International Telecommunication Union

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TELECOMMUNICATION STANDARDIZATION SECTOR OF ITU

G.8601/Y.1391

(06/2006)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

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Internet protocol aspects – Transport

Architecture of service management in multi-bearer, multi-carrier environment

ITU-T Recommendation G.8601/Y.1391

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ITU-T Recommendation G.8601/Y.1391

Architecture of service management in multi-bearer, multi-carrier environment

Summary

This Recommendation defines a set of requirements that are applicable to Client Service Management in multi-carrier, multi-transport-technology networks.

Source

ITU-T Recommendation G.8601/Y.1391 was approved on 6 June 2006 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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ITU-T Recommendation G.8601/Y.1391

Architecture of service management in multi-bearer, multi-carrier environment

1 Scope

This Recommendation defines architectural requirements for the edge-to-edge management and/or control of client services transported over various transport network topologies and technologies. The services for which such management capabilities are required are included.

The requirements for the transference of the management and/or control data between the edge points is described along with the requirements for accessibility to management and/or control information at some point in the network, other than the end point.

The provision of such management services is also considered in the context of business relationships that may be involved in the delivery of a service to, for example, the Service Provider, Network Operator(s) and the Enterprise End customer. Consideration is also given to the management and/or control of Customer Located Equipment which is owned by the Service Provider and carrying said services.

Although the client service management detail is not within the scope of this Recommendation, consideration is given to three generic management and/or control functions: performance reporting, status reporting and client service control (e.g., loopback, end node configuration, etc).

This Recommendation describes the architecture for service management and/or control, and includes the reference points of the architecture. It does not define the implementation methodology or any of the interfaces that may need to be specified.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.707/Y.1322 (2007), *Network node interface for the synchronous digital hierarchy (SDH).*

– ITU-T Recommendation G.709/Y.1331 (2003), *Interfaces for the Optical Transport Network (OTN).*

– ITU-T Recommendation G.806 (2006), *Characteristics of transport equipment – Description methodology and generic functionality*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 anomaly: (See ITU-T Rec. G.806) The smallest discrepancy which can be observed between the actual and desired characteristics of an item. The occurrence of a single anomaly does not constitute an interruption in the ability to perform a required function. Anomalies are used as the input for the Performance Monitoring (PM) process and for the detection of defects.

3.2 **defect**: (See ITU-T Rec. G.806) The density of anomalies has reached a level where the ability to perform a required function has been interrupted. Defects are used as input for PM, the control of consequent actions, and the determination of fault cause.

3.3 **degrade**: A degrade is the presence of a defect for a sufficient period of time that impairs the ability of a resource to perform the desired function.

3.4 **edge service**: The service from the perspective of a single SOF.

3.5 **edge-to-edge**: The path serving the service that sources at a local SOF (Service Origination Function) and sinks at a remote SOF.

3.6 **end-to-end**: The complete path that the customer/client signal takes that sources at a local Customer Equipment (CE) and sinks at the remote CE.

3.7 **failure**: (See ITU-T Rec. G.806) The fault cause persisted long enough to consider the ability of an item to perform a required function to be terminated. The item may be considered as failed; a fault has now been detected.

3.8 **fault**: (See ITU-T Rec. G.806) A fault is the inability of a function to perform a required action. This does not include an inability due to preventive maintenance, lack of external resources, or planned actions.

3.9 **management access point (MAP)**: The Management Access Point is the point in the transport network where the Management System has its point of contact for purposes of management and/or control. This MAP may be at any point in the transport network including at the edge of the transport network.

3.10 **network resource**: Resources that are owned and managed by the SP in support of the offered customer service.

3.11 **service status**: Service status indicates that the service is in one of four states.

1) Operational: Service is operating within the bounds of the established SLA.
2) Degraded: Service is operational; however, its performance is degraded in reference to the SLA.
3) Failure: Service failure has occurred and is not operational.
4) In-test: Service is under control of service/network operator for maintenance actions.

Service failure may be attributed to path level defects, service failures at the client link, or significant disparity in achieving adherence to the SLA.

The Service Status is generated by each SOF. The Service Status is generated by comparing local edge-service PMs and remote edge-service PMs (conveyed between edges) to formulate edge-to-edge service PMs. These edge-to-edge service PMs are then compared to SLA thresholds to determine the operational disposition of the service.

3.12 **service management function (SMF)**: A logical entity found within a service-aware NE that performs Management Access Point (MAP) and/or Test Access Point (TAP) functions.

3.13 **service origination function (SOF)**: The Network Element (NE) function, managed by the Service Provider (SP) which represents the edge optical service point. It performs customer frame/signal mapping to the SP optical network. Typically incorporates a SMF.

3.14 **user network interface (UNI)**: The UNI is the bearer between the CPE and the Network.

4 Acronyms and abbreviations

This Recommendation uses the following abbreviations:

C/R	Command Response
CE	Customer Equipment
CLE_NE	Customer Located Equipment Network Element
CPE	Customer Premises Equipment
CSM	Client Service Management
EM	Element Management
ETH	Ethernet MAC layer network
ETY	Ethernet Physical interface
FD	Flow Domain
MAP	Management Access Point
NE	Network Element
NM	Network Manager
NMS	Network Management System
NNI	Network to Network Interface
NO	Network Operator
OAM	Operations, Administration and Maintenance
OAMiF	OAM in Frame
OM-n	Ownership Model n
OSS	Operations Support System
OTN	Optical Transport Network
PDH	Plesiochronous Digital Hierarchy
PE	Provider Edge
PL	Private Line
PM	Performance Monitoring
PTE	Path Terminating Equipment
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
SM	Service Management
SMF	Service Management Function
SNC	SubNetwork Connection
SOF	Service Origination Function
SP	Service Provider
SS	Service Status
TAP	Test Access Point
UNI	User Network Interface

5 Conventions

5.1 Nomenclature

For purposes of signal identification, the following nomenclature will be used in this Recommendation.

Signal Names will have the format: Letter.number.number

Where: Letter represents the Service Provider (SP):

(e.g., R = Red SP; B = Blue SP; G = Green SP; P = Purple SP).

Number represents the individual signal number belonging to the SP.

Number represents the Ownership Model (OM).

Examples:

R.3.1 is Owned by Red SP (SP_R), and is SP_R's 3rd signal and is configured as OM-1.

B.1.0 is Owned by Blue SP (SP_B), and is SP_B's 1st signal and is configured as OM-0.

P.2.2 is Owned by Purple SP (SP_P), and is SP_P's 2nd signal and is configured as OM-2.

NOTE – The ownership model at each edge of a client signal connection may be different; this is dependant on the location of the MAP and whether the SP owns the edge device.

6 Introduction

Service providers are demanding a simple service model for transport of Client Data Services over networks that fits their existing operational model. That is, the Client Data private line service must be analogous to existing private line services, and more importantly must interface into existing management systems.

This Recommendation is structured with **numbered requirements** integrated into the descriptive normative clauses. In some instances where a requirement is applicable to more than one clause, there will be a reference to the original instance of that requirement. All requirements will appear on a separate line in **Bold**.

NOTE – The numbering is not always contiguous to allow for insertion of requirements if and when this Recommendation is updated.

R1 Management of the Client Private Line Service should interface to existing management systems.

R2 A defect or failure in a given layer network should not cause multiple alarm events to be raised, nor cause unnecessary corrective actions to be taken, in any higher level client layer networks. This applies to all client layer network types that the Private Line service is required to carry.

R3 If a network defect or failure occurs in an interface, mapping function, or path, it is necessary to detect it, diagnose it, localize it, notify the NMS/OSS and take corrective actions appropriate to the type of defect. The primary objective is to reduce operating costs by minimizing service interruptions, operational repair times and operational resource.

The business drivers for managed Client Services are:

- Manageability of the network.
- Management of the service offered to the customer.
- Interconnection of billing/management data to carrier OSS systems.
- Accessibility of performance data for confirmation of service level agreement (SLA) conformance.

Also of importance is the manageability of remotely located Customer Located Equipment (CLE).

Several business models are used to define the requirements for Client Service Management (CSM).

The Network Technologies and combinations thereof are defined, as are the applicable Client Service types.

R4 To confirm SLA compliance with the customer, the Service Provider (SP) must have visibility of the performance of the Client Interface at the edge of the transport network.

a) The edge NE must support the ability of a remote device to query service configuration information (i.e., Service or Circuit ID, service PM, thresholds, etc.).

R5 To confirm SLA compliance with the customer, the SP must have visibility of the mapping function performance at the edge of the transport network.

a) The edge NE must support the ability of a remote device to query the edge devices mapping function performance.

7 General description of client service management

Client Service Management (CSM) is the management and/or control of the client services by the Service Provider (SP), regardless of the location of the SP (within the topology of the transport network) and consists of the following general management and/or control functions:

a) Performance Monitoring at the edge of the transport network.

b) Monitoring of the status of the edge-to-edge transport connection.

c) Control of the 'edge' device (commands and responses to/from the edge device).

d) Generation and reception of anomalous conditions of the service and the NE at the edge.

The components of CSM will be dependant on:

1) Business relationships between SP and enterprise customer.
   i) Single Carrier configuration.
   ii) Multiple Carrier configuration.

2) Network transport technologies (and combinations thereof).

3) Communications between SP and edge device necessary for a – d above.

7.1 General management areas

While more complex network diagrams are possible, a simple model of a Client Data network to show the management areas would only show the endpoints of a single carrier's network. This is based on the relationship shown in Figure 1.

The simple Client Data network management areas shown in Figure 1 are:

A End-to-End: CE – CE (i.e., service – customer to customer): Customer OAM.

B Access Link: CE – PE (i.e., facility – carrier to customer): Access OAM.

C Edge-to-Edge: PE – PE (i.e., service – intra carrier): Service OAM.

D Transport (i.e., facility – intra carrier): Path OAM.

FCAPS (fault, configuration, accounting, performance, and security) is an acronym for a categorical model of the working objectives of network management. The carriage of management information is often dependant on the network or service that is being managed. Each of these four areas would have a carriage and FCAPS component.

R6 The OAM functionality of optical PL service should not be dependant on any specific server or client-layer network. This is architecturally critical to ensure that layer networks can evolve (or new/old layer networks be added/removed) without impacting other layer networks.

R7 The use of Service OAM functions should be optional for the operator. Network operators should be able to choose which OAM functions to use and which connections they apply them to.

R8 In the case of failures, OAM mechanisms provided should ensure (as far as reasonably practicable) that customers should not have to detect failures. It is therefore necessary that service faults be detected and notifications sent to the SP.

R9 In the case of degraded performance, OAM mechanisms provided should ensure (as far as reasonably practicable) that customers should not have to detect service degrades. It is therefore necessary that service degrade conditions be detected and notifications sent to the SP.

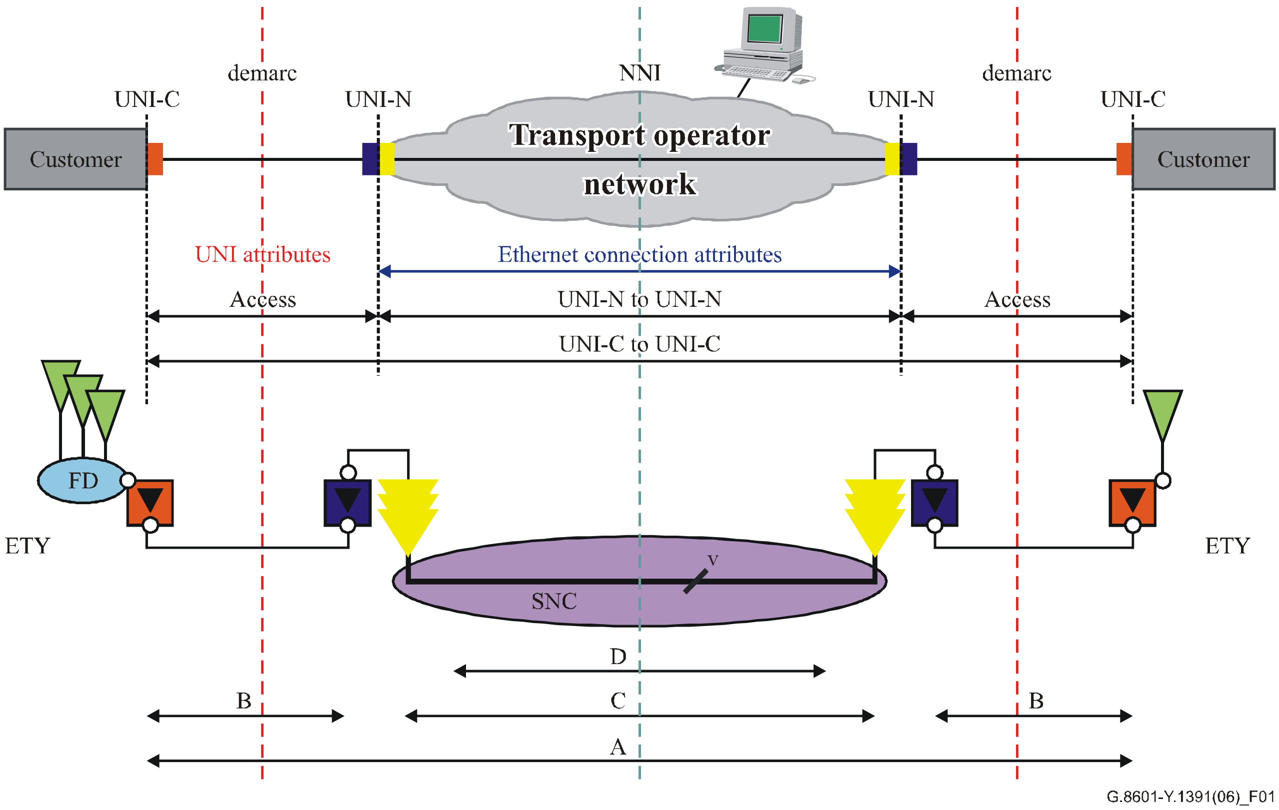

Figure 1/G.8601/Y.1391 – Simple view of general management areas

7.1.1 End-to-end management

This is the management performed by the Enterprise customer between clients at both ends (A in Figure 1). This service management of live traffic assumes the Client Data link through the transport network to be transparent.

7.1.2 Access link management

This is the enterprise customer to transport portion of the Client Data connection (B in Figure 1).

7.1.3 Edge-to-edge management

This is the management of Client Data Services over the transport network (C in Figure 1). This will carry data relating to the service edge function/process and also relevant information from the terminated link management.

7.1.4 Transport management

This is the network management of the carrier's facilities, for example, fault isolation within the carrier's network (D in Figure 1). It is performed using well-defined transport network management techniques.

7.2 OAM flow categories

7.2.1 Customer OAM

- This OAM flow identifies the OAM operations associated with the connection between the CPE source and CPE sink devices. This flow identifies the OAM functionality supported between two customer sites.

7.2.2 UNI OAM

- This OAM flow identifies the OAM operations associated with the connection between the SOF and the CE. For example in the case of Ethernet service, the OAM operations are based on IEEE 802.3ah (i.e., Ethernet Link OAM).

7.2.3 Path OAM

- Path OAM flows are between PTEs.
- These flows identify OAM operations associated with network resource (e.g., equipment) management functions.

7.2.4 Service OAM

- This OAM flow identifies the OAM operations associated with the edge-to-edge service. OAM information conveyed in the Service OAM flow can include network path level OAM and UNI link OAM information.
- Service OAM flows follow the network path flows serving the service being offered. It can be optionally monitored at intermediate optical service NEs.

8 Business relationship models: Service provider to end customer

It is important to understand who is buying what and from whom when Broadband Services are being transported over a transport network. In the following models, it is assumed that the Client Data Private Line service is being sold by a Service Provider to an Enterprise end customer.

In all business relationship models, the Management Access Point (MAP) could be at any NE along the transport path.

A Client Service Management scheme is required that will be consistent and compatible with several business relationship models.

R10 The ability of the Management Access Point (MAP) located at any point along the transport path to perform service/network/equipment management functions on the edge/remote or CLE/NE devices is required.

a) If the end-to-end PL service is being transported over networks belonging to different operators, the operator that offers the service to the customer should be aware of a service fault even if the fault and detection point are located in the network of another operator.

R11 The SP requires a management connection to the Edge NE for PM reporting purposes.

a) This performance monitoring will be governed by the technology of the native customer signal.

R12 The SP needs to be notified of anomalous service conditions at the edge of the transport network. This notification needs to be done in a timely manner.

R13 The SP needs to be able to do rudimentary intrusive control at the Edge NE for purposes of Management of the Client Service. The edge NE must support the ability of a remote device to modify, add, or set service configuration information. For example:

a) To query Service or Circuit ID (service PM, thresholds, etc.).

b) To activate/deactivate the service.

c) To interrogate the client interface status.

d) To apply loopback(s) in test & commission phase.

8.1 Single carrier: Ownership Model 0 (OM-0)

The simplest ownership model is the single carrier model, shown in Figure 1. The customer – supplier relationship is between the enterprise customer and the service provider. That is, payment for service is from enterprise customer to service provider only. This is a retail only model. For OM-0 the SP owns the entire transport network across which the Client Signal is to be transported. The SP therefore provides connectivity and mapping to transport the Client Signal. Since there are performance guarantees per a contract, there is a resulting SLA between the demarcation points (demarc or UNI) as noted in Figure 1.

The network connection and transport facility path are virtually identical – the transport path starts just after service encapsulation.

In this single-carrier case, it is desirable to have an operational model that is consistent with the multi-carrier case. (See clause 8.2.)

Single Carrier Model (Ownership Model 0) is depicted in Figure 2:

- NO_R and SP_R are synonymous.
- NO_R provides transport connection for the edge-to-edge service.
- NO_R provides transport PTE functions.
- NO_R performs client frame adaptation (mapping) into transport.
- SP_R is the Service Provider (SP) and has a SLA with the enterprise customer (shown as CPE).
- To confirm SLA compliance with the customer, SP_R needs to have visibility of the performance of the Client Interface and the mapping function.
- SP_R requires a management connection to NO_R's Edge NE for PM reporting purposes.
- SP_R needs to be able to do rudimentary intrusive control at NO_R's Edge NE for purposes of Management of the Client Service.
  – For example to activate/deactivate the service; interrogate the client interface status; apply loopback(s) in test & commission phase.

Figure 2 also shows that in the Single Carrier network Scenario:

- Each Network 'edge' device can have several service instances (example: R.1.0 & R.2.0 connected to edge device E-R1).
- There can be several Network edge devices in the network (example: E-R1 & E-R2) each carrying multiple services.
- In the single carrier case, there is only one SP that requires access to the edge device(s).

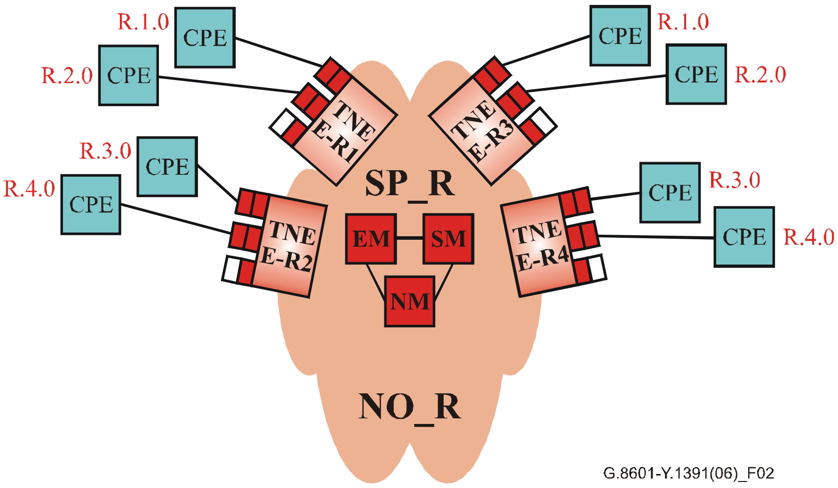

Figure 2/G.8601/Y.1391 – Single carrier network – Ownership Model 0

R14 The CSM operational model for Single Carrier network (OM-0) must be consistent with that for the Multi-Carrier (OM-1 and OM-2) network(s); see 8.2.

R15 Each Network 'edge' device can have several service instances (example Figure 2: R.1.0 & R.2.0 connected to edge device E-R1).

R16 There can be several Network edge devices in the network (example Figure 2: E-R1 & E-R2) and each edge device can carry multiple services.

Requirements 10, 11, 12 and 13 also apply to the OM-0 case.

8.1.1 Single carrier dark fibre connection

An alternative Single Carrier scenario is depicted in Figure 3. Here the SP could offer a managed connection, which is provided by two equipments directly interconnected via a fibre (or a wavelength). The signal carried would be the customer's native signal and would be different from the NO's network transport technology (for example NO is SDH while customer's native signal is OTN or GbE).

In this case:

- NO_R and SP_R are synonymous.
- NO_R provides only dark fibre for the edge-to-edge native customer signal.
- NO_R performs adaptation of customer's native signal onto dark fibre/wavelength.
- SP_R is the Service Provider (SP) and has a SLA with the enterprise customer (shown as CPEs connected to E-R5 and E-R6 in Figure 3).
- To confirm SLA compliance with the customer, SP_R needs to have visibility of the performance of the Client Interface and the adaptation function.
  - This performance monitoring will be governed by the technology of the native customer signal.

- SP_R requires a management connection to NO_R's Edge NE for PM reporting purposes.
- SP_R needs to be able to do rudimentary intrusive control at NO_R's Edge NE for purposes of Management of the Client Signal.
  - For example to activate/deactivate the service; interrogate the client interface status; apply loopback(s) in test & commission phase.

In the Single Carrier dark fibre Scenario (similarly to the Single Carrier case above but not depicted):

- Each Network 'edge' device can have several native customer signal instances.
- There can be several Network edge devices in the network each carrying multiple native customer signals.
- In the single carrier case, there is only one SP that requires access to the edge device(s).

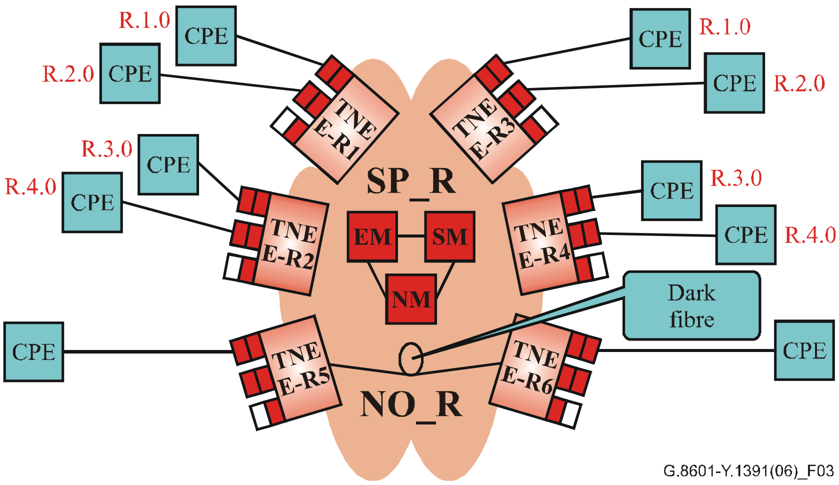

Figure 3/G.8601/Y.1391 – Single carrier (Dark fibre connection)

R17 In the case where transport network edges are connected via a wavelength or dark fibre, each Network 'edge' device can have several native customer signal instances.

R18 There can be several Network edge devices pairs in the network (each pair interconnected by wavelength or dark fibre) and each edge device can carry multiple native customer signals.

R19 There shall be no requirement to have client signals belonging to different Service providers carried over this scenario where an edge pair is interconnected by wavelength or dark fibre scenario.

8.2 Multiple carriers

The reality is that several carriers may be involved in the edge-to-edge transport of a Client Data private line service between two end points.

The multiple-carrier model is one where the SP owns part of the transport path but does not have management and/or control access to the edge(s) of the transport network.

This wholesale multiple-carrier scenario results in two pertinent ownership models. These are:

- Ownership Model-1 (OM-1) shown in Figure 4; and
- Ownership Model-2 (OM-2) shown in Figure 5.

In both cases, the customer – supplier relationship is still between the enterprise and service provider. However, in both OM-1 and OM-2, the service provider does not have physical management connectivity to the transport network edges. However, the service provider ***is*** the retailer and holds the edge-to-edge contract with the enterprise customer. As in the OM-0 case, a SLA guarantees provider edge to provider edge performance (UNI to UNI).

In order to complete the service offering, the service provider buys transport connectivity, and may also buy mapping/de-mapping functionality from a carrier with physical presence near the enterprise customer. The presence carriers wholesale their service to the service provider. This relationship requires another level of agreements at the interface between carriers.

Each network owner monitors transport performance across its own transport network. The service provider needs to monitor service performance edge-to-edge. As a result, the service provider needs a mechanism to gather actual service performance parameters from the edge NEs. It is important to note at this point that transport section overhead originating at the edge NE will terminate at the NNI, so it cannot be used to convey performance service data. Only the path overhead traverses all networks.

R20 The CSM operational model for Multiple Carrier networks (OM-1 and OM-2) must be consistent with that for the Single-Carrier (OM- 0) network.

R21 Each network owner shall monitor transport performance across its own transport network.

R22 The service provider needs to monitor service performance edge-to-edge.

- **a) As a result, the service provider needs a mechanism to gather actual service performance parameters from the edge NEs.**

R23 The service provider needs to have access to the edge NE for service control purposes.

R24 The service provider needs to have access to the edge NE for the purposes of receiving anomalous condition reports.

8.2.1 Ownership Model 1 (OM-1)

Ownership Model 1 is depicted in Figure 4: SP_R is isolated from the edge owned by NO_B:

- NO_B provides transport connection from the service edge to the handoff between NO_B & NO_R.
- NO_B provides transport PTE functions.
- NO_B performs client frame adaptation (mapping) into transport.
- SP_R is the Service Provider (SP) and has a SLA with the enterprise customer (shown as CPE).
- SP_R buys connectivity from NO_B.
- SP_R also buys mapping from NO_B.
- To confirm SLA compliance with the customer, SP_R needs to have visibility of the performance of the Client Interface and the mapping function.
- The minimum that SP_R requires is a management connection to NO_B's Edge NE for PM reporting purposes.
- SP_R needs to be able to do rudimentary intrusive control at NO_B's Edge NE for purposes of Management of the Client Service.
  - For example to activate/deactivate the service; interrogate the client interface status; apply loopback(s) in test & commission phase.

Figure 4 also shows that in the Ownership Model 1:

- The Network 'edge' device can have several service instances (example: R.5.1 & R.6.1 connected to edge device E-B1).
- There can be several Network edge devices in the 'local' network (example: E-B1 & E-B2) each carrying multiple services (example: E-B1 carrying R.5.1 & R.6.1 and E-B2 carrying R.7.1 & R.8.1).
- A network edge device can have service instances belonging to multiple SPs (example: E-B1 carrying R.5.1, R.6.1 & P.1.1).

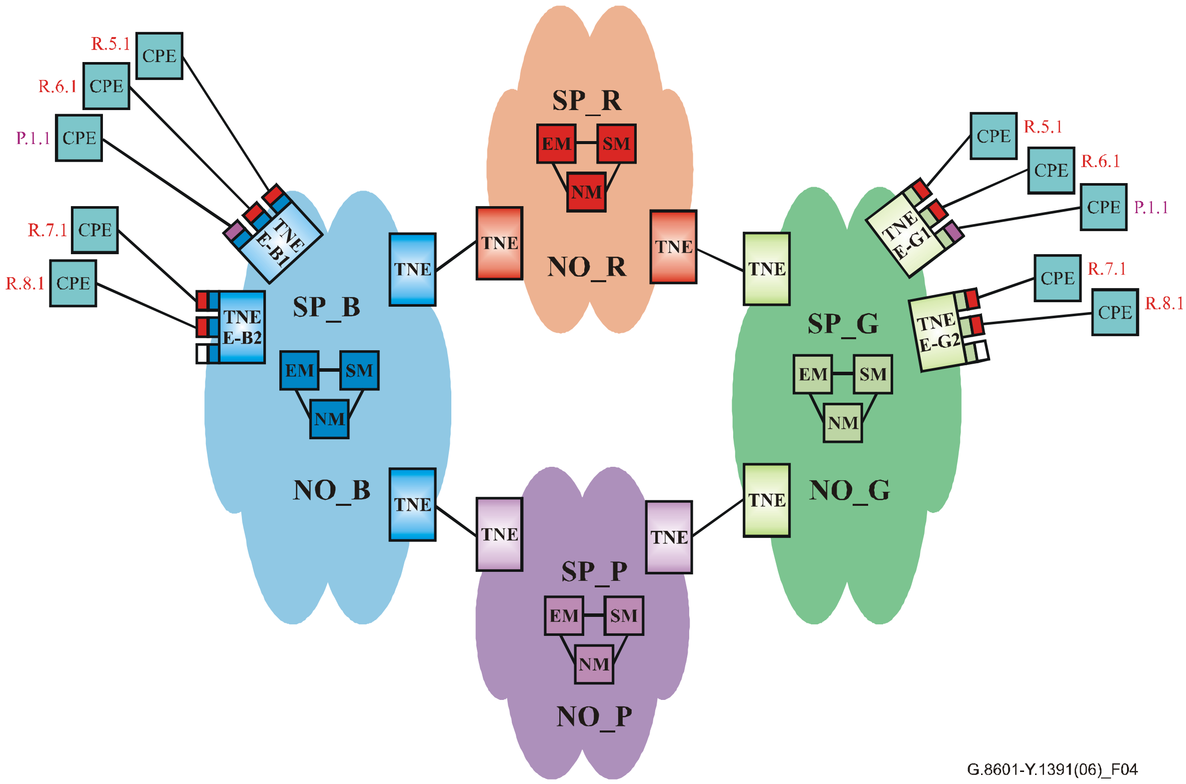

Figure 4/G.8601/Y.1391 – Multi-carrier network – Ownership Model 1

R25 **The isolated SP requires a management connection to the Edge NE for PM reporting purposes.**

R26 **The isolated SP requires a management connection to the edge NE for edge event reporting.**

R27 **The isolated SP requires a management connection to the Edge NE to enable rudimentary intrusive control at the Edge NE for purposes of Management of the Client Services.**

a) For example to activate/deactivate the service; interrogate the client interface status; apply loopback(s) in test & commission phase.

R28 **The Network 'edge' device can have several service instances (example Figure 4: R.5.1 & R.6.1 connected to edge device E-B1).**

R29 **There can be several Network edge devices in the 'local' network (example Figure 4: E-B1 & E-B2) each carrying multiple services (example Figure 4: E-B1 carrying R.5.1 & R.6.1 and E-B2 carrying R.7.1 & R.8.1).**

R30 A network edge device can have service instances belonging to multiple SPs (example Figure 4: E-B1 carrying R.5.1, R.6.1 & P.1.1).

R31 Where a single or small number of services is supported by a service provider over a third party network operator's element, the service provider does not need to support network element management, but could provide service management at a service level. Where a group of services might be more efficiently managed as a bundle, they might be managed together.

8.2.2 Ownership Model 2

Ownership Model 2 is depicted in Figure 5: SP_R is isolated from the edge owned by SP_B.

In this model, SP_R's customer-located NE (CLE_NE) is remotely located beyond NO_B's network. SP_R therefore needs a way to manage both its services and this remotely located NE.

- NO_B provides part of the transport connection between the service edge and the handoff between NO_B & NO_R.
- SP_R is the Service Provider and has a SLA with the enterprise customer (shown as CPE).
- SP_R has an NE (located beyond NO_B's network) which does the mapping into transport. The transport signal(s) are then transported over NO_B's network to NO_R's network.
- SP_R buys only connectivity from NO_B.
- SP_R needs visibility of client I/F PMs, mapping PMs and also Path PMs at the edge of the transport network. In OM-2, this is at the CLE_NE.
- SP_R needs management communication to the remotely located NE at the edge of the transport network for purposes of Service management.
- SP_R needs management communication to the remotely located NE at the edge of the transport network for purposes of NE management.

Figure 5 also shows that in the Ownership Model 2:

- The remotely located CLE-NE can have several service instances (example: R.9.2 & R.10.2 connected to CLE-R1).
- There can be several CLE-NEs connected to a 'local' network edge device (example: CLE-R1 & CLE-R2 connected to E-B3) each carrying multiple services (example: CLE-R1 carrying R.9.2 & R.10.2 and CLE-R2 carrying R.11.2 & R.12.2).
- CLE_NEs belonging to different SPs may be connected to a 'local' network edge device (example: CLE-P1 & CLE-G1 connected to E-B4).

NOTE – Only services belonging to one SP can be connected to a CLE.

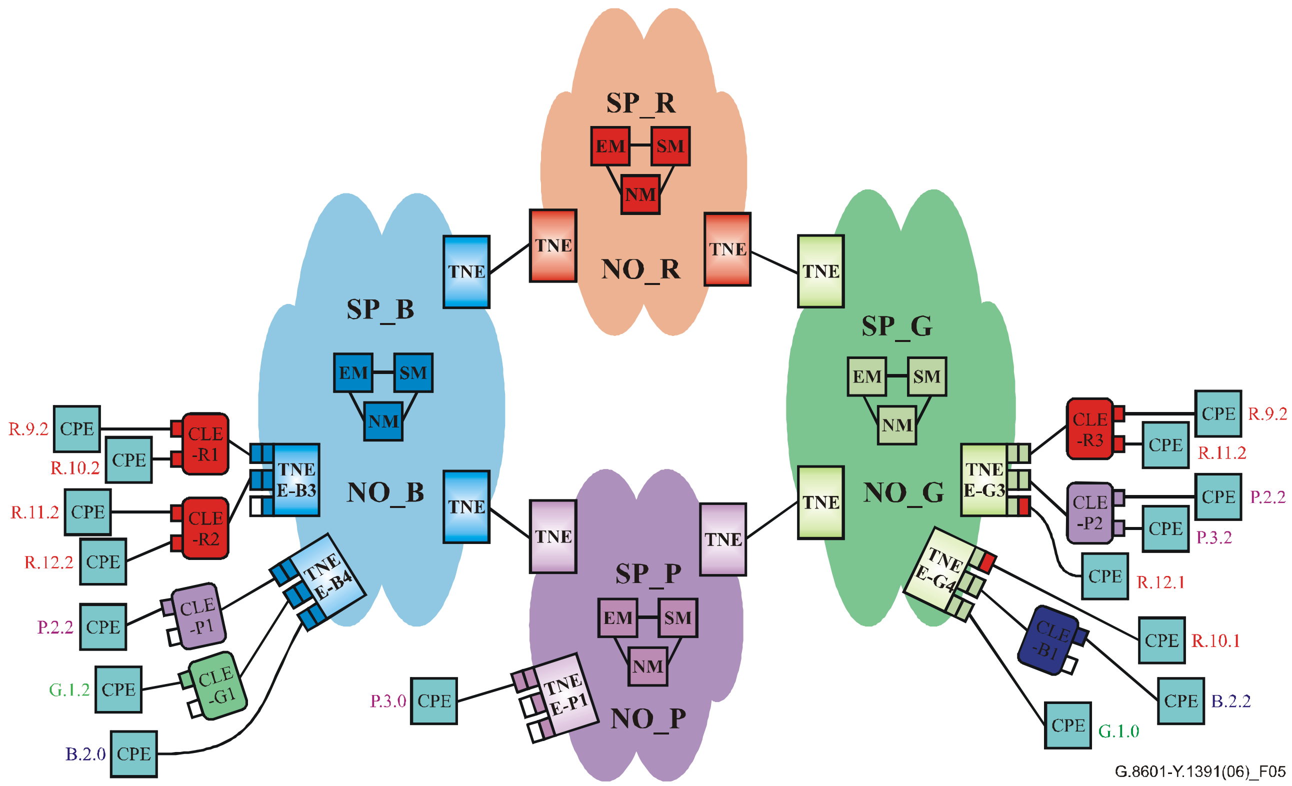

Figure 5/G.8601/Y.1391 – Multi-carrier network – Ownership Model 2

R32 **The isolated SP needs management connection to the remotely located NE at the edge of the transport network for purposes of Service management.**

a) The isolated SP requires a management connection to the Customer Located Edge NE (CLE) for PM reporting purposes.

R33 **The isolated SP requires a management connection to the Customer Located Edge NE for edge anomalous service condition reporting.**

R34 **The isolated SP requires management communication to the remotely located NE at the edge of the transport network for purposes of NE management.**

a) The isolated SP requires a management connection to the Customer Located Edge NE (CLE_NE) for control purposes.

b) The isolated SP requires a management connection to the Customer Located Edge NE for the purposes of equipment management.

1) This includes Software Download.

R35 **The remotely located CLE device can have several service instances (example Figure 5: R.9.2 & R.10.2 connected to CLE-R1).**

R36 **There can be several CLE devices connected to a 'local' network edge device (example Figure 5: CLE-R1 & CLE-R2 connected to E-B3) each carrying multiple services (example Figure 5: CLE-R1 carrying R.9.2 & R.10.2 and CLE-R2 carrying R.11.2 & R.12.2).**

R37 **Where the service edge device is a remote element (CLE_NE) owned and operated by the service provider, the service management function may be considered along with management of the remotely located network element itself.**

R38 CLEs belonging to different SPs may be connected to a 'local' network edge device (example Figure 5: CLE-P1 & CLE-G1 connected to E-B4).

R39 Only services belonging to one SP can be connected to a CLE.

8.2.3 Incompatible edge device

When the edge equipment is from a vendor other than the equipment of the management domain and the edge equipment is incompatible with regard to management communications, it mimics an OM-2 model.

In this case:

- NO_R and SP_R are synonymous.
- NO_R provides the transport connection for the edge-to-edge service (including the edge device).
- SP_R is the Service Provider and has a SLA with the enterprise customer (shown as CPE connected to E-R7 and E-R8 in Figure 6).
- The NEs (E-R7 and E-R8 in Figure 6) located beyond NO_R's main network do the mapping into transport.
- SP_R needs visibility of client I/F PMs, mapping PMs and Path PMs at the edge.
- SP_R needs management communication to the NE located at the edge of the transport network for purposes of Service management.
- SP_R needs management communication to the NE located at the edge of the transport network for purposes of NE management.

R40 In the case where an edge device is incompatible with the NO's management communication, each Network 'edge' device can have several native customer signal instances.

R41 In the case where an edge device is incompatible with the NO's management communication, there can be several edge devices with each edge device carrying multiple native customer signals.

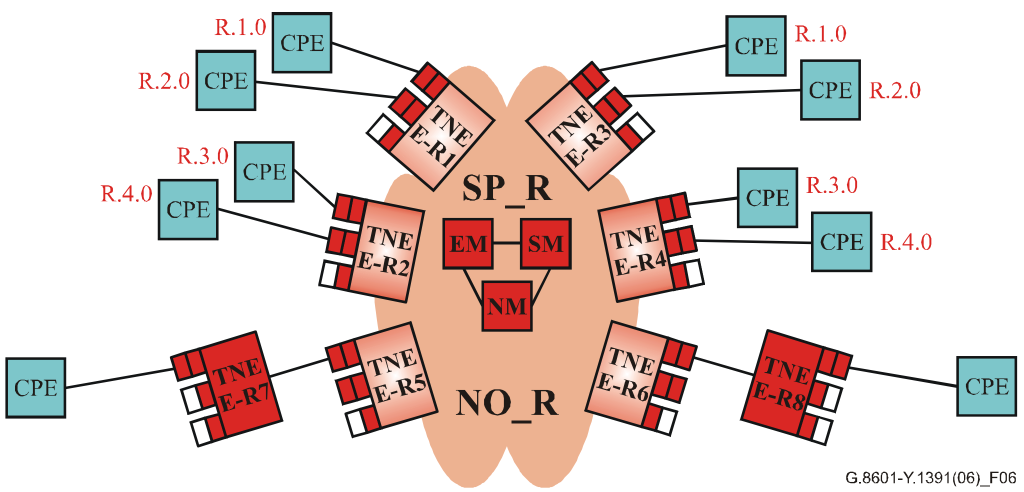

Figure 6/G.8601/Y.1391 – Single carrier scenario – Edge device is incompatible with NO management systems

8.3 Composite carrier scenarios

It is possible that services may be transported over a network where more than a single Ownership Model applies.

The composite network diagram shown in Figure 7 shows that any combination of the Ownership Models (OM-0, OM-1, and OM-2) may be present on a typical Client Service connection in a multi-carrier network. A service may have the following Ownership Model combinations:

- OM-0 to OM-0
  - Example Figure 7: R.1.0 (E-R1) to R.1.0 (E-R3).
- OM-0 to OM-1
  - Example Figure 7: B.1.0 (E-B2) to B.1.1 (E-R3).
- OM-0 to OM-2
  - Example Figure 7: B.2.0 (E-B4) to B.2.2 (CLE-B1).
- OM-1 to OM-1
  - Example Figure 7: R.5.1 (E-B1) to R.5.1 (E-G1).
- OM-1 to OM-2
  - Example Figure 7: R.10.1 (E-G4) to R.10.2 (CLE-R1).
- OM-2 to OM-2
  - Example Figure 7: R.9.2 (E-B3) to R.9.2 (E-G3).

Figure 7 also demonstrates that a 'local' network edge device may carry service of any/all ownership models.

Figure 7 demonstrates that a SP may be 'isolated' from its service end-point by multiple 'intervening' networks.

Figure 7 demonstrates that an 'intervening' NOs edge device can support transport signals in both OM-1 and OM-2 modes; furthermore the signal may belong to different SPs.

R42 The following Ownership Model combinations at the edges of a service connection shall be possible:

OM-0 to/from OM-0

OM-0 to/from OM-1

OM-0 to/from OM-2

OM-1 to/from OM-1

OM-1 to/from OM-2

OM-2 to/from OM-2

R43 A 'local' network edge device may carry service of any/all ownership models.

R44 A SP may be 'isolated' from its service edge-point by multiple intervening networks.

R45 An 'intervening' NOs edge device can support transport signals in both OM-1 and OM-2 modes.

R46 Services at an edge device may 'belong' to different SPs.

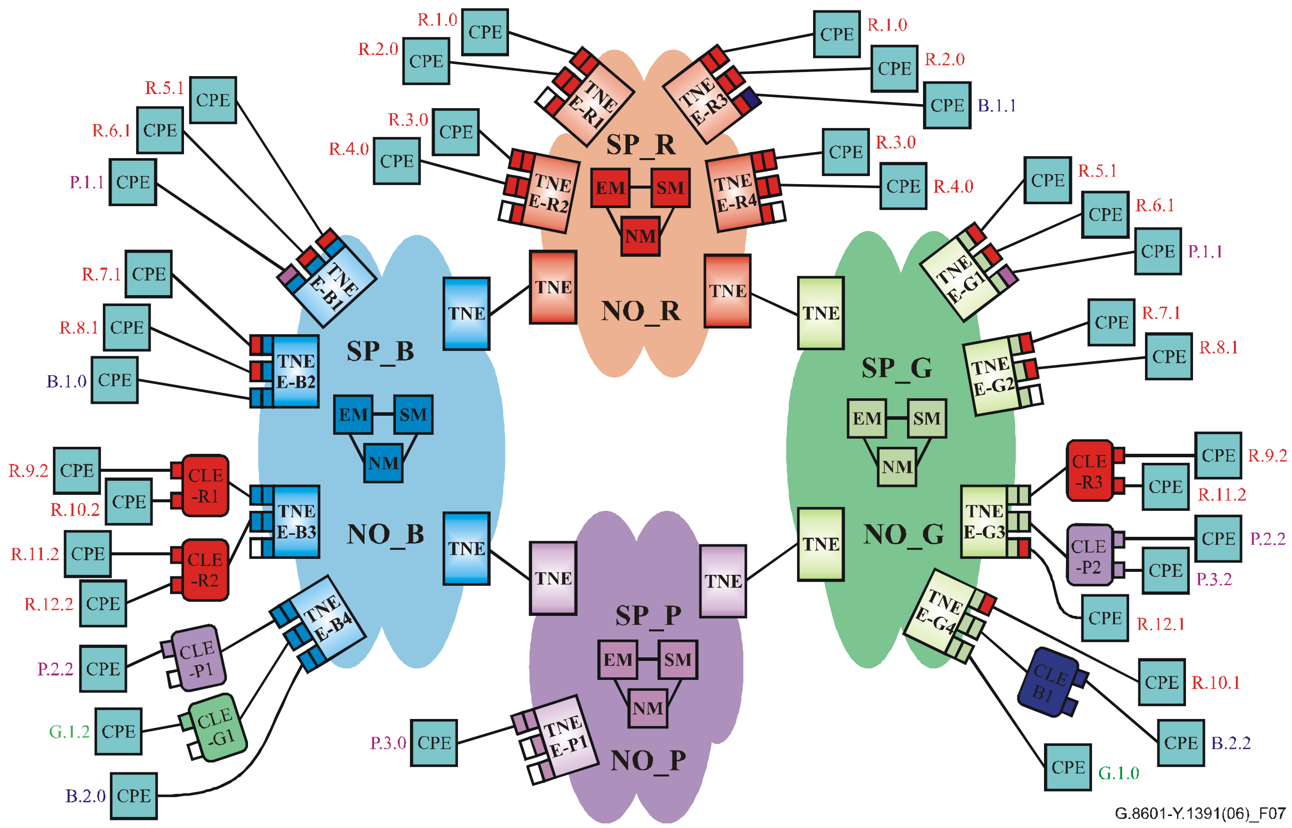

Figure 7/G.8601/Y.1391 – Composite network scenario (OM-0, OM-1 and OM-2)

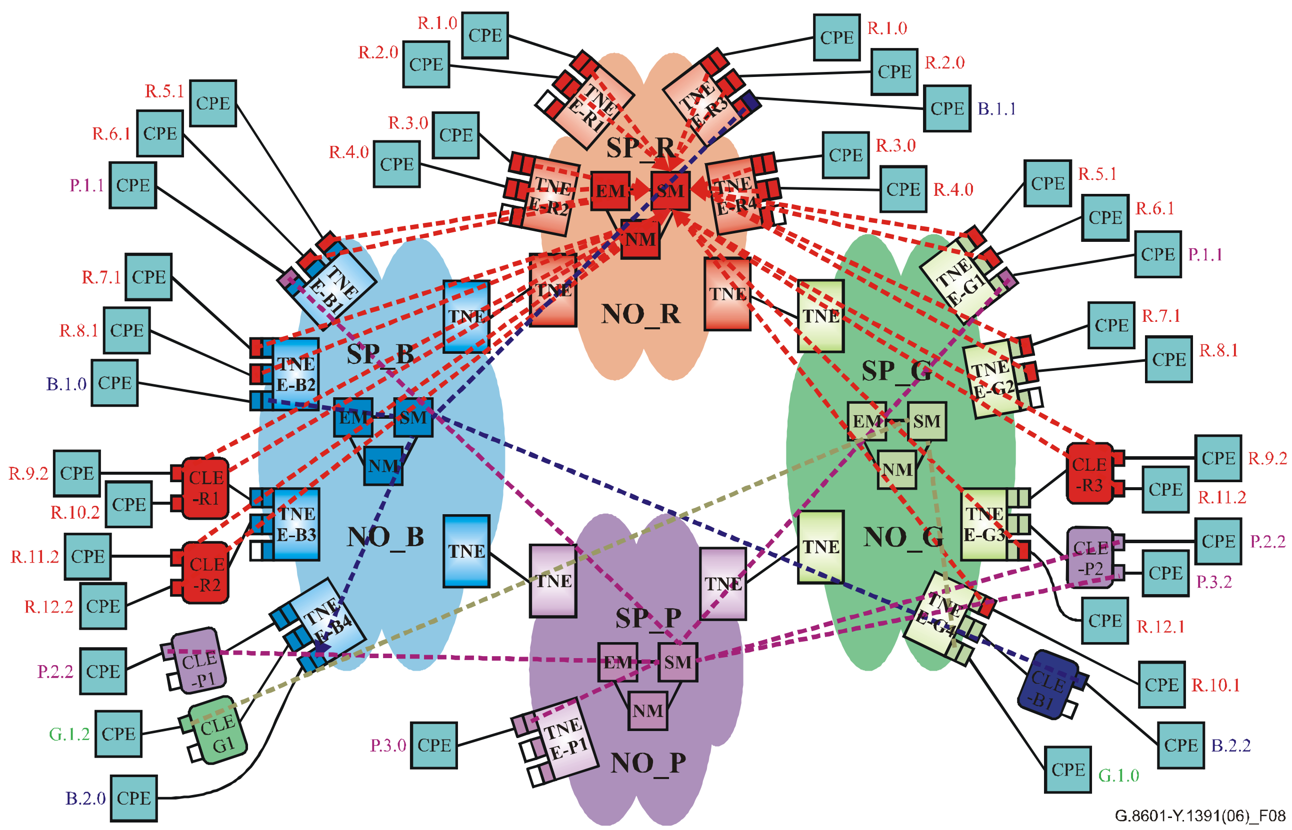

Figure 8/G.8601/Y.1391 – Composite network scenario showing service management signal flows

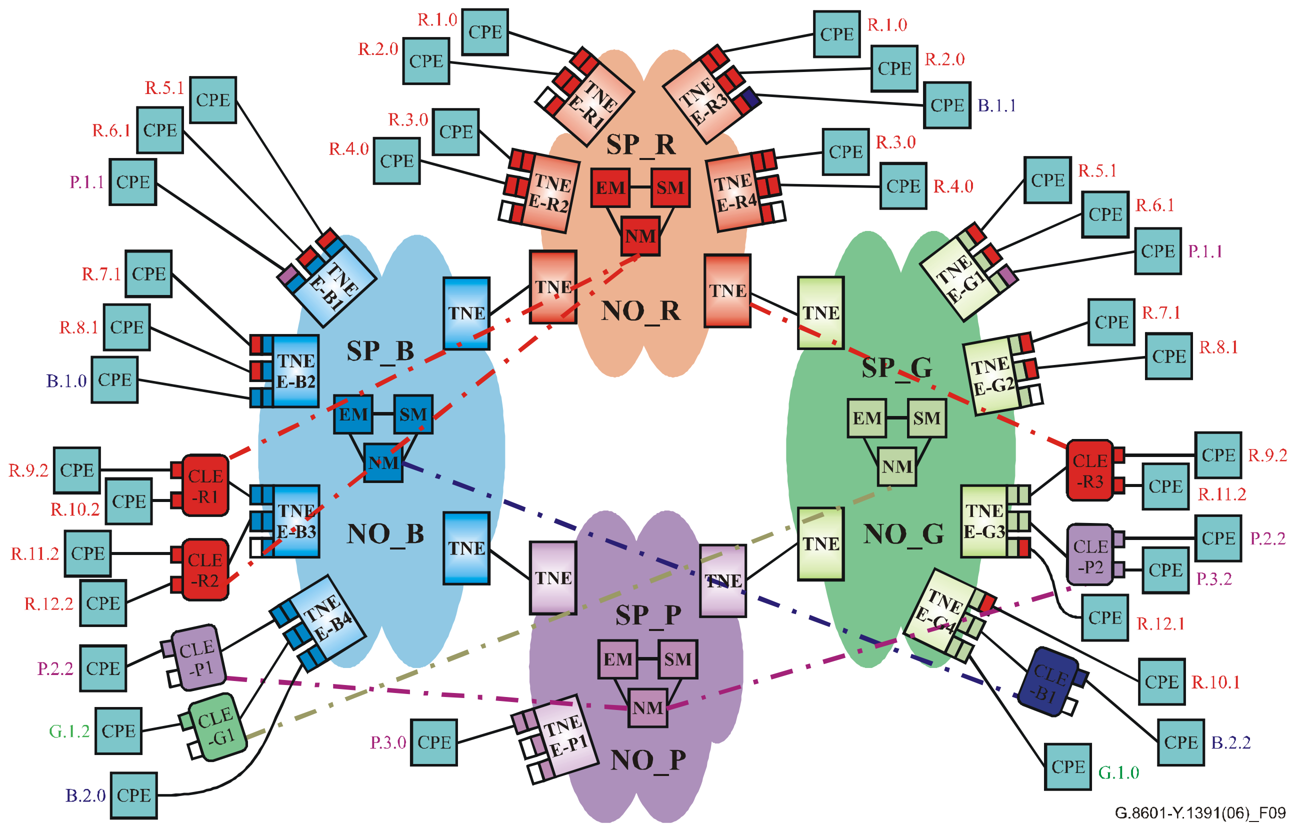

Figure 9/G.8601/Y.1391 – Composite network scenarios showing CLE management signal flows

Figure 7 shows a composite view of OM-0, OM-1 and OM-2.

Each SP has to be able to communicate all Service Management functions to its relevant end points.

Figure 8 shows the composite view with the necessary Service Management Communications shown as dotted lines.

Each SP has to be able to communicate all Network Element Management functions to its relevant remotely located CLE.

Figure 9 shows this composite view with the necessary CLE_NE management communications shown as dot-dashed lines. This includes the download of NE Software up-grades.

The requirements of the Service and CLE_NE management communication functions are in 8.2.2.

9 Network transport technology

This clause describes "transport technology models" and makes certain starting assumptions based on current existing standards and the management requirements. Emphasis is placed on the need to manage both single technology and multi-technology networks in a similar manner. The application of Multi-technology models to the various Ownership Models described in clause 8 is discussed in 9.4.

9.1 Drawing conventions

To assist clarity and legibility, the drawing conventions in Figure 10 are used in this clause.

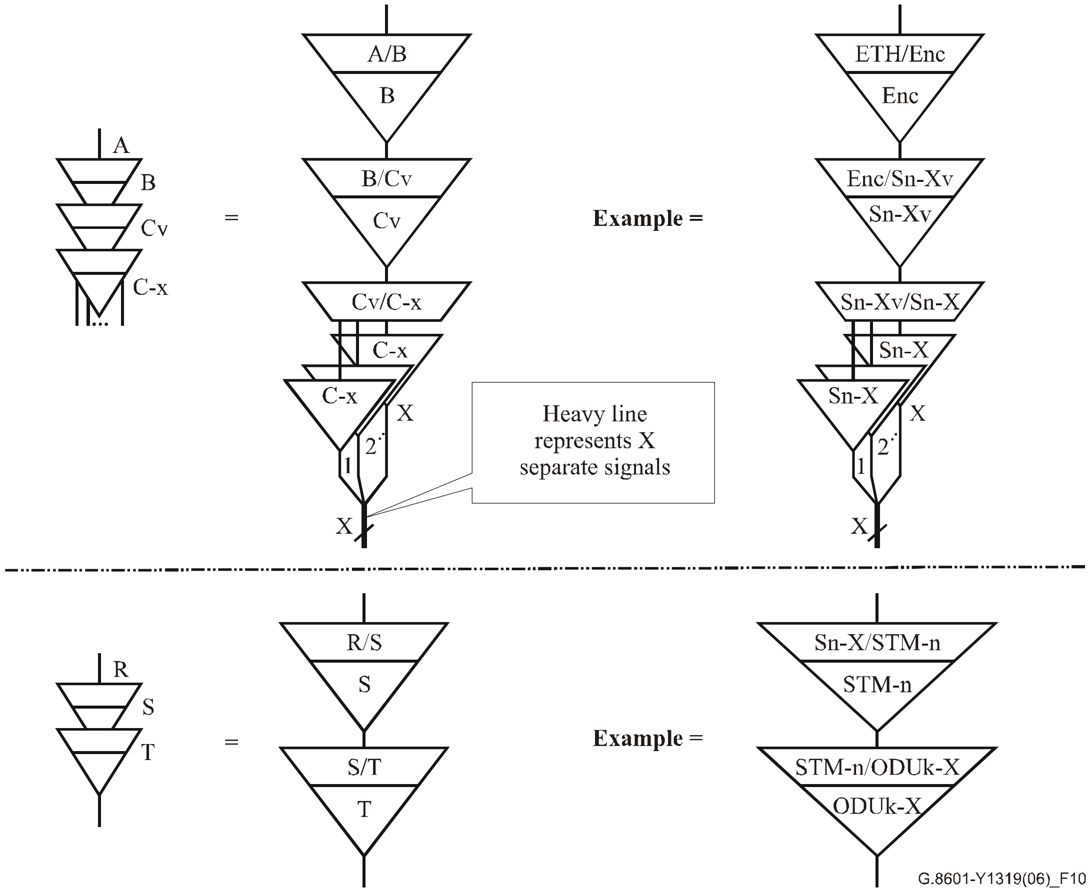

Figure 10/G.8601/Y.1391 – Drawing conventions

9.2 Candidate technologies

SONET/SDH, OTN and PDH transport technologies are considered applicable for Client Service Management.

It is considered highly improbable that the OTN transport technology will be used to interface to Client Data signals at the Edge of the transport network. Therefore, OTN technology at the edge is not considered in this Recommendation.

Furthermore, it is highly improbable that the MAP will be within the OTN transport technology.

R47 The valid transport technologies for Client Service Management (CSM) shall be:

a) SONET/SDH

b) OTN

c) PDH

R48 The use of OTN transport technology at the edge shall not be applicable to CSM.

R49 The sitting of the MAP within an OTN transport portion of the network is not applicable to Client Service Management.

9.3 Technology models

Also please see clause 9.4 regarding the applicability of Technology Models to the Ownership models.

9.3.1 Single technology model

This is the simplest of the technology models since there is no hand-off between different transport technologies along the path, and therefore the signal will not be de-encapsulated within the single transport technology path.

R50 It shall be assumed, for Client Service Management purposes, that the client signal is encapsulated into the network transport technology at the 'edge' of the single transport technology network and transported across the entire network without being de-encapsulated until delivery at the other edge.

9.3.2 Multiple technology models

This is defined as a network where the transport path transcends two or more of the transport technology types listed in 9.2. While the minimum number of transport technology spans is two, the assumption that OTN will not be used at the edge of the transport network means that if OTN is part of the path then there will be at least three transport technology portions.[1]

Furthermore, the only standardized mappings under consideration are:

1) PDH into SDH: Refer to ITU-T Rec. G.707/Y.1322.

2) SDH into OTN: Refer to ITU-T Rec. G.709/Y.1331.

It is also possible that a client signal will be transported across a path where the edges are of different transport technologies. Considering the unlikely use of OTN at the edge, the only edge combinations are:

a) SDH:SDH

b) PDH:PDH

c) PDH:SDH

The intervening transport technologies between the 'edge' networks can be of any combination provided that the standardized mappings above are adhered to.

In the case of a and b above, it is permissible to de-encapsulated/re-encapsulate at any point along the transport path.

In the case of c above, it is necessary to de-encapsulate the client signal from the 'receiving' transport technology and re-encapsulated it into the 'delivery' transport technology at some point along the transport path. The details of this de-encapsulation/re-encapsulation are outside the scope of this Recommendation.

Furthermore, the MAP may be at any legitimate point within the SONET/SDH or PDH transport technologies.

R51 The only standardized mappings to be considered are:

- **a) PDH into SDH: Refer to ITU-T Rec. G.707/Y.1322.**
- **b) SDH into OTN: Refer to ITU-T Rec. G.709/Y.1331.**

R52 Therefore, combinations of these technologies that can be considered are:

- **a) SDH:SDH**
- **b) PDH:PDH**
- **c) PDH:SDH**

[1] SDH edge with OTN in the path: SDH:OTN:SDH results in three technology spans.

R53 **In the case of 'same-edge' transport technologies (Req 52a and 52b), it is permissible for the client signal to be de-encapsulated/re-encapsulated at any point within the transport path.**

R54 **In the case of 'different-edge' transport technologies (Req 52c), the client signal must be de-encapsulated from the 'receiving' edge transport technology and re-encapsulated into the 'delivery' edge transport technology. This can be at any suitable point in the path where these two technologies interface.**

R55 **The MAP may be within any of the SONET/SDH or PDH transport technology portions of the overall transport network.**

R56 **The management of client services transported in concatenated technologies (either contiguous or virtual concatenation) is required. This is applicable to both SONET/SDH and PDH transport technologies.**

NOTE – There is no limit to the number of 'transport technology' islands within any one transport path, provided that the combinations above in Req 51 are adhered to.

A functional model of an example SDH:OTN:SDH network is shown in Figure 11. This shows an Ethernet Client signal being transported across a network consisting of two SDH networks separated by an OTN 'island'. The hand-off between the SDH and the OTN network technologies is shown in the functional layer diagram. Note that in this case, the SDH signal is carried over the OTN island. Other combinations of standardized technologies are of course possible.

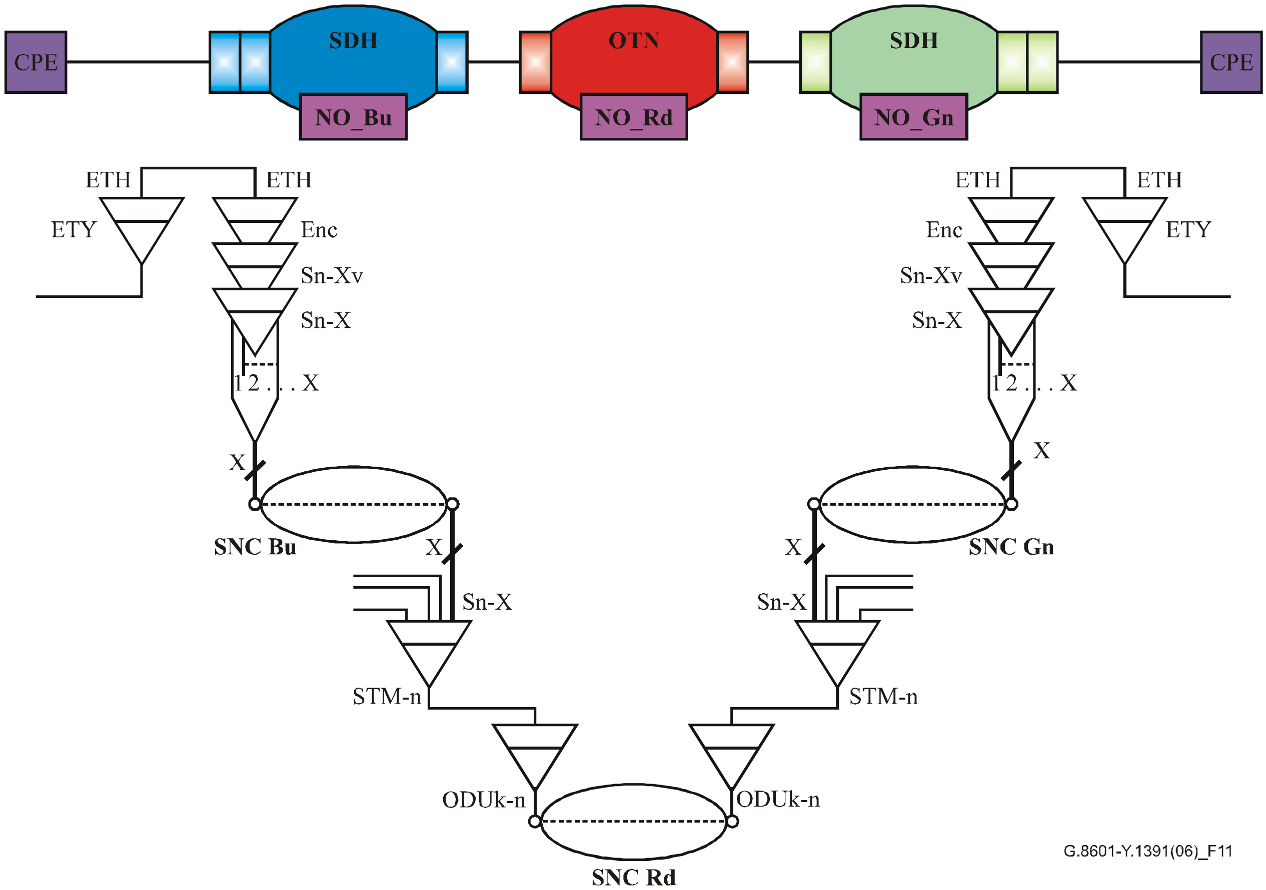

Figure 11/G.8601/Y.1391 – Functional model of SDH:OTN:SDH network

9.4 Applicability of technology models to ownership models

The technology models described above are directly applicable to all Ownership Models.

In a multi-technology network, the hand-off combinations in 9.3.2 above must be adhered to, and as per requirement 55 the MAP may be within any of the SONET/SDH or PDH sections of the transport network.

R57 The boundary between NOs along the path of such a multi-technology network path can be at any of the technology interfaces. The boundary between NOs may also be within a technology span.

Figure 12 below shows an example transport path consisting of several transport technology spans. Each of the interfaces is supported by the list in 9.3.2. Two multi-carrier example combinations for the same multi-technology path are shown in Figures 12 and 13:

Example #1 (Figure 12) shows four carriers:

– NO_R (Red): PDH-SDH-PDH interfacing to

– NO_B (Blue): SDH-OTN-SDH-PDH interfacing to

– NO_G (Green): SDH-OTN-SDH interfacing to

– NO_P (Purple): PDH (Single Technology)

Example #2 (Figure 13) shows four carriers with the transport technology straddling on of the NO boundaries (between Red and Blue). This is equivalent to a same technology hand-off between the Red and Blue NOs.

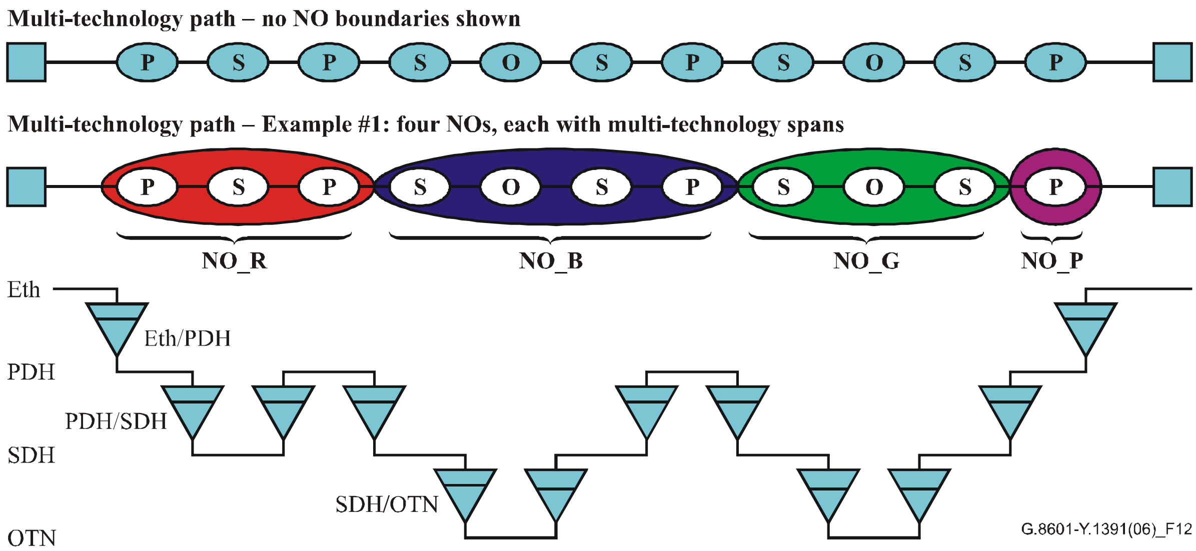

Figure 12/G.8601/Y.1391 – Multi-technology, multi-carrier transport path combinations showing dittering technology I/F at carrier boundary

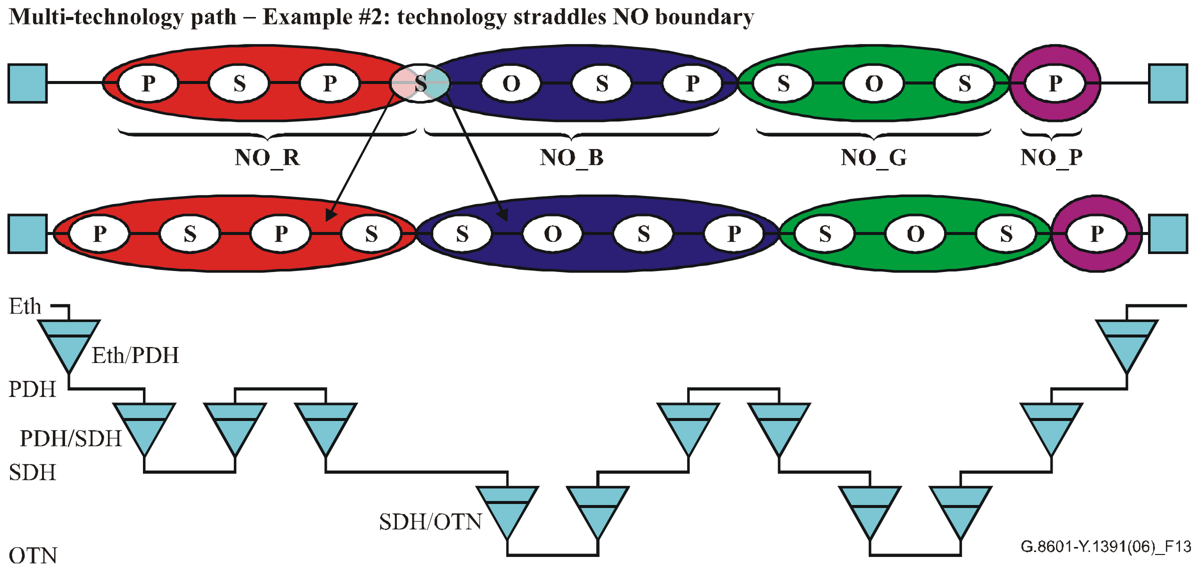

Figure 13/G.8601/Y.1391 – Multi-technology, multi-carrier transport path combinations showing same technology I/F at carrier boundary

Based on these examples of multi-technology and multi-carrier transport network paths, it is clear that:

1) The Multi-technology Models place no restriction on the Ownership Models.

2) Similarly, the Ownership Models place no restriction on the Multi-technology models.

3) The boundary between neighbouring NOs can be at any point along the transport path.

   a) A boundary occurring in the 'mid-span' of a given technology is the same as having that technology on both sides of the NO handoff. See Figure 12.

Figure 14 shows an example transport path consisting of several transport technology spans. Each of the interfaces are supported by the list in 9.3.2.

NOTE – In this example the start and end of the path have DIFFERENT transport technologies.

In this simple scenario, the client signal MUST be de-encapsulated at a point in the path where it can be re-encapsulated into the transport technology of the delivery edge. This is at point A in Figure 14.

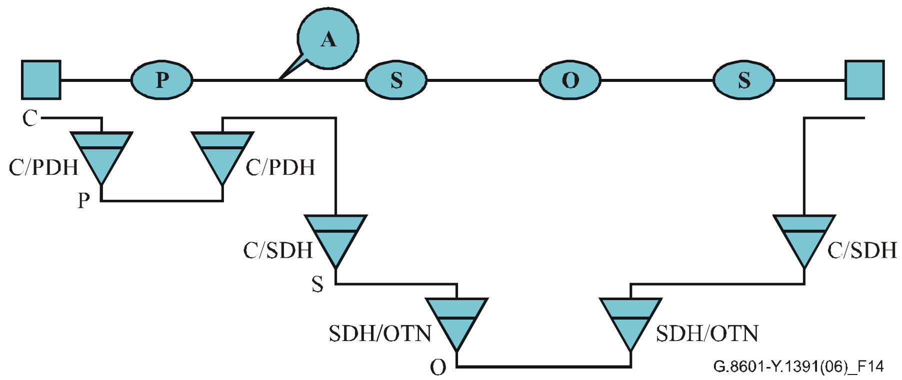

Figure 14/G.8601/Y.1391 – Example of 'Different-transport-technology' edges

10 Applicable client service types

R58 The following Point-to-point Client Service types are required to be managed:

a) Ethernet (Private Line)

b) Fibre Channel (Private Line)

c) PDH (Private Line)

1) DS1

2) DS3

3) E1

4) E3

11 Management communication functions

The CSM system will have communication functions to perform Client Service, and remotely located CLE management. These communication functions will be between the transport network edge(s) and the Management Access Point (MAP). This clause outlines these communication functions but does not define the actual management function or the content of such communications. This is outside the scope of this Recommendation.

The CSM system will be required to perform two distinct management functions:

- Management of the Service at the Service Edge:
  - Applies to Ownership Model 1 (OM-1), Ownership Model 2 (OM-2) and the single carrier case (OM-0).
- Management of the remotely located CLE_NE:
  - Applies only to Ownership Model 2.

The CSM system will be required to convey three types of management information:

- Performance information.
- Commands and responses.
- Autonomous notification.

Inspection of the basic requirements and the Ownership Models clearly shows that there are several distinct management communication functions for effective Client Service/CLE_NE Management.

a)	Performance Monitoring (Service)	Edge to MAP
b)	Performance Monitoring (Service)	Edge to Edge
c)	Service Status	Edge to Edge
d)	Service Status	Edge to MAP
e)	C/R (Service)	MAP to Edge (command); Edge to MAP (response)
f)	C/R (Equipment)	MAP to Edge (command); Edge to MAP (response)
g)	Autonomous Notification (service)	Edge to MAP
h)	Autonomous Notification (equip)	Edge to MAP

To ensure consistent operational methods, the information flows in the following clauses and depicted in Figures 8 and 9 are applicable to both the multiple-carrier and the single carrier model.

All mentions of MAP in the following refer to the Management Access Point within the Service Providers network which may be isolated from either end of the Edge-to-edge SONET/SDH path.

11.1 Performance information

Performance monitoring messages convey (single-ended) service metrics computed at an Edge device. These messages inform the MAP of the Edge service metrics. They also inform near-end Edge of far-end Edge service metrics.

Performance monitoring signals are sent periodically by the Edge device. These messages are therefore considered as scheduled.

The performance messages from the edge will include:

a) Monitoring and reporting of Access Link Termination:
   i) This will monitor and report metrics from the termination function performed at the Access Link Interface.

      Examples are: Frames Received, Frames Transmitted, Frames Dropped, Frame throughput.

b) Monitoring and reporting of Mapping Function:
   i) This will monitor and report metrics from the encapsulation of the service into transport.

      Examples are: Framing statistics, mapping errors, code violations.

c) Monitoring and reporting of Path related functions:
   i) This will monitor and report metrics from the path termination function.

      Examples are: remote defects, error counts.

d) Monitoring and reporting of Service Status:
   i) This will be an indication of the health of the service. Service status indicates that the service is in one of four states.
      1) Operational: Service is operating within the bounds of the established SLA.
      2) Degraded: Service is operational; however, its performance is degraded in reference to the SLA.
      3) Failure: Service failure has occurred and is not operational.
      4) In-test: Service is under control of service/network operator for maintenance actions.

The Service Status is generated by each Edge on a service by service basis. The Service Status is generated by comparing local edge-service PMs and remote edge-service PMs (conveyed between edges) to formulate edge-to-edge service PMs. These edge-to-edge service PMs are then compared to SLA thresholds to determine the operational disposition of the service.

Service failure may be attributed to path level defects, service failures at the client link, or significant disparity in achieving adherence to the SLA.

R59 It is required to regularly report Performance Metrics from Edge-to-Edge for each Service instance and for all Ownership Models.

R60 It is required to regularly report Performance Metrics from the Edge to the MAP for each Service instance and for all Ownership Models.

R61 The regularity of the Performance reports is TBD.

R62 It is required to regularly report Service Status (SS) from Edge-to-Edge for each Service instance and for all Ownership Models.

R63 It is required to regularly report Service Status (SS) from Edge to MAP for each Service instance and for all Ownership Models.

R64 The regularity of SS reports is TBD.

11.2 Commands and responses

Command signals

- Convey a request for an action.
- Originate at only the MAP.
- Are processed only by Edge Device. They are not processed at the MAP.
- Are unscheduled messages. They can occur at any time.

Examples of command signals include service configuration query.

Response signals

- Result from a received command.
- Originate only at the Edge Device.
- Are unscheduled messages. They can occur at any time.

R65 It is required to convey Command signals from MAP to Edge for purposes of Service Management. This shall apply to each service instance and all Ownership Models.

R66 It is required to convey Command signals from MAP to Edge CLE for purposes of CLE_NE management. This shall apply to each CLE_NE and shall apply to Ownership Model 2.

R67 It is required to convey Response signals from Edge to MAP for purposes of service Management. This shall apply to each Service instance and for all Ownership Models.

R68 It is required to convey Response signals from Edge to MAP for purposes of CLE management. This shall apply to each CLE_NE and shall apply to Ownership Model 2.

11.3 Autonomous notification

Autonomous Notification:

- Provides a mechanism for reporting anomalous service conditions.
- Provides a mechanism for reporting non-service affecting conditions.
  i) Examples include equipment alarms such as 'fan failure', 'cabinet open', 'environmental alarm', etc.
- Typically indicates a service affecting condition (e.g., service alarm indications).
- Are unscheduled messages. They can occur at any time.

Examples of service affecting conditions are a client signal failure or service remote fault. Other examples include service activation status, and loopback invocations.

R69 It is required to convey Autonomous Notifications from Edge to MAP for purposes of Service management. This shall apply to each Service instance and all Ownership Models.

R70 It is required to convey Autonomous Notifications from Edge to MAP for purposes of CLE management. This shall apply to each CLE_NE and shall apply to Ownership Model 2.

11.4 Remotely located NE (CLE) software upgrades

Because in the Ownership Model 2 scenario, the SP does not have direct management connectivity to the Edge NE, the CSM needs to be able to perform software upgrades to this CLE_NE.

R71 The CSM shall be capable of communicating to the remotely located (CLE) NE for purposes of software upgrades.

NOTE – In OM-1 and in the single carrier case (OM-0), management of the 'edge' NE will be performed by the NO in whose network the edge NE resides, and therefore software updates from the MAP will not be required.

12 Testing requirements

There is a need by some carriers to be able to perform certain remote testing procedures in order to streamline the deployment and delivery of broadband services. The current service model that is expected to be employed for the delivery of Ethernet private line (EPL) services is that used to manage, test and deploy DS-1 private line services today.

R72 It is required that Service testing be performed from a centralized location.

R73 It is required that testing requests and testing result collection be performed under the control of a centralized test operation system.

R74 For certain tests it is required that the test set, under the control OS, may issue commands to a far-end system to, for example, initiate a loopback.

Further testing requirements are for further study.

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Printed in Switzerland
Geneva, 2007