NetworkResourceFulfillment - DDP BA

TMF518_NRF

Version 1.2

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Not Applicable.

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Executive Summary

This document is the Business Agreement (BA) part of the Network Resource Fulfillment (NRF) Document Delivery Package (DDP). This BA addresses the Data Model (DM) aspects of resource fulfillment and as such it defines all resource related managed entities visible across the Interface that are used in support of resource fulfillment.

1 Introduction

1.1 DDP Structure

In order to allow for more efficient release delivery, the previous monolithic BA, IA and SS documents have been partitioned into smaller self-contained (though not independent) units called Document Delivery Packages (DDPs).

This is similar to the 3GPP concept of Integration Reference Point (IRP). The basic idea is that the Interface, which is specified by the entire document set (of a release), is partitioned into DDPs where each DDP specifies “a certain aspect” of the Interface, which needs to be very clearly scoped.

There are three kinds of DDPs:

- the FrameWork DDP (FMW) – this DDP contains the generic artifacts 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)

The unified deliverables structure for any given MTOSI / MTNM product release is as follows:

- Product Release Notes:
  - a scope specification for the type and extent of the delivered product,
  - the partitioning of the release into DDPs (i.e., definitions of various aspects of the release),
  - and an overview of the release’s (delta) deliverables;
- For each DDP:
  - Business Agreements (BAs): a business view specification
  - Information Agreements (IAs): a system view specification
  - Interface Implementation Specifications (ISSs): implementation and deployment view specification per supported enabling technology (mapping of the IA to either CORBA (IDL, services usage) or XML (WSDL, XSD, bindings…)
  - Supporting Documentation: normative and informative supporting documents.
- Reference Implementation (optional) of core IIS fragments for selected interfaces and enabling technologies.

1.2 Document Structure

This document is divided into the following sections:

Section 1 is this introduction.

Section 2 defines the business problem and project scope.

Section 0 has the requirements and associated descriptive text.

Section 4 contains the use cases.

Section 5 has traceability matrices between the use cases and associated requirements, and vice versa.

Section 6 provides a summary and list of open issues to be considered in later versions of this document.

Section 7 lists references and states IPR claims, if any.

Section 8 provides administrative details such as author contact information, document history and acknowledgements.

1.3 Terminology Used In This Document

Refer to the SD0-1 supporting document.

2 Business Problem Description, Project Scope

2.1 Project Scope

The TM Forum Integration Program is responsible for all of the interface and business services work within the TM Forum. In some cases, interface work is delegated to other teams but the final verification for technical uniformity and integrity is the responsibility of the TM Forum Integration Program.

Initially, the TM Forum Integration Program was formed to coordinate the various existing TM Forum interfaces activities (as shown in **Figure 2-1**). In particular, the responsibility for maintaining MTOSI and MTNM is now covered by the MTOSI-MTNM Users Group which is a team within the TM Forum Integration Program. The long term plan (which is already well under progress) is to migration the various input work to a single harmonized suite of interfaces.

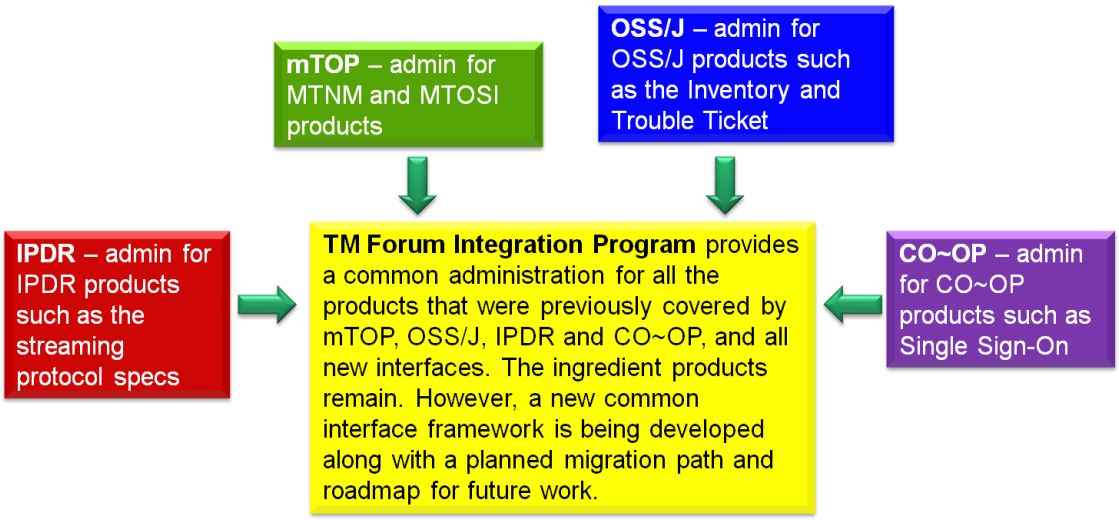

Figure 2-1**. Inputs to the TM Forum Integration Program**

Figure 2-2 provides a summary of the team within the TM Forum Integration Program as well as a few teams outside of the program but which also do some interface work. In terms of MTOSI and MTNM, the main input for updates come from the Resource and Service Management Team.

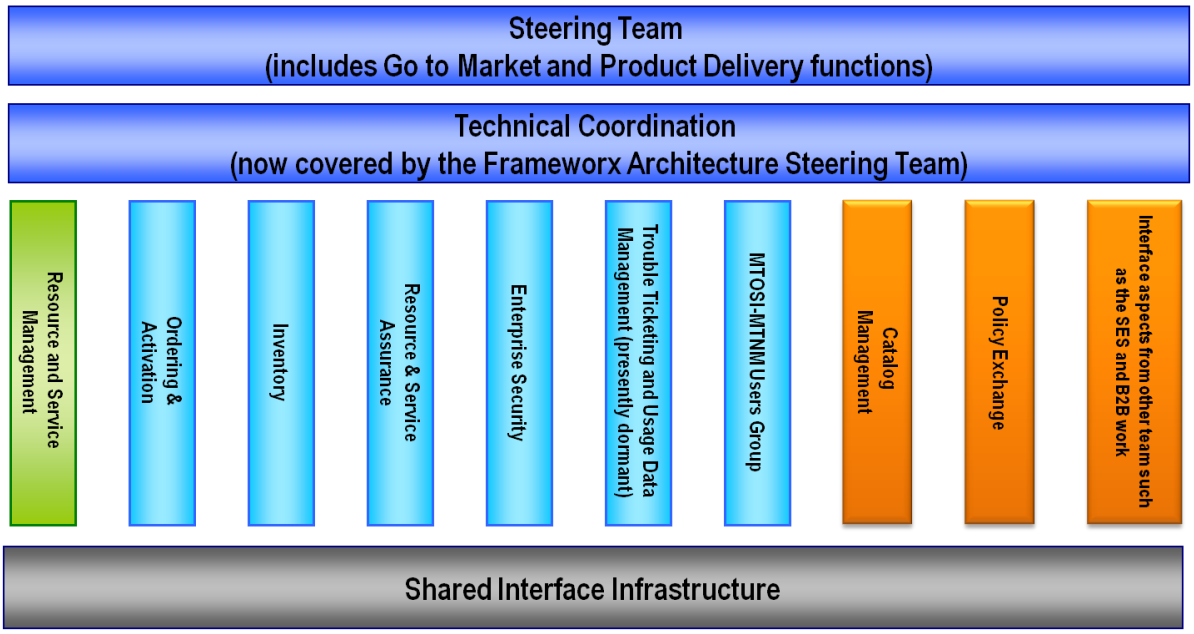

Figure 2-2**. TM Forum Integration Program**

2.2 Benefits

MTOSI and MTNM provide a set of Interface specifications that allow for resource and service management (with only MTOSI covering service management, but with MTOSI and MTNM both covering resource management, using very much the same information model).

These specifications are intended to lower design, implementation, Verification Validation & Testing (VVT), and maintenance costs for management interfaces. These Interfaces are intended for use by service providers, suppliers of equipment and OSS suppliers. The intention is to also encourage system integrator usage of management systems that make use of the Interfaces.

In particular, the followed approach tends to minimize the cost of integration, provide access to all necessary information and control, and support all vendor/operator differentiation. The intent of the interface is to provide compatibility among different version, for a detailed description see SD2-6_VersioningAndExtensibility.

2.2.1 Service Provider Benefits

The service provider benefits are as follows:

- One stop shopping concerning feature requests for much of the TM Forum contract specification work is part of the defined Change Control Group (CCG) process that TM Forum makes available in order to control the interface.
- The technical deliverables are also of high value to the service provider. The Interface specifications allow for an open, multi-supplier environment, shorten delivery times and lower integration costs.
- The MTOSI and MTNM products provide an integrated, multi-technology interface with support for most key layer 1 and layer 2 transport technologies. This is in contrast to earlier approaches where

each technology-specific forum provided a single-technology management interface. The service provider was faced with having to use many different, uncoordinated management interfaces.

- These products are not bound to any one middleware, transport or computing language. So, the service provider will be able to evolve to new technologies as they arise.

2.2.2 Supplier Benefits

The supplier benefits are as follows:

- Fewer Adapters leads to Lower Costs – in as much as MTOSI and MTNM gain market penetration (and there has already been significant market acceptance of these interfaces), the supplier is faced with the need to build fewer adapters between their products and the products of their partners. A supplier can also directly see cost savings in the use of the Interfaces among its own products (as the need for an open interface arises).
- Lower Middleware Transitions Costs – the Interfaces are defined to be middleware and transport independent. So, the supplier can migrate from one middleware or transport technology to another without changing the supporting business logic in the code.
- Increase Usage by System Integrators (SIs) – a supplier's support of their own "open" interfaces goes only so far to encourage SIs. Clearly, an SI would like to make use of supplier products (both equipment and OSS suppliers) that make use of well supported standard interfaces rather than supplier specific interfaces. The latter case forces the SI into a situation characterized by many pair-wise negotiations between various suppliers.
- Lower Training Cost – in as much as a supplier re-uses the Interfaces for multiple products and for multiple customers, the various training costs are lower because the designers, system engineers, developers and testers are using the same Interfaces over and over again.

3 Business Processes

3.1 Category I: Static and Structural Requirements

3.1.1 Operations System (OS)

R_TMF518_NRF_I_0001	The ***Operations System (OS)*** object represents the Operations System itself (an EMS, NMS or SMS). The ***OS*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes:
	• ***software version*** – this attribute shall represent the software version of the OS.
	• ***product name*** – this attribute shall represent the product name for the OS.
	• ***manufacturer*** – this attribute shall represent the name of the OS supplier.
	• ***resource fulfillment state*** – this attribute shall indicate the current resource fulfillment state of the OS. The resource fulfillment state of the OS is intended to reflect the state of the Interface application. The possible values for this attribute are:
	  • In Service
	  • Out of Service
	  • Out of Service for Maintenance. (OPTIONAL).
	• ***subordinateOS*** – this attribute shall indicate whether the OS is a subordinate OS (refer to R_TMF518_NRF_I_0002 for the definition of a subordinate OS).

Source	TMF 517, Version 1.1, Requirement I.3

R_TMF518_NRF_I_0002	An OS that has direct access to the CCV is referred to as a ***top-level OS***. A subordinate OS accesses the CCV indirectly via a top-level OS.
Source	TMF 517, Version 1.1, Requirement I.4

3.1.2 Managed Element (ME)

R_TMF518_NRF_I_0003	A ***Managed Element (ME)*** object shall represent the OS view of a Network Element (NE).
Source	TMF 513, Version 3.0, Requirement I.002

R_TMF518_NRF_I_0004	An Managed Element (ME) object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***location*** - this attribute shall represent the geographical location of the NE. • ***software version*** - this attribute shall represent the software version of the NE. • ***product name*** - this attribute shall represent the NE vendor's name/designation for the product (i.e. the name the vendor uses to identify the NE). • ***communication state*** -this attribute shall represent the state of the current connectivity between the OS and the Network Element. • ***supported connection layer rate list*** - this attribute shall represent a list of the rates for which cross-connects can be established in the NE. • ***synchronization state*** - this attributes shall indicate whether the OS is able to keep its data synchronized with the NE data and generate all appropriate notifications relating to changes in the data. • ***manufacturer*** - this attribute shall represent the NE vendor name. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the NE. • ***manufacture date*** – this attribute shall represent the date on which the NE was manufactured. It is relevant production data as defined in ISO 8601 and ISO/IEC 15418. The format shall be YYYYMMDD.
Source	TMF 513, Version 3.0, Requirement I.003 TMF 517, Version 1.2, Requirement I.5

3.1.3 Termination Point (TP)

R_TMF518_NRF_I_0005	A ***Termination Point (TP)*** object shall represent a logical abstraction of an endpoint (actual or potential) of either: • A Topological Link (TL) or • A Subnetwork Connection (SNC)
Source	TMF 513, Version 3.0, Requirement I.004

R_TMF518_NRF_I_0006	A ***TP*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes:
	• ***directionality*** - this attribute shall represent the directionality of the signal flow at the endpoint. The possible values for this attribute are:
	  • bidirectional
	  • source
	  • sink
	• ***protection association*** - this attribute shall represent whether the ***TP*** is participating in a Path Switched Ring (PSR) protection scheme with another TP. (For example in a multi-layer subnetwork, if 'a', 'b', 'c' are edge points and a three-ended connection is required from 'a' to 'b', where 'b' is one of the endpoints. If 'c' is the constrained choice for 'b' as the other end of the three-ended connection, then 'b' and 'c' are said to be associated by a protection association.).
	• ***edge point*** - this attribute represents whether the TP is at the edge of a subnetwork. Refer to R_TMF518_NRF_I_0008.
	• ***equipment protected*** - this attribute shall indicate whether or not the ***TP*** is supported by Equipment that is protected.
	• ***ingress TMD state*** - this attribute shall indicate the state of consistency between a ***TP*** and its associated ingress Transmission Descriptor (TMD).
	• ***egress TMD state*** - this attribute shall indicate the state of consistency between a ***TP*** and its associated egress Transmission Descriptor (TMD).
	• ***GTP*** or ***TPPool*** - this attribute shall represent the name of the Group Termination Point (GTP) or Termination Point Pool (TP Pool) of which this ***TP*** is a member, if applicable.
	• ***layered transmission parameter list*** - this attribute shall represent the transmission parameters associated with the different layers that are encapsulated within the

	TP. Refer to SD1-16 for details of the currently defined transmission parameters. • ***ingress TMD*** - this attribute shall represent the name of the ingress Transmission Descriptor (TMD) associated with the ***TP***. • ***egress TMD*** - this attribute shall represent the name of the egress Transmission Descriptor (TMD) associated with the ***TP***. • ***TCA parameter profile*** - this attribute shall represent the name of the Threshold Crossing Alert (TCA) Parameter Profile associated with the ***TP***. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the ***TP***. • ***performance monitoring point list*** - this attribute shall represent the names of the Performance Monitoring Points (PMP) associated with the ***TP***.
Source	TMF 513, Version 3.0, Requirement I.005

3.1.4 Physical Termination Point (PTP)

R_TMF518_NRF_I_0007	A ***Physical Termination Point (PTP)*** object shall represent the signal termination and assurance functions supported by a port. A ***PTP*** is a Termination Point (TP) that includes a physical layer rate (refer to R_TMF518_NRB_I_0003) The ***PTP*** does not represent the physical connector itself. Examples of ***PTP***s are T1 ports, T3 ports, OC-N optical ports, etc. ***PTP***s have a containment relationship with Connection Termination Points (CTP). ***PTP***s forming a UPSR pair are related and contain related CTPs. If the ***PTP*** is potentially able to support a CTP on a particular layer rate, then that CTP shall be represented at the Interface. CTPs are always clients of the ***PTP*** but the layer relationship may reverse (refer to SD1-18). A ***PTP*** object is a type of TP object that shall have the attributes identified in R_TMF518_NRF_I_0006.
Source	TMF 513, Version 3.0, Requirement I.007

3.1.4.1 Edge Termination Point (Edge TP)

R_TMF518_NRF_I_0008	An ***Edge Termination Point (Edge TP)*** is a Termination Point

	(TP) that is at an entrance or exit point of a Subnetwork, (i.e. add-drop or TPs that terminate Topological Links between two Subnetworks).
Source	TMF 513, Version 3.0, Requirement I.008

3.1.5 Connection Termination Point (CTP)

R_TMF518_NRF_I_0009	A ***Connection Termination Point (CTP)*** object shall represent the end point (actual or potential) of either: • A Subnetwork Connection (SNC) or • An ATM Network Interface (ATMNI) at the Network Interface layer rate. A ***CTP*** may be contained by and be the client of: • a Physical Termination Point (PTP) • a Floating Termination Point (FTP) or • a CTP. A ***CTP*** may be contained by and be the server of an FTP or a CTP (via inverse multiplexing).
Source	TMF 513, Version 3.0, Requirement I.006

R_TMF518_NRF_I_0010	A ***CTP*** object is a type of Termination Point (TP) and therefore shall have, in addition to the attributes identified in R_TMF518_NRF_I_0006, the following attributes: • ***connection state*** - this attribute shall indicate whether the ***CTP*** is involved in an active cross-connection at the ***CTP***'s rate. (Refer to R_TMF518_NRF_I_0037). • ***mapping mode*** - this attribute shall indicate if the ***CTP*** is configured such that it is capable of supporting lower rate connections, or if the CTP is configured such that it is capable of supporting cross-connections at the TP's rate. Refer to SD1-18 for details on the mapping mode.
Source	TMF 513, Version 3.0, Requirement I.062

3.1.6 Floating Termination Point (FTP)

R_TMF518_NRF_I_0011	A ***Floating Termination Point (FTP)*** object shall represent a Termination Point (TP) that is not directly supported by a physical port. An **FTP** is a TP without a physical layer that behaves both like a Physical Termination Point (PTP) and a Connection Termination Point (CTP): • ***FTP***s (client side) behave like PTPs wherever PTPs are used in the Interface. • ***FTP***s (server side) behave like CTPs wherever CTPs are used in the Interface. ***FTP***s have a containment relationship with CTPs. The FTP will contain CTPs in client layers and may contain CTPs in server layers (via inverse multiplexing). An ***FTP*** object is a type of CTP object and also a type of PTP object and shall have the attributes identified in R_TMF518_NRF_I_0010 and R_TMF518_NRF_I_0007.
Source	TMF 513, Version 3.0, Requirement I.075

3.1.7 Group Termination Point (GTP)

R_TMF518_NRF_I_0012	A ***Group Termination Point (GTP)*** object shall represent a sequence of Connection Termination Point (CTP) (with a specific order) in the same Network Element (NE). ***GTP***s shall have the following behavior: • The CTPs comprising a ***GTP*** need not be contiguous. • A CTP can not belong to more than one ***GTP*** at a time. • Once a CTP is included in a ***GTP***, it can not be cross-connected independent of the ***GTP***. • All CTPs in a ***GTP*** must have the same connection state and be in the same network access domain. • A ***GTP*** shall be named with respect to the containing Managed Element (ME).
Source	TMF 513, Version 3.0, Requirement I.069

R_TMF518_NRF_I_0013	A ***GTP*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***contained TP list*** - this attribute shall represent a list of

	the names of the Termination Points (TP) that are contained by the ***GTP***. • ***connection state*** - this attribute shall represent whether the ***GTP*** is involved in an active cross-connection. (Refer to R_TMF518_NRF_I_0037). • ***alarm reporting*** - this attribute shall indicate whether alarm reporting for the ***GTP*** is enabled or disabled. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the ***GTP***. • ***TP Pool*** - this attribute shall represent the name of the Termination Point Pool (TP Pool) of which this ***GTP*** is a member, if applicable.
Source	TMF 513, Version 3.0, Requirement I.070

3.1.8 Termination Point Pool (TP Pool)

R_TMF518_NRF_I_0014	A ***Termination Point Pool (TP Pool)*** object shall represent a grouping (without a specific order) of Termination Points (TP) or Group Termination Points (GTP) from the same subnetwork, for some administrative management purposes (e.g. bandwidth reservation, common routing, etc.). The members of a ***TP Pool*** are administered and used independently of each other but for a common purpose. A Connection Termination Point (CTP) that is contained in a GTP cannot be a member of a ***TP Pool***, but the whole GTP can be a member of a ***TP Pool***. A CTP that is contained in a ***TP Pool*** cannot be added to a GTP. A TP or GTP can be a member of at most one ***TP Pool***. For ATM, this object shall be used to support the administrative partitioning of the ATM Network Interface (ATM NI) consisting of a reserved range of Virtual Path Identifier (VPI) values and bandwidth. In this example the set of potential client CTPs of the ATM NI CTP is partitioned into a set of ***TP Pool*** objects. While the ATM NI CTP represents a real network interface the ***TP Pool*** objects represent virtual network interfaces consisting of a set or range of ATM VP CTPs If a target Operations System (OS) does not support the concept of administrative partitioning, then no ***TP Pool*** objects shall be present at the Interface.
Source	TMF 513, Version 3.0, Requirement I.009

R_TMF518_NRF_I_0015	A ***TP Pool*** object shall have, in addition to the attributes identified in R_TMF518_FMW_I_0001, the following attributes:

	• ***contained member list*** - this attribute shall represent a list of the names of the Termination Points (TP) or Group Termination Points (GTP) that are contained by the ***TP Pool***. • ***number of members*** - this attribute shall represent the total number of currently contained TPs or GTPs. • ***number of idle members*** - this attribute shall represent the number of currently contained idle TPs or GTPs that are free to be used for the intended management purpose (e.g., potential ATM VP CTPs that are currently not "in use"). • ***layered transmission parameter list*** - this attribute shall represent the common layers and transmission parameters (if any) associated with the contained TPs (or the TPs contained in contained GTPs). Refer to R_TMF518_NRF_I_0006. • ***description of use*** - this attribute shall optionally describe the specific use of the ***TP Pool***, in particular how its members are collected and administered. For example, the description of use of an ATM VP ***TP pool*** could be "Virtual UNI".
Source	TMF 513, Version 3.0, Requirement I.094

3.1.9 Connectionless Termination Points

3.1.9.1 Connectionless Port Termination Point (CPTP)

R_TMF518_NRF_I_0016	A ***Connectionless Port Termination Point (CPTP)*** represents a potential port capability for connectionless technologies, i.e. the ***CPTP*** has potential client Termination Points (TP) which are Flow Points (FP). A ***CPTP*** is not an object visible across the Interface. The term ***CPTP*** is used in this specification for defining the characteristics of a port at a connectionless matrix. **Note**: The clients of a CPTP, i.e. FPs, are connected via the matrix. A ***CPTP*** can be a Physical Termination Point (PTP), a Floating Termination Point (FTP) or a Connection Termination Point (CTP). A ***CPTP*** is modeled as: • a PTP object if the port is an external port, or • an FTP object if the port is an internal encapsulation port or • a CTP object if the port is an external encapsulation port. For examples for ***CPTP***s implemented as either a PTP or an FTP or a CTP refer to the SD1-44.

	A boolean layered parameter at connectionless layers (e.g. Ethernet) shall identify a TP as a ***CPTP***. **Note**: In the case of Ethernet client layer: • a ***CPTP*** corresponds to an IEEE bridge port, which can be an UNI port (Network Access Port) or an NNI port (Network Port) • the ***CPTP*** will always have Directionality set to "bidirectional".
Source	TMF 513 Version 3.1, Requirement I 100

3.1.9.2 Flow Domain Edge CPTP (FD Edge CPTP)

R_TMF518_NRF_I_0017	A ***Flow Domain Edge Connectionless Port TP (FD Edge CPTP)*** is a TP that is at either an entrance or exit point of a Flow Domain (FD). It provides endpoint Flow Points (FPs) for the provisioning of Flow Domain Fragments (FDFrs) at a connectionless client layer. It is characterized by the value "fdEdge" of the PortTPRoleState layered parameter (refer to SD1-16) in the PTP/FTP/CTP object. **Note**: In the case of Ethernet, FPs are always bidirectional and so ***FD Edge CPTP***s are entrance and exit points of FDs.
Source	TMF 513, Version 3.5, Requirement I. 101

3.1.9.3 Flow Point (FP)

R_TMF518_NRF_I_0018	A ***Flow Point (FP)*** is a point of a Flow Domain Fragment (FDFr) where the flow enters or exits a Matrix Flow Domain (MFD). An edge ***FP*** represents the end point of an FDFr. An ***FP*** is contained by and is the client of a Connectionless Port TP (CPTP). When the server CPTP is configured as an "fdEdge", all client FPs become edge FPs. ***FP***s are created as CTP objects when the associated FDFr is created, and are deleted when the associated FDFr is deleted. ***FP***s do not exist without an associated FDFr. **Note**: • Only "in use" ***FP***s are represented as CTP objects at the interface and therefore only "in use" FPs can be inventoried. • ***FP***s with layer rate Ethernet will always have Directionality set to "bi-directional". • The connectionless layered parameters are contained

	in the layered transmission parameters attribute inherited from the TP object. This attribute shall represent the technology-specific parameters associated with the different connectionless layers (e.g. Ethernet, DVB, IPTV) that are supported by the ***FP***. Refer to the section "Connectionless Technology Parameters" of the SD1-16 for details of the currently defined connectionless parameters. • It is recommended (not required) that when an NMS does not provide a name for the ***FP*** the OS use the FDFr VLAN-ID if VLAN is used; otherwise use a string with a "P" as a prefix followed by a unique number.
Source	TMF 513, Version 3.5Requirement I. 102

3.1.10 Topological Link (TL)

R_TMF518_NRF_I_0019	A ***Topological Link (TL)*** object represents either: • a physical link between two Physical Termination Points (PTPs) or • a trail between two Termination Points (TP) (e.g., an ATM link between two ATM NI CTPs). The points at each end of the ***TL*** are referred to as the aEnd and zEnd TPs. The layer rate of a ***TL*** is determined by the lowest common layer rate of the two end point TPs; about which the OS has knowledge (with the physical layer being the very lowest). A ***TL*** reported by an OS will usually be between two NEs that are managed by the same OS but need not be adjacent. Depending on the capabilities of the OS and the NEs, a ***TL*** may or may not be auto-discovered by the OS. The end points of a ***TL*** may belong to either: • different Subnetworks, in which case the ***TL*** is referred to as a "***top-level topological link***", or • the same Subnetwork, in which case the ***TL*** is referred to as an "***inner topological link***" • the same NE in which case the ***TL*** is referred to as an "***internal topological link***". For a ***TL*** that has an end point outside of an OS' span of control, if the OS knows about the remote end, the OS may provide this information via a single-ended ***TL***, called an "***off-network TL***". Such a ***TL*** may also be referred to as ***single-ended*** since only one end point, namely the aEnd TP, belongs to the OS managing the topological link the other (i.e., the zEnd TP) being off-network and being reported as a remote address

	(and possibly being managed by another OS). An ***off-network TL*** is also considered to be a ***top-level TL***. For unidirectional ***TL***s the aEnd TP marks the traffic source whereas the zEnd TP marks the traffic sink. Refer to SD1-18 for more information on the modeling of topological links.
Source	Amended from TMF 513, Version 3.0, Requirement I.010

R_TMF518_NRF_I_0020	A ***TL*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***directionality*** - this attribute shall represent the directionality of the ***TL***. A ***TL*** may be unidirectional or bidirectional. A unidirectional ***TL*** may connect two bidirectional TPs. • ***aEnd Termination Point (TP)*** - this attribute shall represent the name of the A end TP of the ***TL***. • ***zEnd Termination Point (TP)*** - this attribute shall represent the name of the Z end TP of the ***TL***. • ***layer rate*** - this attribute shall represent the layer rate of the ***TL***. Refer to R_TMF518_NRB_I_0003. • ***alarm reporting*** - this attribute shall indicate whether alarm reporting for the ***TL*** is enabled or disabled. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the ***TL***.
Source	TMF 513, Version 3.0, Requirement I.011

3.1.11 MultiLayer Subnetwork (MLSN)

R_TMF518_NRF_I_0021	A ***MultiLayer Subnetwork (MLSN)*** object shall represent the topology provided by the OS. The main services provided by an ***MLSN*** are the set-up and tear-down of Subnetwork Connections (SNC). A Managed Element (ME) may belong to more than one ***MLSN***, at different layer rates (e.g. SDH & ATM). However, ***MLSN***s cannot overlap at the same layer rate. Refer to SD1-18 for more information on the concept of ***MLSN***s.
Source	TMF 513, Version 3.0, Requirement I.012

R_TMF518_NRF_I_0022	A ***MLSN*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes:

	• ***type*** - refer to R_TMF518_NRF_I_0023 • ***supported SNC layer rate list*** - refer to R_TMF518_NRB_I_0003.
Source	TMF 513, Version 3.0, Requirement I.013

3.1.11.1 MultiLayer Subnetwork (MLSN) Type

R_TMF518_NRF_I_0023	The Interface shall support the management of the following network topologies or ***MLSN*** types: • ***singleton*** - used for a single NE that is managed independently of its topological link connectivity to other NEs. It may for example be a member of a ring that is managed by a number of OS'. It is acceptable for an OS to represent all NEs as being in Singleton ***MLSNs*** regardless of the actual network configuration. • ***chain*** - used to cover the case where two or more NEs are managed by the same OS and are connected by topological links in a chain. • ***path switched ring (PSR)*** - used to cover the case where two or more NEs are managed by the same OS and are connected by topological links in a ring that is capable of supporting Subnetwork Connection Protection (SNCP). (e.g. UPSR, SNCP Ring) • ***shared protection ring (SPRing)*** - used to cover the case where two or more NEs are managed by the same OS and are connected by topological links in a complete ring that supports Shared Line Protection (e.g. BLSR) • ***open PSR*** - used to cover the case where two or more NEs of a PSR (but not the entire ring) are managed by the same OS. (e.g. Open UPSR) • ***open SPRing*** - used to cover cases where two or more NEs of an SPRing (but not the entire ring) are managed by one OS. (e.g. Open BLSR) • ***mesh*** - used to cover an arbitrary set of two or more NEs not covered by any other type.
Source	Amended from TMF 513, Version 3.0, Requirement I.038

3.1.11.2 Subnetwork Partitioning

The top-level OS (refer to TMF518_FMW for a definition of a top-level OS) is responsible for defining a subnetwork partitioning for the portion of the network that it stores. When a top-level OS does not provide an inventory capability, then subnetwork partitioning is not an issue for the OS. When a top-level OS

does provide an inventory capability, then it must present a single subnetwork partitioning to all of its clients. Various choices are possible.

One option is for the top-level OS can use the same partitioning as the underlying (subordinate OSs). There are several issues with this approach. First, the subordinate OSs may have overlapping responsibility. In this case, the top-level OS will need to untangle the overlap and at least in part construct a new subnetwork partitioning. Second, even if there is no overlap of management coverage by the subordinate OSs, the composite subnetwork partitioning (obtained by combining the subnetwork partitions of the individual subordinate OSs) is likely to be very granular. **Error! Reference source not found.**Figure 3-1 shows the combined subnetwork partitioning of subordinate OSs (EMSs in this cases). As one can see, the combined partitioning is much more granular than needed. A better partitioning would be to represent the entire configuration shown in the figure by a single subnetwork.

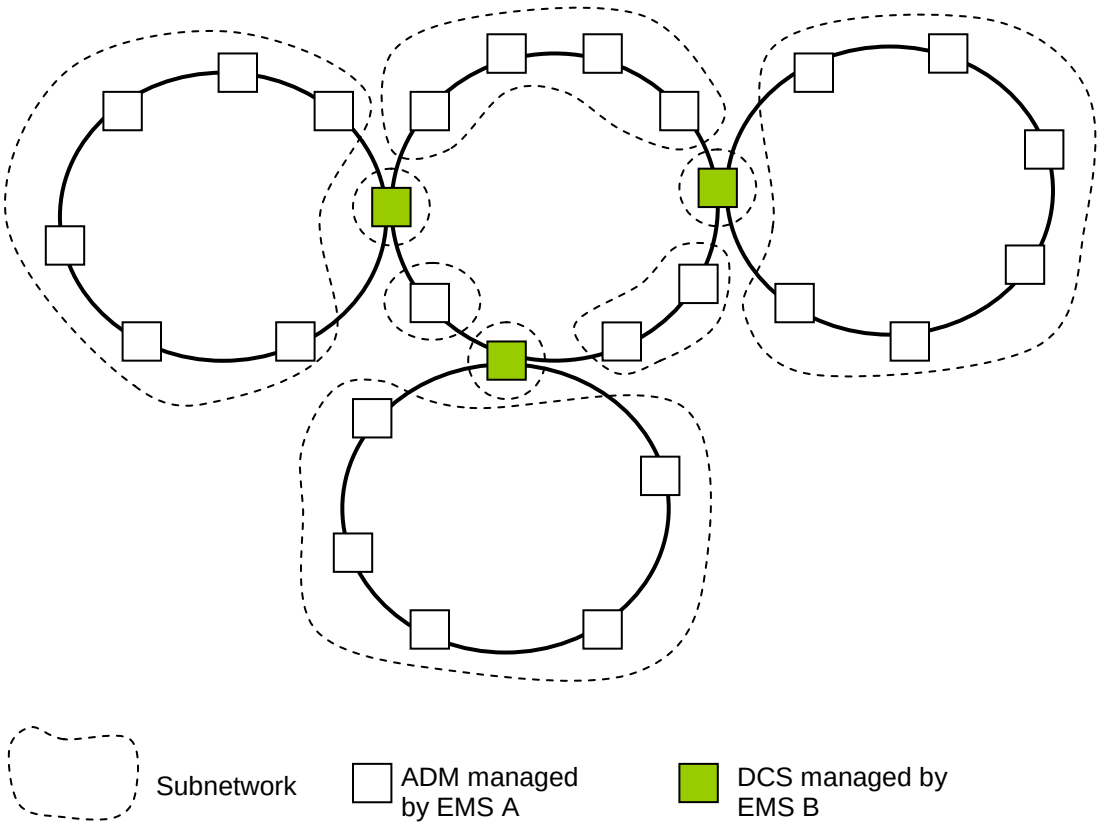

Figure 3-1: Example Subnetwork Partitioning based on Partitioning of Subordinate OSs

Another approach would be for the top-level OS to create a synthesized subnetwork partitioning based on the information obtained by the subordinate OSs. This appears to be an easy task for the example shown in Figure 3-1. The problem becomes more complicated for larger networks. The subnetwork partitioning could be based on any combination of the following factors: size (number of Managed Elements (ME) in the subnetwork), geographic boundaries, administrative boundaries as determined by the service provider, technology boundaries (ring vs. mesh) and connectivity (recall that all the MEs in a subnetwork must have the potential of being connected).

It should be emphasized that the definition of rules to determine a subnetwork partitioning is beyond the scope of this specification. The only requirement is that the supplier of an OS that supports an inventory capability must specify how they intend to provide a partitioning of the network.

In terms of logistics, a top-level OS that supports an inventory capability could be populated with information concerning the subnetwork assignment(s) for each ME by a planning OS. The subnetwork assignments could be provided before the top-level OS even discovers the MEs from the subtending network. This is basically a bottom-down method.

As an example of a bottom-up method consider the following. The subordinate OS mark newly discovered MEs with a subnetwork indicator (this could be put in the Network Access Domain attribute of each ME, for example). The top-level OS uses the subnetwork indicator to create a subnetwork partitioning for the entire network of which it has knowledge. Of course, this approach begs the following question "How do the subordinate OSs know the subnetwork assignment for each ME?" This could be done via some type of default assignment, e.g., all MEs managed by a given set of EMSs are assigned to the same subnetwork. Alternately, a planning OS could inform the subordinate OSs about the subnetwork assignments for each ME beforehand (more of a top-down approach). In this latter case, it would seem easier to have the planning OS provide the subnetworks' assignments to the top-level "inventory" OS.

3.1.12 Subnetwork Connection (SNC)

R_TMF518_NRF_I_0024	A ***Subnetwork Connection (SNC)*** object shall represent the relationship between two of the following types on end points: • Physical Termination Point (PTP) • Connection Termination Point (CTP) or • Group Termination Point (GTP) (in the case of GTPs refer to R_TMF518_NRF_I_0032 for indformation on Bundled SNCs) or • Floating Termination Point (FTP) An ***SNC*** represents a transparent end-to-end connection or a trail (closed or half-open) through or within an ***MLSN*** according to the roles associated to its end points. If it represents a connection, its end points are CTPs or FTPs with the SNC's layer rate as the connectable layer rate. In the case of GTPs (i.e. a Bundled connection) the SNC does not have an explicit layer rate If it represents a trail, its end points are CTPs or FTPs or PTPs. An ***SNC*** shall be contained in an ***MLSN***.
Source	TMF 513, Version 3.0, Requirement I.014

R_TMF518_NRF_I_0025	An ***SNC*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***state*** - refer to R_TMF518_NRF_I_0028. • ***directionality*** - this attribute shall represent the

	directionality of the ***SNC***. The possible values for this attribute are: • bidirectional • unidirectional • ***layer rate*** - refer to R_TMF518_NRB_I_0003. • ***static protection level*** - this attribute shall represent the degree of internal resilience/protection of the ***SNC*** e.g., to indicate whether the ***SNC*** should be Protected, Preemtible, or Unprotected. The OS will be required to create an SNC with the specified static protection level. • ***type*** - this attribute shall indicate the specific traffic flow through the SNC. (Refer to R_TMF518_NRF_I_0029) • ***aEnd TP list*** - this attribute shall represent a list of the following aEnd Termination Points (TP): • Physical Termination Point (PTP) • Connection Termination Point (CTP) • Group Termination Point (GTP) • Floating Termination Point (FTP) • ***zEnd TP list*** - this attribute shall represent a list of the following zEnd Termination Points (TP): • Physical Termination Point (PTP) • Connection Termination Point (CTP) • Group Termination Point (GTP) • Floating Termination Point (FTP) • ***reroute allowed*** - this attribute shall indicate if an SNC may be rerouted. • ***network routed*** - this attribute shall indicate if the route of the ***SNC*** was computed by either the network or the OS during activation. • ***network reroute*** - this attribute shall indicate if the reroute (if allowed) shall be computed by the network, by the OS, or by either. • ***revertive*** - this attribute shall indicate whether the ***SNC*** shall always attempt to return to it's intended Route. • ***alarm reporting*** - this attribute shall indicate whether alarm reporting for the ***SNC*** is enabled or disabled. • ***correlation identifier*** - this attribute shall contain information about relationships that this ***SNC*** may have to other objects. • ***bundled SNC*** - this attribute shall indicate if the ***SNC*** to be created is a bundled ***SNC***

	• ***GTP deletion*** - this attribute shall only be used when creating bundled ***SNC***s. It shall indicate that the OS has to delete all the interior GTPs supporting the bundled ***SNC*** when the ***SNC*** is deleted. • ***fixed*** - this attribute shall indicate whether the ***SNC*** is fixed (i.e. cannot be deleted by an OS) or flexible. A fixed ***SNC*** is defined a ***SNC*** whose all cross-connects are fixed. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the SNC. • ***retain SNC*** - this attribute shall indicate if when modifying an ***SNC*** whether the original ***SNC*** shall be deleted or put into the pending state. • ***priority*** - this attribute shall represent the priority of the ***SNC*** (i.e., highest (0) to lowest). • ***aEnd point role*** - this attribute shall represent the role of the aEnd Termination Points (TP) of the ***SNC***. Refer to R_TMF518_NRF_I_0026. • ***zEnd point role*** - this attribute shall represent the role of the zEnd Termination Points (TP) of the ***SNC***. Refer to R_TMF518_NRF_I_0026.
Source	TMF 513, Version 3.0, Requirement I.015

3.1.12.1 Subnetwork Connection (SNC) End Point Role

R_TMF518_NRF_I_0026	The Termination Points (TP) role assigned to the end point TPs of a SNC shall indicate whether the TP is either: • an SNC-like end point - referred to as a ***"connection matrix end point"*** • a trail-like end point - referred to as a ***"link connection end point"*** At a ***connection matrix end point*** the span of the SNC starts at a G.805 Connection Point (CP) with a fixed or flexible connection through the Network Element (NE) at the SNC layer, i.e. the connectable layer of the end point. At a ***link connection end point*** connectivity is adapted from a server layer and the span of the SNC starts with a G.805 Termination Connection Point (TCP).
Source	TMF 513, Version 3.0, Requirement I.092

3.1.12.2 Subnetwork Connection Naming

R_TMF518_NRF_I_0027	A Subnetwork Connection (SNC) may be named by: • a “requesting OS” – the request it sends to the target OS to create an SNC contains the value for the name to be assigned to the SNC. • a “target OS” – the request received from a requesting OS does not contain a value for the name and the target OS assigns a name to the SNC. • a “naming OS” – an SNC is discovered in the network and a naming OS is responsible for assigning the name to the SNC. The OS that discovers the SNC may not be the same OS that is responsible for assigning the name to the SNC. In all cases the OS responsible for assigning the name to an SNC shall ensure that each name that is assigned to an SNC shall be unique and shall not be re-used.
Source	TMF 513, Version 3.0, Requirement I.016

3.1.12.3 Subnetwork Connection States

R_TMF518_NRF_I_0028	The ***state*** attribute of the ***SNC*** shall indicate one of the following values: • ***active*** - the SNC is not in pending state, a route has been assigned to the SNC and all XCs for the SNC are active in the network. • ***pending*** - the SNC has been created by an OS and has not been activated by any OS; or the SNC has been successfully deactivated by an OS. This state has no relationship with the network state of the XCs of the SNC. • ***partial*** - the SNC is not in pending state, and either a route has not been assigned to the SNC, or not all of the cross-connects of the SNC are active in the network. This may or may not include activated SNCs for which there are currently no active cross-connects in the network, depending on the SNC management mode of operation.
Source	TMF 513, Version 3.0, Requirement I.017

3.1.12.4 Subnetwork Connection Types

R_TMF518_NRF_I_0029	The Interface shall support the following types of ***SNCs*** : • ***Simple*** • ***Add Drop A*** • ***Add Drop Z*** • ***Double Add Drop*** • ***Interconnect*** • ***Double Interconnect*** • ***Open Add Drop*** • ***Explicit*** Refer to SD1-36 for further information regarding Subnetwork Connection types.
Source	TMF 513, Version 3.0, Requirement I.040

3.1.12.5 Subnetwork Connection (SNC) Routing Constraints

R_TMF518_NRF_I_0030	The OS may provide routing constraint information. The routing constraint information shall include:
	EITHER:
	• Resources that must not be part of the route chosen as a result of the request (i.e. excluded resources). The resources may be:
	  • Managed Elements (ME)
	  • Termination Points (TP)
	  • Subnetwork Connections (SNC)
	  • Topological Links (TL)
	  • Group Termination Points (GTP)
	OR:
	• Resources that must form part of the route chosen as a result of the request (i.e. included resources). The resources may be:
	  • Cross-Connects (XC)
	  • Termination Points (TP)
	  • Managed Elements (ME)
	  • Topological Links (TL)
	  • Group Termination Points (GTP)
	  • SubnetworkConnections (SNC)

	Additional information related to the capabilities of the specific OS may be provided.
Source	TMF 513, Version 3.0, Requirement I.018

3.1.12.6 Subnetwork Connection Configurations

R_TMF518_NRF_I_0031	The Interface shall support the following ***SNC*** configurations: • ***Unidirectional, Point-to-Point*** • ***Unidirectional, Point-to-Multipoint*** • ***Bidirectional, Point-to-Point***
Source	TMF 513, Version 3.0, Requirement I.039

3.1.13 Bundled Subnetwork Connection (B_SNC)

R_TMF518_NRF_I_0032	A ***Bundled Subnetwork Connection (B-SNC)*** is a type of ***SNC*** where the end points are Group Termination Points (GTP). The Route of a ***B-SNC*** is also comprised of a collection of cross-connected GTPs. Figure 3-2 depicts a ***B-SNC*** (see the dotted line). The following conditions apply to a ***B-SNC***: • The Connection Termination Point (CTP) ordering is preserved between the aEnd and zEnd of the ***B-SNC***, i.e., the ith CTP in the aEnd GTP in Managed Element #1 is mapped to the ith CTP in the zEnd GTP in Managed Element #3, refer to SD1-3. • The CTPs within the GTPs along the route of the ***B-SNC*** must match. So, each GTP along the route should contain a sequence CTPs of a given set of layer rates and in a particular order. For example, if one endpoint of a ***B-SNC*** is a GTP whose first 3 CTPs are of layer rate STS-1, the next three CTPs are of layer rate VT1.5 and the last two CTPs are of layer rate STS3c, then all other GTPs supporting the ***B-SNC*** must have the same number of CTPs of each layer rate and in the same order as the given GTP. • The CTPs comprising a GTP that supports a ***B-SNC*** service need not be contiguous. • For a ***B-SNC*** each supporting GTP shall be contained in a Physical Termination Point (PTP) or a Floating Termination Point (FTP). • For a ***B-SNC*** service spanning a non-singleton

	subnetwork, the aEnd and zEnd attributes are GTPs such that the CTPs comprising each GTP are contained in the same PTP or FTP
Source	TMF 513, Version 3.0, Requirement I.076

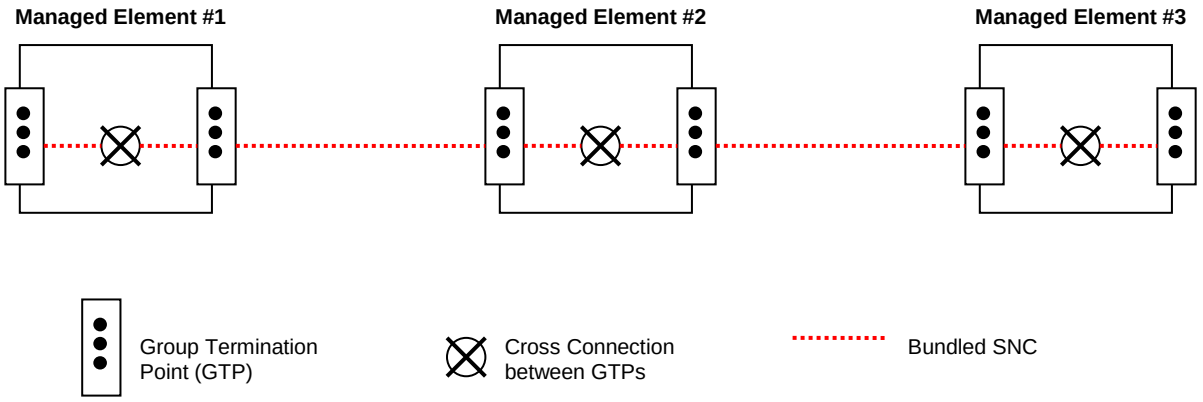

Figure 3-2: Bundled Subnetwork Connection

3.1.14 Cross Connect (XC)

R_TMF518_NRF_I_0033	A ***Cross-Connect (XC)*** object shall represent a physical connection within a Network Element (NE). An ***XC*** is atomic and is identified, similarly to an Subnetwork Connection (SNC) in a singleton subnetwork, based on its external shape. An ***XC*** is primarily used in the specification of the route of an SNC.
Source	TMF 513, Version 3.0, Requirement I.019

R_TMF518_NRF_I_0034	A ***XC*** object shall have the following attributes:
	• ***type*** - this attribute shall indicate the specific traffic flow through the ***XC***. (Refer to R_TMF518_NRF_I_0028).
	• ***directionality*** - this attribute shall represent the directionality of the ***XC***. The possible values for this attribute are:
	  • bidirectional
	  • unidirectional

	• ***active*** - this attribute shall indicate if the ***XC*** is active in the Network Element (NE).
	• ***fixed*** - this attribute shall indicate if the ***XC*** is fixed (i.e. cannot be deleted by the OS) or is flexible.
	• ***additional information*** - refer to R_TMF518_FMW_I_0001.
	• ***aEnd TP list*** - this attribute shall represent a list of the following aEnd Termination Points (TP):
	  • Connection Termination Point (CTP)
	  • Group Termination Point (GTP)
	  • Floating Termination Point (FTP)
	• ***zEnd TP list*** - this attribute shall represent a list of the following zEnd Termination Point (TP) s:
	  • Connection Termination Point (CTP)
	  • Group Termination Point (GTP)
	  • Floating Termination Point (FTP)

Source	TMF 513, Version 3.0, Requirement I.020

3.1.15 Route

R_TMF518_NRF_I_0035	The ***Route*** object shall represent the route of a Subnetwork Connection (SNC). A route shall be represented as a partially ordered series of Cross Connects (XC) through which the SNC traverses. Only XCs on the SNC's layer rate are part of the route. The XCs that are part of the route shall be listed from the NE on which the SNC starts (first entry) to the NE on which the SNC ends (last entry). A SNC may be associated with more than one ***Route*** • always 1 intended ***Route***, i.e. the preferred, or default Route • 0..n backup/alternative ***Route***(s) A ***Route*** belongs to only one SNC. However XCs/ Connection Termination Points (CTP) can be shared by ***Routes*** of different SNCs.
Source	TMF 513, Version 3.0, Requirement I.021

R_TMF518_NRF_I_0036	A ***Route*** object shall have the following attributes:

	• ***identifier*** - this attribute shall represent a unique identifier for the route within the context of the Subnetwork Connection (SNC) name. • ***contained XC list*** - this attribute shall represent the partially ordered list of Cross Connects (XC) that constitute the SNC route. • ***intended*** - this attribute shall indicate whether the route is the intended route (also referred to as the ***preferred***, or ***default*** route) or the backup route. The intended route could be simply the first time provisioned route, or the preferred route for a number of factors, from network engineering to intrinsic media reliability. The backup route shall be partly or totally different from intended route (but with same end points), and its main use is for restoration and maintenance purposes. • ***actual state*** - this attribute shall represent a summary state of the actual states of the XCs in the network, regardless of the SNC that the XCs are currently serving. It can assume only the following values: • ***inactive*** - none of the contained XCs are active in the network • ***active*** - all of the contained XCs are active in the network. So it is the route where SNC traffic is currently carried. There can be at most one active route per SNC. The ***in use by*** attribute shall indicate that the ***Route*** is not being used by another SNC. • ***partial*** - one or more, but not all the XCs are active in the network. • ***administrative state*** - this attribute shall represent whether the Route is allowed to be active or not. • ***in use by*** - this attribute shall indicate whether the Route is being used by another SNC. At Route is considered to be in use by another SNC if at least one of its XCs or CTPs is carrying traffic of another SNC. • ***exclusive*** - this attribute shall indicate that the ***Route*** can only be associated with a single SNC. This means that the XCs and CTPs that are contained by this Route can only be used by the SNC to which the Route is associated. • ***additional information*** - refer to R_TMF518_FMW_I_0001
Source	TMF 513, Version 3.0, Requirement I.089

3.1.16 Connection State

R_TMF518_NRF_I_0037	The ***connection state*** attribute of a Connection Termination Point (CTP) or Group Termination Point (GTP) object shall be have the following values: • ***Sink connected*** • ***Source connected*** • ***Bi-directionally connected*** • ***Not connected***
Source	TMF 513, Version 3.0, Requirement I.023

3.1.17 Matrix Flow Domain (MFD)

R_TMF518_NRF_I_0047	A ***Matrix Flow Domain (MFD)*** is contained within a Managed Element (ME) and represents a grouping of assigned Connectionless Port Termination Point (CPTP). These assigned CPTPs adapt to TPs at a client layer (Flow Points) that support connectionless switching. ***MFD***s are indirectly are interconnected via assigned CPTPs. The ***MFD***s are used to describe the Flow Domain Fragment (FDFr). An ***MFD*** shall be related to at most one FD. Note: If the layer the assigned CPTPs adapts to is the Ethernet MAC layer, the ***MFD*** corresponds to an IEEE 802.1 bridge.
Source	TMF 513, Version 3.5, Requirement I. 103

R_TMF518_NRF_I_0048	A ***Matrix Flow Domain (MFD)*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001 the following attributes: • ***layered transmission parameter list*** - this attribute shall represent the technology-specific parameters associated with the different connectionless layers (e.g. Ethernet, DVB) that are supported by the ***MFD***. Refer to chapter "Connectionless Technology Parameters" of the SD1-16 for details of the currently defined connectionless parameters. • ***flexible*** - this attribute shall indicate whether the ***MFD*** is fixed (i.e., cannot be configured by the NMS) or is flexible. • ***tmd state*** - this attribute shall indicate the state of consistency between the ***MFD*** and its associated Transmission Descriptor (TMD).
Source	TMF 513, Version 3.5, Requirement I. 104

3.1.18 Flow Domain (FD)

R_TMF518_NRF_I_0049	A ***Flow Domain (FD)*** represents a network grouping of zero or more Matrix Flow Domains (MFDs) and zero or more CPTPs that are assigned to these MFDs. FD Edge CPTPs represent the external access points to the ***FD***. FD Internal CPTPs represent the internal points within an FD. A "singleton" ***FD*** is an ***FD*** which contains only one MFD. A "singleton" ***FD*** does not have ***FD*** Internal CPTPs, hence, only has FD Edge CPTPs. The main services provided by an ***FD*** are to serve as container for Flow Domain Fragments (FDFrs) and for their set-up, modify and tear-down operations. **Note**: FDFrs represent connectionless (e.g., Ethernet) services. Additionally, an ***FD*** represents the network view of a region with potential connectionless services. Such a region may be associated with a given service provider's customer or internal network application.
Source	TMF 513, Version 3.5, Requirement I. 105

R_TMF518_NRF_I_0050	A ***Flow Domain (FD)*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001 the following attributes:
	
	• ***layered transmission parameter list*** - this attribute shall represent the technology-specific parameters associated with the different connectionless layers (e.g., Ethernet, DVB, Fiber Channel) that are supported by the ***FD*** for connectionless switching. Refer to chapter "Connectionless Technology Parameters" of the SD1-16 for details of the currently defined connectionless parameters (the same FD may support switching for different connectionless layers).
	
	• ***fd connectivity state*** - this attribute shall provide an indication to the NMS about the server layer connectivity between the MFDs associated to an FD. It shall have one of the following values:
	
	  • ***fully connected*** -
	
	  all FD Edge CPTPs are reachable from one another.
	
	  • ***not fully connected*** -
	
	  at least one FD Edge CPTP is not reachable by another FD Edge CPTP.

	• ***unknown*** -
	the connectivity state of the ***FD*** is not known by the OS. An OS providing the "connectivity-aware" mode is not allowed to set the value to "unknown".
	• ***fd type*** - this attribute shall provide an indication of the type of the ***FD***. It may have one of the following values:
	  • ***singleton*** -
	  the FD contains at most one MFD.
	  • ***network*** -
	  the FD may contain more than one MFD.

Source	TMF 513, Version 3.5, Requirement I. 106

3.1.19 Flow Domain Fragment (FDFr)

R_TMF518_NRF_I_0055	A ***Flow Domain Fragment (FDFr)*** is a logical entity that represents a transparent end-to-end connectivity between two or more Flow Points (FP) (at the same connectionless layer and with compatible directionality) within a Flow Domain (FD). As a consequence all FPs of the ***FDFr*** belong to this FD in the sense that they are client FPs of Connectionless Termination Points of this FD.
Source	TMF 513, Version 3.5, Requirement I. 110

R_TMF518_NRF_I_0056	A ***Flow Domain Fragment (FDFr)*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes:
	• ***directionality*** - this attribute shall represent the directionality of the ***FDFr*** (bidirectional or unidirectional).
	  Note: In the case of Ethernet, Directionality is always bidirectional.
	• ***layered transmission parameter list*** - this attribute shall represent the technology-specific parameters associated with the layer that the is connecting (e.g., Ethernet, DVB). Refer to SD1-16 for details of the currently defined connectionless parameters.
	• ***aEnd TP list*** - this attribute shall represent a list of Flow Points (FP) that delimit the ***FDFr*** and characterize its edges (entrance and/or exit points). They are clients of the FD Edge CPTPs.
	  In case of a unidirectional ***FDFr*** this attribute contains the list of source FPs. In case of a bidirectional ***FDFr*** this attribute may be combined with the zEnd TP list

	attribute to obtain all the FPs that are associated to the ***FDFr***.
	
	Note:
	
	For a bidirectional point to point ***FDFr*** it is suggested, but not mandatory, to put one TP in the aEnd TP list and one in the zEnd TP list, as with SNCs and TLs. For a multipoint ***FDFr***, or a point-to-point ***FDFr*** that may be expanded to multipoint, it is suggested to put all the TPs in the aEnd TP list.
	
	• ***zEnd TP list*** - this attribute shall represent a list of Flow Points that delimit the ***FDFr*** and characterize its edges (entrance and/or exit points). They are clients of the FD Edge CPTPs.
	
	In case of a unidirectional ***FDFr*** this attribute contains the list of sink FPs that delimit the ***FDFr*** and characterize its edges (exit points). They are clients of the FD Edge CPTPs.
	
	In case of a bidirectional ***FDFr*** this attribute may be combined with the aEnd TP list attribute to obtain **all** the FPs that are associated to the ***FDFr***.
	
	• ***flexible*** - this attribute shall indicate whether the ***FDFr*** is fixed or is flexible. Fixed means it cannot be modified or deleted by the NMS, in particular FPs cannot be added or removed.).
	
	• ***administrative state*** - this attribute shall indicate whether the ***FDFr*** is locked (i.e., traffic units cannot flow through the ***FDFr***) or unlocked (i.e., traffic units are allowed to flow through the ***FDFr***).
	
	• ***state*** - the ***FDFr*** state attribute indicates one of the following values:
	
	  • ***active***
	  this state identifies that all MFDFrs and all (edge and internal) FPs for the FDFr are active in the network.
	
	  • ***partial***
	  this state identifies that not all parts (MFDFrs or FPs) of the ***FDFr*** were created during the creation operation, or that not all parts of the ***FDFr*** were deleted during the deletion operation.
	
	• type - this attribute represents the type of the ***FDFr***. Possible values are:
	
	  • point-to-point
	
	  • point-to-multipoint (E-tree)
	
	  • multipoint

Source	TMF 513, Version 3.5, Requirement I. 111

3.1.20 Matrix Flow Domain Fragment (MFDFr)

R_TMF518_NRF_I_0059	A ***Matrix Flow Domain Fragment (MFDFr)*** object shall represent the portion of a Flow Domain (FD) within a Matrix Flow Domain (MFD) inside a Network Element (NE). An ***MFDFr*** is atomic and is similar to a Flow Domain Fragment (FDFr) in a singleton FD. An ***MFDFr*** is primarily used in the specification of a Flow Domain Fragment (FDFr), in cases where the route must be specified by the NMS.
Source	TMF 513, Version 3.5, Requirement I. 114

R_TMF518_NRF_I_0060	An ***MFDFr*** object shall have the following attributes: • ***aEnd TP list*** - this attribute shall represent a list of Flow Points (FPs) that delimit the ***MFDFr*** and characterize its edges (entrance and/or exit points). In case of a unidirectional MFDFr this attribute contains the list of source Flow Points. In case of a bidirectional MFDFr this attribute may be combined with the zEnd TPs attribute to obtain all the Flow Points that are associated to the MFDFr. • ***zEnd TP list*** - this attribute shall represent a list of sink Flow Points that delimit the MFDFr and characterize its edges (exit points). In case of a bidirectional MFDFr this attribute may be combined with the aEnd TPs attribute to obtain all the Flow Points that are associated to the MFDFr. • ***directionality*** - this attribute shall represent the directionality of the MFDFr (bidirectional or unidirectional). **Note**: In the case of Ethernet, the directionality is always bidirectional. • ***flexible*** - this attribute shall indicate whether the ***MFDFr*** is fixed or is flexible. (Fixed means it cannot be modified or deleted by the NMS, in particular FPs cannot be added or removed.). • ***active*** - this attribute shall indicate if the ***MFDFr*** has been successfully activated in the Network Element (NE). • ***type*** - this attribute represents the type of the FDFr. Possible values are: • point-to-point

	• point-to-multipoint (E-tree) • multipoint • ***additional information*** - Refer to R_TMF518_NRB_I_0001
Source	TMF 513, Version 3.5, Requirement I. 115

3.1.21 Flow Domain Fragment Route (FDFr Route)

R_TMF518_NRF_I_0057	An ***FDFr Route*** object shall represent the route of a Flow Domain Fragment (FDFr). An ***FDFr Route*** shall be represented as a partially ordered series of Matrix Flow Domain Fragment (MFDFr) s through which the FDFr traverses. Only MFDFrs on the FDFr's layer rate are part of the route. In case of a unidirectional route, the MFDFrs that are part of the route shall be listed from the Matrix Flow Domain (MFD) on which the FDFr starts (first entry) to the MFD on which the FDFr ends (last entry). A route belongs to only one FDFr. MFDFrs cannot be shared by routes of different FDFrs.
Source	TMF 513, Version 3.5, Requirement I. 112

R_TMF518_NRF_I_0058	An ***FDFr Route*** object shall have the following attributes:
	• ***contained MFDFr list*** - this attribute shall represent the partially ordered list of Matrix Flow Domain Fragments (MFDFrs) that constitute the FDFr route.
	• ***actual state*** - this attribute shall represent a summary state of the actual states of the MFDFrs in the network, regardless of the FDFr that the MFDFrs are currently serving. It can have only the following values:
	  • ***inactive*** - none of the contained MFDFrs are active in the network
	  • ***active*** - all of the contained MFDFrs are active in the network
	  • ***partial*** - one or more, but not all the MFDFrs are active in the network.
	• ***additional information*** - refer to R_TMF518_NRB_I_0001.

Source	TMF 513, Version 3.5, Requirement I. 113

3.1.22 Equipment

R_TMF518_NRF_I_0038	An ***Equipment*** object shall represent the manageable physical components of a NE such as the circuit packs, the fans and any other type of replaceable unit within the NE.
Source	TMF 513, Version 3.0, Requirement I.064

R_TMF518_NRF_I_0039	An ***Equipment*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes:
	• ***resource fulfillment state*** - this attribute shall indicate the current resource fulfillment state of the equipment. The possible values for this attribute are:
	  • In Service
	  • Out of Service
	  • Out of Service for Maintenance
	• ***alarm reporting*** - this attribute shall indicate whether alarm reporting for this equipment is enabled or disabled.
	• ***expected equipment type*** - this attribute shall represent the type of the expected equipment. This attribute may have no value if there is no expected equipment.
	• ***installed equipment type*** - this attribute shall represent the type of installed equipment. This is attribute may have no value if there is no installed equipment.
	• ***installed part number*** - this attribute shall represent the vendor's part number of the installed equipment.
	• ***installed serial number*** - this attribute shall represent the vendor's serial number of the installed equipment. The combination of the installed part number and the installed serial number for a specific piece of vendor equipment shall uniquely identify that equipment.
	• ***installed version*** - this attribute shall represent the vendor's version identifier for the installed equipment.
	• ***manufacturer*** - this attribute shall represent the name of the equipment vendor.
	• ***protection role*** - this attribute shall represent the protection role (e.g. primary or secondary) that the equipment plays in case it takes part in an equipment protection scheme
	• ***protection scheme state*** - this attribute shall indicate the current state of the protection scheme (i.e. whether it is active or locked).
	• ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment

	Profile (ASAP) that has been assigned to the equipment. • ***manufacture date*** – this attribute shall represent the date on which the NE was manufactured. It is relevant production data as defined in ISO 8601 and ISO/IEC 15418. The format shall be YYYYMMDD.
Source	TMF 513, Version 3.0, Requirement I.032 TMF 517, Version 1.2, Requirement (1.1)I.1

3.1.23 Equipment Holder

R_TMF518_NRF_I_0040	An ***Equipment Holder*** object shall represent resources of the Network Element (NE) that are capable of holding other physical components. Specific resources that are represented by an ***Equipment Holder*** object shall be for instance racks (bays), shelves, and slots or sub-slots.
Source	TMF 513, Version 3.0, Requirement I.033

R_TMF518_NRF_I_0041	An ***Equipment Holder*** shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***alarm reporting*** - this attribute shall indicate whether alarm reporting for this equipment holder is enabled or disabled. • ***type*** - this attribute shall indicate the type of the physical container represented by the ***Equipment Holder*** e.g. a rack, a shelf, a sub-shelf, a slot or sub-slot. • ***expected or installed equipment*** - this attribute shall represent the equipment that is installed or is expected to be installed in the physical container represented by the Equipment Holder. • ***acceptable equipment type list*** - this attribute shall represent a list of the types of Equipment that can be contained by the ***Equipment Holder***. Note: this shall apply when the Equipment Holder represents a slot. • ***state*** - this attribute shall represent the current condition of the ***Equipment Holder*** with respect to the contained equipment. • ***alarm severity assignment profile*** - this attribute shall represent the name of the Alarm Severity Assignment Profile (ASAP) that has been assigned to the

	Equipment Holder. • ***manufacture date*** – this attribute shall represent the date on which the NE was manufactured. It is relevant production data as defined in ISO 8601 and ISO/IEC 15418. The format shall be YYYYMMDD. • ***manufacturer*** – this attribute shall represent the name of the business entity responsible for the manufacture of the ***Equipment Holder***. • ***location*** - this attribute shall represent the geographical location of the ***Equipment Holder***.
Source	TMF 513, Version 3.0, Requirement I.065 TMF 517, Version 1.2, Requirement (1.1)I.2 TMF 517, Version 1.2, Requirement (1.1)I.3 TMF 517, Version 1.2, Requirement (1.1)I.4

3.1.24 Transmission Descriptor (TMD)

R_TMF518_NRF_I_0042	A ***Transmission Descriptor (TMD)*** object represents a collection of attributes, which are used to define multi-layered transmission parameters, and additional information parameters on a Termination Point (TP).
Source	TMF 513, Version 3.0, Requirement I.078

R_TMF518_NRF_I_0043	A ***TMD*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***layered transmission parameter list*** - this attribute shall represent a list of transmission parameters which can be set and/or retrieved at a specified layer on a Termination Point (TP) having this ***TMD*** assigned as an egress or ingress ***TMD***. For each layer, a layer-specific Alarm Severity Assignment Profile (ASAP) can be embedded into the respective single-layer list of transmission parameters. • ***additional object information*** - this attribute shall represent additional parameters which can be set and/or retrieved on an object having this ***TMD*** assigned as egress or ingress ***TMD***. • ***external representation*** - this attribute shall represent a reference to the external representation of the ***TMD*** (e.g., an XML file name). The contents of this information is opaque at the Interface and not utilized.
Source	TMF 513, Version 3.0, Requirement I.079

3.1.25 Traffic Conditioning (TC) Profiles

R_TMF518_NRF_I_0052	A ***Traffic Conditioning (TC) Profile*** contains the parameters that police the traffic at the ingress and or egress (in this version only ingress is supported) of a connectionless layer (e.g., Ethernet) network. The policies can be applied to: • a UNI / NNI port (CPTP) (e.g., for Ethernet per VLAN-Id, Priority and CoS) • a point of an Flow Domain Fragment (FDFr) (FP) (e.g., for Ethernet per VLAN-Id, Priority and CoS) ***TC Profiles*** are associated to CPTPs and FPs via the "Traffic Mapping Table" contained in the "***layered transmission parameter list***" attribute. Refer to the SD1-16 for details of the "Traffic Mapping Table". The association of a ***TC Profile*** to an FP or a CPTP is defined in a "cascaded" manner; i.e., parameters associated to traffic units at a CPTP can be overwritten by parameters associated to the same traffic units at an FP.
Source	TMF 513, Version 3.5, Requirement I.107

R_TMF518_NRF_I_0053	The ***TC Profile*** object shall have, in addition to the attributes identified in R_TMF518_NRB_I_0001, the following attributes: • ***default profile*** - this attribute shall indicate whether the ***TC Profile*** can be deleted (modification may be possible or rejected). An OS may contain more than one default profile which condition different TPs. • ***layered traffic conditioning parameter list*** - this attribute shall represent a list of traffic conditioning parameters which can be set and/or retrieved at a specified connectionless layer on a Termination Point (TP) having this ***TC Profile*** assigned. Refer to chapter "Traffic conditioning parameters" of the SD1-16 for details of the currently defined traffic conditioning parameters.
Source	TMF 513, Version 3.5, Requirement I.108

R_TMF518_NRF_I_0054	The OS has to make sure that the traffic conditioning and traffic mapping configured in the NE is always represented by appropriate traffic mapping tables at the CPTPs, FPs or at both. In the case where the requesting OS does not provide a traffic mapping table (or not a complete one), the target OS has to provide the appropriate traffic mapping tables. For details of the traffic mapping table refer to SD1-16. The traffic mapping table shall represent the current configuration of the TPs.

Source	TMF 513, Version 3.5, Requirement I.109

3.1.26 Notifications

R_TMF518_NRF_I_0063	The Interface shall support a reliable mechanism for an OS to send event notifications to other OSs on the CCV.
Source	TMF 517 Version 1.2, Requirement II.22

Table 3-1 identifies the different specific event types that have been defined for the Interface.

Table 3-1 Event Notification Types

	Event
1	Object Creation Notification
2	Object Deletion Notification
3	Object Discovery Notification
4	Attribute Value Change Notification
5	State Change Notification
6	Multi-Event Inventory (MEI) Notification
7	Route Change Notification
8	

3.1.26.1 Object Creation Notification

R_TMF518_NRF_I_0064	The Interface shall support subscription to notifications by interested parties related to the creation of instances of the following objects types: • Equipment • Equipment Holder • Floating Termination Point • Flow Domain • Flow Domain Fragment • Group Termination Point • Managed Element • Matrix Flow Domain • MultiLayer Subnetwork • OS

	• Physical Termination Point • Subnetwork • Subnetwork Connection • Termination Point Pool • Topological Link • Traffic Conditioning Profile • Transmission Descriptor
Source	TMF 513 Version 3.1, Requirement II.064

3.1.26.2 Object Deletion Notification

R_TMF518_NRF_I_0065	The Interface shall support subscription to notifications by interested parties related to the deletion of instances of the object types listed in R_TMF518_NRF_I_0064
Source	TMF 513 Version 3.1, Requirement II.065

3.1.26.3 Object Discovery Notification

R_TMF518_NRF_I_0066	The Interface shall support subscription to notifications by interested parties related to the discovery of instances of the object types listed in R_TMF518_NRF_I_0064
Source	TMF 517 Version 1.2, Requirement II.25

3.1.26.4 Attribute Value Change Notification

R_TMF518_NRF_I_0067	The Interface shall support subscription to notifications by interested parties related to attribute value changes for instances of the object types listed in R_TMF518_NRF_I_0064 and the following object types: • Connection Termination point
Source	TMF 513 Version 3.1, Requirement II.066

3.1.26.5 State Change Notification

R_TMF518_NRF_I_0068	The Interface shall support subscription to notifications by interested parties related to state changes for instances of the following object types: • Connection Termination Point • Equipment

	• Equipment Holder • Floating Termination Point • Flow Domain • Managed Element • Physical Termination Point • Subnetwork Connection
Source	TMF 513 Version 3.1, Requirement II.067

R_TMF518_NRF_I_0069	The Interface shall support inventory notifications (object creations, object deletions, attribute value change and state change) for all ***Managed Element***s meeting filter criteria based on any combination of: • ***location***, • ***manufacturer***, • ***productName*** and • ***resourceState***. (if supported)
Source	TMF 517 Version 1.2, Requirement II.28

When a container object (i.e., an object that contains many other object instances) is created, modified or deleted, there are typically many notifications associated with the event. For example, when an ME is created there will also be object creation notifications (OCNs) for all the contained equipment (EQ), equipment holders (EQH), and PTPs. In many cases, an OS may not want to receive all these notifications. It may simply want to know about the ME creation and then retrieve all the contained objects in the ME.

R_TMF518_NRF_I_0070	Support for notification suppression of objects associated with a newly created container object shall be stated in the implementation statement associated with an OS (i.e., in a static mode, and the process is not automated).
Source	TMF 517 Version 1.2, Requirement II.30

3.1.26.6 Multi-Event Inventory (MEI) Notification

R_TMF518_NRF_I_0071	The Interface shall allow an OS to report on a collection of (not necessarily related) inventory events using an inventory layout structure that is carried in one or more Multi-Event Inventory (MEI) notifications.
Source	TMF518_MRI, Version 1.0

R_TMF518_NRF_I_0072	The various inventory events shall be mapped to a MEI

	notification as described in Table 3 2.
Source	TMF518_MRI, Version 1.0

Table 3-2: Mapping of Inventory Events to Layout carried in an MEI notification

Inventory Event	InformationMapping to Inventory Layout
Object Creation (OC)	Include the data structure for newly created objects with all known attribute values and relationships. The containing objects should be included in the layout (just the object names in cases where the containing object has already been reported).
Object Discovery (ODsc)	Include the data structure for the discovered object with all known attribute values and relationships. The *discovered name* would be included in lieu of the object's *name*. The containing objects should be included in the layout (just the object names in cases where the containing object has already been reported).
Object Deletion (OD)	Include only the deleted object's name and resourceState (set to "Retiring/unavailable") would be reported. The containing objects should be included in the layout (just the object names in cases where the containing object has already been reported). None of the contained objects would be reported (the receiving OS should assume all contained objects are also in the "Retiring/unavailable" state).
Attribute Value Change (AVC)	Include the object with at least the attributes whose values have changed. However, it is acceptable to include the entire data structure (i.e., all attributes) for the object. The containing objects should be included in the layout (just the object names in cases where the containing object has already been reported).
State Change (SC)	Similar treatment to AVCs, except that the source OS may want to send state change notifications immediately (via an individual notification) when the state change is related to a fault condition.

R_TMF518_NRF_I_0073	The MEI notification shall have the following parameters: • ***notificationID*** – an identifier for the notification. The uniqueness and the sequence of the notificationId are not guaranteed. • ***osTime*** – the time at which the sending OS generated the notification • ***events*** – this data structure details the collection of events. It makes use of the inventory layout. • ***vendorExtensions*** – this is used by the OS supplier to append additional parameters to the MEI notification.
Source	TMF518_NRF, Version 1.0

R_TMF518_NRF_I_0074	The following attributes appear in individual objects that

	comprise the inventory layout conveyed in an MEI notification:
	• ***neTime*** – (if known) the time at which the NE detected the inventory change. This only applies to the ME and objects within since an NE would not typically know about containing objects such as subnetworks and management domains.
	• ***eventIndication*** – this attribute indicates the type of change that is being reported for a given object. Possible values are:
	  • ***Object Creation (OC)***,
	  • ***Object Discovery (ODsc)***,
	  • ***Object Deletion (OD)***,
	  • ***Attribute Value Change (AVC)***,
	  • ***State Change (SC)*** and
	  • ***AVC_SC_and_Childern***.
	  Only the acronym (e.g., OC) is used in the actual attribute value. The following conventions apply:
	  • If an object creation or object discovery indicator is applied to a parent object, it implicitly applies to all the children, i.e., the OS sending the notification only needs to set the indicator attribute in the parent object.
	  • If an object deletion is applied to a parent object, it is assumed that all the children are also deleted. The childern should not be listed.
	  • The AVC_SC_and_Childern indication may be applied to a parent object to imply that there may be AVC or SC changes to the parent and some or all of the children.

Source	TMF518_NRF, Version 1.0

3.1.26.7 Route Change Notification

R_TMF518_NRF_I_0046	A ***Route Change Notification*** is an event used across the Interface to indicate a change in a Subnetwork Connection (SNC) Route. A Route Change Notification shall have in addition to the attributes identified in R_TMF518_FMW_I_0011 the following attributes: • ***edge point related*** - this attribute shall indicate whether the event is related to a Termination Point (TP) at the edge of a subnetwork. (Refer to R_TMF518_NRF_I_0008)

	• ***route change state*** - this attribute shall represent the current state of the route change (i.e. started, completed, or failed). • ***route*** – this attribute shall represent the new Route following a successful route change.
Source	TMF513 v3.0, Requirement I.059

3.1.26.8 Software Backup Status Notification

R_TMF518_NRF_I_0075	A ***Software Backup Status Notification*** is an event used across the Interface to indicate the status of the backup of Managed Element (ME) data. A Software Backup Status Notification shall have in addition to the attributes identified in R_TMF518_FMW_I_0011 the following attributes: • ***backup status*** - this attribute shall represent the current state of the transfer (i.e. idle. in progress, completed, aborted or failed)
Source	TMF513 v3.0, Requirement I.086

3.1.26.9 File Transfer Status Notification

R_TMF518_NRF_I_0076	A ***File Transfer Status Notification*** is an event used across the Interface to indicate the status of the transfer of the performance monitoring data file. A File Transfer Status Notification shall have in addition to the attributes identified in R_TMF518_FMW_I_0010 the following attributes: • ***file name*** - this attribute shall represent the name of the file being transferred (this shall include the path name). • ***transfer status*** - this attribute shall represent the current state of the transfer (in progress, failed or completed) • ***percentage complete*** - this attribute shall indicate the percent complete of the file transfer it shall be in the range 0..100. • ***reason for failure*** - this attribute shall represent, in the event of a failure, reason for the failure.
Source	TMF513 v3.0, Requirement I.058

3.2 Category II: Normal Sequences, Dynamic Requirements

Not Applicable.

3.3 Category III: Abnormal or Exception Conditions, Dynamic Requirements

Not Applicable.

3.4 Category IV: Expectations and Non-Functional Requirements

Not Applicable.

3.5 Category V: System Administration Requirements

Not Applicable.

4 Use Cases

Not Applicable.

5 Traceability Matrices

Not Applicable.

6 Future Directions

None identified at this time.

7 References

7.1 References

[1] TMF513, Multi-Technology Network Management (MTNM) Business Agreement, Version 3.1, March 2007.

[2] TMF518_FMW, Framework DDP-BA

[3] TMF518_NRB, Network Resource Basic DDP-BA

[4] TMF518_NRA, Network Resource Assurance DDP-BA

[5] SD1-16, Layered Parameters

[6] SD1-18, Functional Modeling Concepts

[7] SD1-44, Connectionless Technology Management

[8] SD0-1, Dictionary

7.2 IPR Releases and Patent Disclosure

There are no known IPR claims on the material in this document. As per the TM Forum bylaws, any TM Forum member company that has IPR claims on this or any TM Forum specification needs to make the claims known to the TM Forum membership immediately.

8 Administrative Appendix

This Appendix provides additional background material about the TM Forum and this document.

8.1 About this document

This document has been generated from the SD0-3_Template_BA.dot Word template.

8.2 Use and Extension of a TM Forum Business Agreement

This document defines the business problem and requirement model for resource fulfillment. The Business Agreement is used to gain consensus on the business requirements for exchanging information among processes and systems in order to solve a specific business problem. The Business Agreement should feed the development of Information Agreement(s), which is a technology-neutral model of one or more interfaces. While the Business Agreement contains sufficient information to be a "stand alone" document, it is better read together with the Information Agreement document TMF612_NRF when the Information Agreement is available. Reviewing the two documents together helps in gaining a full understanding of how the technology neutral information model solution is defined for this requirement model. An initial Business Agreement may only deal with a subset of the requirements. It is acceptable for subsequent issues of the document to add additional requirements not addressed by earlier releases of the BA. Business Agreements are the basis for requirement traceability for information models.

- It is expected that this document will be used:
- As the foundation for a TM Forum Information Agreement(s)
- To facilitate requirement agreement between Service Providers and vendors
- As input to a service Provider's Request for Information / Request for Proposal (RFI/RFP—RFX)
- As input for vendors developing COTS products
- As a source of requirements for other bodies working in this area

8.3 Document History

Version	Date Modified	Description of changes
1.0	September 2007	This is the first version of the document and as such, there are no changes to report.
1.1	May 2008	Updated based on review and consolidation comments for the preparation of the MTOSI 2.0 release

1.2	September 2011	Updated sections 1.1 and 2. Replaced mTOP by MTNM / MTOSI everywhere in the document Added SNC to the list of included resources in R_TMF518_NRF_I_0030 Corrected missing references in section 3.1.13.

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8.5 Acknowledgments

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