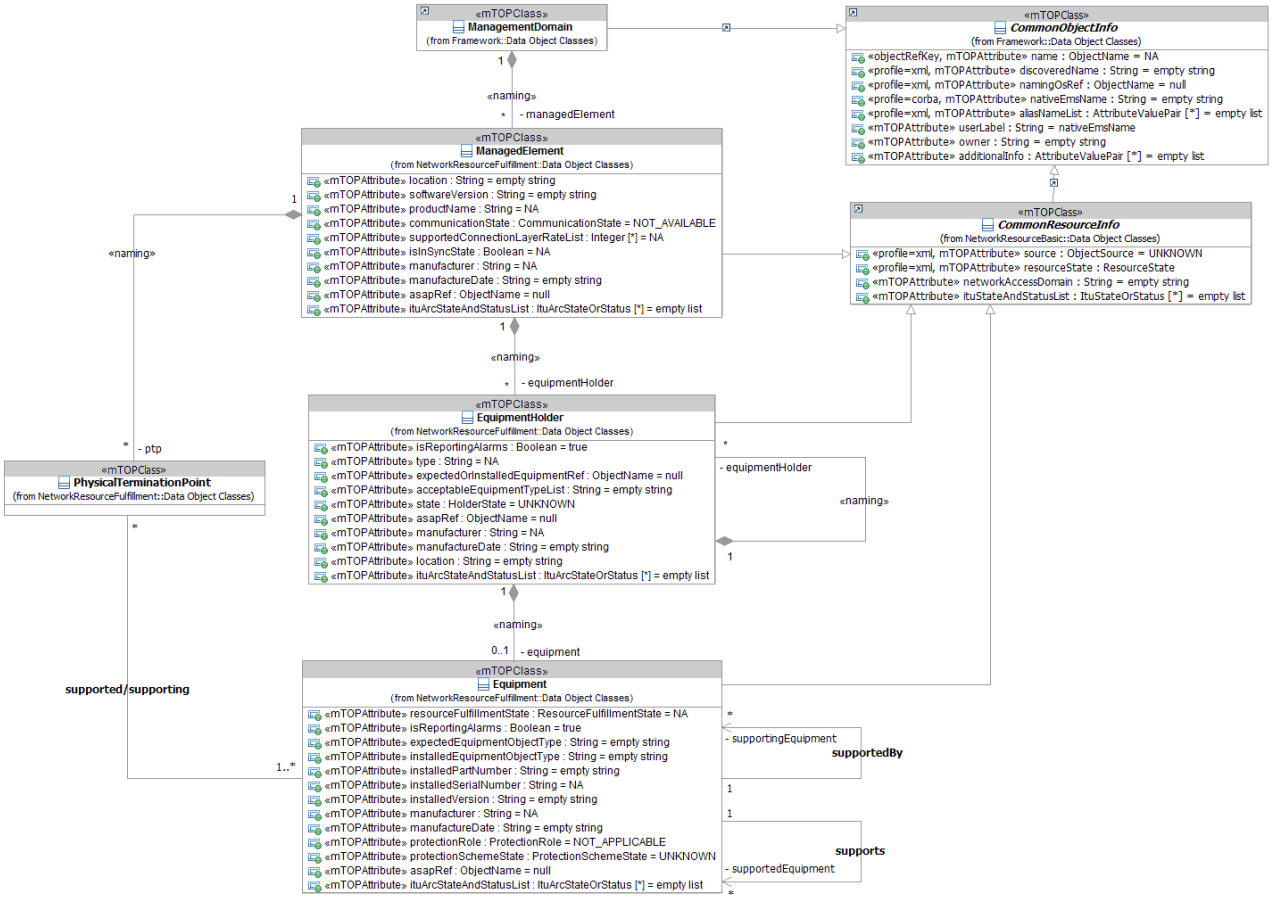


Figure 4.3.3.2: NRF Equipment model class diagram

4.3.3.1 Object Definitions in NRF

ManagedElement, attributes [4]

Attribute name	Description
Location	This attribute identifies the location of the Network Element represented by the Managed Element
softwareVersion	The version attribute identifies the version of the Managed Element as a whole. Changes in the value of this attribute lead to an AVC notification.
productName	This attribute identifies the Managed Element vendor's name/designation for the product.
communicationState	This attribute identifies the state of communication between the target OS and the Managed Element.
supportedConnectionLayerRateList	This attribute identifies the supported connection layer rates of the Managed Element. There is a standardised list of LayerRates
isInSyncState	This attribute identifies whether the target OS is able to keep its data synchronized with the Network Element data. The target OS sets this attribute to False to indicate that it requires resynchronization with the Network Element data and that it is not able to generate the appropriate notifications (such as OCs/ODs/AVCs) while doing so. The target OS sets this attribute back to True when the resynchronization is completed and when notifications can start being generated as appropriate.
manufacturer	This attribute identifies the Managed Element manufacturer name.
manufactureDate	This attribute identifies the production date of the Managed Element in the format of YYYYMMDD where YYYY = the 4-digit year of manufacture, MM is the 2-digit month, and DD is the 2-digit date.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the Managed Element.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.
source, resourceState, networkAccessDomain, ituStateAndStatusList	Inhereted from CommonResourceInfo
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo	Inhereted from CommonObjectInfo

Equipment, attributes [4]

Attribute name	Description
resourceFulfillmentState	This attribute supports basic administration of plug-ins.
isReportingAlarms	This attribute provides an indication of whether alarm reporting for this Equipment is enabled (true) or disabled (false).
expectedEquipmentObjectType	This attribute identifies the type of the expected resource. For example, "Fan" or "STM16" for the Equipment class and "Line Shelf" for the Equipment Holder class.) This is an empty string if there is no expected equipment.
installedEquipmentObjectType	This attribute identifies the type of the installed resource. For example, "Fan" or "STM16" for the Equipment class and "Line Shelf" for the Equipment Holder class.) The installed equipment type is invariant for the lifetime of the hardware. This is an empty string if there is no expected equipment.
installedPartNumber	This attribute identifies the vendor's resource Part Number (PN) of the installed equipment. If PN is not available empty string shall be used. If the part and serial number are both non-null then the part+serial number together shall be unique.
installedSerialNumber	This attribute contains the vendor's serial number of the installed equipment. Unique, if no default is provided. At least one serial number has to be provided.
installedVersion	This attribute identifies the vendor's resource version of the installed equipment.
manufacturer	This attribute identifies the equipment manufacturer name. It is defined as a non-empty free format string with no semantics.
manufactureDate	The manufacturerDate attribute identifies the production date of the Equipment.
protectionRole	This attribute defines the protection role that this equipment plays. In case the equipment is not protected, the value "NOT_APPLICABLE" shall be used.
protectionSchemeState	This attribute identifies the individual lock of this equipment. In case the equipment is not protected, the value "UNKNOWN" shall also be used.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the Equipment.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.
source, resourceState, networkAccessDomain, ituStateAndStatusList	Inhereted from CommonResourceInfo
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo	Inhereted from CommonObjectInfo

Equipmentholder, attributes [4]

Attribute name	Description
isReportingAlarms	This attribute provides an indication of whether alarm reporting for this Equipment Holder is enabled (true) or disabled (false).
type	This attribute identifies the type of the Holder (e.g., Rack (or Bay), Shelf, Sub-shelf, Slot, Subslot, Remote-unit or Remote-subslot).
expectedOrInstalledEquipmentRef	This attribute identifies the equipment object expected or installed in the equipment holder, if any. Null if the equipment holder is empty or if it only contains other equipment holders.
acceptableEquipmentTypeList	This attribute identifies the types of equipment that can be supported by the Equipment Holder.
state	This attribute identifies the state of the Equipment Holder.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the EquipmentHolder.
manufacturer	This attribute identifies the Equipment Holder manufacturer name. It is defined as a non-empty free format string with no semantics.
manufactureDate	The manufactureDate attribute identifies the production date of the Equipment Holder.
location	This attribute identifies the geographical location of the Equipment Holder.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.
source resourceState networkAccessDomain ituStateAndStatusList	inherited from CommonResourceInfo
name discoveredName namingOsRef nativeEmsName aliasNameList userLabel owner additionalInfo	inherited from CommonObjectInfo

PhysicalTerminationPoint, attributes [4]

Attribute name	Description
direction tpProtectionAssociation isEdgePoint isEquipmentProtected egressTmdState ingressTmdState egressTmdRef ingressTmdRef transmissionParameterList asapRef ituArcStateAndStatusList	Inhereted from TerminationPoint
source, resourceState, networkAccessDomain, ituStateAndStatusList	Inhereted from CommonResourceInfo
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo	Inhereted from CommonObjectInfo

TerminationPoint, attributes [4]

Attribute name	Description
direction	This attribute represents a static, inherent capability of the TP.
tpProtectionAssociation	This attribute indicates whether the TP has an associated protection TP and, if so, what kind of protection association exists.
isEdgePoint	This attribute indicates if the TP is an edge point of at least one Subnetwork or Flow Domain, i.e. if it is an end point of a potential inter-Subnetwork/inter-FlowDomain Topological Link.
isEquipmentProtected	This attribute indicates whether or not the TP is supported by a protected Equipment.
egressTmdState	This attribute contains the state of consistency between a TP and its associated egress TransmissionDescriptor.
ingressTmdState	This attribute contains the state of consistency between a TP and its associated ingress TransmissionDescriptor.
egressTmdRef	This attribute represents the name of the egress Transmission Descriptor (TMD) associated with this TP.
ingressTmdRef	This attribute represents the name of the ingress Transmission Descriptor (TMD) associated with this TP.
transmissionParameterList	This attribute contains the layered Transmission Parameters associated with the different layers that are encapsulated within the TP. Refer to attached supporting document SD1-16_LayeredParameters for details of the currently defined Transmission Parameters.
asapRef	This attribute indicates the assignment of an Alarm Severity Assignement Profile (ASAP) to the Termination Point.
ituArcStateAndStatusList	This enumeration contains an ITU Alarm Reporting Control (ARC) state or status together with it's value.

4.3.4 Comparison of Inventory Definitions

The inventory model information in previous chapters shows clearly that both 3GPP and MTOSI inventory models are defined for hardware inventory. This view is visible in both object definitions and object attribute definitions. Both models also follow similar modelling approach where managed element contains hardware related inventory units with relatively simple predefined structure. 3GPP hardware inventory unit model is very generic (contains inventory unit that may contain another inventory units) and the interpretation is seen as an implementation issue of vendors i.e. how to implement inventory unit object hierarchy. MTOSI specification defines the relationship of equipment holders and equipment thus somewhat more specific than 3GPP model. Anyhow the 3GPP inventory model enables this equipment holder – equipment modelling. TMF SID defines objects for hardware and software modelling purposes. The hardware model is similar (but richer) to MTOSI model. SID defines equipment and equipment holder in more detail. SID defines an object for software also unlike 3GPP and MTOSI. And notably, the relationship between software and hardware objects (PhysicalContainer) is also defined.

3GPP and MTOSI model the equipment in very similar manner. MTOSI model contains rack, shelf, subshelf, slot, and subslot (SD2-20) whereas 3GPP model contains rack, shelf, slot, circuit pack, physical port (3GPP TS 32.690). TMF SID model is similar but has a clear object hierarchy for the HW units. These models should be aligned and since hardware inventory unit is technology independent one common model approach should be chosen. The result model should anyhow be at high level and keep the HW details at attribute level to enable flexible usage and extensions.

3GPP and MTOSI HW related attributes are similar but not the same. Both models contain basic attributes of HW units. Comparison table of 3GPP inventoryUnit and MTOSI Equipment object attributes below.

3GPP attribute	MTOSI attribute	comparison
inventoryUnitId	name (FMW DDP)	Semantically same
inventoryUnitType	expectedEquipmentObjectType installedEquipmentObjectType	Semantically same
vendorUnitFamilyType	-	Missing from MTOSI. Definition: Mnemonic of inventory unit family type (e.g. Fan, PSU) assigned by vendor
vendorUnitTypeNumber	installedPartNumber	Semantically same
versionNumber	installedVersion	Semantically same
vendorName	manufacturer	Semantically same
serialNumber	installedSerialNumber	Semantically same
dateOfManufacture	manufactureDate	Semantically same
dateOfLastService	-	Missing from MTOSI
unitPosition	-	Missing from MTOSI Equipment but defined for MTOSI EquipmentHolder
manufacturerData	additionalInfo (FMW DDP)	Semantically same
	resourceFulfillmentState	Missing from 3GPP. Definition: This attribute supports basic administration of plug-ins. Capture the status of the equipment (in service, out of service …)
	isReportingAlarms,	Missing from 3GPP. Definition: This attribute provides an indication of whether alarm reporting for this Equipment is enabled (true) or disabled (false).
	protectionRole, protectionSchemeState, asapRef, ituArcStateAndStatusList,	Considered as MTOSI specific

Both 3GPP and MTOSI inventory models contain very limited definitions for software inventory. In both cases, the SW information is captured at managed element level. Managed element object represents a physical network element that performs managed element functions and contains a set of physical resources. Thus the SW attribute value contains information on whole ME level and more detailed SW information is not possible to define (without using vendor specific definitions). Additionally several SW related attributes, like SW structure, status (installed, active, etc) and installation time are missing from both specifications. As a conclusion, the SW inventory model is quite limited in current specifications and should be enhanced to enable proper SW inventory.

Both 3GPP and MTOSI inventory models contain no definitions for licence inventory. Licenses are an important mean to control different type of functionalities of network elements. License information should be considered as part of inventory information.

Current 3GPP and MTOSI specification do not consider OS systems as part of inventory. Models should be enhanced to include also OS system inventory as per other managed elements.

Adding new inventory objects and attributes should be done by considering the amount of data transferred from EM to NM thus solution should avoid redundant data within inventory file.

4.4 Handling of Vendor-specific Extensions

4.4.1 3GPP

4.4.2 TMF SID

None.

4.4.3 TMF MTOSI

Vendor specific extensions can be modelled by the additionalInfo attribute of CommonObjectInfo class, which is inherited by all MTOSI DataModel classes.

CommonObjectInfo, vendor specific attributes [2]

Attribute name	Description
additionalInfo	This is a vendor specific attribute that contains additional specific information about the object. This list can be empty. The attribute, when present, can be used to convey information from the target OS to the requesting OS, and vice versa, of additional information that isn't explicitly modelled, except that some parameter names and values may be predefined. Any information encoded in the additionalInfo is optional: the target OS need not fill out this information and the requesting OS need not interpret this information.

4.4.4 Comparison of VSE-Handling

4.5 Methodology Aspects

4.5.1 3GPP

4.5.1.1 Characteristics of large scale model

The network resource model for use in FMC network management environment is "large scale" in the following sense:

- Not one authority is responsible for the development, maintenance and evolution of the whole model;
- Not all operators will use and not all vendors products will support the whole model;

The following clauses provide brief descriptions of existing features of IRP Framework that are essential for the maintenance of the integrity of a large scale model.

4.5.1.2 Features

4.5.1.2.1 Fragments

The whole model is partitioned into fragments (one set of TS - Technical Specifications per fragment). The inter-relationship of fragments is strictly enforced but simple:

- Support of TS 32.626 (fragment) is mandatory for any valid model implementation;
- A model element (i.e. the Information Object Class - IOC) defined in one fragment can be used (via Import) but not redefined by another fragment.

Use of fragments and adherence of the simple fragment inter-relationship described above has the following advantages.

- It removes our need to keep the evolution of various fragments in synchrony. For example, it is a valid model implementation where one fragment is from Release 6 while another fragment is from Release 10.
- Domain experts (e.g. LTE experts) can focus his design on its fragments and (can, if wanted to) be ignorant of contents of other fragments (except TS 32.626).

4.5.1.2.2 Ability to reference 'external' models

IRP Framework has defined the use of a specialised IOC called ExternalIOC. Use of this ExternalIOC is to support relations between instances where one instance (say instance-A) is under the management scope of one Domain Manager (i.e. DM or IRPAgent) while the related instance (say instance-B) is under another DM.

The current definition of ExternalIOC does not indicate if the IOC definitions of the two related instances are from one or two standard organizations. We will extend this ExternalIOC feature (see description of ExternalXyz of clause 4.5.1.3.1) to support a clear indication if they are from the same or different standard organizations.

This feature is essential if different organizations are responsible for the IOC definitions of the related instances.

Note that the use of "Externals" is a "field-proven" concept. It is a concept first developed and used by ITU-T for telecommunication network management for similar purpose. The following definitions are quoted from the ITU-T Recommendation [9].

- **External reference**: A type reference, value reference, information object class reference, information object reference, or information object set reference (which may be parameterized), that is defined in some other module than the one in which it is being referenced, and which is being referred to by prefixing the module name to the referenced item (see 3.6.36 of [9])
- **External type**: A type which is a part of an ASN.1 specification that carries a value whose type may be defined externally to that ASN.1 specification. It also carries an identification of the type of the value being carried (see 3.6.37 of [9]).

4.5.1.2.3 Independence of model tooling, solution set technology and access protocol

Use of IRP Framework model does not require the use of a specific modelling tool.

The choice/agreement/design of the NRM (of the IRP Framework) does not imply the use of a specific solution set technologies, e.g. XML, CORBA, etc.

The choice/agreement/design of the NRM (of the IRP Framework) does not imply the use of a specific access protocol (used to read/write the instances of the NRM IOCs). IRP Framework adheres to strict rule ensuring that there is no dependency between NRM and its access protocols.

4.5.1.2.4 Field proven model alignment/harmonization works

We note the following cases of successful and completed model alignment/harmonization work, using the IRP Framework features mentioned above.

- 3GPP2 develop/maintain/evolve the fragment(s) related to CDMA 2000 technologies while 3GPP does similar work related to GSM/UTRAN/EUTRAN technologies plus the GENERIC NRM IRP fragment). Vendors can implement standard network management solutions for these technologies and operators' IRPManagers (a 3GPP IRP Framework conceptual object) can use these solutions in a unified way.

- BBF/Home develop/maintain/evolve the H(e)NB network resource models. Relevant IRP Framework fragments makes references to those H(e)NB network resource models allowing, for example, an IRPManager to download configuration files to, upload PM counters from and receive alarm notifications from H(e)NBs. Vendors can implement standard network management solutions for these technologies and operators' IRPManagers can use these solutions in a unified way.

4.5.1.3 Design patterns

The description of fragment and benefits of using fragments are discussed in clause 3.2.2.1.

There are two modelling design patterns to support the use of fragment.

4.5.1.3.1 Pattern one

4.5.1.3.1.1 Context

The following is a description of the context under which such pattern use is appropriate:

- IRPAgent-A has a management scope (responsibility) over a number of network resources. IRPAgent-B has a management scope (responsibility) over another set of network resources. Some network resources managed by IRPAgent-A has relation (e.g. link) with network resources managed by IRPAgent-B. The IOC definitions of the network resources managed by IRPAgent-A and by IRPAgent-B may or may not be from the same standard organization.

    - In this context, model implementation used by Agent-A needs to have ExternalXyz IOC instances. Each instance is a representation of another instance, representing the related (e.g. linked) network resource managed by Agent-B.

4.5.1.3.1.2 Procedure

We use the ATM transport network case to illustrate the use of this pattern.

TBD

4.5.1.3.2 Pattern two

4.5.1.3.2.1 Context

The following is a description of the context under which such pattern use is appropriate:

- IRPAgent-A has a management scope (responsibility) over mobile and transport network resources. The mobile network resource model is developed and maintained by 3GPP/SA5 while the transport network resource model is developed and maintained by another organization.

The approach is to use SubNetwork IOC to name-contain the transport network resource model. Using a hypothetical ATM transport network resource as an example, the ATM transport network resource model would take the place of the <<ProxyClass>>Any (of [13]). See Appendix A for ease of reference.

4.5.1.3.2.2 Procedure

To illustrate the use of this pattern we use a hypothetical case when UTRAN link resources (see 3GPP TS 32.642 [10]) are supported by ATM transport services, defined by the ATM model [11] (see Appendix B), originally designed in ATM Forum but now maintained by BBF.

1) Create a new TS and in this hypothetical case, the ATM NRM IRP.

2) In the new TS, make Import statements to import all relevant Managed Object Class definitions and their corresponding Name Bindings found in [11], in particular, those of vcLayerNetworkDomain and vpLayerNetworkDomain.

   Note: The term Managed Object Class in [11] encompasses the meaning of the two terms used in IRP Framework, namely Managed Object Class and Information Object Class.

3) In the new TS, declare (e.g. draw in the Class Diagram) vcLayerNetworkDomain and vpLayerNetworkDomain classes to be name-contained by SubNetwork IOC.

4) Make sure the ATMChannelTerminationPoint IOC of 3GPP TS 32.642 [10] has all the attributes of atmNetworkCTP MANAGED OBJECT CLASS of [11].

   Note: The ATMCHannelTerminationPoint IOC does not exist in current version of 3GPP TS 32.642 [10]. It will be present in future version when Option 1 (described in clause 4.1 and 4.2 of [4] is implemented in 3GPP TS 32.642 [10].

4.5.2 TMF SID

4.5.3 TMF MTOSI

4.5.4 Comparison of Methodology Aspects

4.6 Use Cases

4.6.1 Overview

This clause identifies use cases that are intended to help identifying the necessary relationships between the models defined by 3GPP & TMF.

4.6.2 UC Ethernet VLAN provisioning

- Scenario:
  - As a result of a planning exercise it is recognized that additional infrastructure capacity is required to support ongoing service growth. The capacity, in the form of an Ethernet VLAN needs to be created and activated across a mix of wireline and wireless NEs. The Ethernet VLAN is initially simply point to point.
- Network Context
  - The Ethernet VLAN terminates in a wireless equipment and traverses several wireline equipments to terminate at wireline equipment
- Implications - It would appear that at a minimum:
  - The optical adjacency between the wireless and wireline equipment needs to be known to the operator Network OS
  - Some configuration parameters need to be sent to the wireless equipment
- As a result of the activation the operator Network OS should be able to discover the Ethernet VLAN and its path

4.6.3 UC Alarm monitoring

- Scenario

  Operator needs to know if an alarmed radio resource, e.g. End Point instance, is related to or not related to any alarmed wireline resources.

- Network Context

  The transport circuit, terminating at both ends in mobile managed resources, traverses several transport managed resources.

- Implications

  It would appear that at a minimum:

  - Operator needs to know the transport managed resource (e.g. circuit identifier) of the edge node of the transport network that is related to the mobile managed resource in alarm state.

- Description

  Knowing the identifier of the transport managed resource of the edge node of the transport network, operator can discover the identifiers of all transport managed resources supporting the mobile managed resource in alarm state. Knowing their identifiers, operator can know if the identified transport managed resources are in alarmed condition and if so, determine if the alarm condition is causing the alarm condition of the mobile managed resource.

4.7 Model Alignment Approach

4.7.1 Overview

This clause intends to describe the methods used for aligning the models between 3GPP & TMF (given that these models are published and maintained by the respective organizations).

4.8 Solution Set relationship

4.8.1 Overview

This clause is concerned with the principles of how Solutions Set definition published by 3GPP & TMF respectively can relate to each other (e.g. import/include capabilities, name space definitions).

5 Evaluation of 3GPP and TMF Resource Model Alignment Options

5.1.1 Intent

Clause 5.1 first provides (clause 5.1.2) the background and justification for enhancing some IOCs currently defined in [1]. It then details (clause 5.1.3) the enhancement required.

This document closes with raising concern regarding recent changes to the SID and related implications to the alignment activity (clause 5.1.4).

5.1.2 Background and justification for enhancement

One of the tasks of the joint 3GPP/TMF Harmonization work is to identify IOCs defined in 3GPP/SA5 IRP Framework for enhancement such that their meanings are aligned with those similarly defined in TMF SID. One objective of the Harmonization work is to recommend a unified access, for operator process (e.g. IRPManager) to transport and mobile network management services.

One condition to support such "unified access" is to use same concepts/terms/classes that are:

a) Present in both transport and mobile network management environment and

b) Of interest for operator business processes.

5.1.3 Detail change

This clause examines the following IOCs for necessary enhancements.

- SubNetwork
- ManagedElement
- ManagedFunction
- ManagementNode
- Top

5.1.3.1 IOC `SubNetwork`

The following table captures the current situations, regarding Network and SubNetwork modelling.

Alignment work is needed.

Concept	IRP Framework	M.3100 [4]	TMF
Collection of nodes and links	SubNetwork	Network	SID Network
Collection of links	-- does not have equivalence ---	SubNetwork	SID SubNetwork

It is suggest that

a) 3GPP keep IRP Framework SubNetwork as is (that it is equivalent to Network of [4].) Identify SID Network attributes for harmonization purpose.

b) 3GPP investigate to introduce a new SubNetwork2 with semantics as "a collection of links". In this scenario, the Link IOC will be name-contained by SubNetwork2, which is in turn name-contained by SubNetwork.

5.1.3.2 IOC `ManagedElement`

The following table captures the current situations, regarding ManagedElement and similar classes of M.3100 and TMF.

Alignment work is needed.

Concept	IRP Framework	M.3100 [4]	TMF
Collection of managed resources.	ManagedElement	ManagedElement	SID/MTOSI ManagedElement

The definitions of the terms used by the three organizations are similar (e.g. IRP Framework meaning is that the collection is within a physical entity while SID/MTOSI's is a collection of "co-located physical resources managed as a single entity".

The yellow-marked attributes are present in SID/MTOSI ManagedElement. It is suggested adding the yellow-marked attributes with bold font to achieve alignment with that of MTOSI. Whether the addition should be done using inheritance (needing a new name) or just add the attributes keeping the name unchanged, is for further study.

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managedElementId	M	M	-
dnPrefix	M	M	-
managedElementType	M	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedBy	M	M	-
location			
softwareVersion			
productName	O	M	--
communicationState	Note 1		
supportedConnectionLayerRateList	Note 1		
isInSyncState	Note 1		
manufacturer			
manufactureDate	O	M	--
asapRef	Note 2		
ituArcStateAndStatusList	Note 2		
source, resourceState, networkAccessDomain, ituStateAndStatusList			
name, discoveredName, namingOsRef, nativeEmsName, aliasNameList, userLabel, owner, additionalInfo			

Note 1: Need clarification; MTOSI description on this attribute can be ambiguous.

Note 2: TBD, waiting for conclusion of Harmonization work on Fault Management.

5.1.3.3 IOC ManagedFunction

It is an abstract class for subclassing purpose. It has one userLabel attribute only.

SID ManagedEntity is a candidate for harmonization.

Concept	IRP Framework	M.3100 [4]	TMF
	ManagedFunction	-- does not have equivalence ---	SID ManagedEntity

5.1.3.4 IOC ManagementNode

This IOC represents an EM (that manages a number of MEs).

Alignment work is needed.

Concept	IRP Framework	M.3100 [4]	TMF
Represents an EM that manages a number of MEs.	ManagementNode	-- does not have equivalence --	SID ManagementDomain

The yellow-marked attributes are present in SID ManagementDomain. It is suggested adding the yellow-marked attributes with bold font to achieve alignment with that of SID ManagementDomain. Whether the addition should be done using inheritance (needing a new name) or just add the attributes keeping the name unchanged, is for further study.

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
managementNodeId	M	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedElements	M	M	-
name			
discoveredName			
namingOsRef			
nativeEmsName			
aliasNameList			
userLabel			
owner	O	M	-
additionalInfo	O	M	-

5.1.3.5 IOC Top

It represents the superior IOC and all other IOCs are its subordinate in terms of inheritance relations. It is supposed to capture behaviour that all IOCs must have. However, no such behaviour, which can be verifiable via the Itf-N, can be found (since Release 4).

It is suggest to investigate the removal of the two attributes of this IOC but keeping the IOC (empty IOC).

5.1.4 Concern regarding recent changes in TMF SID

So far the TMF SID is understood by the industry as an industry-wide acceptable and usable abstract model that could serve as an "umbrella" model, which can unify many disparate models defined elsewhere. Recent changes within the TMF SID indicate that the TMF seem to have changed its strategy with respect to the SID, as driving the SID towards a mixed abstract/concrete "TMF Super-model" (e.g. SID V9 containing now the previous TMF MTNM/MTOSI models, instead of creating as separate MTNM/MTOSI model which enables alignment with SID definitions via inheritance). Such changes had various impacts on the initial purpose of the TMF SID, and potentially limiting the possibility of other standards and industry organizations to rely on the TMF SID as an "umbrella" model (given that such an "umbrella" model has to be very stable, and independent of continuous changes driven by frequent additions and adjustments).

It is suggested that (a) 3GPP should discuss whether it actually could rely on the current version of the SID as an "umbrella" model for model alignment, and (b) the TMF should be made of aware of the implications of these changes to their SID strategy, and be asked to consider reversing this strategy with respect to the SID (so the SID could serve its initial purpose for the industry).

5.2 Inventory alignment suggestions

Inventory management maintain the information of static or semi-static data items. Current 3GPP inventory model is mainly specified for hardware inventory. Hardware is clearly a data item for inventory and has been the only inventory item in the past. TMF specifications contain also some aspects of software inventory. Software is an example of semi-static data items that do not need to be changed frequently but is changing during the time when software upgrades are made. Thus software is not counted as configuration data similar to e.g. radio network attributes where changes are implemented frequently. Software is part in inventory. License information is comparable to software.

Target for the alignment is to have a model that captures the inventory items and related attributes. Inventory items are technology independent thus update could be done to either 3GPP or TMF specifications. The alignment in this TR propose changes to 3GPP inventory NRM since 3GPP defines the inventory information model as a dedicated NRM IRP clearly separated from interface IRPs and technology specific information models.

6 Recommendations for 3GPP and TMF Resource Model Alignment

6.1 Inventory recommendations

6.1.1 General

This chapter identified the recommended changes based on comparison in chapter 4.3 and alignment chapter 5. 3.

The recommendation is to update 3GPP inventory NRM to enable one specification capturing all necessary inventory items regardless of the technology. 3GPP IRP concept is also clearly separating the interface and resource model definitions, which is a key concept for enabling technology agnostic inventory management.

NGNM top 10 requirements [4] identifies inventory as one of the key functionalities. The content of the requirement is to have inventory information at inventory management system and changes in the inventory information should be available to related systems ("Notification of any change to a passive or active element or its configuration relevant to a business process must be possible" [4]).

6.1.2 Inventory model and information

Network element consists of one or several logical functionalities. The logical functionalities are realized by one or several HW units, related SW and controlling licences combinations. Current 3GPP inventory NRM captures already the NE level information in ManagedElement object. NE may contain one or several logical entities which may again contain either logical and/or physical entities. Current model enables only HW related split. To address this hierarchy of the logical and physical entities, the recommendation is to add following object

Editors Note: The M/O qualifiers used below are FFS.

- inventoryUnit NE representing and realizing logical and physical structure of the NE. InventoryUnit NE should contain following attributes:
    - id: vendor defined unique identifier of a logical or physical network element unit
    - customerIdentifier: Unique identification of a vendors' customer
    - productName: NE name classifying a vendor's product family or function
    - vendorName: Name of inventory unit vendor (or vendors may provide manufacturer name)
    - productType: Identifier of the platform, in case the product can be based on different HW/SW platforms (not used for logical NEs)
    - salesUniqueId (O): Unique identifier used by vendor (used e.g. for ordering a new unit)
    - operatorUniqueName (O): Unique NE identifier used by operator
    - siteId (O): NE site in customer network
    - additionalInformation (O): Supplementary information about NE inventory data (if any)

InventoryUnit NE consists of HW units, SW units and licenses (LIC) controlling the functionalities. The SW and LIC may be the same for several entities of same type within one InventoryUnit NE. Same applies to HW in case of shared resources. To address properly the HW, SW and license items, the recommendation is to add following objects

- InventoryUnit HW (hardware) containing following attributes for least replaceable units
    - serialNo: Serial number given from factory (empty value in case of NE as highest equipment holder)
    - hwType: Type of the HW unit e.g. equipment holder, carriage
    - hwName (O):Mnemonic of hw inventory unit family type (e.g. Fan, PSU) assigned by vendor.
    - hwVersion: Version / revision no. of current unit e.g. firmware version (empty value possible in case no versioning is available)
    - vendorName (O): Name of inventory unit vendor (or vendors may provide manufacturer name)
    - salesUniqueId (O): Unique identifier used by vendor (used e.g. for ordering a new unit)hwUnitLocation: Unique physical / logical location identifier within NE
    - model: Equipment configuration, e.g. standard hw unit or a variant that may contain additional disk capacity (empty value possible))

- hwCapability (O): Hardware capability e.g. capacity, size (empty value is possible)
- modificationDate (O): Date/time stamp of last change (e.g. repair action)
- additionalInformation (O): Supplementary information about HW inventory data (if any)
- manualDataEntry: Indicates whether unit is passive or active

- InventoryUnit SW (software) containing following attributes

  - id: Unique identifier of a SW unit
  - swName (O): SW release name used
  - swVersion: Version identifier of the SW unit
  - vendorName (O): Name of inventory unit vendor (or vendors may provide manufacturer name)
  - salesUniqueId (O): Unique identifier used by vendor (used e.g. for ordering a new unit)classification: Name of installed SW (e.g. SW release, SW build, SW patches), empty value possible
  - swStatus: Status of the SW unit (e.g. installed, archived)
  - installationTime (O): Date/time stamp of SW installation
  - additionalInformation (O): Supplementary information about SW inventory data (if any)

- InventoryUnit LIC (license) containing following attributes

  - id: Unique identifier of a license (e.g. name, code)
  - lictype (O): Describing type of current license (e.g. capacity, particular feature, no. of subscribers)
  - vendorName (O): Name of inventory unit vendor (or vendors may provide manufacturer name)
  - licActivationDate (O): Date/time stamp of license activation
  - Validity (O): License validity which may include one of the elements duration, end (expiration date) or forever
  - key (O): License activation key according to the used licensing system
  - licStatus (O): License status – applicable only for managed licenses (e.g. scheduled, valid, expired, invalid, capacity violated)
  - additionalInformation (O): Supplementary information about license inventory data (if any)
  - salesUniqueId: Unique identifier used by vendor (used e.g. for ordering a new unit)

In order to minimize the amount of data in inventory data file, the redundant information should be minimized. It is recommended that object shall contain relationships to other objects.

Element/domain management system is seen as part of network from network management perspective thus recommendation is to include EM/DM to inventory entities also.

Inventory data consist of information of the whole network managed by the operator. The information is related to network structure and entities (logical and physical entities), hardware components, software and licenses controlling the functionalities.

The inventory data amount may be huge. A large network consists of tens of thousands of network elements. Considering that network element hardware consist of racks, shelves, slots, cards and physical ports etc, the number of objects only for hardware inventory is enormous. Software items can also be seen/defined in a similar structured way than hardware, even if the SW structure is more vendor-specific than hardware. SW items consist of releases, builds, modules etc. Thus the number of SW inventory items is also large. An estimation of 100 inventory items per network element may lead to millions of inventory items per network.

SW inventory items are to be linked to some network elements and/or hardware thus we need to define the SW information for every NE/HW entity (vendor dependent). Though in several cases, the same type of network elements run the same SW. Or a license applies to several network elements. Thus repeating the SW information for every NE/HW entity leads to huge amount of redundant information. License information can be compared to SW information thus creating additional redundant information. The target should be to eliminate “waste”, redundant information, without loosing any information. SW and license inventory items should appear only as “independent” inventory items and hardware and network element inventory items should have a relationship to these SW and license inventory items. An estimation of save in “space” is a factor 10. Also the logical and physical structure on inventory network element can be separated from hardware inventory items.

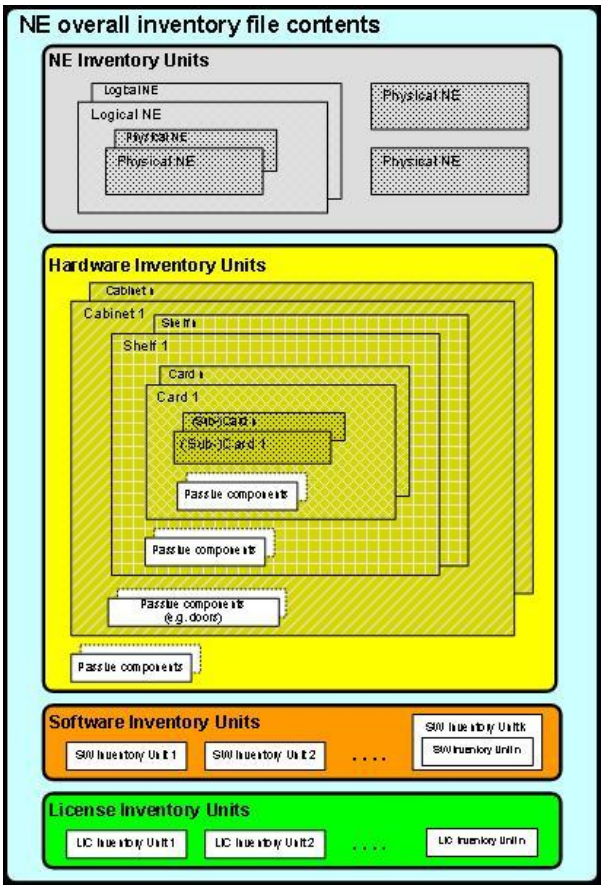


Figure 6.1.2.1: Inventory unit structure and some visualization of the nested structure

The example shown below shows how relationships between the different Inventory items could be defined (using an XML structure).

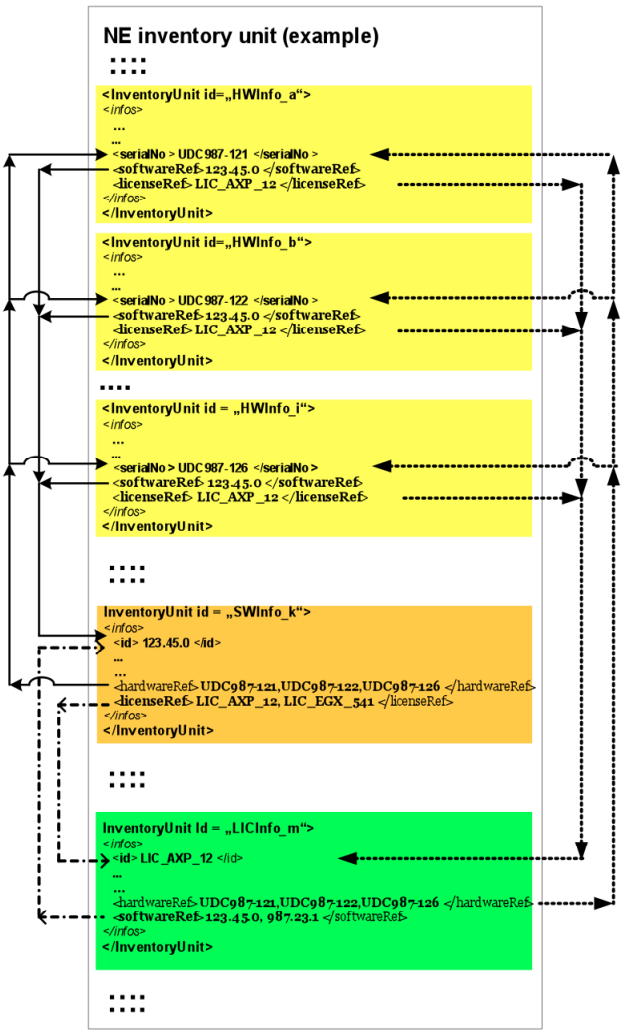


Figure 6.1.2.2: Relationships between the different Inventory items (example)

The figure below shows another example for NE inventory file.

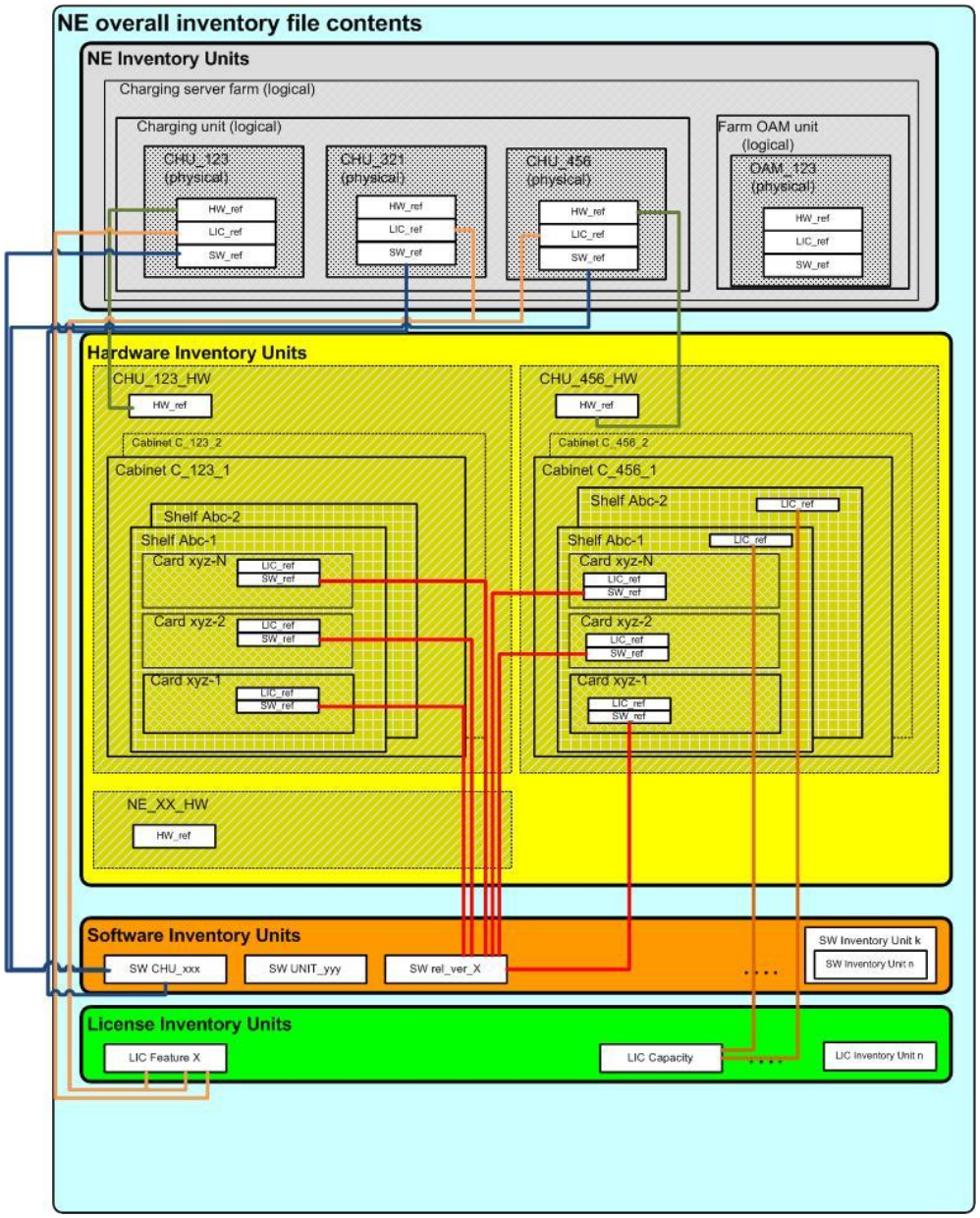


Figure 6.1.2.3: Relationships between the different Inventory items (example 2)

The structure above would enable inventory data collection per network element resulting to an output file per network element. The final definition of network element inventory unit logical and other inventory units are defined at contract phase depending on the operator needs.

6.1.3 Inventory interface enhancement

Currently two methods are defined in 3GPP for uploading inventory information:

- Explicitly via Bulk CM IRP / Inventory NRM IRP
- Implicitly via FT IRP / Inventory NRM IRP (with the notification capabilities of the FT IRP to inform an IRP Manager about the availability of changed inventory information)

It is proposed to establish the method “FT IRP / Inventory NRM IRP” as a viable alternative for transferring inventory information. Reason: The inventory information is either static or semi static meaning that the information does not

change (static) or changes very seldom (semi static). For this reason, inventory information does not need to be updated and transferred to network management system in real time nor as frequently as configuration management information. Depending on the case the update may happen e.g. once per day or once per week or per need basis. The inventory data could be stored per network element in an inventory file. The files would be available for upload per request or per schedule using existing File Transfer IRP [3] capabilities, which already allows for inventory data transfer – though a File Format Definition will have to be defined based on the enhanced inventory information outlined in this study. File Transfer IRP contains also the notification mechanism (notifyFileReady).

6.1.4 Inventory object model

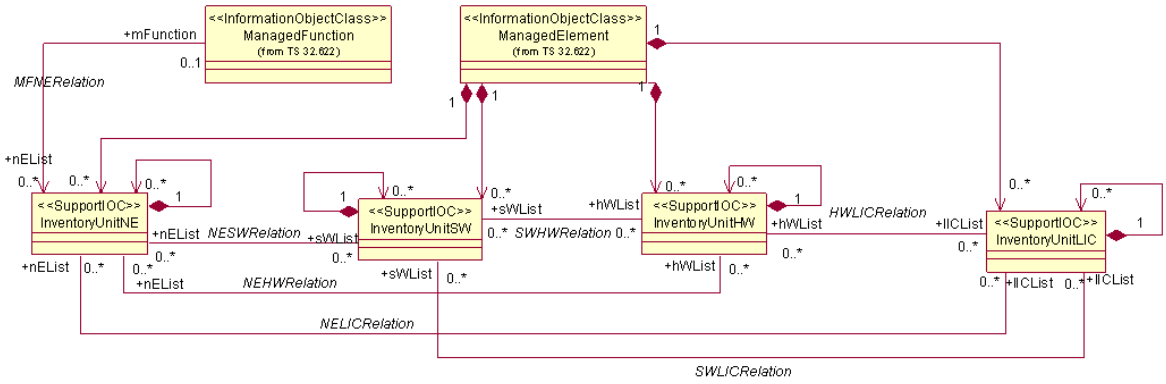


Figure 6.1.4.1: Inventory Model

InventoryUnitNE IOC definition

This IOC represents the logical and physical structure of the NE.

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
neId	M	M	-
customerIdentifier	O	M	-
productName	M	M	-
vendorName	M	M	-
productType	M	M	-
salesUniqueId	O	M	-
operatorUniqueName	O	M	-
siteId	O	M	-
additionalInformation	O	M	-

InventoryUnitHw IOC definition

This IOC represents the hardware components.

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
serialNo	M	M	-
hwType	M	M	-
hwName	O	M	-
hwVersion	M	M	-
vendorName	O	M	-
salesUniqueId	O	M	-
hwUnitLocation	M	M	-
model	M	M	-
hwCapability	O	M	-
modificationDate	O	M	-
additionalInformation	O	M	-
manualDataEntry	M	M	-

InventoryUnitSw IOC definition

This IOC represents the software components.

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
swId	M	M	-
swName	O	M	-
swVersion	O	M	-
vendorName	O	M	-
salesUniqueId	O	M	-
classification	M	M	-
swStatus	O	M	-
installationTime	O	M	-
additionalInformation	O	M	-

InventoryUnitLic IOC definition

This IOC represents the licence components.

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
licId	M	M	-
licType	O	M	-
vendorName	O	M	-
licActivationDate	O	M	-
validity	O	M	-
key	O	M	-
licStatus	O	M	-
salesUniqueId	O	M	-
additionalInformation	O	M	-

Information attribute definitions Attribute Name	Definition	Information Type / Legal Values
additionalInformation	Supplementary information about inventory data (if any)	
classification	Name of installed SW (e.g. SW release, SW build, SW patches), empty value possible	
customerIdentifier	Unique identification of a vendors' customer	
hwCapability	Hardware capability e.g. capacity, size (empty value is possible)	
hwName	Mnemonic of hw inventory unit family type (e.g. Fan, PSU) assigned by vendor.	
hwType	Type of the HW unit e.g. equipment holder, carriage	
hwUnitLocation	Unique physical / logical location identifier within NE	
hwVersion	Version / revision no. of current unit e.g. firmware version (empty value possible in case no versioning is available)	
id	An attribute whose 'name+value' can be used as an RDN when naming an instance of this object class. This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	
installationTime	Date/time stamp of SW installation	
key	License activation key according to the used licensing system	
licActivationDate	Date/time stamp of license activation	
licId	Unique identifier of a license (e.g. name, code)	
licStatus	License status – applicable only for managed licenses (e.g. scheduled, valid, expired, invalid, capacity violated)	
licType	Describing type of current license (e.g. capacity, particular feature, no. of subscribers)	
manualDataEntry	Indicates whether unit is passive (manual insertion of inventory data is needed) or active (inventory data can be read from the unit)	
model	Equipment configuration, e.g. standard hw unit or a variant that may contain additional disk capacity (empty value possible)	
modificationDate	Date/time stamp of last change (e.g. repair action)	
neId	vendor defined unique identifier of a logical or physical network element unit	
operatorUniqueName	Unique NE identifier used by	

Information attribute definitions Attribute Name	Definition	Information Type / Legal Values
	operator	
productName	NE name classifying a vendor's product family or function	
productType	Identifier of the e.g. platform, in case the product can be based on different HW/SW platforms (not used for logical NEs)	
salesUniqueId	Unique identifier used by vendor (used e.g. for ordering a new unit)	
serialNo	Serial number given from factory.	
siteId	NE site in customer network	
swId	Unique identifier of a SW unit	
swName	SW release name used	
swStatus	Status of the SW unit (e.g. installed, archived)	
swVersion	Version identifier of the SW unit	
validity	License validity which may include one of the elements duration, end (expiration date) or forever	
vendorName	Name of inventory unit vendor (or vendors may provide manufacturer name)	

6.2 Solution Set recommendations

The Model alignment should be able to reuse the existing standard implementation as much as possible. The federated network model approach could maximum reuse the existing defined mobile and fixed model implementation.

The FMC model alignment should focus on the common model harmonization and reuse the technology specific model as much as possible.

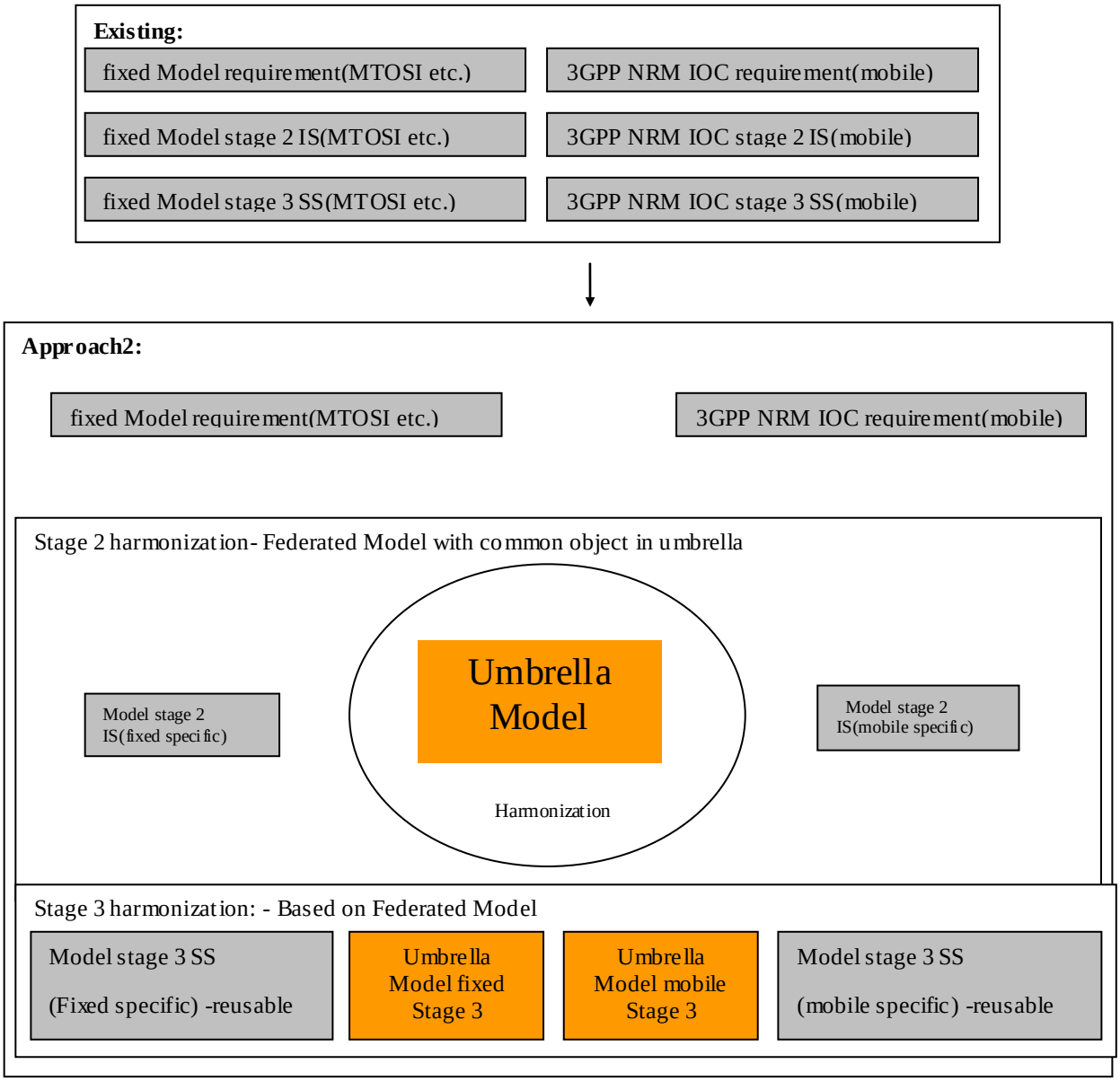


Figure 6.2.1:

The following diagram shows how the umbrella model is built with the harmonization joint work based on the existing models :

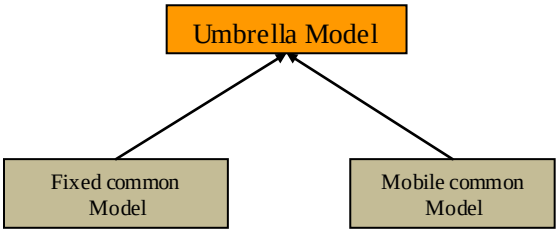


Figure 6.2.2:

6.3 Federated Network Model (FNM)

6.3.1 Characteristics of FMC NW model

The network (resource) model for use in FMC network management environment is "large scale" in the following sense:

- Not one authority (e.g. SDO) can be responsible for the development, maintenance and evolution of the whole model. Different organizations are responsible for the development, maintenance and evolution of their own domain specific model
- Operators may use the whole FMC model or part of the FMC model depending on their own business cases.
- Vendors can supply products using part of the FMC model depending on their own business cases.
- The model needs to hold thousands of inter-related modelled entities. Different versions of modelled entities can co-exist in the model.

6.3.2 Features of FNM

This section describes FNM features that are essential for the maintenance of the integrity of a large and scalable FMC NW model.

6.3.2.1 Fragments

The FMC NW model is partitioned into fragments. Clear rules defined for inter-relationship of fragments. The rules should be simple and stable (not changing frequently).

Use of fragments and adherence of the simple fragment inter-relationship described above has the following advantages.

- It removes the need to keep the evolution of various fragments in synchrony (see more on 5.6). For example, it is a valid model implementation where one fragment has evolved (requiring new solution) while other fragment remained unchanged (does not require new solution).
- Domain experts (e.g. LTE experts) can focus his design on its fragments and (can, if wanted to) be ignorant of contents of other fragments (e.g., mobile backhaul networks experts).

6.3.2.2 Ability to reference classes of 'external' models

A fragment can make use of a specialised class called ExternalIOC. Use of ExternalIOC is to support a uni-directional relation from one instance to another instance where the former is of class ExternalIOC and the latter is one mirrored (or referred to) by the former. The former and latter may be managed by different Domain Manager (i.e. DM or Agent).

The ExternalIOC supports an indication if the class definitions of the two related instances are from the same or different standard organizations.

This feature is essential if different organizations are responsible for the class definitions of the related instances.

Note that the use of "Externals" is a "field-proven" concept that was first developed and used by ITU-T [15] for telecommunication network management for similar purpose.

6.3.2.3 Ability to import models designed elsewhere

Use of this feature, in one fragment say fragment-A, is for fragment-A to include model elements (e.g. classes) defined in another fragment, say fragment-B.

This feature can also be used, say by fragment-A, to include model elements (e.g. classes for transport managed resources, classes of TMF defined abstract classes) designed by other organizations (e.g. TMF, BBF, etc)

This feature is essentially a copy and paste procedure with a clear indication of the 'source' or design authority of the imported model elements.

Note that the concept of Import is well known in software and modelling design work.

6.3.2.4 Independence of tool and platform

Use of FNM does not require nor mandate the use of a specific tool. Tool and model are evolving at their own paces and decoupling them allows standard authors to choose the best tool for the job (e.g., validation model design, generation of solution).

Decoupling model design from specific deployment platform is a necessary condition since it is unrealistic to assume a particular deployment platform for all products in compliance to FMC NM standards.

6.3.2.5 Independence of solution technology and access protocol design

It does not imply nor mandate the use of a specific machine-readable language to express the designed model elements, e.g. XSD, CORBA IDL, GDMO, etc.

It does not imply nor mandate the use of a specific access protocol (e.g. to manipulate or query the parameter values of a class instance). It ensures no dependency can exist between model design and access protocol design.

6.3.2.6 Experience

The FNM concept has been used successfully, albeit in a much smaller scale than FMC NW model, in the following cases.

- 3GPP2 develop/maintain/evolve the fragment(s) related to CDMA 2000 technologies while 3GPP does similar work related to GSM/UTRAN/EUTRAN technologies plus the GENERIC NRM IRP fragment). Vendors can implement standard network management solutions for these technologies and operators' IRPManagers (a 3GPP IRP Framework conceptual object) can use these solutions in a unified way.

- BBF/Home develop/maintain/evolve the H(e)NB network resource models. Relevant IRP Framework fragments makes references to those H(e)NB network resource models allowing, for example, an IRPManager to download configuration files to, upload PM counters from and receive alarm notifications from H(e)NBs. Vendors can implement standard network management solutions for these technologies and operators' IRPManagers can use these solutions in a unified way.

6.3.2.7 SDO's fragments Release handling

The 3GPP specification Release cycles are well understood and maintained. For example, the Release 10 management solutions are expected to manage Release 10 features defined by RAN/CT groups. There is a time gap between confirmation of a new feature and the availability of network management solutions. This gap will be larger and may not be predictable if alternate approach (or methodology), such as one using an external organization to maintain a repository of fragments, is used.

6.3 Elements of the FNM

This section describes the two key elements of FNM in terms of fragment relations (6.1) and production of model definitions specifications (6.2).

FNM is a Federation of Models for the purpose of End-to-End Management, consisting of an Umbrella Model and a series of Domain/Technology-specific Concrete Models.

The **Umbrella Model** provides abstract definitions applicable across Domain/Technology-specific Concrete Models to enable end-to-end consistency of such definitions (it is described as 'abstract' in the sense that its components are inherited by Domain/Technology-specific Concrete Models, and that it is not designed for the purpose of partial or full instantiation of its components and therefore not sufficient to provide meaningful network management service). Domain/Technology-specific **Concrete Models** are described as 'concrete models' in the sense that their instantiation is necessary to provide meaningful management services. These Domain/Technology-specific Concrete Models inheriting common definitions from the Umbrella Model for the purpose of end-to-end consistency of management information

semantics. In addition, these Domain/Technology-specific Concrete Models have defined relationships between each other to enable end-to-end monitoring and management of a converged network.

6.3.1 Relations between fragments and Umbrella

This section is a graphical representation of the FNM in terms of relation between fragments and the Umbrella.

There are two areas under study currently:

- The definitions of the classes inside the Umbrella.
- The definitions of relation (R0) used between various classes in fragments and the Umbrella classes.

We aim to have identical R0 for use by all fragments. The relation is not symmetrical in that the Umbrella classes need not have knowledge of its usage by fragment classes. This would guarantee a form of consistency (e.g. resource management style, paradigm) for managing mobile managed resources, as well as other managed resources such as transport managed resources.

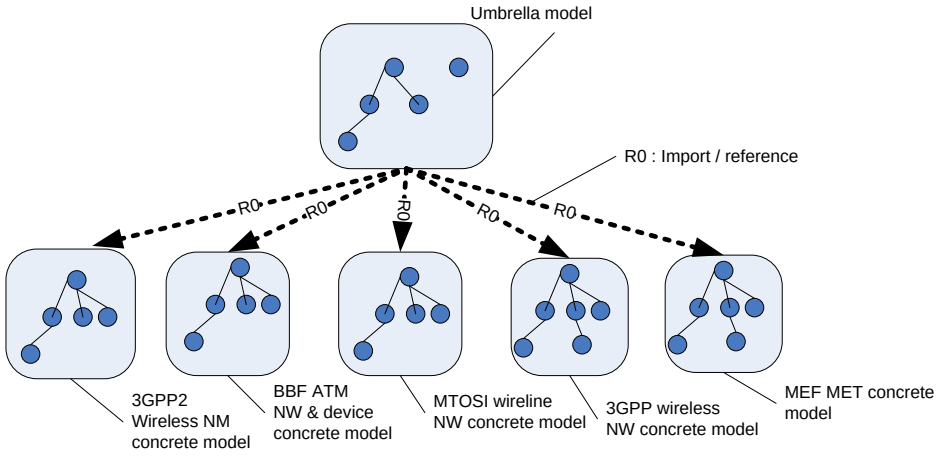


Figure 6.3.1.1: Relation between fragments and Umbrella

Take the example of "3GPP wireless nw classes" and the Umbrella, 3GPP fragments (e.g. TS 32.622 [19]) would Import relevant Umbrella classes and make derivatives for its use. R0 in this case is an inheritance relation. There are other forms of relations that would be defined.

6.3.2 Relations among pairs of fragments

This section is a graphical representation of the FNM in terms of bilateral relation between each pair of fragments.

The relation between pairs of fragments may not be same. Each relation may or may not be symmetrical. Umbrella would not be involved in such pair-wise relations.

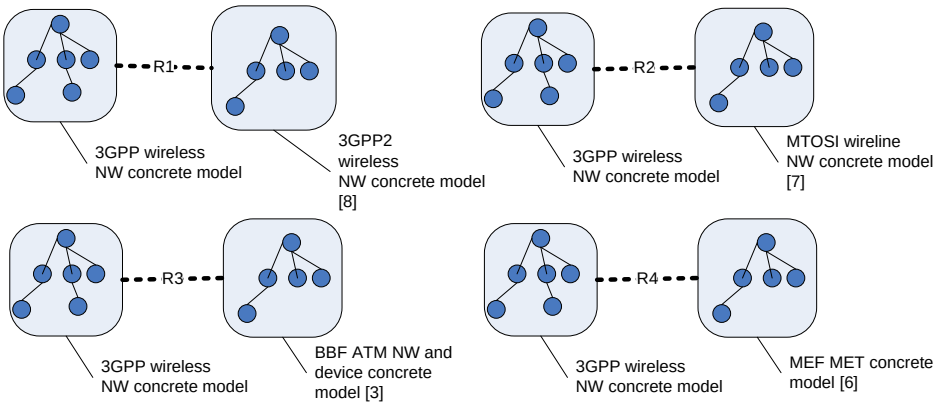


Figure 6.3.2.1: Relation between pairs of fragments

Take the example of relation between 3GPP fragment and BBF ATM fragments (i.e. R3). 3GPP fragments would create necessary 3GPP defined ExternalIOC representing one of the classes of "BBF ATM nw and device classes". The purpose of this type of relation (used extensively in 3GPP IRP framework for the purpose of navigation from one managed domain to another).

6.3.3 Production of solutions re FNM

This section is a graphical representation of the FNM in relation to tools that generate machine-readable model forms in various languages such as XSD, CORBA IDL, GDMO, etc.

In the context of this document, The "Solution specifications" refers to only the model part (e.g. encoding of the managed resource modelled constructs over the wire). Examples of such are the various 3GPP NRM IRP SSs. They do not refer to the Interface specifications such as the 3GPP Interface IRP SSs. This document does not deal with the question if the Tool generates the Interface specifications. No single physical Repository is required to hold FNM.

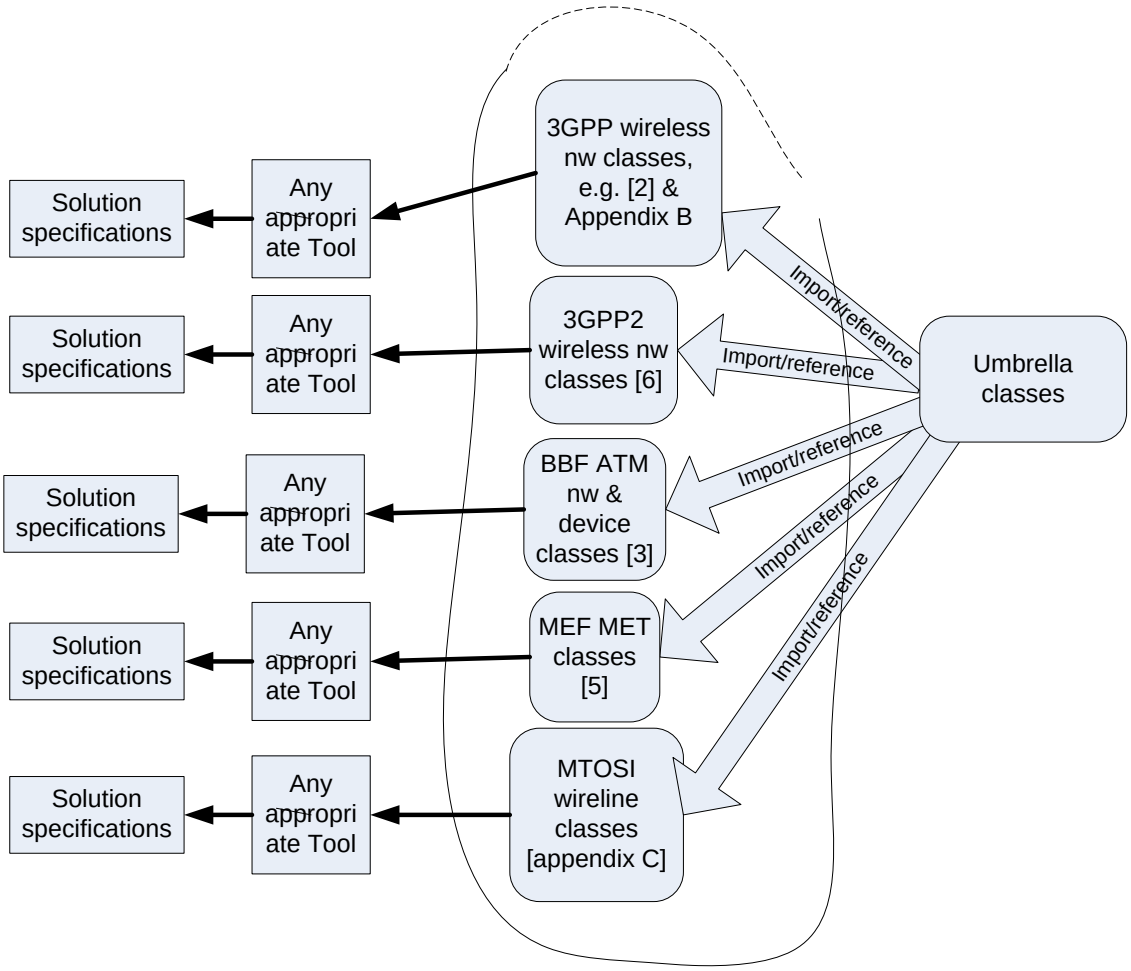


Figure 6.3.3.1: (Model) Solution production for the FNM

6.4 Federated Network Model (FNM) Umbrella

These Umbrella classes (i.e. logical UML classes) are protocol independent in that they only capture the semantics of the NM information. They do not relate to a) syntax or representation of the NM information in a system or on-the-wire between systems and b) the protocol used to create/delete/read/write/modify the NM information.

Various SDOs[1] and organizations[2] will use the Umbrella classes for their creations of domain specific concrete classes to define their respective NM services. This procedure would ensure the domain specific concrete classes (from various SDOs) would be semantically consistent, a necessary characteristics for FMC NM purposes.

Currently, 3GPP SA5 defines its abstract classes in its Generic NRM IRP [5] and defines concrete classes in other NRM IRPs such as EUTRAN NRM IRP. 3GPP/SA5 have agreement and will consider changes in classes in its Generic NRM IRP such that they are harmonized (if not identical) to those (to-be-defined) as Umbrella classes.

Umbrella classes are partitioned. Classes in "Partition operational" are used to capture run-time behaviour of managed resources. Classes in "Partition inventory" are used to capture static behaviour of managed resources.

---

[1] 3GPP is one example. Its UTRAN NRM IRP IOCs are examples of the concrete classes involved.

[2] TMF is one example. Its MTOSI classes are examples of the concrete classes involved.

6.4.1 Partition operational

6.4.1.1 Class diagram

This section proposes the following Umbrella classes. These classes supports configuration management (CM).

The criteria for choosing these classes is their relevance to (e.g. can be used by) Domain Specific model classes (e.g. 3GPP/SA 5 network resource model, BBF ATM network management model [1]).

Note that this set is the most basic classes. They are all *abstract*. Other classes are for further study.

- `SubNetwork_` (similar to `SubNetwork` of 3GPP and SID/MTOSI)
- `ManagedElement_` (similar to `ManagedElement` of 3GPP and SID/MTOSI)
- `ManagedFunction_` (similar to `ManagedFunction` of 3GPP)
- `ManagementNode_` (similar to `ManagementNode of 3GPP, ManagedDomain` of SID/MTOSI)
- `Link_` (`Link` of 3GPP)

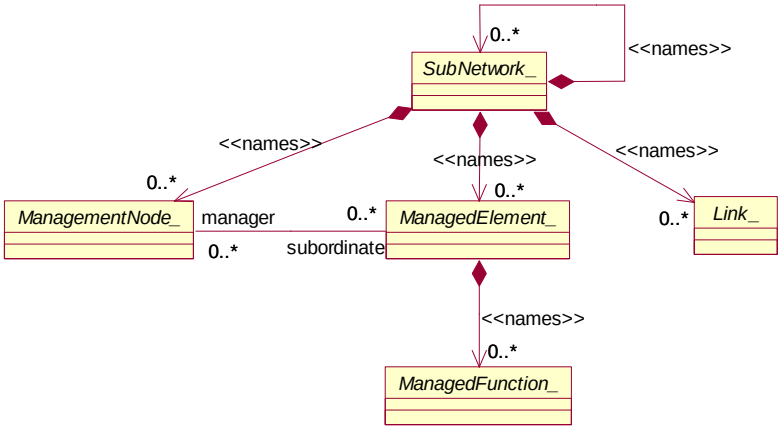


Figure 6.4.1.1.1: UML classes

Editor Notes:

- UML classes above is not sufficient for FNM NM purposes. Their class names may not be appropriate.
- These Umbrella classes are for inheritance only.
- Other Umbrella classes may be used for relation other than inheritance.

6.4.1.2 Class definition

Note: Attributes that are coloured RED are extracted from SID/MTOSI specifications; attributes of no colour are from 3GPP Generic NRM IRP [1]. The tracked changes show the difference between proposal for Umbrella classes and in [1]. Attributes that are coloured YELLOW are proposed for removal from Umbrella classes since they are more "inventory" related.

6.4.1.2.1 `SubNetwork_`

4.1.2.1.1 Definition

This represents a set of managed entities.

6.4.1.2.1.2 Attributes

Attributes of SubNetwork

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
Id	M	M	-
dnPrefix	M	M	-
userLabel	M	M	M
userDefinedNetworkType	M	M	-
setOfMcc	O	M	-

6.4.1.2.2 ManagedElement_

6.4.1.2.2.1 Definition

This represents telecommunications equipment within the telecommunications network that performs Managed Element (ME) functions, e.g., provides support and/or service to the subscriber.

An ME communicates with a manager (directly or indirectly) for the purpose of being monitored and/or controlled. MEs may or may not additionally perform element management functionality.

An ME contains equipment that may or may not be geographically distributed. An ME is often referred to as a "Network Element".

6.4.1.2.2.2 Attributes

Attributes of ManagedElement

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
dnPrefix	M	M	-
managedElementType	O	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedBy	M	M	-
productName	O	M	-
manufactureDate	O	M	-

6.4.1.2.3 ManagedFunction_

6.4.1.2.3.1 Definition

This is provided for sub-classing only. Note that a ManagedElement may contain several managed functions.

4.1.2.3.2 Attributes

Attributes of ManagedFunction

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
userLabel	M	M	M

6.4.1.2.4 ManagementNode_

6.4.1.2.4.1 Definition

This represents a telecommunications management system (EM) that contains functionality for managing a number of ManagedElements (MEs). The management system communicates with the MEs directly or indirectly over one or more interfaces for the purpose of monitoring and/or controlling these MEs.

This class has similar characteristics as the ManagedElement. The main difference between these two classes is that the ManagementNode has a special association to the managed elements that it is responsible for managing.

6.4.1.2.4.2 Attributes

Attributes of ManagementNode

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
Id	M	M	-
userLabel	M	M	M
vendorName	M	M	-
userDefinedState	M	M	M
locationName	M	M	-
swVersion	M	M	-
managedElements	M	M	-
owner	O	M	-
additionalInfo	O	M	-

6.4.1.2.5 Link_

6.4.1.2.5.1 Definition

This represents a communication link between two network entities. This does not indicate whether the represented communication link is a physical or logical entity.

This is defined for sub-classing purposes.

6.4.1.2.5.2 Attributes

Attributes of `Link`

Attribute Name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
userLabel	M	M	M
aEnd	M	M	-
zEnd	M	M	-
linkType	O	M	-
protocolName	O	M	-
protocolVersion	O	M	-

6.4.2 Partition inventory

TBD

6.4.3 Class attribute definitions

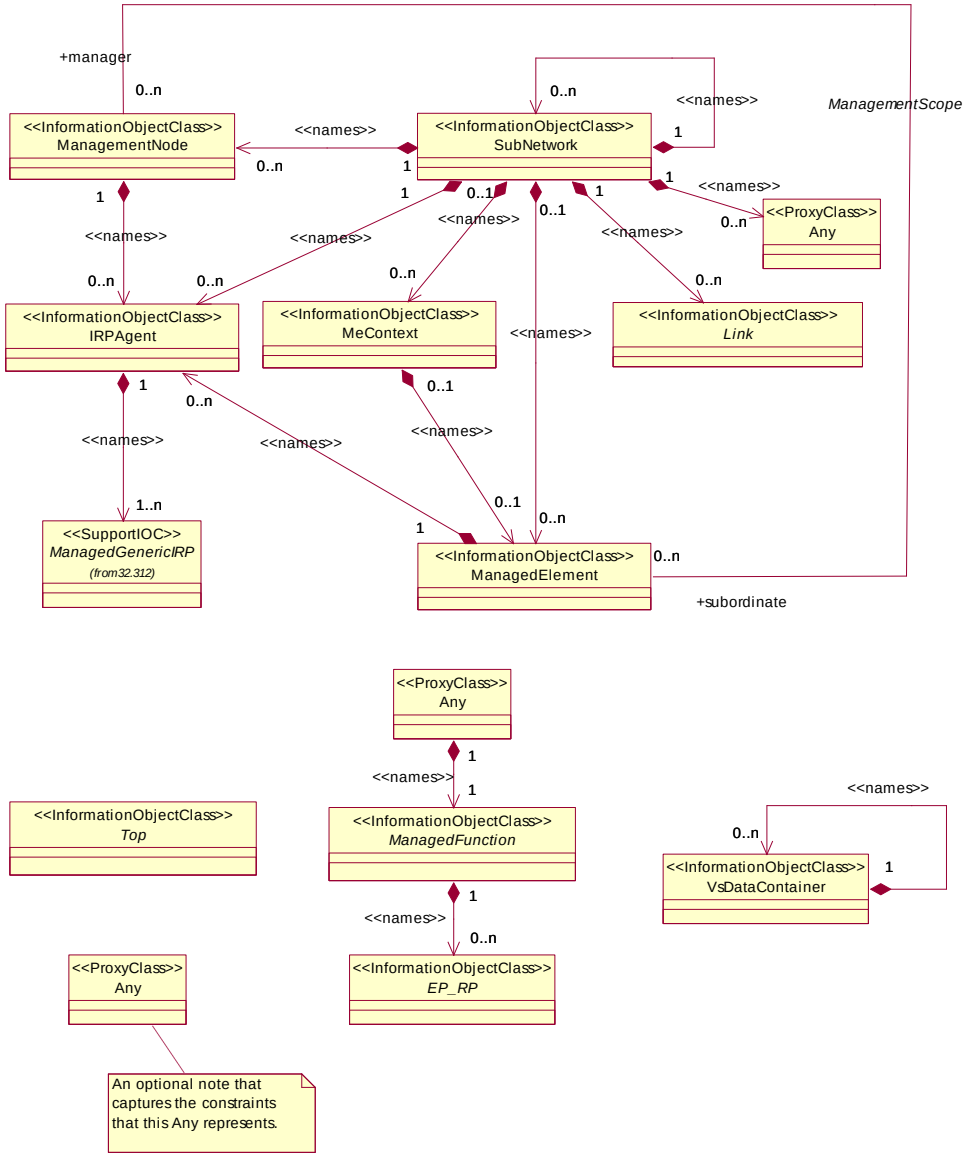
6.4.3.1 Definitions and legal values

Attribute Name	Definition	Legal Values
additionalInfo	This is a vendor specific attribute that contains additional specific information about the object.	
aEnd	The value of this attribute shall be the Distinguished Name of the alphabetically first instance in the Link subclass name to which this link/relation is associated (i.e., pointing to the instance of <X> as described in the definition of Link IOC in the present document). As an example, with Link_As_Slf, aEnd would contain the Distinguished Name of the AsFunction instance, and the zEnd would contain the Distinguished Name of SlfFunction instance.	Values to be conformant with TS 32.300 [3]
dnPrefix	It carries the DN Prefix information as defined in Annex C of 32.300 [22] or no information.	
id	An attribute whose class name and value can be used as an RDN when naming an instance of the object class. This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	Values to be conformant with TS 32.300 [22]
managedElementType	The type of managed element. It is a multi-valued attribute with one or more unique elements. Thus, it may represent one ME functionality or a combination of more than one functionality. The actual syntax and encoding of this attribute is Solution Set specific.	The legal values of this attribute are the names of the IOC(s) that are (a) derived/subclassed from ManagedFunction and (b) directly name-contained by ManagedElement IOC (on the first level below ManagedElement), but with the string “Function” excluded. If a ManagedElement contains multiple instances of a ManagedFunction this attribute will not contain repeated values. The capitalisation (usage of upper/lower case) of characters in this attribute is insignificant. Thus, the IRPManager should be case insensitive when reading these values. Two examples of legal values are: • NodeB; • HLR,VLR.
linkType	This attribute defines the type of the link.	Signalling, Bearer, OAM&P, Other or multiple combinations of the above types.
locationName	The physical location of this entity (e.g. an address).	

Attribute Name	Definition	Legal Values
managedElements	Models the role Manager. This attribute contains a list of the DN(s) of the related ManagedElement instance(s).	
managedBy	Models the role subordinate. This attribute contains a list of the DN(s) of the related ManagementNode instance(s).	
manufactureDate	This attribute identifies the production date of the Managed Element in the format of YYYYMMDD where YYYY = the 4-digit year of manufacture, MM is the 2-digit month, and DD is the 2-digit date.	
Owner	This attribute represents an identifier for the owner of the object.	
productName	This attribute identifies the Managed Element vendor's name/designation.	
protocolName	Name(s) and additional descriptive information for the protocol(s) used for the associated communication link. Syntax and semantic is not specified.	
protocolVersion	Versions(s) and additional descriptive information for the protocol(s) used for the associated communication link. Syntax and semantic is not specified.	
swVersion	The software version of the ManagementNode or ManagedElement. This is used for determining which version of the vendor specific information is valid for the ManagementNode or ManagedElement.	
userDefinedNetworkType	Textual information regarding the type of network, e.g. UTRAN.	
userDefinedState	An operator defined state for operator specific usage.	
userLabel	A user-friendly (and user assignable) name of this object.	
vendorName	The name of the vendor.	
zEnd	The value of this attribute shall be the Distinguished Name of the alphabetically second instance in the Link subclass name to which this link/relation is associated (i.e., pointing to the instance of <Y> as described in the definition of Link IOC in the present document). As an example, with Link_As_Slf, aEnd would contain the Distinguished Name of the AsFunction instance, and the zEnd would contain the Distinguished Name of SlfFunction instance.	Values to be conformant with TS 32.300 [22]

Annex A:
Name-Containment Class diagram from 3GPP TS 32.622

Here is a class diagram extracted from 3GPP TS 32.622 [13].


+manager
0..n
<<InformationObjectClass>>
ManagementNode
<<names>>
0..n
1
<<InformationObjectClass>>
SubNetwork
0..n
<<names>>
ManagementScope
1
<<names>>
<<ProxyClass>>
Any
0..n
<<names>>
<<names>>
<<names>>
<<names>>
<<InformationObjectClass>>
IRPAgent
<<InformationObjectClass>>
MeContext
<<InformationObjectClass>>
Link
<<names>>
<<names>>
<<names>>
<<SupportIOC>>
ManagedGenericIRP
(from32.312)
<<InformationObjectClass>>
ManagedElement
0..n
+subordinate
<<ProxyClass>>
Any
<<names>>
<<InformationObjectClass>>
Top
<<InformationObjectClass>>
ManagedFunction
<<names>>
<<names>>
<<InformationObjectClass>>
VsDataContainer
<<ProxyClass>>
Any
<<InformationObjectClass>>
EP_RP
An optional note that
captures the constraints
that this Any represents.

Annex B:
Containment Diagram from M4 Network View CMIP MIB Specification

Here is the Containment Diagram from [11].

Containment Diagram

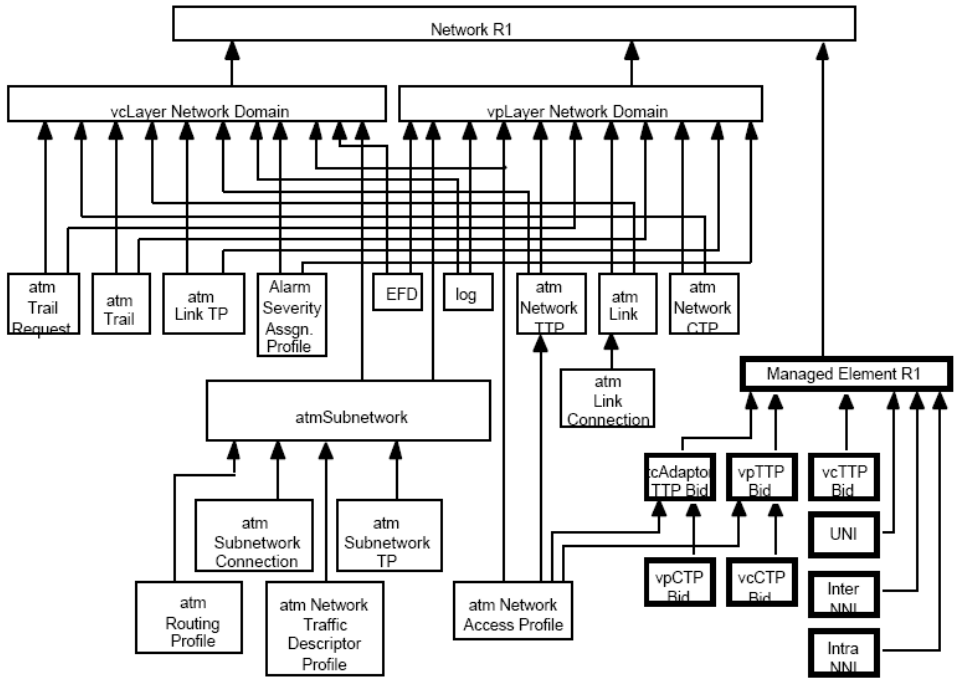


Figure 1 Containment Diagram

The objects in bold boxes on the Naming Diagram above indicate objects that are defined in the M4 NE view. These objects may be included in an implementation where they are referenced from the defined M4 Network View objects described in this document, and where both the M4 NE View and the M4 Network View are supported. Implementation of both the M4 NE View and M4 Network View together represents a specific design choice. Also, implementations that provide a "stand alone" network view (no references to M4 NE

Annex C:
Needed Inventory NRM IS changes

NOTE: the text in the present clause defines the needed changes in TS 32.692 (V9.0.0) which implements the inventory model recommendations in chapter 6.1 of this TR. Thus this annex contains both text from TS 32.692 V9.0.0 in chapter 6 and the updates based on recommendations i.e. alternate inventory model and related object, relation and attribute definitions. Additions are underlined.

6 Information Object Classes

6.1 Imported information entities and local labels

Label reference	Local label
32.622 [10], information object class, Top	Top
32.622 [10], information object class, ManagedElement	ManagedElement

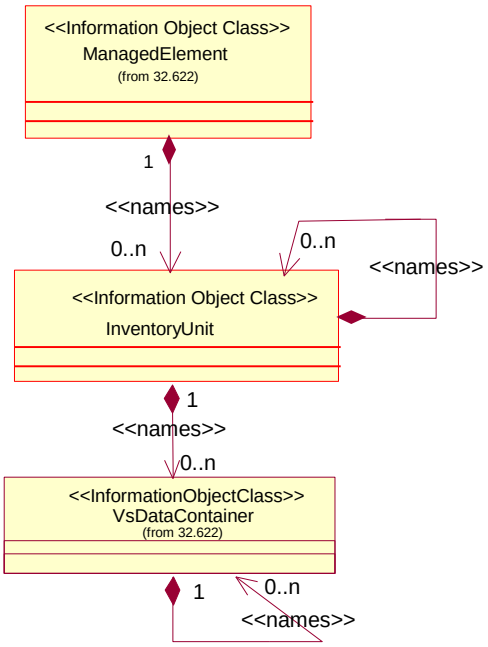
6.2 Class diagram

6.2.1 Attributes and relationships

This clause depicts the set of IOCs that encapsulate information relevant for this service. This clause provides the overview of all information object classes in UML. Subsequent clauses provide more detailed specification of various aspects of these information object classes.

The inventory NRM contains two alternatives for inventory data modeling. Alternative 1 is for NE structure and hardware inventory. Alternative 2 is an extended version for inventory information modeling consisting of NE structure, hardware, software and license data inventory.

Alternative 1, hardware inventory model



NOTE: The listed cardinality numbers represent transient as well as steady-state numbers, and reflect all managed object creation and deletion scenarios.

Figure 6.2.1: Alternative 1 - Inventory Management NRM Containment/Naming and Association diagram

Each IOC instance is identified with a Distinguished Name (DN) according to 3GPP TS 32.300 [7] that expresses its containment hierarchy. As an example, the DN of a IOC representing a InventoryUnit could have a format like:

`SubNetwork=Sweden,meContext=MEC-Gbg-1,ManagedElement=RNC-Gbg-1,InventoryUnit=Inv-1.`

Alternative 2, extended model for hardware, software and licence inventory

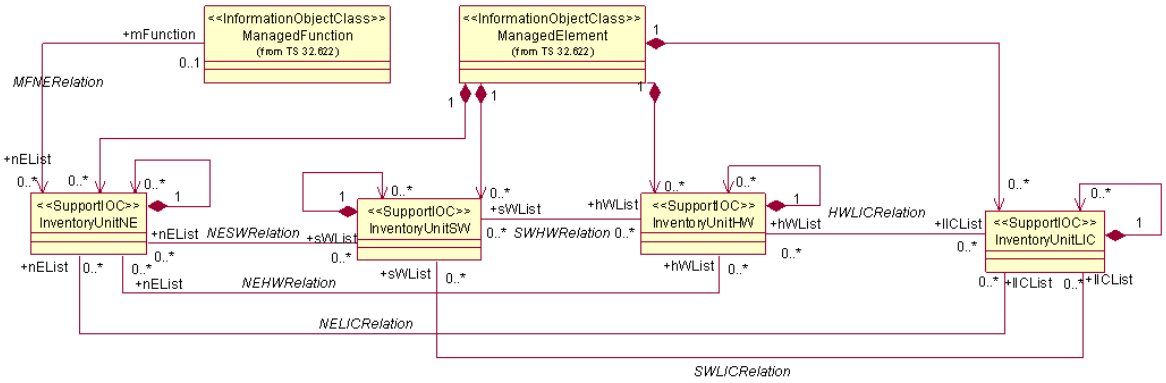


Figure 6.2.2: Alternative 2 - Inventory Management NRM Containment/Naming and Association diagram

NOTE: Inventory information upload in alternative 2 is done using the the FT IRP and related FT IRP notification capabilites

6.2.2 Inheritance

This subclause depicts the inheritance relationships that exist between IOCs.

Figure 6.2.2 shows the inheritance hierarchy for the IM NRM.

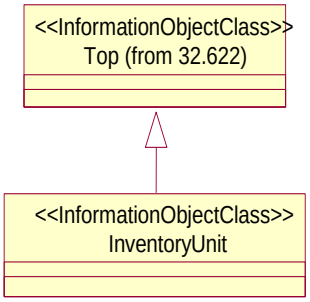


Figure 6.2.2: Inventory Management NRM Inheritance Hierarchy

6.3 Information object class definitions

6.3.1 InventoryUnit

6.3.1.1 Definition

This IOC represents inventory information for an Inventory Unit.

6.3.1.2 Attributes

Attributes of `InventoryUnit`

Attribute name	Visibility	Support Qualifier	Read Qualifier	Write Qualifier
inventoryUnitId	+	M	M	-
inventoryUnitType	+	M	M	-
vendorUnitFamilyType	+	O	M	-
vendorUnitTypeNumber	+	O	M	-
versionNumber	+	O	M	-
vendorName	+	M	M	-
serialNumber	+	O	M	-
dateOfManufacture	+	O	M	-
dateOfLastService	+	O	M	-
unitPosition	+	O	M	-
manufacturerData	+	O	M	-

6.3.1.3 Attribute constraints

Optional attributes vendorUnitFamilyType, vendorUnitTypeNumber and serialNumber shall be mandatory for hardware.

6.3.1.4 Relationships

None.

6.3.1.5 State diagram

None.

6.3.1.6 Notifications

None.

6.3.2 InventoryUnitNE

6.3.2.1 Definition

This SupportIOC represents the logical and physical structure of the NE.

6.3.2.2 Attributes

Attributes of `InventoryUnitNE`

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
neId	M	M	-
customerIdentifier	O	M	-
productName	M	M	-
vendorName	M	M	-
productType	M	M	-
salesUniqueId	O	M	-
operatorUniqueName	O	M	-
siteId	O	M	-
additionalInformation	O	M	-

6.3.2.3 Attribute constraints

None.

6.3.2.4 Relationships

None.

6.3.2.5 State diagram

None.

6.3.2.6 Notifications

None.

6.3.3 InventoryUnitHw

6.3.3.1 Definition

This SupportIOC represents the hardware components.

6.3.3.2 Attributes

Attributes of `InventoryUnitHw`

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
serialNo	M	M	-
hwType	M	M	-
hwName	O	M	-
hwVersion	M	M	-
vendorName	O	M	-
salesUniqueId	O	M	-
hwUnitLocation	M	M	-
model	M	M	-
hwCapability	O	M	-
modificationDate	O	M	-
manualDataEntry	M	M	-
additionalInformation	O	M	-

6.3.3.3 Attribute constraints

None.

6.3.3.4 Relationships

None.

6.3.3.5 State diagram

None.

6.3.3.6 Notifications

None.

6.3.4 InventoryUnitSw

6.3.4.1 Definition

This SupportIOC represents the software components.

6.3.4.2 Attributes

Attributes of `InventoryUnitSw`

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
swId	M	M	-
swName	O	M	-
swVersion	O	M	-
vendorName	O	M	-
salesUniqueId	O	M	-
classification	M	M	-
swStatus	O	M	-
installationTime	O	M	-
additionalInformation	O	M	-

6.3.4.3 Attribute constraints

None.

6.3.4.4 Relationships

None.

6.3.4.5 State diagram

None.

6.3.4.6 Notifications

None.

6.3.5 InventoryUnitLic

6.3.5.1 Definition

This SupportIOC represents the licence components.

6.3.5.2 Attributes

Attributes of `InventoryUnitLic`

Attribute name	Support Qualifier	Read Qualifier	Write Qualifier
id	M	M	-
licId	M	M	-
licType	O	M	-
vendorName	O	M	-
licActivationDate	O	M	-
validity	O	M	-
key	O	M	-
licStatus	O	M	-
salesUniqueId	O	M	-
additionalInformation	O	M	-

6.3.5.3 Attribute constraints

None.

6.3.5.4 Relationships

None.

6.3.5.5 State diagram

None.

6.3.5.6 Notifications

None.

6.4 Information relationship definitions

Not applicable.

6.4.1 MFNERelation (O)

6.4.1.1 Definition

This association represents the unidirectional relation between `ManagedFunction` and `InventoryUnitNE`.

6.4.1.2 Roles

Name	Definition
NEList	This role represents the associated InventoryUnitNE instances of a ManagedFunction instance.
MFunction	This role represents the associated ManagedFunction instances of a InventoryUnitNE instance.

6.4.1.3 Constraints

None.

6.4.2 NESWRelation (O)

6.4.2.1 Definition

This association represents the bidirectional relation between InventoryUnitNE and InventoryUnitSW.

6.4.2.2 Roles

Name	Definition
NEList	This role represents the associated InventoryUnitNE instances of a InventoryUnitSW instance.
SWList	This role represents the associated InventoryUnitSW instances of a InventoryUnitNE instance.

6.4.2.3 Constraints

None.

6.4.3 NEHWRelation (O)

6.4.3.1 Definition

This association represents the bidirectional relation between InventoryUnitNE and InventoryUnitHW.

6.4.3.2 Roles

Name	Definition
NEList	This role represents the associated InventoryUnitNE instances of a InventoryUnitHW instance.
HWList	This role represents the associated InventoryUnitHW instances of a InventoryUnitNE instance.

6.4.3.3 Constraints

None.

6.4.4 NELICRelation (O)

6.4.4.1 Definition

This association represents the bidirectional relation between InventoryUnitNE and InventoryUnitLIC.

6.4.4.2 Roles

Name	Definition
NEList	This role represents the associated InventoryUnitNE instances of a InventoryUnitLIC instance.
LICList	This role represents the associated InventoryUnitLIC instances of a InventoryUnitNE instance.

6.4.4.3 Constraints

None.

6.4.5 SWLICRelation (O)

6.4.5.1 Definition

This association represents the bidirectional relation between InventoryUnitSW and InventoryUnitLIC.

6.4.5.2 Roles

Name	Definition
SWList	This role represents the associated InventoryUnitSW instances of a InventoryUnitLIC instance.
LICList	This role represents the associated InventoryUnitLIC instances of a InventoryUnitSW instance.

6.4.5.3 Constraints

None.

6.4.6 SWHWRelation (O)

6.4.6.1 Definition

This association represents the bidirectional relation between InventoryUnitSW and InventoryUnitHW.

6.4.6.2 Roles

Name	Definition
SWList	This role represents the associated InventoryUnitSW instances of a InventoryUnitHW instance.
HWList	This role represents the associated InventoryUnitHW instances of a InventoryUnitSW instance.

6.4.6.3 Constraints

None.

6.4.7 HWLICRelation (O)

6.4.7.1 Definition

This association represents the bidirectional relation between InventoryUnitHW and InventoryUnitLIC.

6.4.7.2 Roles

Name	Definition
HWList	This role represents the associated InventoryUnitHW instances of a InventoryUnitLIC instance.
LICList	This role represents the associated InventoryUnitLIC instances of a InventoryUnitHW instance.

6.4.7.3 Constraints

None.

6.5 Information attribute definitions

6.5.1 Definition and legal values

Table 6.5.1 defines the attributes that are present in several Information Object Classes of the present document.

Table 6.5.1: Attributes

Attribute Name	Definition	Legal Values
additionalInformation	Supplementary information about inventory data (if any)	
classification	Name of installed SW (e.g. SW release, SW build, SW patches), empty value possible	
customerIdentifier	Unique identification of a vendors' customer	
dateOfManufacture	Date of Manufacture of inventory unit.	
dateOfLastService	Date of last service or repair of inventory unit.	
hwCapability	Hardware capability e.g. capacity, size (empty value is possible)	
hwName	Mnemonic of hw inventory unit family type (e.g. Fan, PSU) assigned by vendor.	
hwType	Type of the HW unit e.g. equipment holder, carriage	
hwUnitLocation	Unique physical / logical location identifier within NE	
hwVersion	Version / revision no. of current unit e.g. firmware version (empty value possible in case no versioning is available)	
id	An attribute whose 'name+value' can be used as an RDN when naming an instance of this object class. This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	
installationTime	Date/time stamp of SW installation	
inventoryUnitId	An attribute whose 'name+value' can be used as an RDN when naming an instance of this object class. This RDN uniquely identifies the object instance within the scope of its containing (parent) object instance.	
inventoryUnitType	Type of inventory unit (see TS 32.690 [11])	
key	License activation key according to the used licensing system	
licActivationDate	Date/time stamp of license activation	
licId	Unique identifier of a license (e.g. name, code)	
licStatus	License status – applicable only for managed licenses (e.g. scheduled, valid, expired, invalid, capacity violated)	
licType	Describing type of current license (e.g. capacity, particular feature, no. of subscribers)	
manualDataEntry	Indicates whether unit is passive (manual insertion of inventory data is needed) or active (inventory data can be read from the unit)	
manufacturerData	Manufacturer specific data of inventory unit.	
model	Equipment configuration, e.g. standard hw unit or a variant that may contain additional disk capacity (empty value possible)	
modificationDate	Date/time stamp of last change (e.g. repair action)	
neId	vendor defined unique identifier of a logical or physical network element unit	
operatorUniqueName	Unique NE identifier used by operator	
productName	NE name classifying a vendor's product family or function	
productType	Identifier of the e.g. platform, in case the product can be based on different HW/SW platforms (not used for logical NEs)	
salesUniqueId	Unique identifier used by vendor (used e.g. for ordering a new unit)	
serialNo	Serial number given from factory	
serialNumber	Serial number of inventory unit.	
siteId	NE site in customer network	
swId	Unique identifier of a SW unit	
swName	SW release name used	
swStatus	Status of the SW unit (e.g. installed, archived)	
swVersion	Version identifier of the SW unit	
unitPosition	Position of inventory unit (e.g. Rack, shelf, slot, etc.). Depending on the implementation of the inventory unit in the managed system, the value and meaning of this attribute may vary. For example, if a system has three levels and types of inventory units representing Rack, Shelf and Slot respectively (i.e. the Managed Element contains multiple Rack inventory units, each Rack inventory unit contains multiple Shelf inventory units and each Shelf inventory unit contains multiple Slot inventory units), then for this example: – for the Inventory Unit representing a Rack, the Frame Identification code may be used as the value of this attribute; – for the Inventory Unit representing a Shelf, the Rack Shelf code may be used as the value of this attribute; – for the Inventory Unit representing a Slot, the position code may be used as the value of this attribute.	
validity	License validity which may include one of the elements duration, end (expiration date) or forever	String?
vendorName	Name of inventory unit vendor (or vendors may provide manufacturer name)	String?

Attribute Name	Definition	Legal Values
vendorName	Name of inventory unit vendor.	
vendorUnitFamilyType	Mnemonic of inventory unit family type (e.g. Fan, PSU) assigned by vendor.	
vendorUnitTypeNumber	A vendor/manufacturer defined and assigned number which uniquely identifies the unit type and optionally for backward compatibility reasons only, also version (used for replacing HW units, spares).	
versionNumber	The version information related to vendorUnitTypeNumber.	

6.5.2 Constraints

None.

6.6 Particular information configurations

None.

Annex D (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
05-2010	SA-48	SP-100287	--	--	Presentation to SA for information	---	1.0.0
03-2011	SA-51	SP-110121	--	--	Presentation to SA for approval	1.0.0	2.0.0
03-2011	--	--	--	--	Publication	2.0.0	10.0.0