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Digital networks – Optical transport networks

Management aspects of optical transport network elements

Recommendation ITU-T G.874

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Recommendation ITU-T G.874

Management aspects of optical transport network elements

Summary

Recommendation ITU-T G.874 addresses management aspects of optical transport network elements containing transport functions of one or more of the layer networks of the optical transport network. The management of the optical layer networks is separable from that of its client layer networks so that the same means of management can be used regardless of the client. The management functions for fault management, configuration management and performance monitoring are specified.

The 2008 revision of this Recommendation has updated the management information to align with Recommendation ITU-T G.798, reorganized the sections to align with the structure of Recommendation ITU-T G.7710/Y.1701, and replaced the generic text with pointers to Recommendation ITU-T G.7710/Y.1701.

The 2010 revision of this Recommendation has added the management of new transport functions that have been introduced in the 2010 revision of Recommendation ITU-T G.798, including OPSMnk_TT, OPSM/OTUk-a_A, and ODUk for k=0, 2e, 4, and flex.

The 2013 revision of this Recommendation has added the management of hitless adjustment of ODUflex (GFP) (HAO), APS, Application codes and PM data collection.

History

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

Recommendation ITU-T G.874 addresses management aspects of optical transport network elements containing transport functions of one or more layer networks of the optical transport network (OTN) as described in [ITU-T G.709]. The management of optical layer networks is separable from that of its client layer networks; therefore the same means of management can be used regardless of the client. The management functions for fault management, configuration management, account management, performance management and security management are specified.

This Recommendation describes the management network organizational model for communication between an element management layer (EML) operations system and the optical equipment management function within an OTN network element.

The architecture described in this Recommendation for the management of optical transport networks is based upon the following considerations:

– The management view of network element functional elements should be uniform whether those elements form part of an inter-domain interface or part of an intra-domain interface. Those properties necessary to form such a uniform management view are to be included in this Recommendation.
– Optical layer network entities (OLNEs) refer to trail termination, adaptation and connection functions as described in [ITU-T G.872].
– A network element may only contain optical layer network entities.
– A network element may contain both optical layer network entities (OLNEs) and client layer network entities (CLNEs).
– Client layer entities are managed as part of their own logical domain (e.g., SDH management network).
– CLNEs and OLNEs may or may not share a common message communications function (MCF) and management application function (MAF) depending on application.
– CLNEs and OLNEs may or may not share the same agent.

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 G.695] Recommendation ITU-T G.695 (2010), *Optical interfaces for coarse wavelength division multiplexing applications*.

[ITU-T G.698.2] Recommendation ITU-T G.698.2 (2009), *Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces*.

[ITU-T G.709] Recommendation ITU-T G.709/Y.1331 (2012), *Interfaces for the Optical Transport Network (OTN).*

[ITU-T G.784] Recommendation ITU-T G.784 (2008), *Management aspects of synchronous digital hierarchy (SDH) transport network elements*.

[ITU-T G.798] Recommendation ITU-T G.798 (2012), *Characteristics of optical transport network hierarchy equipment functional bocks*.

[ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.

[ITU-T G.806] Recommendation ITU-T G.806 (2012), *Characteristics of transport equipment – Description methodology and generic functionality*.

[ITU-T G.826] Recommendation ITU-T G.826 (2002), *End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections*.

[ITU-T G.870] Recommendation ITU-T G.870/Y.1352 (2012), *Terms and definitions for optical transport networks*.

[ITU-T G.872] Recommendation ITU-T G.872 (2012), *Architecture of optical transport networks*.

[ITU-T G.873.1] Recommendation ITU-T G.873.1 (2011), *Optical Transport Network (OTN): Linear protection.*

[ITU-T G.874.1] Recommendation ITU-T G.874.1 (2012), *Optical transport network (OTN): Protocol-neutral management information model for the network element view*.

[ITU-T G.959.1] Recommendation ITU-T G.959.1 (2012), *Optical transport networks physical layer interfaces*.

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2012), *Common equipment management function requirements*.

[ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2010), *Architecture and specification of data communication network*.

[ITU-T M.20] Recommendation ITU-T M.20 (1992), *Maintenance philosophy for telecommunication networks*.

[ITU-T M.2120] Recommendation ITU-T M.2120 (2002), *International multi-operator paths, sections and transmission systems fault detection and localization procedures*.

[ITU-T M.2140] Recommendation ITU-T M.2140 (2000), *Transport network event correlation*.

[ITU-T M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network*.

[ITU-T M.3013] Recommendation ITU-T M.3013 (2000), *Considerations for a telecommunications management network*.

[ITU-T M.3100] Recommendation ITU-T M.3100 (2005), *Generic network information model*.

[ITU-T Q.822] Recommendation ITU-T Q.822 (1994), *Stage 1, stage 2 and stage 3 description for the Q3 interface – Performance management*.

[ITU-T X.700] Recommendation ITU-T X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications*.

[ITU-T X.701] Recommendation ITU-T X.701 (1997) | ISO/IEC 10040:1998, *Information technology – Open Systems Interconnection – Systems management overview*.

[ITU-T X.721] Recommendation ITU-T X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information*.

[ITU-T X.733] Recommendation ITU-T X.733 (1992) | ISO/IEC 10164-4:1992, *Information technology – Open Systems Interconnection – Systems Management: Alarm reporting function*.

[ITU-T X.735] Recommendation ITU-T X.735 (1992) | ISO/IEC 10164-6:1993, *Information technology – Open Systems Interconnection – Systems Management: Log control function*.

[ITU-T X.744] Recommendation ITU-T X.744 (1996) | ISO/IEC 10164-18:1997, *Information technology – Open Systems Interconnection – Systems management: Software management function*.

3 Terms and definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 agent: [ITU-T X.701]

3.1.2 aggregate audible/visual indicators: [ITU-T M.3100]

3.1.3 alarm reporting: [ITU-T M.3100]

3.1.4 alarm reporting control: [ITU-T M.3100]

3.1.5 alarm reporting control interval: [ITU-T M.3100]

3.1.6 atomic function: [ITU-T G.806]

3.1.7 data communications channel (DCC): [ITU-T G.784]

3.1.8 data communication network (DCN): [ITU-T G.7712]

3.1.9 embedded control channel (ECC): [ITU-T G.7712]

3.1.10 general communication channel: [ITU-T G.709]

3.1.11 general management communications overhead: [ITU-T G.709]

3.1.12 inhibited: [ITU-T M.3100]

3.1.13 inter-domain interface (IrDI): [ITU-T G.872]

3.1.14 intra-domain interface (IaDI): [ITU-T G.872]

3.1.15 local craft terminal (LCT): [ITU-T G.7710]

3.1.16 managed entity: [ITU-T M.3100]

3.1.17 managed object: [ITU-T X.700]

3.1.18 managed object class: [ITU-T X.701]

3.1.19 managed resource: [ITU-T M.3100]

3.1.20 managed resource-specific: [ITU-T M.3100]

3.1.21 management application function (MAF): [ITU-T G.7710]

3.1.22 management interface: [ITU-T M.3100]

3.1.23 management point (MP): [ITU-T G.806]

3.1.24 manager: [ITU-T X.701]

3.1.25 message communication function: [ITU-T M.3013]

3.1.26 network element: [ITU-T M.3010]

3.1.27 network element function: [ITU-T M.3010]

3.1.28 operations system (OS): [ITU-T M.3010]

3.1.29 OTN network element (O.NE): [ITU-T G.870]

3.1.30 OTN management network (O.MN): [ITU-T G.870]

3.1.31 OTN management subnetwork (O.MSN): [ITU-T G.870]

3.1.32 persistence interval: [ITU-T M.3100]

3.1.33 Q interface: [ITU-T M.3010]

3.1.34 qualified problem: [ITU-T M.3100]

3.1.35 reset threshold report: [ITU-T M.3100]

3.1.36 threshold report: [ITU-T M.3100]

3.1.37 timed interval: [ITU-T M.3100]

3.1.38 unit audible/visual indicator: [ITU-T M.3100]

3.1.39 workstation function: [ITU-T M.3010]

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

1second	1-second pulse
AcPT	Accepted PT
AcSTAT	Accepted STAT
AcTI	Accepted TTI
AdminState	Administrative State
AIS	Alarm Indication Signal
ALM	Alarm reporting
AP	Access Point
APR	Automatic Power Reduction
APRCntrl	Automatic Power Reduction Control
ARC	Alarm Reporting Control
AutoMS	Automatic configuration of the Multiplex Structure
BDI	Backward Defect Indicator
BDI-O	Backward Defect Indicator Overhead
BDI-P	Backward Defect Indicator Payload
BIAE	Backward Incoming Alignment Error
BIP	Bit Interleaved Parity
CBRx	Constant Bit Rate signal of bit rate [range] x

CLNE	Client Layer Network Entity
COMMS OH	general management Communications Overhead
CP	Connection Point
CTP	Connection Termination Point
CWDM	Coarse Wavelength Division Multiplexing
DCC	Data Communications Channel
DCN	Data Communication Network
DS	Defect Second
DS-O	Defect Second Overhead
DS-P	Defect Second Payload
DEG	Degraded defect
DEGM	DEG consecutive 1-second monitoring intervals
DEGThr	DEG 1-second EBC threshold
DTDL	Defect Type and Defect Location
DWDM	Dense Wavelength Division Multiplexing
EBC	Errored Block Count
ECC	Embedded Control Channel
EMF	Equipment Management Function
EMS	Element Management System
ExDAPI	Expected Destination Access Point Identifier
ExMSI	Expected Multiplex Structure Identifier
ExSAPI	Expected Source Access Point Identifier
ExtCMD	External Command
F	Far-end
FCAPS	Fault, Configuration, Accounting, Performance and Security management
FDI	Forward Defect Indicator
FDI-O	Forward Defect Indicator Overhead
FDI-P	Forward Error Correction Payload
FEC	Forward Error Correction
FECEn	Forward Error Correction Enabled
FECCorrErr	Forward Error Correction Corrected Errors
FOP	Failure of Protocol
FOP-PM	Failure of Protocol; Provisioning Mismatch
FOP-NR	Failure of Protocol; No Response
GCC	General Communication Channel
GCCAccess	General Communication Channel Access
GCCCont	General Communication Channel Continue

GetAcTI	Get Accepted trail Trace Identifier
GFC	Generic Flow Control
GNE	Gateway Network Element
HEC	Header Error Control
HoTime	Hold-off Time
IAE	Incoming Alignment Error
IaDI	Intra-Domain Interface
IrDI	Inter-Domain Interface
LAN	Local Area Network
LCD	Loss of Cell Delineation
LCK	Locked defect
LOA	Loss of Alignment
LOF	Loss of Frame
LOFLOM	Loss of Frame and (Loss of) Multiframe
LOFOTL	Loss of Frame of Optical Lane
LOL	Loss of Lane alignment
LOM	Loss of Multiframe
LOOMFI	Loss of OPU Multiframe Indication
LOS	Loss of Signal
LOS-O	Loss of Signal Overhead
LOS-P	Loss of Signal Payload
LSS	Loss of pseudo-random bit Sequence lock
LTC	Loss of Tandem Connection
MAF	Management Application Function
MCF	Message Communications Function
MCN	Management Communication Network
MI	Management Information
MIB	Management Information Base
MO	Managed Object
MP	Management Point
MPI	Main Path Interface
MSI	Multiplex Structure Identifier
MSIM	Multiplex Structure Identifier Mismatch
NALM	No Alarm reporting
NALM-CD	No Alarm reporting, CountDown
NALM-NR	No Alarm reporting, NotReady
NALM-QI	No Alarm reporting, Qualified Inhibit

NALM-TI	No Alarm reporting, Timed Inhibit
NE	Network Element
NEF	Network Element Function
NT	Network Terminal
OCh	Optical Channel
OChr	Optical Channel with reduced functionality
OCI	Open Connection Indication
ODU	Optical Data Unit
ODUi	Optical Data Unit of level i
ODU[i]j	Optical Data Unit of level j and i (i is optional; i < j)
ODUj	Optical Data Unit of level j
ODUj[/i]	Optical Data Unit of level j or i (i is optional; i < j)
ODUk	Optical Data Unit of level k, k=0, 1, 2, 2e, 3, 4, flex
ODUkP	Optical Data Unit of level k, Path, k=0, 1, 2, 2e, 3, 4, flex
ODUkT	Optical Data Unit of level k, Tandem connection sub-layer, k=0, 1, 2, 2e, 3, 4, flex
ODUkTm	ODUkT non-intrusive monitoring function, k=0, 1, 2, 2e, 3, 4, flex
OLNE	Optical Layer Network Entity
O.MN	OTN Management Network
OMS	Optical Multiplex Section
O.MSN	OTN Management Subnetwork
OMSn	Optical Multiplex Section of level n
O.NE	OTN Network Element
OOS	Optical transport module Overhead Signal
OPSn	Optical Physical Section of level n, n=0, 16, 32
OPSMnk	OPS Multi-lane, k=3, 4; n=4
OS	Operations System
OSC	Optical Supervisory Channel
OSI	Open Systems Interconnection
OTH	Open Transport Hierarchy
OTL	Optical channel Transport Lane
OTLk.n.	Optical Transmission Lane of OTUk lane number n
OTM	Optical Transport Module
OTN	Optical Transport Network
OTS	Optical Transmission Section
OTSn	Optical Transmission Section of level n
OTU	Optical Transmission Unit
OTUk	Optical Transmission Unit of level k, k=1, 2, 3, 4

OTUkV	Optical Transmission Unit of level k, functional standardized, k=1, 2, 3, 4
PCS	Physical Coding Sublayer
PLM	PayLoad Mismatch
PMC	Performance Monitoring Clock
PPP	Point-to-Point Protocol
ProtType	Protection Type
PRBS	Pseudo-Random Bit Sequence
PT	Payload Type
RSn	Regenerator Section of level n
RTC	Real-Time Clock
RTR	Reset Threshold Report
SCN	Signalling Communication Network
SDH	Synchronous Digital Hierarchy
Sk	Sink
So	Source
SSF	Server Signal Fail
SSF-O	Server Signal Fail Overhead
SSF-P	Server Signal Fail Payload
STAT	Status field
TCP	Termination Connection Point
TI	Trace Identifier
TIM	Trace Identifier Mismatch
TIMActDis	Trace Identifier Mismatch consequent Actions Disabled
TIMDetMo	Trace Identifier Mismatch Detection Mode
TMN	Telecommunications Management Network
TP	Termination Point
TPusgActive	TP usage measurement Active
TR	Threshold Report
TSE	Test Sequence Error
TT	Trail Termination
TTI	Trail Trace Identifier
TTP	Trail Termination Point
TTPSk	Trail Termination Point Sink
TTPSo	Trail Termination Point Source
TxMSI	Transmitted Multiplex Structure Identifier
TxTI	Transmitted trail Trace Identifier
VcPLM	Virtual concatenation Payload Mismatch

VP	Virtual Path
VPI	Virtual Path Identifier
WDM	Wavelength Division Multiplexing

5 Conventions

In this Recommendation, O.MN stands for OTN management network, O.MSN for OTN management subnetwork, O.NE for OTN NE and FFS for further study.

6 OTN management functions

See clause 6 of [ITU-T G.7710] for the generic architecture for managing transport equipment. OTN-specific management architecture is described below.

6.1 OTN network management architecture

The transport layer networks of the optical transport network (OTN) are described in [ITU-T G.872] and [ITU-T G.709]. The management of the OTN layer networks is separable from that of its client layer networks so that the same means of management can be used regardless of the client.

6.1.1 Relationship between TMN, O.MN and O.MSN

The OTN management network (O.MN) may be partitioned into OTN management subnetworks (O.MSNs). The inter-relationship between a management network, its subnetworks and a TMN as generically described in clause 6 of [ITU-T G.7710] is applicable to OTN.

6.1.2 Access to the O.MSN

See clause 6.1.2 of [ITU-T G.7710] for the generic requirements.

6.1.3 O.MSN requirements

See clause 6.1.3 of [ITU-T G.7710] for the generic requirements.

In addition, the O.MSN allows for the support of the following:

1) O.NEs must support management communications functions. The message communications function of an O.NE initiates/terminates (in the sense of the lower protocol layers), forwards, or otherwise processes management messages over ECCs, or over other data communications network interfaces. The OTN allows the ECC options of using the general management communication overhead (COMMS OH) or the general communication channels (GCC).
   - All O.NEs are required to terminate the COMMS OH, see clause 6.1.4. In OSI terms, this means that each NE must be able to perform the functions of an end system.
   - All O.NEs are required to terminate the OTUk GCC0, see clause 6.1.4, to connect to O.NEs (e.g., OTH NTs) that are equipped with OTM-0 and/or OTM-nr interfaces only.
   - O.NEs may also be required to forward management messages between ports according to routing control information held in the O.NE. In OSI terms, this means that some O.NEs may be required to perform the functions of an intermediate system.
   - In addition to supporting interfaces for the COMMS OH and GCC, an O.NE may also be required to support other DCN interfaces.
2) OTN inter-site communications. The inter-site or inter-office communications link between O.NEs will normally be formed from the COMMS OH.

3) OTN intra-site communications. Within a particular site, O.NEs may communicate via an intra-site COMMS OH or via an LAN.

Each O.MSN must have at least one O.NE/mediation device that is connected to an OS. This O.NE is termed a gateway network element (GNE). The GNE should be able to perform an intermediate system network layer forwarding function for COMMS OH messages destined for any end system in the O.MSN. Messages passing between the OS and any of the end systems in the subnetwork are routed through the GNE and, in general, other intermediate systems.

The use of the general communication channels (GCC) for management communications is within the scope of this Recommendation, see clause 6.1.4.

6.1.4 O.MSN data communications network

Refer to clause 6.1.4 of [ITU-T G.7710] for the generic requirements.

The main ECC for OTN is considered to be the COMMS OH in the OTM-n signal, see clause 15.1.7 of [ITU-T G.709]. The COMMS OH is carried in the OTM overhead signal (OOS), which in turn is carried in the optical supervisory channel (OSC). This COMMS-based ECC is equivalent to the SDH STM-N MS-DCC. The use of a GCC as an ECC is typically used when one has to reach a remote CPE or a remote subnetwork, and on OTM-0 and OTM-nr type interfaces (OTUk GCC0).

6.1.4.1 General communication channel (GCC)

The OTN supports three general communication channels (GCCs):

1) GCC0

2) GCC1

3) GCC2

Figure 6-1 illustrates a network scenario consisting of two operators. Operator B provides an ODUk service to operator A (i.e., operator B transports the ODUk frame which begins and ends in operator A's domain). According to [ITU-T G.709], only a subset of the ODUk overhead (e.g., path monitoring, etc.) is guaranteed to be passed through operator B's network. Other overheads, such as tandem connection monitoring overhead, as well as GCC1 and GCC2 are subject to the service level agreement made between operator A and operator B.

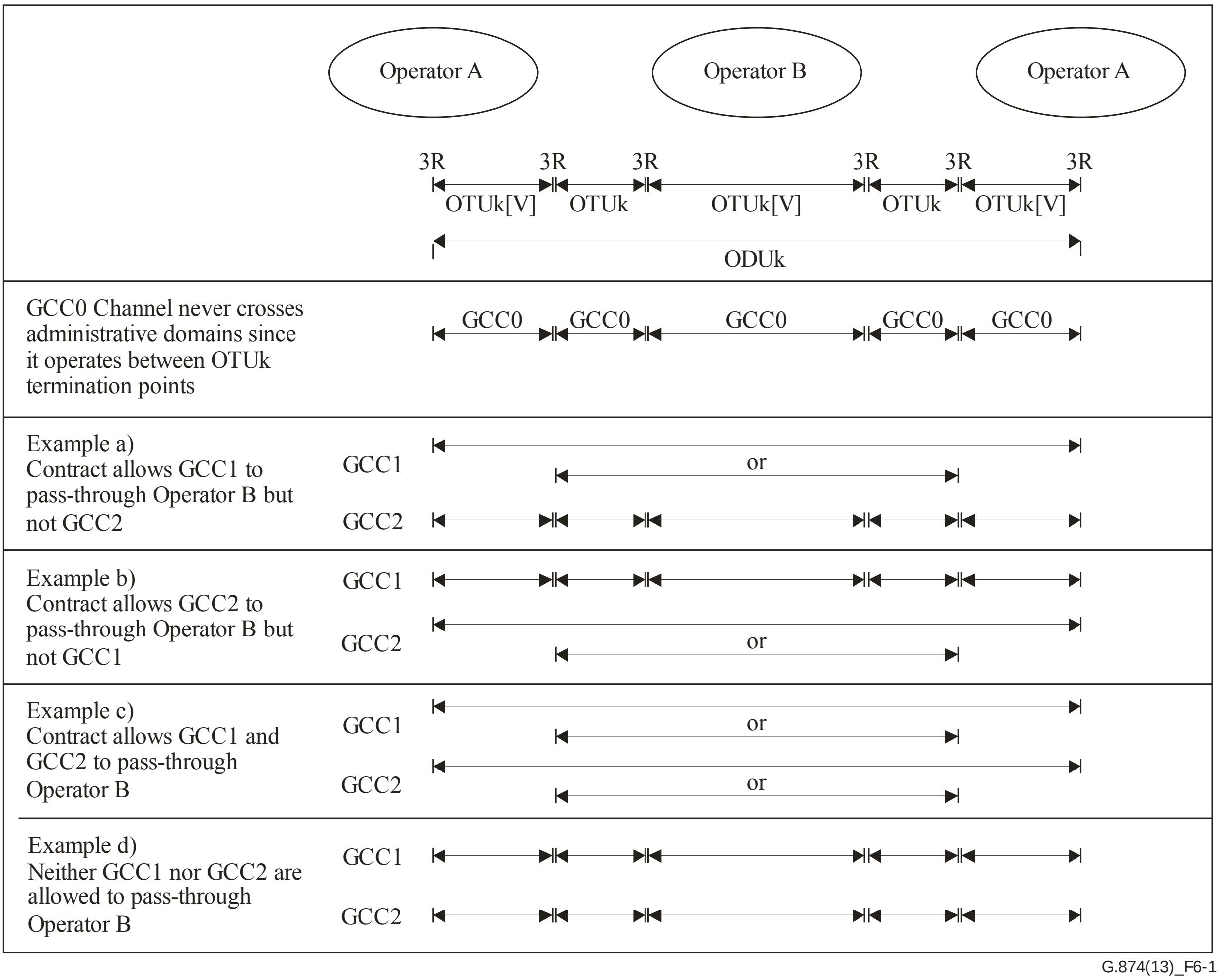

Figure 6-1 – GCC contract scenarios

GCC0 is a channel between OTUk termination points and therefore does not cross administrative domains, since an IrDI interface supports 3R points on either end of the interface. Example a) illustrates a scenario where the contract between operators A and B only allows GCC1 to pass through operator B's network. In such a scenario, operator B may use GCC2 within its own network. Example b) illustrates a scenario where the contract between operators A and B only allows GCC2 to pass through operator B's network. In this scenario, operator B may use GCC1 within its own network. Example c) illustrates a scenario where the contract between operators A and B allows both GCC1 and GCC2 to pass through operator B's network. In this scenario, operator B cannot use GCC1 or GCC2. Example d) illustrates a scenario where the contract between operators A and B does not allow GCC1 or GCC2 to pass through operator B's network. In this scenario, operator B can use both GCC1 and GCC2 within its own network.

6.1.4.1.1 GCC physical characteristics

The OTUk general communication channel 0 (GCC0) shall operate as a single message channel between OTUk termination points using the OTUk overhead bytes located in row 1, columns 11 and 12 of the OTUk overhead. The bit rate of the GCC0 depends on the rate of the OTUk. For an OTU1, the GCC0 channel shall operate at 326.723 kbit/s. For an OTU2, the GCC0 channel shall operate at 1312.405 kbit/s. For an OTU3, the GCC0 channel shall operate at 5271.864 kbit/s. For an OTU4, the GCC0 channel shall operate at 13702.203 kbit/s.

The ODUk GCC1 shall operate as a single message channel between any two network elements with access to the ODUk frame structure using the ODU overhead bytes located in row 4, columns 1 and 2 of the ODUk overhead. The bit rate of the GCC1 depends on the rate of the ODUk.

For an ODU1, the GCC1 channel shall operate at 326.723 kbit/s. For an ODU2, the GCC1 channel shall operate at 1312.405 kbit/s. For an ODU3, the GCC1 channel shall operate at 5271.864 kbit/s. For an ODU4, the GCC1 channel shall operate at 13702.203 kbit/s.

The ODUk GCC2 shall operate as a single message channel between any two network elements with access to the ODUk frame structure using the ODU overhead bytes located in row 4, columns 3 and 4 of the ODUk overhead. The bit rate of the GCC2 depends on the rate of the ODUk. For an ODU2, the GCC1 channel shall operate at 326.723 kbit/s. For an ODU2, the GCC2 channel shall operate at 1312.405 kbit/s. For an ODU3, the GCC2 channel shall operate at 5271.864 kbit/s. For an ODU4, the GCC2 channel shall operate at 13702.203 kbit/s.

Note that the above GCC0/1/2 rates are nominal rates with ±20ppm rate tolerance.

6.1.4.1.2 GCC data link layer protocol

When used for management applications, the data link protocol PPP provides point-to-point connections between nodes of the underlying transmission network. Mapping of OTN data-link layer frame into the GCC is specified in [ITU-T G.7712].

6.1.4.1.3 Support of MCN and SCN separation

In some network deployment scenarios it might be desirable to have separation of MCN and SCN, such as separately enabling/disabling the MCN and SCN traffic on each DCN interface. This might include scenarios where the SCN spans across multiple network domains. The following mechanisms can be used to meet such an application requirement.

– GCC1 and GCC2 can be used simultaneously and separately via two parallel independent instances of the ODUkP/COMMS_A function. For these two instances, one must be configured as GCC1 (MI_GCCAccess = "GCC1") while the other instance must be configured as GCC2 (MI_GCCAccess = "GCC2"). The two COMMS_CPs can then be assigned to the MCN and SCN, respectively.

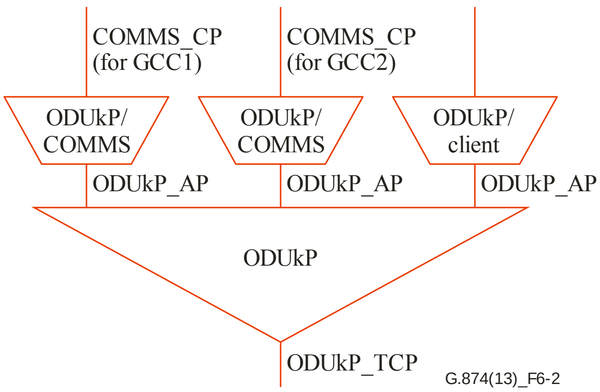

Figure 6-2 – COMMS (GCC1 and GCC2) access at ODUkP access point (Enhancement to Figure 14-70 of [ITU-T G.798])

– GCC1 and GCC2 can be used simultaneously and separately via two cascaded independent instances of the ODUk/COMMS_AC atomic function. For these two instances, one must be configured as GCC1 (MI_GCCAccess = "GCC1") while the other instance must be configured as GCC2 (MI_GCCAccess = "GCC2"). The two COMMS_CPs can then be assigned to the MCN and SCN, respectively.

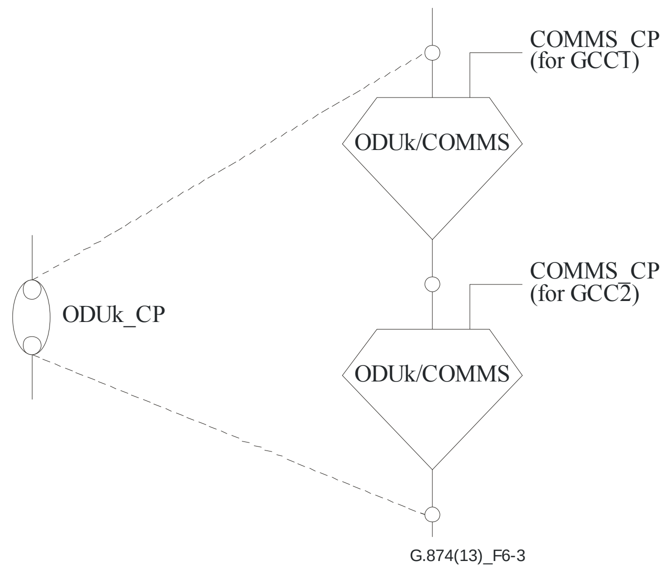

Figure 6-3 – ODUk_CP expansion for COMMS access for GCC1 and GCC2 (Enhancement to Figure 14-75 of [ITU-T G.798])

– In the case where there is limitation in the ODUk layer network deployment such that GCC1 and GCC2 cannot be used separately and simultaneously, it is necessary to have at least two HO ODUk connections between the two NEs (if possible) such that the GCC of one HO ODUk connection can be used as MCC and the GCC of the other HO ODUk connection can be used as SCC.

– In the case where there is limitation in the ODUk layer network deployment such that GCC1 and GCC2 cannot be used separately and simultaneously and it is also not possible to have two HO ODUk connections between the two NEs, mechanisms such as deep packet inspection would be needed if the MCC and the SCC are sharing that single GCC. This would however mean that the MCC/SCC messages need to be analysed beyond OSI layer 3.

6.1.4.2 General management communications overhead (COMMS OH)

The general management communications overhead (COMMS OH) is defined in [ITU-T G.709].

6.1.4.2.1 COMMS OH physical characteristics

The COMMS OH is a logical element within the OTM overhead signal (OOS). It provides general management communications between two optical network elements with access to the OOS. As such, the COMMS OH supports the ECC of the OTN optical supervisory channel (OSC). The OOS is transported via the OSC.

The specific physical frame structure and coding for the COMMS OH is outside the scope of [ITU-T G.709] and therefore not standardized.

6.1.4.2.2 COMMS OH data link layer protocol

The adaptation of COMMS OH data link layer into the physical layer is for further study.

6.1.5 Management of DCN

See [ITU-T G.7710] for the generic requirements.

6.1.6 Remote log-in

See [ITU-T G.7710] for the generic requirements.

6.1.7 Relationship between technology domains

See [ITU-T G.7710] for the generic requirements.

6.2 OTN equipment management function

This clause provides an overview of the minimum functions which are required to support inter-vendor O.NE management including single-ended maintenance of O.NEs within an O.MSN, or between communicating peer O.NEs across a network interface. Single-ended maintenance is the ability to access remotely located O.NEs to perform maintenance functions (see [ITU-T G.7710] for the performance management applications).

It should be noted that the management functions have been categorized according to the classifications given in [ITU-T X.700].

Protocol-neutral specifications of the management application functions, in terms of managed objects classes, attributes and message specification are provided in [ITU-T G.874.1].

The OTN equipment management function (EMF) (see Figure 6-4) provides the means through which the OTN network element function (NEF) is managed by an internal or external manager. If a network element (NE) contains an internal manager, this manager will be part of the OTN EMF.

The OTN EMF interacts with the other atomic functions (refer to [ITU-T G.798]) by exchanging information across the management point (MP) reference points. See [ITU-T G.806] and [ITU-T G.798] for more information on atomic functions and on MPs. The OTN EMF contains a number of functions that provide a data reduction mechanism on the information received across the MP reference points. The outputs of these functions are available to the agent via the network element resources and management application functions (MAFs) which represent this information as managed objects.

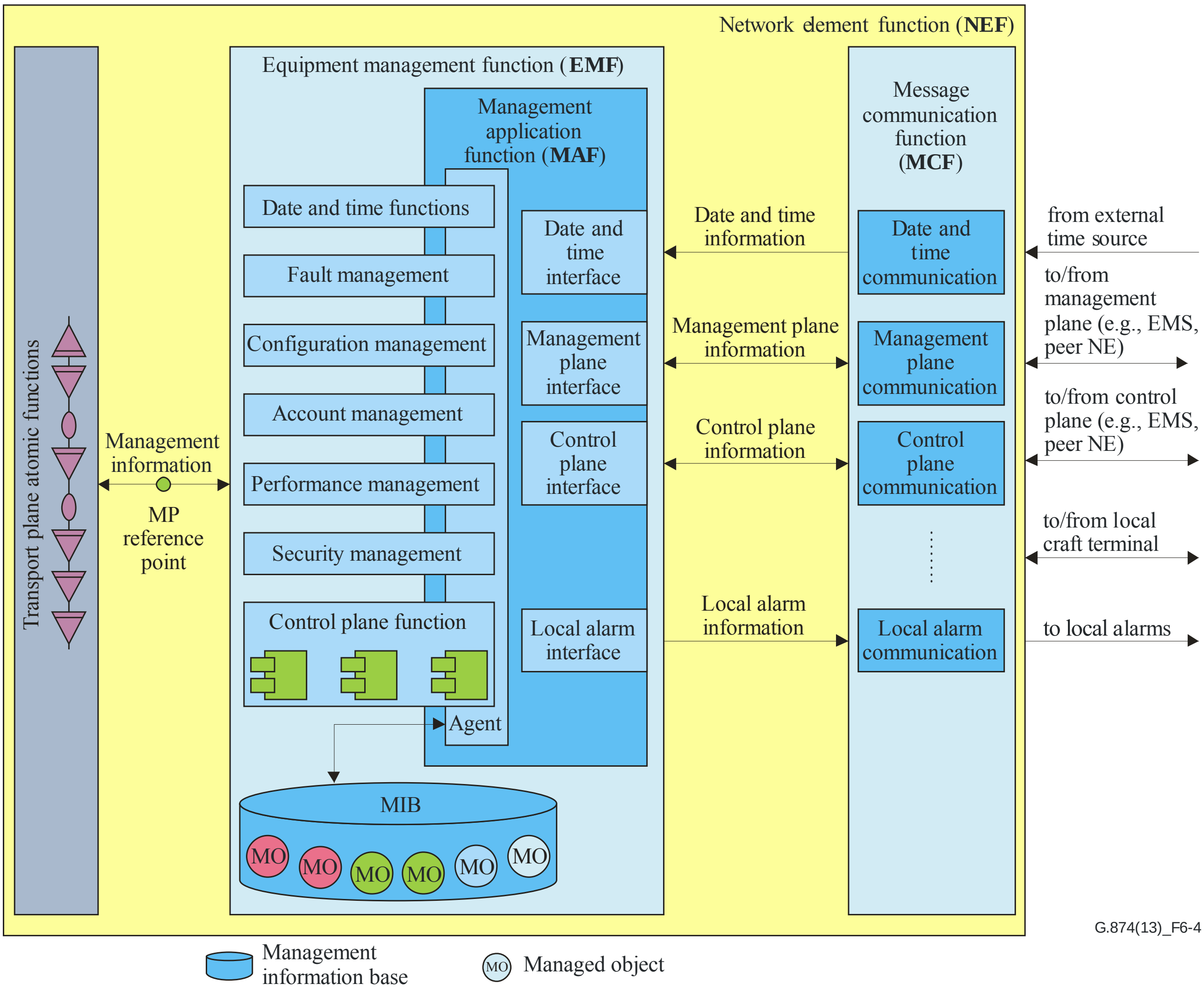

Figure 6-4 – Optical equipment management function

Network element resources provide event processing and storage. The MAF processes the information provided to and by the NE resources. The agent converts this information to management messages and responds to management messages from the manager by performing the appropriate operations on the managed objects.

This information to and from the agent is passed across the V reference point to the message communications function (MCF).

6.3 Information flows over management points (MPs)

The information flows described in this clause are functional. The existence of these information flows in the equipment will depend on the functionality provided by the O.NE and the options selected.

The information flow over the MP reference points that arises from anomalies and defects detected in the atomic functions is described in specific detail for each atomic function in [ITU-T G.798]. Note that these information flows and associated functions apply equally to both the client and supervisory channel due to the independent nature of these signals. This implies neither that the supervisory channel shall provide all the functions described nor that [ITU-T G.798] will provide the details of which functions are available.

The information flow over the MP reference points that arises from provisioning and reporting data is described in specific details for each atomic function in [ITU-T G.798]. The information listed under the input column refers to the provisioning data that is passed from the OTN EMF to the atomic functions. The information listed under the output column refers to the reports passed to the OTN EMF from the atomic functions.

7 Fault management

Fault management is a set of functions which enables the detection, isolation and correction of abnormal operation of the telecommunication network and its environment. It provides facilities for the performance of the maintenance phases from [ITU-T M.20]. The quality assurance measurements for fault management include component measurements for reliability, availability and survivability.

7.1 Fault management applications

See [ITU-T G.7710] for a description of the basic fault management applications.

7.1.1 Supervision

The supervision process describes the way in which the actual occurrence of a disturbance or fault is analysed for the purpose of providing an appropriate indication of performance and/or detected fault condition to maintenance personnel. The supervision philosophy is based on the concepts underlying the functional model of [ITU-T G.805] and [ITU-T G.872] and the alarm reporting function of [ITU-T X.733].

The five basic supervision categories are related to transmission, quality of service, processing, equipment and environment. These supervision processes are able to declare fault causes, which need further validation before the appropriate alarm is reported. See [ITU-T G.7710] for additional discussion of these categories.

The O.NE shall indicate to the OS when a termination point is no longer able to supervise the signal (e.g., implementing equipment has a fault or loss of power).

7.1.1.1 Transmission supervision

See [ITU-T G.7710] for a description of transmission supervision.

7.1.1.2 Quality of Service supervision

See [ITU-T G.7710] for a description of quality of service supervision.

7.1.1.3 Processing supervision

See [ITU-T G.7710] for a description of processing supervision.

7.1.1.4 Hardware supervision

See [ITU-T G.7710] for a description of hardware supervision.

7.1.1.5 Environment supervision

See [ITU-T G.7710] for a description of environment supervision.

7.1.2 Fault cause validation

See [ITU-T G.7710] for a description of fault cause validation.

7.1.3 Alarm handling

7.1.3.1 Severity assignment

See [ITU-T G.7710] for a description of severity categories.

7.1.3.2 Alarm reporting control

Alarm reporting control (ARC) provides an automatic in-service provisioning capability.

The following ARC states may be specified for a managed entity:

ALM	Alarm reporting; alarm reporting is turned on.
NALM	No Alarm reporting; alarm reporting is turned off.
NALM-CD	No Alarm reporting, CountDown; this is a sub-state of NALM-QI and performs the persistence timing countdown function when the managed entity is qualified problem free.
NALM-NR	No Alarm reporting, NotReady; this is a sub-state of NALM-QI and performs a wait function until the managed entity is qualified problem free.
NALM-QI	No Alarm reporting, Qualified Inhibit; alarm reporting is turned off until the managed entity is qualified problem free for a specified persistence interval.
NALM-TI	No Alarm reporting, Timed Inhibit; alarm reporting is turned off for a specified timed interval.

Alarm reporting may be turned off (using NALM, NALM-TI or NALM-QI) on a per-managed entity basis to allow sufficient time for customer testing and other maintenance activities in an "alarm free" state. Once a managed entity is ready, alarm reporting is automatically turned on (to ALM). The managed entity may be automatically turned on either by using NALM-TI or NALM-QI and allowing the resource to transition out automatically, or by invoking first the NALM state from an EMS and, when maintenance activity is done, invoking the ALM state. This later automation is carried out by the EMS. For further details relating to ARC, see [ITU-T M.3100].

7.1.3.3 Reportable failures

See [ITU-T G.7710] for a description of reportable failures.

7.1.3.4 Alarm reporting

Alarm surveillance is concerned with the detection and reporting of relevant events and conditions, which occur in the network. In a network, events and conditions detected within the equipment and incoming signals should be reportable. In addition, a number of events external to the equipment should also be reportable. Alarms are indications that are automatically generated by an NE as a result of the declaration of a failure. The OS shall have the ability to define which events and conditions generate autonomous reports, and which shall be reported on request.

The following alarm-related functions shall be supported:

1) autonomous reporting of alarms;
2) request for reporting of all alarms;
3) reporting of all alarms;
4) allow or inhibit autonomous alarm reporting;
5) reporting on request status of allow or inhibit alarm reporting;
6) control of the termination point mode of termination points;
7) reporting of protection switch events.

7.1.3.4.1 Local reporting

See [ITU-T G.7710] for a description of local reporting.

7.1.3.4.2 TMN reporting

See [ITU-T G.7710] for a description of TMN reporting.

7.2 Fault management functions

Figure 7-1 contains the functional model of fault management inside the OTN EMF. This model is consistent with the alarm flow functional model, specified in [ITU-T M.3100]. It must be noted that it does not address configuration aspects relating to fault management, the full ARC functional model, nor does it define where all possible event report parameters get assigned. Figure 7-1 is intended only to illustrate which well-known functions are impacted by ARC, and which are not, and to provide a generalized alarm flow view.

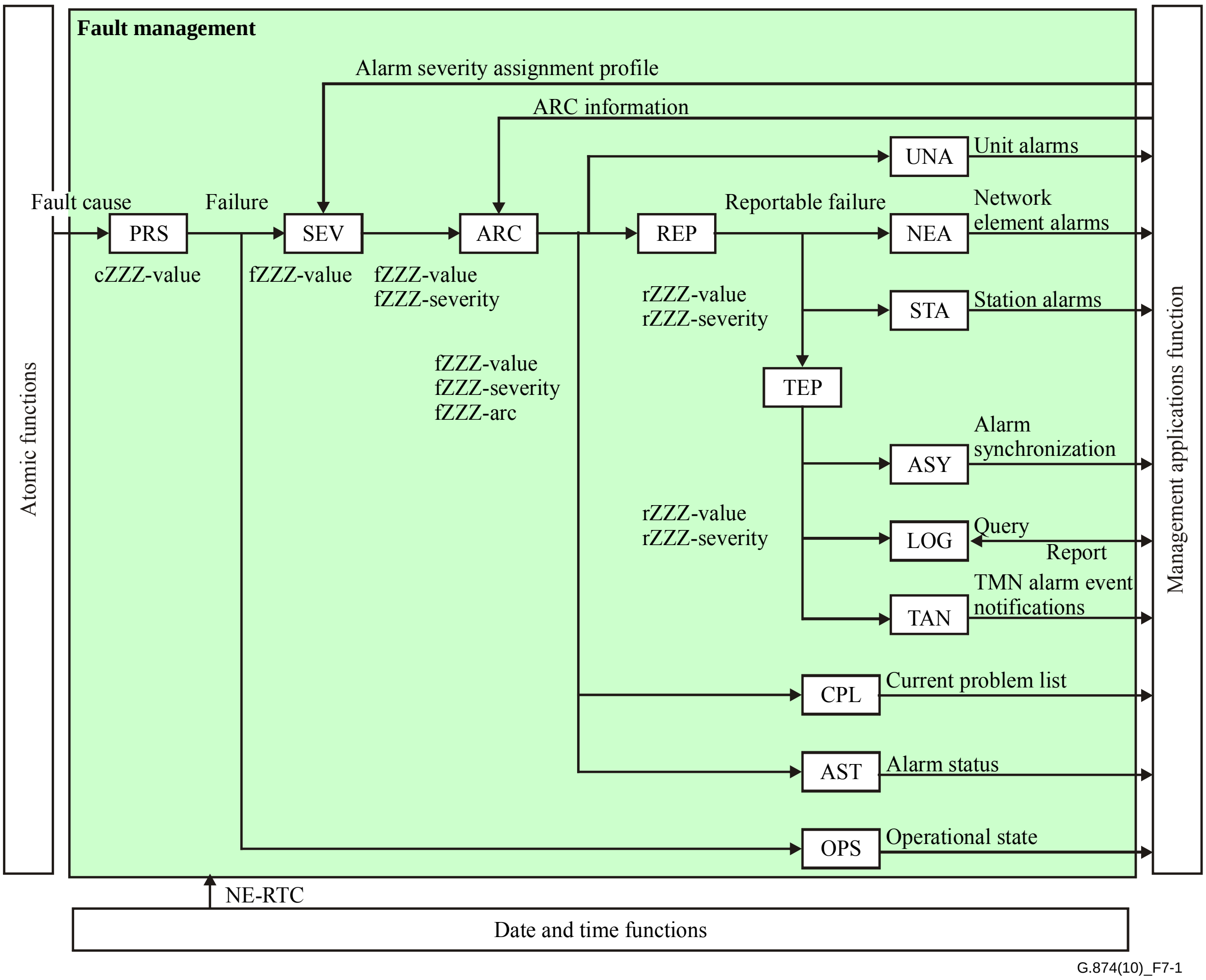

Figure 7-1 – Fault management within the OTN NEF

7.2.1 Fault cause persistency function – PRS

The defect correlations provide a data reduction mechanism on the fault and performance monitoring primitives' information presented at the MP reference points.

The fault cause persistency function will provide a persistency check on the fault causes (that are reported across the MP reference points) before it declares that a fault cause is a failure. In addition to the transmission failures, hardware failures with signal transfer interruption are also reported at the input of the fault cause function for further processing. See Figure 7-2.

Symbol

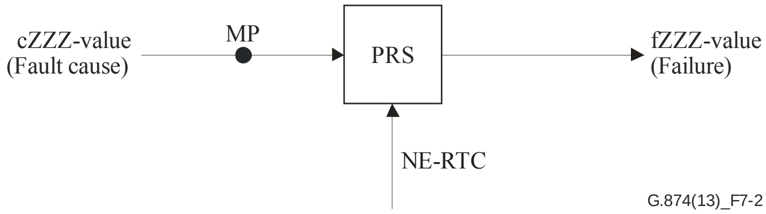

Figure 7-2 – Fault cause persistency function

For an O.NE that supports the atomic functions listed in Table 7-1, the EMF PRS process shall support the persistency check for the associated fault causes.

Inputs and outputs

Table 7-1 – Inputs/outputs for the fault cause persistency function

Atomic functions	Input (fault cause)	Output (failure)
OTSn_TT_Sk	cTIM cBDI cBDI-O cBDI-P cLOS-O cLOS-P cLOS	fTIM fBDI fBDI-O fBDI-P fLOS-O fLOS-P fLOS
OMSn_TT_Sk	cBDI cBDI-O cBDI-P cSSF cSSF-O cSSF-P cLOS-P	fBDI fBDI-O fBDI-P fSSF fSSF-O fSSF-P fLOS-P
OMSnP_TT_Sk	cSSF cSSF-O cSSF-P	fSSF fSSF-O fSSF-P
OPSn_TT_Sk	cLOS-P	fLOS-P
OPSMnk_TT_Sk	cLOS cLOL	fLOS fLOL
OPSM/OTUk-a_A_Sk	cLOS cLOM	fLOS fLOM
OPSM/OTUk-b_A_Sk	cLOS cLOM	fLOS fLOM
OCh_TT_Sk	cLOS-P cSSF cSSF-P cSSF-O cOCI	fLOS-P fSSF fSSF-P fSSF-O fOCI
OChr_TT_Sk	cLOS cSSF-P	fLOS fSSF-P
OCh/OTUk-a_A_Sk	cLOF cLOM	fLOF fLOM

Table 7-1 – Inputs/outputs for the fault cause persistency function

Atomic functions	Input (fault cause)	Output (failure)
OCh/OTUk-b_A_Sk	cLOF cLOM	fLOF fLOM
OCh/OTUk-v_A_Sk	cLOF cLOM	fLOF fLOM
OCh/OTUkV_A_Sk	cLOF cLOM (multiframe OTUkV only)	fLOF fLOM
OCh/RSn_A_Sk	cLOF	fLOF
OTUk_TT_Sk	cTIM cDEG cBDI cSSF	fTIM fDEG fBDI fSSF
OTUkV_TT_Sk	cTIM cDEG cBDI cSSF	fTIM fDEG fBDI fSSF
OTUkV/ODUk_A_Sk (*If loss of alignment supervision is performed*)	cLOA	fLOA
ODUk_C	cFOP-PM cFOP-NR	fFOP-PM fFOP-NR
ODUkP_TT_Sk	cOCI cTIM cDEG cBDI cSSF cLCK	fOCI fTIM fDEG fBDI fSSF fLCK
ODUkP/CBRx_A_Sk	cPLM cCSF	fPLM fCSF
ODUkP/VP_A_Sk	cPLM cLCD	fPLM fLCD
ODUkP/NULL_A_Sk	cPLM	fPLM
ODUkP/PRBS_A_Sk	cPLM cLSS	fPLM fLSS
ODUkP/RSn_A_Sk	cPLM cLOF	fPLM fLOF
ODUkP/ODU[i]j_A_Sk	cPLM cMSIM[p] cLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively	fPLM fMSIM[p] fLOFLOM[p]

Table 7-1 – Inputs/outputs for the fault cause persistency function

Atomic functions	Input (fault cause)	Output (failure)
ODUkP/ODUj-21_A_Sk	cPLM cLOOMFI cMSIM[p] cLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP	fPLM fLOOMFI fMSIM[p] fLOFLOM[p]
ODUkP-h/ETH_A_Sk	cPLM cLFD cUPM cEXM cCSF	fPLM fLFD fUPM fEXM fCSF
ODUkP-h/ODUj-21_A_Sk	cPLM cLOOMFI cMSIM[p] cRCOHM NOTE – [p] = [1...n], when doing n x ODUj_CP	fPLM fLOOMFI fMSIM[p] fRCOHM
ODUkT_TT_Sk	cOCI cTIM cDEG cBDI cSSF cLCK cLTC	fOCI fTIM fDEG fBDI fSSF fLCK fLTC
ODUkTm_TT_Sk	cOCI cTIM cDEG cBDI cSSF cLCK cLTC	fOCI fTIM fDEG fBDI fSSF fLCK fLTC
ODUkP-Xv/ODUkP-X-L_A_Sk	cPLM[1..XMR]	fPLM[1..XMR]
ODUkP-X-L/CBRx_A_Sk	cVcPLM	fVcPLM
ODUkP-X-L/RSn_A_Sk	cVcPLM cLOF	fVcPLM fLOF
ODUkP-X-L/VP_A_Sk	cVcPLM cLCD	fVcPLM fLCD
ODUkP-X-L/NULL_A_Sk	cVcPLM	fVcPLM
ODUkP-X-L/PRBS_A_Sk	cVcPLM cLSS	fVcPLM fLSS
OSx_TT_Sk	cLOS	fLOS

Process

The equipment management function within the network element performs a persistency check on the fault causes before it declares a fault cause a failure.

A transmission failure (fXXX) shall be declared if the fault cause persists continuously for 2.5 ± 0.5 s. The failure shall be cleared if the fault cause is absent continuously for 10 ± 0.5 s.

Transmission failures associated with the three types (termination, adaptation and connection) of transport atomic functions are listed in Table 7-1.

The failure declaration and clearing shall be time-stamped. The time-stamp shall indicate the time at which the fault cause is activated at the input of the fault cause persistency (i.e., defect-to-failure integration) function, and the time at which the fault cause is deactivated at the input of the fault cause persistency function.

7.2.2 Severity assignment function – SEV

See [ITU-T G.7710] for a description of the severity assignment function.

7.2.3 Alarm reporting control function – ARC

The alarm reporting-control (ARC) function allows a management system to control the alarm reporting on a per-managed entity basis as defined in [ITU-T M.3100].

The alarms that can be controlled with this function are defined for each atomic function in [ITU-T G.798].

The ARC states that may be specified for a managed entity are defined in clause 7.1.3.2. For O.NE:

– The ALM state is required for all managed entities that can detect alarms.

– In addition, at least one of the states: NALM, NALM-TI or NALM-QI must be supported.

– If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

In Table 7-2 below, for each managed entity a subset of the plausible failures (defined in Table 7-1) are selected as qualified problems. These qualified problems are recommended as they are deemed essential to the operability of the subject managed entity. Note that for each managed entity, one or more of the qualified problems could then be further selected by the management system to be included in the ARC list (see clause 7.2.3 of [ITU-T G.7710]) for controlling the reporting of alarm for the entity. When an entity is put in the ARC state of NALM-QI, alarm reporting for the entity is turned off until the managed entity is free of all the failures specified in the ARC list.

Default ARC state is also specified for each managed entity. If the ARC function is supported by the O.NE and an ARC state is not explicitly provisioned from the management system for the managed entity, then the default ARC specified in Table 7-2 should be in effect.

For an O.NE that supports the atomic functions listed in Table 7-2, the EMF ARC process shall support alarm reporting control for the associated fault causes.

Table 7-2 – ARC specifications for the OTN

Atomic function	Qualified problems	QoS reporting	Default ARC state value constraints
OTSn_TT_Sk	fTIM fBDI fBDI-P fLOS-P fLOS	FFS	ALM
OMSn_TT_Sk	fBDI fBDI-P fSSF fSSF-P fLOS-P	FFS	ALM
OMSnP_TT_Sk	fSSF fSSF-P	FFS	ALM
OPSn_TT_Sk	fLOS-P	FFS	ALM
OPSMnk_TT_Sk	fLOS fLOL	FFS	ALM
OPSM/OTUk-a_A_Sk	fLOF fLOM	FFS	ALM
OPSM/OTUk-b_A_Sk	fLOF fLOM	FFS	ALM
OCh_TT_Sk	fLOS-P fSSF fSSF-P fOCI	FFS	ALM
OChr_TT_Sk	fLOS fSSF-P	FFS	ALM
OCh/OTUk-a_A_Sk	fLOF fLOM	FFS	ALM
OCh/OTUk-b_A_Sk	fLOF fLOM	FFS	ALM
OCh/OTUkV_A_Sk	fLOF fLOM	FFS	ALM
OCh/RSn_A_Sk	fLOF	FFS	ALM
OTUk_TT_Sk	fTIM fDEG fBDI fSSF	FFS	ALM
OTUkV_TT_Sk	fTIM fDEG fBDI fSSF	FFS	ALM
OTUkV/ODUk_A_Sk	fLOA	FFS	ALM
ODUk_C	fFOP-PM fFOP-NR	FFS	ALM

Table 7-2 – ARC specifications for the OTN

Atomic function	Qualified problems	QoS reporting	Default ARC state value constraints
ODUkP_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK	FFS	ALM
ODUkP/CBRx_A_Sk	fPLM fCSF	FFS FFS	ALM FFS
ODUkP/VP_A_Sk	fPLM fLCD	FFS	ALM
ODUkP/NULL_A_Sk	fPLM	FFS	ALM
ODUkP/PRBS_A_Sk	fPLM fLSS	FFS	ALM
ODUkP/RSn_A_Sk	fPLM fLOF	FFS	ALM
ODUkP/ODU[i]j_A_Sk	fPLM fMSIM[p] fLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively	FFS	ALM
ODUkP/ODUj-21_A_Sk	fPLM fLOOMFI fMSIM[p] fLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP	FFS	ALM
ODUkP-h/ETH_A_Sk	fPLM fLFD fUPM fEXM fCSF	FFS	ALM
ODUkP-h/ODUj-21_A_Sk	fPLM fLOOMFI fMSIM[p] fRCOHM NOTE – [p] = [1...n], when doing n x ODUj_CP	FFS	ALM

Table 7-2 – ARC specifications for the OTN

Atomic function	Qualified problems	QoS reporting	Default ARC state value constraints
ODUkT_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK fLTC	FFS	ALM
ODUkTm_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK fLTC	FFS	ALM
ODUkP-Xv/ODUkP-X-L_A_Sk	fPLM[1..XMR]	FFS	ALM
ODUkP-X-L/CBRx_A_Sk	fVcPLM	FFS	ALM
ODUkP-X-L/RSn_A_Sk	fVcPLM fLOF	FFS	ALM
ODUkP-X-L/VP_A_Sk	fVcPLM fLCD	FFS	ALM
ODUkP-X-L/NULL_A_Sk	fVcPLM	FFS	ALM
ODUkP-X-L/PRBS_A_Sk	fVcPLM fLSS	FFS	ALM
OSx_TT_Sk	fLOS	FFS	ALM

7.2.4 Reportable failure function – REP

See [ITU-T G.7710] for a description of the reportable failure function.

7.2.5 Unit alarm function – UNA

See [ITU-T G.7710] for a description of the unit alarm function.

7.2.6 Network element alarm function – NEA

See [ITU-T G.7710] for a description of the network alarm function.

7.2.7 Station alarm function – STA

See [ITU-T G.7710] for a description of the station alarm function.

7.2.8 TMN event pre-processing function – TEP

See [ITU-T G.7710] for a description of the TMN event pre-processing alarm function.

7.2.9 Alarm synchronization function – ASY

See [ITU-T G.7710] for a description of the alarm synchronization function.

7.2.10 Logging function – LOG

Alarm history management is concerned with the recording of alarms. Historical data shall be stored in registers in the NE. Each register contains all the parameters of an alarm message.

Registers shall be readable on-demand or periodically. The OS can define the operating mode of the registers as wrapping, or stop, when full. The OS may also flush the registers or stop recording at any time.

NOTE – Wrapping is the deletion of the earliest record to allow a new record when a register is full. Flushing is the removal of all records in the register. See [ITU-T X.735] for additional details.

See [ITU-T G.7710] for a description of the logging function.

7.2.11 TMN alarm event notification function – TAN

See [ITU-T G.7710] for a description of the TMN alarm event notification function.

7.2.12 Current problem list function – CPL

See [ITU-T G.7710] for a description of the current problem list function.

7.2.13 Alarm status function – AST

See [ITU-T G.7710] for a description of the alarm status function.

7.2.14 Operational state function – OPS

See [ITU-T G.7710] for a description of the operational state function.

Table 7-3 lists the failures that could influence the operational state of the related objects.

For an O.NE that supports the atomic functions listed in Table 7-3, the EMF OPS process shall support the operational state for the associated fault causes.

Table 7-3 – Input and output signals of the operational state function for OTN

Atomic function	Failure input (fZZZ-value)	Operational state output (enabled/disabled) of the trail object class
OTSn_TT_Sk	fTIM fBDI fBDI-P fLOS-P fLOS	Enabled Enabled Enabled Disabled Disabled
OMSn_TT_Sk	fBDI fBDI-P fSSF fSSF-P fLOS-P	Enabled Enabled Enabled Enabled Disabled
OMSnP_TT_Sk	fSSF fSSF-P	Enabled Enabled
OPSn_TT_Sk	fLOS-P	Disabled
OPSMnk_TT_Sk	fLOS fLOL	Disabled Disabled
OPSM/OTUk-a_A_Sk	fLOF fLOM	Disabled Disabled
OPSM/OTUk-b_A_Sk	fLOF fLOM	Disabled Disabled

Table 7-3 – Input and output signals of the operational state function for OTN

Atomic function	Failure input (fZZZ-value)	Operational state output (enabled/disabled) of the trail object class
OCh_TT_Sk	fLOS-P fSSF fSSF-P fOCI	Disabled Enabled Enabled Enabled
OChr_TT_Sk	fLOS fSSF-P	Disabled Enabled
OCh/OTUk-a_A_Sk	fLOF fLOM	Disabled Disabled
OCh/OTUk-b_A_Sk	fLOF fLOM	Disabled Disabled
OCh/OTUkV_A_Sk	fLOF fLOM	Disabled Disabled
OCh/RSn_A_Sk	fLOF	Disabled
OTUk_TT_Sk	fTIM fDEG fBDI fSSF	Enabled Enabled Enabled Enabled
OTUkV_TT_Sk	fTIM fDEG fBDI fSSF	Enabled Enabled Enabled Enabled
OTUkV/ODUk_A_Sk	fLOA	Disabled
ODUk_C	fFOP-PM fFOP-NR	Disabled Disabled
ODUkP_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK	Enabled Enabled Enabled Enabled Enabled Enabled
ODUkP/CBRx_A_Sk	fPLM fCSF	Disabled Enabled
ODUkP/VP_A_Sk	fPLM fLCD	Disabled Disabled
ODUkP/NULL_A_Sk	fPLM	Disabled
ODUkP/PRBS_A_Sk	fPLM fLSS	Disabled Disabled
ODUkP/RSn_A_Sk	fPLM fLOF	Disabled Disabled

Table 7-3 – Input and output signals of the operational state function for OTN

Atomic function	Failure input (fZZZ-value)	Operational state output (enabled/disabled) of the trail object class
ODUkP/ODU[i]j_A_Sk	fPLM fMSIM[p] fLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively	Disabled Disabled Disabled
ODUkP/ODUj-21_A_Sk	fPLM fLOOMFI fMSIM[p] fLOFLOM[p] NOTE – [p] = [1...n], when doing n x ODUj_CP	FFS FFS FFS Disabled
ODUkP-h/ETH_A_Sk	fPLM fLFD fUPM fEXM fCSF	Disabled Disabled Disabled Disabled Enabled
ODUkP-h/ODUj-21_A_Sk	fPLM fLOOMFI fMSIM[p] fRCOHM NOTE – [p] = [1...n], when doing n x ODUj_CP	Disabled Disabled Disabled FFS
ODUkT_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK fLTC	Enabled Enabled Enabled Enabled Enabled Enabled FFS
ODUkTm_TT_Sk	fOCI fTIM fDEG fBDI fSSF fLCK fLTC	Enabled Enabled Enabled Enabled Enabled Enabled FFS
ODUkP-Xv/ODUkP-X-L_A_Sk	fPLM[1..XMR]	FFS
ODUkP-X-L/CBRx_A_Sk	fVcPLM	FFS
ODUkP-X-L/RSn_A_Sk	fVcPLM fLOF	FFS Disabled

Table 7-3 – Input and output signals of the operational state function for OTN

Atomic function	Failure input (fZZZ-value)	Operational state output (enabled/disabled) of the trail object class
ODUkP-X-L/VP_A_Sk	fVcPLM fLCD	FFS Disabled
ODUkP-X-L/NULL_A_Sk	fVcPLM	FFS
ODUkP-X-L/PRBS_A_Sk	fVcPLM fLSS	FFS FFS
OSx_TT_Sk	fLOS	Disabled

7.2.15 External events

For further study.

8 Configuration management

See [ITU-T G.7710] for the generic requirements for configuration management. OTN-specific specifications, if needed, are explicitly described.

8.1 Hardware

See [ITU-T G.7710] for a description of hardware management.

8.2 Software

See [ITU-T G.7710] for a description of software management.

8.3 Protection switching

See [ITU-T G.7710] for a description of protection switching management.

8.4 Trail termination

See [ITU-T G.7710] for a description of trail termination management.

This function allows a user to provision and monitor the operation of the OTN trail termination process.

A trail trace identifier (TTI) at the OTS layer is useful to ensure proper fibre connection between network elements, in particular in meshed network topology with optical cross-connects that have several line input ports and several line output ports.

TTIs are also a means for the OS to deduce the network topology at OTS layer first, and then at OMS and OCh level. Specifically, the OS gets the list of source and sink TTIs of all network elements and can automatically deduce the trails at the OTS layer by a comparison of the expected TTIs of the sink objects and the TTIs sent from the source objects. Then, as there is only one instance of an OMS connection point and one instance of an OMS TTP, the OS can deduce automatically the topology at the OMS layer. A similar method may be applied at the OCh level from the list of existing ochCTP (which are named by omsTTP).

The TTIs received are used at the network element level to detect wrong fibre connection and generate an OTS trail trace identifier mismatch alarm if the accepted value is different from the expected value.

The trail trace identifier at the OCh layer is necessary to check that the signal received by a sink originates from the intended source. To be able to localize the cross-connection responsible for a trail trace identifier mismatch, the expected and the received OCh TTIs are needed at the sink.

The received OCh TTI is used at the network element level to detect wrong OCh connections and to generate an OCH trail trace identifier mismatch alarm.

The MI signals listed in the following table are communicated between the EMF and the OTN trail termination process across the management point within the O.NE.

For the trail termination functions supported by an O.NE, the O.NE EMF shall support the following management functions:

– Provisioning the trail termination management information
– Retrieving the trail termination management information
– Notifying the changes of the trail termination management information
– Receiving the monitored trail termination management information

Table 8-1 – Trace identifier-related provisioning and reporting

MI signal	Value range	Default value
OTSn_TT_So Provisioning		
OTSn_TT_So_MI_TxTI	According to [ITU-T G.709]	Not applicable
OTSn_TT_So_MI_APRCntrl	Enable, Disable	Enable
OTSn_TT_Sk Provisioning		
OTSn_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
OTSn_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
OTSn_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
OTSn_TT_Sk_MI_TIMDetMo	According to [ITU-T G.798]	FFS
OTSn_TT_Sk_MI_TIMActDis	True, false	True
OTSn_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
OMSn_TT_Sk Provisioning		
OMSn_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
OTUk_TT_So Provisioning		
OTUk_TT_So_MI_TxTI	According to [ITU-T G.709]	Not applicable
OTUk_TT_Sk Provisioning		
OTUk_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
OTUk_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
OTUk_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
OTUk_TT_Sk_MI_TIMDetMo	According to [ITU-T G.798]	FFS
OTUk_TT_Sk_MI_TIMActDis	True, false	True
OTUk_TT_Sk_MI_DEGThr	In number of errored blocks or in percentage between 0% and 100%; see Table 7-1 of [ITU-T G.806]	–
OTUk_TT_Sk_MI_DEGM	2-10; see Table 7-1 of [ITU-T G.806]	10
OTUk_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable

Table 8-1 – Trace identifier-related provisioning and reporting

MI signal	Value range	Default value
OTUkV_TT_So Provisioning		
OTUkV_TT_So_MI_TxTI	According to [ITU-T G.709]	Not applicable
OTUkV_TT_Sk Provisioning		
OTUkV_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
OTUkV_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
OTUkV_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
OTUkV_TT_Sk_MI_TIMDetMo	According to [ITU-T G.798]	FFS
OTUkV_TT_Sk_MI_TIMActDis	Enabled, disabled	Disabled
OTUkV_TT_Sk_MI_DEGThr	In number of errored blocks or in percentage between 0% and 100%; see Table 7-1 of [ITU-T G.806]	–
OTUkV_TT_Sk_MI_DEGM	2-10; see Table 7-1 of [ITU-T G.806]	10
OTUkV_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
ODUkP_TT_So Provisioning		
ODUkP_TT_So_MI_TxTI	According to [ITU-T G.709]	Not applicable
ODUkP_TT_So_MI_DM_Source	true, false	false
ODUkP_TT_So_MI_DMValue	Not applicable. See [ITU-T G.798]	Not applicable
ODUkP_TT_Sk Provisioning		
ODUkP_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
ODUkP_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
ODUkP_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
ODUkP_TT_Sk_MI_TIMDetMo	According to [ITU-T G.798]	FFS
ODUkP_TT_Sk_MI_TIMActDis	Enabled, disabled	Disabled
ODUkP_TT_Sk_MI_DM_Source	true, false	false
ODUkP_TT_Sk_MI_DMValue	Not applicable. See [ITU-T G.798]	Not applicable.
ODUkT_TT_So Provisioning		
ODUkT_TT_So_MI_TxTI	According to [ITU-T G.709]	Not applicable
ODUkT_TT_So_MI_DM_Source	true, false	false
ODUkT_TT_So_MI_DMValue	Not applicable. See [ITU-T G.798]	Not applicable.
ODUkT_TT_Sk Provisioning		
ODUkT_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
ODUkT_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
ODUkT_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
ODUkT_TT_Sk_MI_TIMDectMo	According to [ITU-T G.798]	FFS
ODUkT_TT_Sk_MI_TIMActDis	Enabled, disabled	Disabled

Table 8-1 – Trace identifier-related provisioning and reporting

MI signal	Value range	Default value
ODUkT_TT_Sk_MI_DEGThr	In number of errored blocks or in percentage between 0% and 100%; See Table 7-1 of [ITU-T G.806]	–
ODUkT_TT_Sk_MI_DEGM	2-10; see Table 7-1 of [ITU-T G.806]	10
ODUkT_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
ODUkT_TT_Sk_MI_DM_Source	true, false	trufalse
ODUkT_TT_Sk_MI_DMValue	Not applicable. See [ITU-T G.798]	Not applicable.
ODUkT_TT_Sk_MI_LTCAct_Enable	true, false	false
ODUkT_TT_Sk Reporting		
ODUkT_TT_Sk_MI_AcTI	According to [ITU-T G.709]	Not applicable
ODUkTm_TT_Sk Provisioning		
ODUkTm_TT_Sk_MI_Level	1..6	Not applicable
ODUkTm_TT_Sk_MI_ExSAPI	According to [ITU-T G.709]	Not applicable
ODUkTm_TT_Sk_MI_ExDAPI	According to [ITU-T G.709]	Not applicable
ODUkTm_TT_Sk_MI_GetAcTI	According to [ITU-T G.798]	Not applicable
ODUkTm_TT_Sk_MI_TIMDectMo	According to [ITU-T G.798]	FFS
ODUkTm_TT_Sk_MI_TIMActDis	Enabled, disabled	Disabled
ODUkTm_TT_Sk_MI_DEGThr	In number of errored blocks or in percentage between 0% and 100%; see Table 7-1 of [ITU-T G.806]	–
ODUkTm_TT_Sk_MI_DEGM	2-10; see Table 7-1 of [ITU-T G.806]	10
ODUkTm_TT_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
ODUkTm_TT_Sk Reporting		
ODUkTm_TT_Sk_MI_AcTI	According to [ITU-T G.709]	Not applicable
OSx_TT_So Provisioning		
OSx_TT_So_MI_APRCntrl (Notes 1 and 2)	Enable, disable	Enable
NOTE 1 – If APR is required. NOTE 2 – The APRCntrl commands depend on the specific APR process.		

For the management of the connectivity at OTS layer, the following trail trace identifier attributes are recommended:

1) otsTTIsent attribute in every otsTTPsource (get – replace);
2) otsTTIexpected attribute in every otsTTPsink (get – replace);
3) otsTTIreceived attribute in every otsTTPsink (get – replace).

For the management of the connectivity at OCH layer, the following trail trace identifier attributes are recommended:

1) ochTTIsent attribute in every ochTTPsource (get – replace);
2) ochTTIexpected attribute in every ochTTPsink and ochCTPsink (get – replace);
3) ochTTIreceived attribute in every ochTTPsink and ochCTPsink (get only).

8.5 Adaptation

See [ITU-T G.7710] for a description of adaptation management.

An access point that has multiple adaptation functions connected to it, thereby allowing different clients to be transported via the server signal, requires a mechanism for the selection of the active client.

The adaptation function allows a user to provision and monitor the operation of the OTN adaptation processes.

The activation/deactivation of adaptation functions is via MI_Active signals.

Both OMS/OCh_A and OCh/Application_A will report on request from the OTN EMF the value of the received and accepted payload type indication signal via the MI_AcPTI.

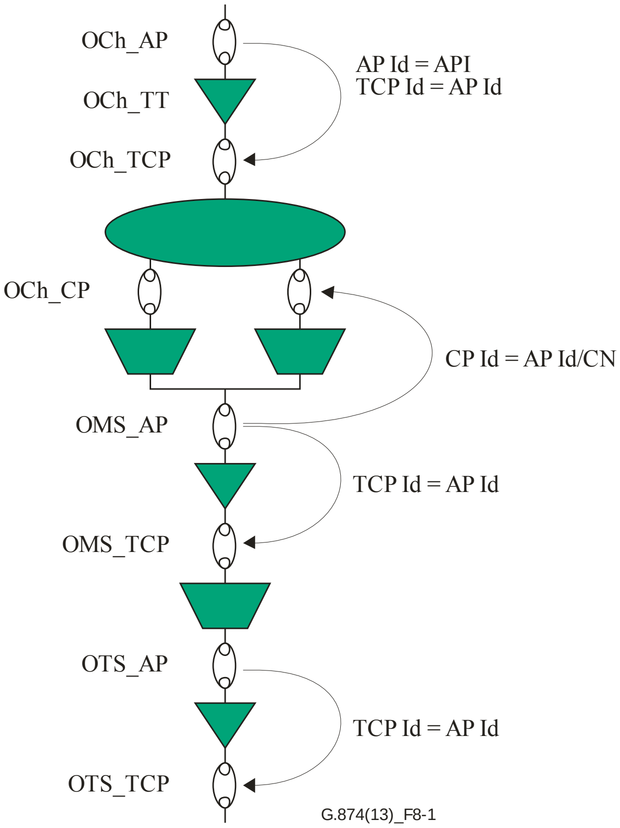

Figure 8-1 – CP and TCP identification scheme

The MI signals listed in Table 8-2 are communicated between the EMF and the adaptation processes across the management point within the OTN NE.

For the adaptation functions supported by an O.NE, the O.NE EMF shall support the following management functions:

– Provisioning the adaptation management information
– Retrieving the adaptation management information
– Notifying the changes of the adaptation management information

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
OPSM/OTUk-a_A_So Provisioning		
OPSM/OTUk-a_A_So_MI_Active	True, false	False
OPSM/OTUk-b_A_So Provisioning		
OPSM/OTUk-b_A_So_MI_Active	True, false	False
OPSM/OTUk-a_A_Sk Provisioning		
OPSM/OTUk-a_A_Sk_MI_FECEn (not for OTU4)	True, false	True
OPSM/OTUk-a_A_Sk_MI_Active	True, false	False
OPSM/OTUk-a_A_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
OPSM/OTUk-b_A_Sk Provisioning		
OPSM/OTUk-b_A_Sk_MI_Active	True, false	False
OCh/OTUk-a_A_So Provisioning		
OCh/OTUk-a_A_So_MI_Active	True, false	False
OCh/OTUk-b_A_So Provisioning		
OCh/OTUk-b_A_So_MI_Active	True, false	False
OCh/OTUk-a_A_Sk Provisioning		
OCh/OTUk-a_A_Sk_MI_FECEn	True, false	True
OCh/OTUk-a_A_Sk_MI_Active	True, false	False
OCh/OTUk-a_A_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
OCh/OTUk-b_A_Sk Provisioning		
OCh/OTUk-b_A_Sk_MI_Active	True, false	False
OCh/OTUk-v_A_So Provisioning		
OCh/OTUk-v_A_So_MI_Active	True, false	False
OCh/OTUk-v_A_Sk Provisioning		
OCh/OTUk-v_A_Sk_MI_FECEn	True, false	True
OCh/OTUk-v_A_Sk_MI_Active	True, false	False
OCh/OTUk-v_A_Sk_MI_1second	According to [ITU-T G.798]	Not applicable
OCh/OTUkV_A_So Provisioning		
OCh/OTUkV_A_So_MI_Active	True, false	False
OCh/OTUkV_A_Sk Provisioning		
OCh/OTUkV_A_Sk_MI_Active	True, false	False
OCh/OTUkV_A_Sk_MI_1second (Note 1)	According to [ITU-T G.798]	Not applicable

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
OCh/CBRx_A_So Provisioning		
OCh/CBRx_A_So_MI_Active	True, false	False
OCh/CBRx_A_Sk Provisioning		
OCh/CBRx_A_Sk_MI_Active	True, false	False
OCh/RSn_A_So_Provisioning		
OCh/RSn_A_So_MI_Active	True, false	False
OCh/RSn_A_Sk_Provisioning		
OCh/RSn_A_Sk_MI_Active	True, false	False
OTUk/ODUk_A_So_Provisioning		
OTUk/ODUk_A_So_MI_AdminState	LOCKED, Not LOCKED	Not LOCKED
OTUk/ODUk_A_So_MI_APS_EN	true, false	true
OTUk/ODUk_A_So_MI_APS_LVL	0..6, 0 for path and 1..6 for TCM	–
OTUk/ODUk_A_Sk_Provisioning		
OTUk/ODUk_A_Sk_MI_AdminState	LOCKED, Not LOCKED	Not LOCKED
OTUk/ODUk_A_Sk_MI_APS_EN	true, false	true
OTUk/ODUk_A_Sk_MI_APS_LVL	0..6, 0 for path and 1..6 for TCM	–
OTUkV/ODUk_A_So_Provisioning		
OTUkV/ODUk_A_So_MI_AdminState	LOCKED, Not LOCKED	Not LOCKED
OTUkV/ODUk_A_So_MI_APS_EN	true, false	true
OTUkV/ODUk_A_So_MI_APS_LVL	0..6, 0 for path and 1..6 for TCM	–
OTUkV/ODUk_A_Sk_Provisioning		
OTUkV/ODUk_A_Sk_MI_AdminState	LOCKED, Not LOCKED	Not LOCKED
OTUkV/ODUk_A_Sk_MI_APS_EN	true, false	true
OTUkV/ODUk_A_Sk_MI_APS_LVL	0..6, 0 for path and 1..6 for TCM	–
OTUk/COMMS_A_So_Provisioning		
OTUk/COMMS_A_So_MI_Active	True, false	False
OTUk/COMMS_A_Sk_Provisioning		
OTUk/COMMS_A_Sk_MI_Active	True, false	False

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
OTUkV/COMMS_A_So_Provisioning		
OTUkV/COMMS_A_So_MI_Active	True, false	False
OTUkV/COMMS_A_Sk_Provisioning		
OTUkV/COMMS_A_Sk_MI_Active	True, false	False
ODUkP/CBRx-a_A_So_Provisioning		
ODUkP/CBRx-a_A_So_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/CBRx-b_A_So_Provisioning		
ODUkP/CBRx-b_A_So_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/CBRx_A_Sk_Provisioning		
ODUkP/CBRx_A_Sk_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/CBRx_A_Sk Reporting		
ODUkP/CBRx_A_Sk_MI_AcPT, k=1, 2, 2e, 3; (Note 2)	According to [ITU-T G.709]	Not applicable
ODUkP/CBRx-g_A_So Provisioning		
ODUkP/CBRx_A_So_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/ CBRx-g_A_Sk Provisioning		
ODUkP/CBRx_A_Sk_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/ CBRx-g_A_Sk Reporting		
ODUkP/CBRx_A_Sk_MI_AcPT, k=1, 2, 2e, 3; (Note 2)	According to [ITU-T G.709]	Not applicable
ODUkP/CBRx-g_A_So Provisioning		
ODUkP/CBRx_A_So_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/CBRx-g_A_Sk Provisioning		
ODUkP/CBRx_A_Sk_MI_Active, k=1, 2, 2e, 3; (Note 2)	True, false	False
ODUkP/CBRx_A_Sk_MI_Enable_PCSL_Section_Mon	True, false	False
ODUkP/CBRx-g_A_Sk Reporting		
ODUkP/CBRx_A_Sk_MI_AcPT, k=1, 2, 2e, 3; (Note 2)	According to [ITU-T G.709]	Not applicable
ODU0P/CBRx_A_So Provisioning		
ODU0P/CBRx_A_So_MI_Active, k=0; (Note 3)	True, false	False
ODU0P/CBRx_A_Sk Provisioning		
ODU0P/CBRx_A_Sk_MI_Active, k=0; (Note 3)	True, false	False
ODU0P/CBRx_A_Sk Reporting		
ODU0P/CBRx_A_Sk_MI_AcPT, k=0; (Note 3)	According to [ITU-T G.709]	Not applicable
ODUkP/VP_A_So Provisioning		
ODUkP/VP_A_So_MI_Active, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_So_MI_CellDiscardActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_So_MI_TPusgActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_So_MI_GFCActive, k=1, 2, 2e, 3	True, false	False

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP/VP_A_So_MI_VPI-KActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk Provisioning		
ODUkP/VP_A_Sk_MI_Active, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_CellDiscardActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_TPusgActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_VPIrange, k=1, 2, 2e, 3	0..4095	Not applicable
ODUkP/VP_A_Sk_MI_HECactive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_GFCactive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_DTDLuseEnabled, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_VPI-KActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk_MI_VPIK_SAISActive, k=1, 2, 2e, 3	True, false	False
ODUkP/VP_A_Sk Reporting		
ODUkP/VP_A_Sk_MI_AcPT, k=1, 2, 2e, 3	According to [ITU-T G.709]	Not applicable
ODUkP/NULL_A_So Provisioning		
ODUkP/NULL_A_So_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/NULL_A_So_MI_Nominal_Bitrate_and_Tolerance	According to [ITU-T G.709]	Not applicable
ODUkP/NULL_A_Sk_Provisioning		
ODUkP/NULL_A_Sk_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/NULL_A_Sk Reporting		
ODUkP/NULL_A_Sk_MI_AcPT, k=0, 1, 2, 2e, 3, 4, flex	According to [ITU-T G.709]	Not applicable
ODUkP/PRBS_A_So Provisioning		
ODUkP/PRBS_A_So_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/PRBS_A_So_MI_Nominal_Bitrate_and_Tolerance	According to [ITU-T G.709]	Not applicable
ODUkP/PRBS_A_Sk Provisioning		
ODUkP/PRBS_A_Sk_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/PRBS_A_Sk Reporting		
ODUkP/PRBS_A_Sk_MI_AcPT, k=0, 1, 2, 2e, 3, 4, flex	According to [ITU-T G.709]	Not applicable
ODUkP/RSn-a_A_So Provisioning		
ODUkP/RSn-a_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP/RSn-b_A_So Provisioning		
ODUkP/RSn-b_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP/RSn_A_Sk Provisioning		
ODUkP/RSn_A_Sk_MI_Active, k=1, 2, 3	True, false	False

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP/RSn_A_Sk Reporting		
ODUkP/RSn_A_Sk_MI_AcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP/ODU[i]j_A_So Provisioning		
ODUkP/ODU[i]j_A_So_MI_Active	True, false	False
ODUkP/ODU[i]j_A_So_MI_AdminState[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	LOCKED, Not LOCKED	Not LOCKED
ODUkP/ODU[i]j_A_So_MI_APS_EN[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	true, false	true
ODUkP/ODU[i]j_A_So_MI_APS_LVL [p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	0..6, 0 for path and 1..6 for TCM	–
ODU3P/ODU12_A_So Provisioning		
ODU3P/ODU12_A_So_MI_TxMSI	According to Table 14-30 of [ITU-T G.798]	Not applicable
ODUkP/ODU[i]j_A_Sk Provisioning		
ODUkP/ODU[i]j_A_Sk_MI_Active	True, false	False
ODUkP/ODU[i]j_A_Sk_MI_AdminState[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	LOCKED, Not LOCKED	Not LOCKED
ODUkP/ODU[i]j_A_Sk_MI_APS_EN[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	true, false	true
ODUkP/ODU[i]j_A_Sk_MI_APS_LVL [p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	0..6, 0 for path and 1..6 for TCM	–
ODU3P/ODU12_A_Sk Provisioning		
ODU3P/ODU12_A_Sk_MI_ExMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	According to Table 14-32 of [ITU-T G.798]	Not applicable
ODUkP/ODU[i]j_A_Sk Reporting		
ODUkP/ODU[i]j_A_Sk_MI_AcPT	According to [ITU-T G.709]	Not applicable
ODUkP/ODU[i]j_A_Sk_MI_AcMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP and [p] = [1..m] when doing m x ODUi_CP respectively.	According to [ITU-T G.709]	Not applicable

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP/ODUj-21_A_So Provisioning		
ODUkP/ODUj-21_A_So_MI_Active	True, false	False
ODUkP/ODUj-21_A_So_MI_TxMSI	According to [ITU-T G.798]	Not applicable
ODUkP/ODUj-21_A_So_MI_AUTOpayloadtype NOTE – See Appendix III for Payload Type to Adaptation mapping	According to [ITU-T G.709]	Not applicable
ODUkP/ODUj-21_A_So_MI_ODUType_Rate[i]	According to clause 19.6 of [ITU-T G.709]	Not applicable
ODUkP/ODUj_A_So_MI_AdminState[n]	LOCKED, Not LOCKED	Not LOCKED
ODUkP/ODUj-21_A_So_MI_APS_EN [n]	true, false	true
ODUkP/ODUj-21_A_So_MI_APS_LVL [n]	0..6, 0 for path and 1..6 for TCM	–
ODUkP/ODUj-21_A_So Reporting		
ODUkP/ODUj-21_A_So_MI_TrPT	According to [ITU-T G.709]	Not applicable
ODUkP/ODUj-21_A_Sk Provisioning		
ODUkP/ODUj-21_A_Sk_MI_Active	True, false	False
ODUkP/ODUj-21_A_Sk_MI_ExMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.798]	Not applicable
ODUkP/ODUj-21_A_Sk_MI_AdminState[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	LOCKED, Not LOCKED	Not LOCKED
ODUkP/ODUj-21_A_Sk_MI_Nominal_Bitrate_and_Tolerance[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.709]	Not applicable
ODUkP/ODUj-21_A_Sk_MI_ODUType [p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to clause 19.6 of [ITU-T G.709]	Not applicable
ODUkP/ODUj-21_A_Sk_MI_APS_EN[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	true, false	true
ODUkP/ODUj-21_A_Sk_MI_APS_LVL[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	0..6, 0 for path and 1..6 for TCM	–
ODUkP/ODUj-21_A_Sk Reporting		
ODUkP/ODUj-21_A_Sk_MI_AcPT	According to [ITU-T G.709]	Not applicable
ODUkP/ODUj-21_A_Sk_MI_AcMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.709]	Not applicable

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP-h/ETH_A_So Provisioning, k=flex		
ODUkP-h/ETH_A_So_MI_Active	True, false	False
ODUkP-h/ETH_A_So_MI_CSFEnable	True, false	False
ODUkP-h/ETH_A_So_MI_CSFrdifdiEnable	True, false	False
ODUkP-h/ETH_A_So_MI_INCREASE	True, false	False
ODUkP-h/ETH_A_So_MI_DECREASE	True, false	False
ODUkP-h/ETH_A_So_MI_TSNUM	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ETH_A_So_MI_Timer	TBD	TBD
ODUkP-h/ETH_A_So_MI_ODUflexRate	FlexCBR, FlexGFP	N/A
ODUkP-h/ETH_A_So Reporting, k=flex		
ODUkP-h/ETH-m_A_So_MI_ADJSTATE	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ETH_A_Sk Provisioning, k=flex		
ODUkP-h/ETH_A_Sk_MI_Active	True, false	False
ODUkP/ETH-h_A_Sk_MI_FilterConfig	According to [ITU-T G.7044]	Not applicable
ODUkP/ETH-h_A_Sk_MI_CSF_Reported	true, false	false
ODUkP/ETH-h_A_Sk_MI_MAC_Length	1518, 1522, 2000	2000
ODUkP-h/ETH_A_Sk_MI_CSFrdifdiEnable	True, false	False
ODUkP-h/ETH_A_Sk_MI_INCREASE	True, false	False
ODUkP-h/ETH_A_Sk_MI_DECREASE	True, false	False
ODUkP-h/ETH_A_Sk_MI_Timer	TBD	TBD
ODUkP-h/ETH_A_Sk Reporting; k=1, 2, 3, flex		
ODUkP/ETH_A_Sk_MI_AcPT	According to [ITU-T G.709]	Not applicable
ODUkP/ETH_A_Sk_MI_AcEXI	According to [ITU-T G.709]	Not applicable
ODUkP/ETH_A_Sk_MI_AcUPI	According to [ITU-T G.709]	Not applicable
ODUkP-h/ODUj-21_A_So Provisioning; k=2,3,4; j=0,1,2,2e,3,flex		
ODUkP-h/ODUj-21_A_So_MI_Active	True, false	False
ODUkP-h/ODUj-21_A_So_MI_TxMSI[p] [p] = [1...n], when doing n x ODUj_CP	According to [ITU-T G.798]	Not applicable
ODUkP-h/ODUj-21_A_So_MI_AUTOpayloadtype	According to [ITU-T G.798]	Not applicable
ODUkP-h/ODUj-21_A_So_MI_AdminState[p] [p] = [1...n], when doing n x ODUj_CP	According to [ITU-T G.798]	Not applicable
ODUkP-h/ODUj-21_A_So_MI_APS_EN [n]	true, false	true

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP-h/ODUj-21_A_So_MI_APS_LVL [n]	0..6, 0 for path and 1..6 for TCM	–
ODUkP-h/ODUj-21_A_So_MI_INCREASE	True, false	False
ODUkP-h/ODUj-21_A_So_MI_DECREASE	True, false	False
ODUkP-h/ODUj-21_A_So_MI_TSMAP	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ODUj-21_A_So_MI_TPID	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ODUj-21_A_So_MI_Timer	TBD	TBD
ODUkP-h/ODUj-21_A_So Reporting; k=2,3,4; j=0,1,2,2e,3,flex		
ODUkP-h/ODUj-21_A_So_MI_TRPT	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ODUj-21_A_Sk Provisioning; k=2,3,4; j=0,1,2,2e,3,flex		
ODUkP-h/ODUj21_A_Sk_MI_Active	True, false	False
ODU3P-h /ODUj21_A_Sk_MI_ExMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.798]	Not applicable
ODUkP-h /ODUj-21_A_Sk_MI_AdminState[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.798]	Not applicable
ODUkP-h /ODUj-21_A_Sk_MI_Nominal_Bitrate_and_Tolerance[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.709]	Not applicable
ODUkP-h/ODUj-21_A_Sk_MI_APS_EN [p]	true, false	true
ODUkP-h/ODUj-21_A_Sk_MI_APS_LVL [p]	0..6, 0 for path and 1..6 for TCM	–
ODUkP-h/ODUj-21_A_Sk_MI_INCREASE	True, false	False
ODUkP-h/ODUj-21_A_Sk_MI_DECREASE	True, false	False
ODUkP-h/ODUj-21_A_Sk_MI_TSMAP	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ODUj-21_A_Sk_MI_TPID	According to [ITU-T G.7044]	Not applicable
ODUkP-h/ODUj-21_A_Sk_MI_Timer	TBD	TBD
ODUkP-h/ODUj-21_A_Sk Reporting; k=2,3,4; j=0,1,2,2e,3,flex		
ODUkP-h/ODUj-21_A_Sk_MI_AcPT	According to [ITU-T G.709]	Not applicable
ODUkP-h/ODUj-21_A_Sk_MI_AcMSI[p] NOTE – [p] = [1...n], when doing n x ODUj_CP.	According to [ITU-T G.709]	Not applicable
ODUkP/COMMS_A_So Provisioning		
ODUkP/COMMS_A_So_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/COMMS_A_So_MI_GCCAccess, k=0, 1, 2, 2e, 3, 4, flex	GCC1, GCC2, GCC1+GCC2	Not applicable

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP/COMMS_A_Sk Provisioning		
ODUkP/COMMS_A_Sk_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUkP/COMMS_A_Sk_MI_GCCAccess, k=0, 1, 2, 2e, 3, 4, flex	GCC1, GCC2, GCC1+GCC2	Not applicable
ODUk/COMMS_AC_So Provisioning		
ODUk/COMMS_AC_So_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUk/COMMS_AC_So_MI_GCCAccess, k=0, 1, 2, 2e, 3, 4, flex	GCC1, GCC2, GCC1+GCC2	Not applicable
ODUk/COMMS_AC_Sk Provisioning		
ODUk/COMMS_AC_Sk_MI_Active, k=0, 1, 2, 2e, 3, 4, flex	True, false	False
ODUk/COMMS_AC_Sk_MI_GCCAccess, k=0, 1, 2, 2e, 3, 4, flex	GCC1, GCC2, GCC1+GCC2	Not applicable
ODUk/COMMS_AC_Sk_MI_GCCCont, k=0, 1, 2, 2e, 3, 4, flex	True, false	True
ODUkT/ODUk_A_So Provisioning		
ODUkT/ODUk_A_So_MI_AdminState, k=0, 1, 2, 2e, 3, 4, flex	LOCKED, Not LOCKED	Not LOCKED
ODUkT/ODUk_A_Sk Provisioning		
ODUkT/ODUk_A_Sk_MI_AdminState, k=0, 1, 2, 2e, 3, 4, flex	LOCKED, Not LOCKED	Not LOCKED
ODUkP-Xv/ODUkP-X-L_A_So Provisioning		
ODUkP-Xv/ODUkP-X-L_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-Xv/ODUkP-X-L_A_Sk Reporting		
ODUkP-Xv/ODUkP-X-L_A_Sk_MI_AcPT[1..XMR] , k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP-Xv/ODUkP-X-L_A_Sk_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/CBRx-a_A_So Provisioning		
ODUkP-X-L/CBRx-a_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/CBRx-b_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/CBRx_A_Sk Provisioning		
ODUkP-X-L/CBRx_A_Sk_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/CBRx_A_Sk Reporting		
ODUkP-X-L/CBRx_A_Sk_MI_AcVcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP-X-L/RSn-a_A_So Provisioning		
ODUkP-X-L/RSn-a_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/RSn-b_A_So Provisioning		
ODUkP-X-L/RSn-b_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/RSn_A_Sk Provisioning		
ODUkP-X-L/RSn_A_Sk_MI_Active, k=1, 2, 3	True, false	False

Table 8-2 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
ODUkP-X-L/RSn_A_Sk Reporting		
ODUkP-X-L/RSn_A_Sk_MI_AcVcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP-X-L/VP_A_So Provisioning		
ODUkP-X-L/VP_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_So_MI_CellDiscardActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_So_MI_TPusgActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_So_MI_GFCActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_So_MI_VPI-KActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk Provisioning		
ODUkP-X-L/VP_A_Sk_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_CellDiscardActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_TPusgActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_VPIrange, k=1, 2, 3	0..4095	Not applicable
ODUkP-X-L/VP_A_Sk_MI_HECactive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_GFCactive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_DTDLuseEnabled, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_VPI-KActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk_MI_VPI-K_SAISActive, k=1, 2, 3	True, false	False
ODUkP-X-L/VP_A_Sk Reporting		
ODUkP-X-L/VP_A_Sk_MI_AcVcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP-X-L/NULL_A_So Provisioning		
ODUkP-X-L/NULL_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/NULL_A_Sk Provisioning		
ODUkP-X-L/NULL_A_Sk_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/NULL_A_Sk Reporting		
ODUkP-X-L/NULL_A_Sk_MI_AcVcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
ODUkP-X-L/PRBS-a_A_So Provisioning		
ODUkP-X-L/PRBS-a_A_So_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/PRBS_A_Sk Provisioning		
ODUkP-X-L/PRBS_A_Sk_MI_Active, k=1, 2, 3	True, false	False
ODUkP-X-L/PRBS_A_Sk Reporting		
ODUkP-X-L/PRBS_A_Sk_MI_AcVcPT, k=1, 2, 3	According to [ITU-T G.709]	Not applicable
NOTE 1 – If the OTUkV has multiframe. NOTE 2 – x = 2G5, 10G, 10G3, 40G. NOTE 3 – 0 ≤ x ≤ 1.25G.		

8.6 Connection

See [ITU-T G.7710] for a description of connection management.

This function allows a user to provision the operation of an OTN connection process.

The MI signals listed in Table 8-3 are communicated from the EMF to the connection process through the management point.

For the connection functions supported by an O.NE, the O.NE EMF shall support the following management functions:

– Provisioning the connection management information
– Retrieving the connection management information
– Notifying the changes of the connection management information

Table 8-3 – Provisioning and reporting for connection functions

MI signal	Value range	Default value
OMSnP_C Provisioning		
OMSnP_C_MI_OperType	Revertive, non-revertive	Revertive
OMSnP_C_MI_WTR	5..12 minutes	FFS
OMSnP_C_MI_HoTime	0..10 seconds in steps of 100 ms	FFS
OMSnP_C_MI_ExtCMD	– (Command)	Not applicable
OMSnP_C_MI_SSF-ODis	True, false	False
OCh_C Provisioning		
OCh_C_MI_MatrixControl	Connect, disconnect	Not applicable
Per protection group: OCh_C_MI_OperType OCh_C_MI_WTR OCh_C_MI_HoTime OCh_C_MI_ExtCMD OCh_C_MI_TSF-ODis	 Revertive, non-revertive 5..12 minutes 0..10 seconds in steps of 100 ms – (Command) True, false	 Revertive FFS FFS Not applicable False
ODUk_C Provisioning		
ODUk_C_MI_MatrixControl	Connect, disconnect	Not applicable
Per protection group: ODUk_C_MI_ProtType ODUk_C_MI_OperType ODUk_C_MI_WTR ODUk_C_MI_HoTime ODUk_C_MI_ExtCMD ODUk_C_MI_APSChannel (Note) ODUk_C_MI_SDEnable	 According to clause 8.4 of [ITU-T G.873.1]. Revertive, non-revertive 5..12 minutes 0..10 seconds in steps of 100 ms – (Command) 0..7 (for Path, TCM1..6, Section) True, false	 000x Revertive FFS FFS Not applicable Not applicable True
NOTE – For SNC protection with APS protocol.		

Reconfigurable network elements provide connection capabilities at the OCh layer. Cross-connections can be configured between client add ports and line output ports, or between line input ports and client drop ports, or between line input ports and line output ports (straight through matrix connections).

NOTE 1 – A matrix connection between a client add port and a client drop port is not useful from a network provisioning point of view as it does not carry a signal through the optical core network, but it can be useful for loop back test purposes.

The following management functions are identified.

1) *Get connectivity capabilities*

Because reconfigurable network elements may have static cross-connection restrictions, the OS should be aware of these restrictions.

This function gives an overview of the fabric's static capability to connect termination points. This is done by identifying one or more sets of termination points which can be connected among each other.

Restrictions of connectivity may be caused by principal design of the switch matrix or by the fact that not all sink termination points are fully reachable from all source termination points. One example for restricted connectivity capability is a missing frequency conversion function in an all-optical network.

This function should not take limited processing capacity, usage or current problems into account. These additional restrictions have to be considered dynamically by the OS.

2) *Report connectivity changes of an optical cross-connect*

The availability of frequency converters in a cross-connect may change. As a consequence, the connectivity sets (sets of TPs that can be connected by the fabric) may change. The NE has to send a report when the connectivity of the fabric changes.

NOTE 2 – After receiving a report about connectivity changes, the OS may again get all connectivity sets to update its connectivity topology.

3) *Create a unidirectional point-to-point cross-connection*

A unidirectional point-to-point cross-connection can be created between:

a) One ochCTPsink and one ochCTPsource (straight through); in case of connection monitoring via och adapter.
b) One ochCTPsink and one ochTTPsink (drop).
c) One ochTTPsource and one ochCTPsource (add).
d) One ochTTPsource and one ochTTPsink (for loop back test purposes).

A cross-connection object is created and a report on this creation has to be sent to the OS.

4) *Remove a unidirectional point-to-point cross-connection*

This action disconnects the ochXTPs connected together. The cross-connection object is deleted and a report on this deletion has to be sent to the OS.

5) *Suspend/resume traffic on a point-to-point cross-connection*

This function provides the possibility to suspend and resume traffic on a point-to-point cross-connection to put it out of service (suspend) or to put it in service (resume). This change has to be reported to the OS.

6) *Get all point-to-point cross-connections*

This action returns the list of all point-to-point cross-connections created.

8.7 DEG thresholds

See [ITU-T G.7710] for a description of DEG thresholds configuration.

8.8 XXX_Reported

XXX_Reported is not applicable to O.NEs.

8.9 Alarm severity

See [ITU-T G.7710] for a description of alarm severity configuration functions.

8.10 Alarm reporting control (ARC)

See [ITU-T G.7710] for a description of alarm reporting control configuration functions.

8.11 PM thresholds

See [ITU-T G.7710] for a description of PM thresholds configuration functions.

8.12 Tandem connection monitoring (TCM) activations

See [ITU-T G.7710] for a description of TCM activations configuration functions.

8.13 Date and Time

The date and time functions within the OTN EMF comprise the local real-time clock (RTC) function and the performance monitoring clock (PMC) function. The message communication function within the OTN NEF shall be capable of setting the local real-time clock function.

The date and time values are incremented by a free-running local clock, or by an external timing source. The FCAPS functions need date and time information, e.g., to time-stamp event reports. They obtain this information from the date and time function.

8.13.1 Date and time applications

[ITU-T G.7710] identifies three date and time applications. These are:

– time-stamping;

– performance monitoring clock signals;

– activity scheduling.

The OTN NEF functional requirements for these applications are specified in the following clauses.

8.13.1.1 Time-stamping

See [ITU-T G.7710] for a description of the time-stamping application.

8.13.1.2 Performance monitoring clock signals

See [ITU-T G.7710] for a description of the PMC signals.

8.13.1.3 Activity scheduling

See [ITU-T G.7710] for a description of the activity scheduling.

8.13.2 Date and time functions

There are three date and time functions defined. The local real-time clock (RTC) function is required for time-stamping and activity scheduling. The local real-time clock alignment function is required for aligning the clock with an external time reference. The performance monitoring clock (PMC) function, in addition to RTC, is typical for digital counter measurements.

8.13.2.1 Local real-time clock function

The local real-time clock function is specified in [ITU-T G.7710].

8.13.2.2 Local real-time clock alignment function with external time reference

The local real-time clock alignment function with external time reference is specified in [ITU-T G.7710].

8.13.2.3 Performance monitoring clock function

The performance monitoring clock function is specified in [ITU-T G.7710].

8.14 Control function

The ODUkT_TCMC functions are responsible for the activation/deactivation of a TCM trail. An ODUkT_TCMC function is connected to the ODUkT_TT and ODUkT/ODUk_A functions at the TCM control points (TCMCP) as shown in Figure 14-93 of [ITU-T G.798].

Currently only an ODUkT_TCMC function for manual activation/deactivation via the management is defined. ODUkT_TCMC functions for automatic activation are for further study.

The MI signals listed in Table 8-4 are communicated from the EMF to the connection process through the management point.

For the control functions supported by an O.NE, the O.NE EMF shall support the following management functions:

– Provisioning the control management information
– Retrieving the control management information
– Notifying the changes of the control management information

Table 8-4 – Provisioning and reporting for control functions

MI signal	Value range	Default value
ODUkT_TCMCm Provisioning		
ODUkT_TCMCm_MI_Level	1..6	Not applicable
ODUkT_TCMCm_MI_ModeSo	OPERATIONAL, MONITOR, TRANSPARENT	FFS
ODUkT_TCMCm_MI_ModeSk	OPERATIONAL, MONITOR, TRANSPARENT	FFS
ODUkT_TCMCm_MI_TCM_Extension	Normal, Pass-through, Erase	Normal
ODUkT_TCMCm Reporting		
ODUkT_TCMCm_MI_AcSTATSo[1..6]	According to clause 15.8.2.2.5 of [ITU-T G.709]	Not applicable
ODUkT_TCMCm_MI_AcSTATSk[1..6]	According to clause 15.8.2.2.5 of [ITU-T G.709]	Not applicable

8.15 Application Identifier management

This clause specifies management requirements for the OTN NE having optical channels that support optical system standard applications (defined in ITU-T Recommendations, e.g., [ITU-T G.695], [ITU-T G.698.2], and [ITU-T G.959.1]) and proprietary applications.

ITU-T Recommendations [ITU-T G.695], [ITU-T G.698.2], and [ITU-T G.959.1] provide optical parameter values of physical layer interfaces for the CWDM system, DWDM system, and non-WDM system respectively. The applications specified in these Recommendations are defined using optical interface parameters at the S (or MPI-S) reference point, at the R (or MPI-R) reference point, as well as for the optical link between the reference points.

The specifications of the optical interface parameters in the above ITU-T Recommendations are organized according to sets of Application Codes. Revised ITU-T Recommendation [ITU-T G.872] has generalized the Application Code to Application Identifier so that proprietary (i.e., non-standard) applications can be handled.

For the OTN NE having optical channels that support standards and/or proprietary applications, there is a need to provision/report on the supported set of application identifiers and to select a specific one from the set to ensure application identifier compatibility among the transmitter, the receiver, and the link.

Note that an Application Identifier does not specify the actual Nominal Central Frequency or actual Nominal Central Wavelength, though it does specify the range of the Nominal Central Frequency/Wavelength. In the cases of DWDM and CWDM, in addition to the Application Identifier, the Nominal Central Frequency or Nominal Central Wavelength needs to be specified as well.

[ITU-T G.872] has introduced some new terms to better describe the media aspects of optical networking. In particular, the media path that interconnects an OCh Source with an OCh Sink is called a Network Media Channel. A black link is an instance of a network media channel.

For the OCh trail termination in an OTN-compliant NE supporting standard and/or proprietary application identifiers, the OTN NE EMF shall support the following management functions:

– Provisioning the supportable Application Identifiers for the OCh trail termination
– Retrieving the supportable Application Identifiers from the OCh trail termination
– Notifying the changes of the supportable Application Identifiers of the OCh trail termination
– Selecting the Application Identifier to be used for the OCh trail termination
– Retrieving the selected Application Identifier from the OCh trail termination
– Notifying the changes of the selected Application Identifier of the OCh trail termination
– If the selected Application Identifier defines a tributary to a DWDM system, provisioning the Nominal Central Frequency of the OCh_TT
– If the selected Application Identifier defines a tributary to a DWDM system, retrieving the Nominal Central Frequency of the OCh_TT
– If the selected Application Identifier defines a tributary to a DWDM system, notifying the changes in the Nominal Central Frequency of the OCh_TT
– If the selected Application Identifier defines a tributary to a CWDM system, provisioning the Nominal Central Wavelength of the OCh_TT
– If the selected Application Identifier defines a tributary to a CWDM system, retrieving the Nominal Central Wavelength of the OCh_TT
– If the selected Application Identifier defines a tributary to a CWDM system, notifying the changes in the Nominal Central Wavelength of the OCh_TT

Valid ITU-T standard application identifiers are specified in ITU-T Recommendations, e.g., [ITU-T G.695], [ITU-T G.698.2], and [ITU-T G.959.1]. In the management interface, when an ITU-T standard application code is referred to, the values and value ranges of the optical parameters as specified in the corresponding ITU-T Recommendation for that application code are assumed.

Note that an operable OCh trail is formed from an OCh_TT Source, a network media channel and an OCh_TT Sink all of which share a common application identifier.

9 Account management

Account management is for further study.

10 Performance management

See [ITU-T G.7710] for the generic requirements for performance management. OTN-specific management requirements are described below.

Note that, due to the frame synchronous mapping between an ODUkP and an ODUkT and between an ODUk and an OTUk, a frame slip that already exists at the source of the ODUkT or the OTUk trail is also detected at the sink of the ODUkT and the OTUk trail. This frame slip will result in bit error detection at the trail termination sink, even if the trail contains no errors. In order to suppress these bit errors, incoming alignment error (IAE) and backward incoming alignment error (BIAE) signalling is supported in the OTN. IAE is generated at the trail source if a frame slip is detected. It is transmitted to the trail sink to suppress the bit errors. BIAE is the signalling for the reverse direction and is used to suppress the backward error indication. Due to the detection, propagation and signalling delay, no fixed time relation between the occurrence of bit errors and the detection of the IAE exists. Therefore, bit errors detected in the current or previous second are wrong and must be suppressed if IAE is detected.

The following rules apply:

– If pBIAE is active, the F_DS and the F_EBC values of the previous and the current second must be discarded.

– If pIAE is active, the N_DS, the F_DS, the N_EBC and the F_EBC values for the previous and the current second must be discarded.

Note that the previous second must be discarded due to the delay of the IAE information coming from the remote source.

10.1 Performance management applications

See [ITU-T G.7710] for the generic description for performance management applications.

10.1.1 Concepts of "near-end" and "far-end"

See [ITU-T G.7710] for a description of near-end and far-end concepts.

10.1.2 Maintenance

See [ITU-T G.7710] for a description of performance management for maintenance.

10.1.3 Bringing-into-service

See [ITU-T G.7710] for a description of bringing-into-service.

10.1.4 Quality of service

See [ITU-T G.7710] for a description of quality of service.

10.1.5 Availability

See [ITU-T G.7710] for a description of availability.

10.1.6 Reporting

See [ITU-T G.7710] for a description of reporting.

As soon as a threshold is reached or crossed in a 15-minute/24-hour period for a given performance measurement, a threshold report (TR) is generated.

As an option for 15-minute periods, an alternative method of threshold reporting can be used. When, for the first time, a threshold is reached or crossed for a given performance measurement, a threshold report is generated. No threshold reports will be generated in subsequent 15-minute periods until the value of the performance measurement falls below a specific threshold. Then, a reset threshold report (RTR) is generated.

Performance data shall be reportable across the NE/OS interface automatically upon reaching or crossing a performance-monitoring threshold.

10.1.6.1 Performance data collection

See [ITU-T G.7710] for the generic description of performance data collection.

Counter-based performance data collection refers to the measurement counting associated with each of the performance measurements and any additional performance parameter defined in this Recommendation.

Two types of performance data collection are possible:

– A collection as specified in [ITU-T M.2120], i.e., based on information of each direction of transport independently. This type is also referred to as performance data collection for maintenance purposes.

– The collection as specified in [ITU-T G.826], i.e., based on information of both directions of transport together. This type is also referred to as performance data collection for error performance assessment purposes.

Counts are taken over fixed time periods of 15 minutes and 24 hours. Counting is stopped during unavailable time.

Gauge-based performance data collection refers to the measurement gauge crossings associated with each of the performance measurements and any additional performance parameter defined in this Recommendation.

Performance history data is necessary to assess the recent performance of transmission systems. Such information can be used to sectionalize faults and to locate the source of intermittent errors.

Historical data, in the form of performance measurement, may be stored in registers in the NE or in mediation devices associated with the NE. For specific applications, for example when only quality of service alarms are used, historical data may not be stored.

All the history registers shall be time-stamped.

The history registers operate as follows:

– 15-minute registers:

  The history of the 15-minute monitoring is contained in a stack of 16 registers per monitored measurement. These registers are called the recent registers.

  Every 15 minutes, the contents of the current registers are moved to the first of the recent registers. When all 15-minute registers are used, the oldest information will be discarded.

– 24-hour registers:

  The history of the 24-hour monitoring is contained in a single register per monitored measurement. This register is called the recent register.

  Every 24 hours the contents of the current registers are moved to the recent register.

10.1.6.2 History storage suppression

See [ITU-T G.7710] for a description of history storage suppression.

10.1.7 Thresholding

A thresholding mechanism can be used to generate an autonomous measurement report when the performance of a transport entity falls below a predetermined level. The general strategy for the use of thresholds is described in [ITU-T M.20]. Specific information for optical networks is for further study. The thresholding mechanism is applicable only for the maintenance-based collection.

See [ITU-T G.7710] for a description of thresholding.

10.1.7.1 Threshold setting

The thresholds may be set in the NE via the OS. The OS shall be able to retrieve and change the settings of the 15-minute and 24-hour thresholds.

The threshold values for measurements evaluated over the 15-minute period should be programmable within the specified range.

10.1.7.2 Threshold reporting

As soon as a threshold is reached or crossed in a 15-minute/24-hour period for a given performance measurement, a threshold report (TR) is generated.

As an option for 15-minute periods, an alternative method of threshold reporting can be used. When, for the first time, a threshold is reached or crossed for a given performance measurement, a threshold report is generated. No threshold reports will be generated in subsequent 15-minute periods until the value of the performance measurement falls below a specific threshold. Then, a reset threshold report (RTR) is generated.

The detailed functioning of the threshold mechanisms is for further study.

Performance data shall be reportable across the NE/OS interface automatically upon reaching or crossing a performance-monitoring threshold.

10.1.7.3 Evaluation for counters

See [ITU-T G.7710] for a generic description.

10.1.7.4 Evaluation for gauges

See [ITU-T G.7710] for a generic description.

10.1.8 Delay measurement requirements

1. OTN delay measurement is defined as a "round trip" measurement; i.e., it can only be used in bidirectional connections.
2. The "toggling" of the DMValue has to be synchronised between the source and sink atomic functions.
3. DM_Source in the source and sink atomic functions have always the same value.
4. DM_Source should be set to false in all involved atomic functions when no delay measurement is required.
5. On-demand delay measurement must be supported.
6. Proactive delay measurement is for further study.

10.2 Performance management functions

See [ITU-T G.7710] for generic requirements of performance management functions.

OTN NE provides the following PM management information.

Table 10-1 – PM management information

PM management information	OTN function	PM current data and history data collected in EMF
OTSn_TT_Sk_MI_pN_DS-P OTSn_TT_Sk_MI_pN_DS-O OTSn_TT_Sk_MI_pF_DS-P OTSn_TT_Sk_MI_pF_DS-O	OTSn_TT_Sk	OTSn_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}(Note 3)
OMSn_TT_Sk_MI_pN_DS-P OMSn_TT_Sk_MI_pN_DS-O OMSn_TT_Sk_MI_pF_DS-P OMSn_TT_Sk_MI_pF_DS-O	OMSn_TT_Sk	OMSn_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}
OPSn_TT_Sk_MI_pN_DS-P	OPSn_TT_Sk	OPSn_TTP_Sk: nES, nSES, nUAS
OPSM/OTUk-a_A_Sk_MI_pFECcorrErr	OPSM/OTUk-a_A_Sk	OTUk_CTP_Sk: CD/HD: #FECcorrErr where #FECcorrErr = count of FEC-corrected Errors
OCh/OTUk-a_A_Sk_MI_pFECcorrErr	OCh/OTUk-a_A_Sk	
OCh/OTUk-v_A_Sk_MI_pFECcorrErr	OCh/OTUk-v_A_Sk	
OCh/OTUkV_A_Sk_MI_pFECcorrErr (Note 1)	OCh/OTUkV_A_Sk	
OTUk_TT_Sk_MI_pN_EBC OTUk_TT_Sk_MI_pN_DS OTUk_TT_Sk_MI_pF_EBC OTUk_TT_Sk_MI_pF_DS OTUk_TT_Sk_MI_pBIAE OTUk_TT_Sk_MI_pIAE	OTUk_TT_Sk	OTUk_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}, nBBE, fBBE, (Note 4)
OTUkV_TT_Sk_MI_pN_EBC OTUkV_TT_Sk_MI_pN_DS OTUkV_TT_Sk_MI_pF_EBC OTUkV_TT_Sk_MI_pF_DS OTUkV_TT_Sk_MI_pBIAE (Note 2) OTUkV_TT_Sk_MI_pIAE (Note 2)	OTUkV_TT_Sk	
ODUkP_TT_Sk_MI_pN_EBC ODUkP_TT_Sk_MI_pN_DS ODUkP_TT_Sk_MI_pF_EBC ODUkP_TT_Sk_MI_pF_DS ODUkP_TT_Sk_MI_pN_delay	ODUkP_TT_Sk	ODUkP_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}, nBBE, fBBE, nDelay where nDelay is sum of pN_Delay. See 14.2.1/G.798 for pN_Delay
ODUkP/CBRx_A_So_MI_pN_PCS_BIP	ODUkP/CBRx_A_So	CBRx or generic client layer CTP_So: Sum of pN_PCS_BIP

Table 10-1 – PM management information

PM management information	OTN function	PM current data and history data collected in EMF
ODUkP/CBRx_A_Sk_MI_pN_PCS_BIP	ODUkP/CBRx_A_Sk	CBRx or generic client layer CTP_Sk: Sum of pN_PCS_BIP
ODUkP/PRBS_A_Sk_MI_pN_TSE	ODUkP/PRBS_A_Sk	PRBS or generic client layer CTP_Sk: Sum of pN_TSE
ODUkP/ETH_A_Sk_MI_pFCSErrors	ODUkP/ETH_A_Sk	ETH or generic client layer CTP_Sk: Sum of pFCSErrors
ODUkT_TT_Sk_MI_pN_EBC ODUkT_TT_Sk_MI_pN_DS ODUkT_TT_Sk_MI_pF_EBC ODUkT_TT_Sk_MI_pF_DS ODUkT_TT_Sk_MI_pN_delay ODUkT_TT_Sk_MI_pBIAE ODUkT_TT_Sk_MI_pIAE	ODUkT_TT_Sk	ODUkT_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}, nBBE, fBBE, nDelay, where nDelay is sum of pN_Delay, (Note 4)
ODUkTm_TT_Sk_MI_pN_EBC ODUkTm_TT_Sk_MI_pN_DS ODUkTm_TT_Sk_MI_pF_EBC ODUkTm_TT_Sk_MI_pF_DS ODUkTm_TT_Sk_MI_pBIAE ODUkTm_TT_Sk_MI_pIAE	ODUkTm_TT_Sk	ODUkTm_TTP_Sk: nES, nSES, fES, fSES, {UAS|nUAS, fUAS}, nBBE, fBBE, (Note 4)
ODUkP-X-L/PRBS_A_Sk_MI_pN_TSE	ODUkP-X-L/PRBS_A_Sk	PRBS or generic client layer CTP_Sk: Sum of pN_TSE
OSx_TT_Sk_MI_pN_DS	OSx_TT_Sk	OSx_TTP_Sk: nES, nSES, nUAS

NOTE 1 – If the function performs FEC.

NOTE 2 – In case of frame-synchronous mapping of ODUk client signal.

NOTE 3 – {UAS|nUAS, fUAS} means bidirectional UAS or Unidirectional "nUAS and fUAS".

NOTE 4 – pIAE and pBIAE are used for the suppression of the PM data in the equipment management functions. If pBIAE is active, the F_DS and F_EBC values of the previous and current second have to be discarded (EBC = 0 and DS = false). If pIAE is active, the N/F_DS and N/F_EBC and N_delay values of the previous and current second have to be discarded (EBC = 0 and DS = false). The previous second has to be included due to the delay of the IAE information coming from the remote source.

The EMF shall support the following functions:

– collecting OTN layer-specific current PM data as specified in Table 10-1 above.
– collecting OTN layer-specific history PM data as specified in Table 10-1 above.
– resetting of the OTN layer-specific current PM data registers.
– reporting OTN layer-specific current PM data at the maturity of the monitoring time interval.
– on-demand retrieval of the collected OTN layer-specific PM data.
– setting of the threshold of the monitored OTN layer-specific PM data collection.
– reporting of threshold crossing for the collected OTN layer-specific current PM data.
– notifying on the change of the threshold of the monitored OTN layer-specific PM data collection.

11 Security management

For further study.

Appendix I

Management information for CM

(This appendix does not form an integral part of this Recommendation.)

Regarding configuration management, the OTN network elements can be configured via the following management information (MI) signals that are defined per atomic function in [ITU-T G.798]:

– <atomic function name>_MI_Active
– <atomic function name>_MI_AutoMS
– <atomic function name>_MI_AdminState
– <atomic function name>_MI_APRCntrl
– <atomic function name>_MI_APSChannel
– <atomic function name>_MI_CellDiscardActive
– <atomic function name>_MI_DTDLuseEnabled
– <atomic function name>_MI_ExtCMD
– <atomic function name>_MI_ExDAPI
– <atomic function name>_MI_ExMSI
– <atomic function name>_MI_ExSAPI
– <atomic function name>_MI_FECEn
– <atomic function name>_MI_GCCAccess
– <atomic function name>_MI_GCCCont
– <atomic function name>_MI_GetAcTI
– <atomic function name>_MI_GFCActive
– <atomic function name>_MI_HECactive
– <atomic function name>_MI_HoTime
– <atomic function name>_MI_Level
– <atomic function name>_MI_MatrixControl
– <atomic function name>_MI_ModeSk
– <atomic function name>_MI_ModeSo
– <atomic function name>_MI_OperType
– <atomic function name>_MI_ProtType
– <atomic function name>_MI_SDEnable
– <atomic function name>_MI_TIMActDis
– <atomic function name>_MI_TIMDetMo
– <atomic function name>_MI_TPusgActive
– <atomic function name>_MI_TSF-ODis
– <atomic function name>_MI_TxMSI
– <atomic function name>_MI_TxTI
– <atomic function name>_MI_VPIrange
– <atomic function name>_MI_VPI-KActive

– <atomic function name>_MI_VPIK_SAISActive
– <atomic function name>_MI_WTR

Regarding configuration management, the OTN network elements can provide the configuration data via the following management information (MI) signals that are defined per atomic function in [ITU-T G.798]:

– <atomic function name>_MI_AcMSI
– <atomic function name>_MI_AcPT
– <atomic function name>_MI_AcPT[1..XMR]
– <atomic function name>_MI_AcTI
– <atomic function name>_MI_Active
– <atomic function name>_MI_AcSTATSk[1..6]
– <atomic function name>_MI_AcSTATSo[1..6]
– <atomic function name>_MI_AcVcPT

Appendix II

Management information for PM

(This appendix does not form an integral part of this Recommendation.)

Regarding performance management, the OTN network elements can be configured via the following management information (MI) signals that are defined per atomic function in [ITU-T G.798]:

– <atomic function name>_MI_1second
– <atomic function name>_MI_DEGM
– <atomic function name>_MI_DEGThr

Regarding performance management, the OTN network elements can provide the performance data via the following management information (MI) signals that are defined per atomic function in [ITU-T G.798]:

– <atomic function name>_MI_pBIAE
– <atomic function name>_MI_pF_DS-O
– <atomic function name>_MI_pF_DS-P
– <atomic function name>_MI_pFECcorrErr
– <atomic function name>_MI_pF_EBC
– <atomic function name>_MI_pF_DS
– <atomic function name>_MI_pIAE
– <atomic function name>_MI_pN_DS-O
– <atomic function name>_MI_pN_DS-P
– <atomic function name>_MI_pN_EBC
– <atomic function name>_MI_pN_DS
– <atomic function name>_MI_pN_delay
– <atomic function name>_MI_pN_TSE
– <atomic function name>_MI_pN_PCS_BIP

Appendix III

Mapping between OPUk Payload Type and Adaptation Function

(This appendix does not form an integral part of this Recommendation.)

The following mapping table relates the OPUk Payload Types (PT) defined in Table 15-8 of [ITU-T G.709] to the corresponding Adaptation Atomic Functions.

<table>
<tr><th colspan="2">[ITU-T G.709]</th><th colspan="2">[ITU-T G.798] or
[ITU-T G.8021]</th></tr>
<tr><th>PT in Hex code</th><th>Interpretation</th><th colspan="2">Adaptation Atomic Function</th></tr>
<tr><td>01</td><td>Experimental mapping</td><td colspan="2">–</td></tr>
<tr><td>02</td><td>Asynchronous CBR mapping, see clause 17.2</td><td>ODUkP/
CBRx-a_A_so</td><td rowspan="2">ODUkP/
CBRx_A_Sk</td></tr>
<tr><td>03</td><td>Bit synchronous CBR mapping, see clause 17.2</td><td>ODUkP/
CBRx-b_A_So</td></tr>
<tr><td>04</td><td>ATM mapping, see clause 17.3</td><td colspan="2">ODUkP/VP_A</td></tr>
<tr><td>05</td><td>GFP mapping, see clause 17.4</td><td colspan="2">ODUkP/ETH_A
ODUkP-X-L/ETH_A;
k = 1, 2, 3
NOTE – Since GFP is not an adaptation, i.e., only a mapping, the adaptation function is depending on the client signal.</td></tr>
<tr><td>06</td><td>Virtual Concatenated signal, see clause 18</td><td colspan="2">ODUkP-Xv/ODUkP-X-L_A</td></tr>
<tr><td>07</td><td>1000BASE-X into OPU0 mapping, see clauses 17.7.1 and 17.7.1.1</td><td colspan="2">ODU0P/CBRx_A
(0≤x≤1.25G)</td></tr>
<tr><td>08</td><td>FC-1200 into OPU2e mapping, see clause 17.8.2</td><td colspan="2">ODUkP/CBRx-g_A</td></tr>
<tr><td>09</td><td>GFP mapping into Extended OPU2 payload, see clause 17.4.1</td><td colspan="2">ODU2P/EthPP-OS_A</td></tr>
<tr><td>0A</td><td>STM-1 mapping into ODU0, see clause 17.7.1</td><td colspan="2" rowspan="2">ODUkP/RSn_A</td></tr>
<tr><td>0B</td><td>STM-4 mapping into ODU0, see clause 17.7.1</td></tr>
<tr><td>0C</td><td>FC-100 mapping into ODU0, see clause 17.7.1</td><td colspan="2" rowspan="6">ODUkP/CBRx-g_A</td></tr>
<tr><td>0D</td><td>FC-200 mapping into ODU1, see clause 17.7.2</td></tr>
<tr><td>0E</td><td>FC-400 mapping into ODUflex, see clause 17.9</td></tr>
<tr><td>0F</td><td>FC-800 mapping into ODUflex, see clause 17.9</td></tr>
<tr><td>10</td><td>Bit stream with octet timing mapping, see clause 17.6.1</td></tr>
<tr><td>11</td><td>Bit stream without octet timing mapping, see clause 17.6.2</td></tr>
<tr><td>12</td><td>IB SDR mapping into OPUflex, see clause 17.9</td><td colspan="2"></td></tr>
<tr><td>13</td><td>IB DDR mapping into OPUflex, see clause 17.9</td><td colspan="2"></td></tr>
<tr><td>14</td><td>IB QDR mapping into OPUflex, see clause 17.9</td><td colspan="2"></td></tr>
<tr><td>15</td><td>SDI mapping into OPU0, see clause 17.7.1</td><td colspan="2"></td></tr>
</table>

[ITU-T G.709]		[ITU-T G.798] or [ITU-T G.8021]
PT in Hex code	**Interpretation**	**Adaptation Atomic Function**
16	(1.485/1.001) Gbit/s SDI mapping into OPU1, see clause 17.7.2	
17	1.485 Gbit/s SDI mapping into OPU1, see clause 17.7.2	
18	(2.970/1.001) Gbit/s SDI mapping into OPUflex, see clause 17.9	
19	2.970 Gbit/s SDI mapping into OPUflex, see clause 17.9	
1A	SBCON/ESCON mapping into OPU0, see clause 17.7.1	
1B	DVB_ASI mapping into OPU0, see clause 17.7.1	
1C	FC-1600 mapping into OPUflex, see clause 17.9	
20	ODU multiplex structure supporting ODTUjk only, see clause 19 (AMP only)	ODUkP/ODU[i]j_A
21	ODU multiplex structure supporting ODTUk.ts or ODTUk.ts and ODTUjk, see clause 19 (GMP capable)	ODUkP/ODUj-21_A
55	Not available	–
66	Not available	–
80-8F	Reserved codes for proprietary use	–
FD	NULL test signal mapping, see clause 17.5.1	ODUkP/NULL_A
FE	PRBS test signal mapping, see clause 17.5.2	ODkP/PRBS_A

NOTE – The Payload Type (PT) does not have a unique value for every adaptation function. Multiple adaptation functions share the same PT value. An overview is presented below:

– 14.3.1/G.798 ODUkP/CBRx_A, bit sync: <k,x> = <1,2G5>, <2,10G>, <2e,10G3>, <3,40G>, <flex,beyond_2.5G>, async: <1,2G5> (20 ppm), <1,2G5> (32 ppm), <2,10G>, <3,40G>; no need to manage 2G5 ppm differences

  Payload Type (PT) of these adaptation functions;

  PT=0x02 for async mapping of CBR2G5, CBR10G, CBR40G

  PT=0x03 for bitsync mapping of CBR2G5, CBR10G, CBR10G3, CBR40G

  PT=0x0E for bitsync mapping of FC400

  PT=0x0F for bitsync mapping of FC800

  PT=0x12 for bitsync mapping of IB QDR

  PT=0x13 for bitsync mapping of IB QDR

  PT=0x14 for bitsync mapping of IB QDR

  PT=0x18 for bitsync mapping of (2.970/1.001)G SDI

  PT=0x19 for bitsync mapping of 2.970G SDI

  PT=0x1C for bitsync mapping of FC1600

– 14.3.3/G.798 ODU2P/EthPP_OS_A => 11.5.3/G.8021 ODU2P/EthOS_A

  PT=0x05

– 14.3.4/G.798 ODUkP/NULL_A

PT=0xFD.

Additional control here is for ODUk, k=flex the nominal bit rate.

– 14.3.5 ODUkP/PRBS_A

PT=0xFE.

Additional control here is for ODUk, k=flex the nominal bit rate.

– 14.3.6 ODUkP/RSn_A, <k,n> = <1,16>, <2,64>, <3,256>

PT=0x02 for async mapping of RS16, RS64, RS256,

PT=0x03 for bitsync mapping of RS16, RS64, RS256.14.3.7 ODU0P/CBRx_A, x = 155M, 622M, ETC3, FC100, SBCON, DVB_ASI

PT=0x0A for STM-1 (155M)

PT=0x0B for STM-4 (622M)

PT=0x0C for FC100

PT=0x07 for 1000BASE-X (ETC3)

PT=0x1A for SBCON/ESCON

PT=0x1B for DVB_ASI

– 14.3.8 ODUkP/CBRx-g_A, CBRx-g = ETC5, ETC6, FC200

PT=0x07 for 40GBASE-R (ETC5)

PT=0x07 for100GBASE-R (ETC6)

PT=0x0D for FC200

– 14.3.9 ODUkP/ODU[i]j_A

PT=0x20.

Additional control here is on a per LO ODUj basis, which can be performed as part of LO ODU connection management:

MI_TxMSI, MI_ExMSI[p], MI_AdminState[p], MI_APS_EN[p], MI_APS_LVL [p]

– 14.3.10 ODUkP/ODUj-21_A

PT=0x21

Additional control here is MI_AUTOpayloadtype.

Further additional control is on a per LO ODUj basis, which can be performed as part of LO ODU connection management:

MI_TxMSI. MI_ExMSI[p], MI_ODUType_Rate[i], MI_AdminState[n], MI_APS_EN [n], MI_APS_LVL [n]

– 14.3.11 ODUkP/ETH_A, see 11.5.1/G.8021 ODUkP/ETH_A

PT=0x06.

vcPT=0x05.

Additional control here is MI_CSFEnable and MI_CSFrdifdiEnable, MI_FilterConfig, MI_CSF_Reported, MI_MAC_Length.

– 14.3.12 ODUkP-h/ETH_A, k=flex

PT=0x05. The same PT value is used for this HAO capable function as for the regular, non-HAO capable function.

Additional control here is MI_ODUflexRate, MI_CSFEnable, MI_CSFrdifdiEnable, MI_FilterConfig, MI_CSF_Reported, MI_MAC_Length.

Further additional control here is for HAO; i.e., MI_INCREASE, MI_DECREASE, MI_TSNUM.

– 14.3.13 ODUkP-h/ODUj-21_A

PT=0x21. The same PT value is used for this HAO capable function as for the regular, non-HAO capable function.

Additional control here is MI_AUTOpayloadtype.

Further additional control is on a per LO ODUj basis, which can be performed as part of LO ODU connection management:

MI_TxMSI[p]. MI_ExMSI[p], MI_ODUType_Rate[i], MI_AdminState[n], MI_APS_EN [n], MI_APS_LVL [n]

Further additional control here is for HAO of a LO ODUflex; i.e., MI_INCREASE, MI_DECREASE, MI_TSMAP, MI_TPID.

– [14.3.v ODU2eP/FC1200_A] to be added

PT=0x08.

– [14.3.w ODUkP-X-L/ETH_A], see 11.5.2/G.8021 ODUkP/ETH_A

PT=0x06.

vcPT=0x05.

Additional control here is MI_CSFEnable and MI_CSFrdifdiEnable, MI_FilterConfig, MI_CSF_Reported, MI_MAC_Length.

– [14.3.x ODUkP/MT_A] see 11.2.1/G.8121 ODUkP/MT_A

PT=0x05. This PT value is the same as for ODUkP/ETH_A functions.

Additional control here is MI_SCCType.

Further additional control is on a per PW/LSP basis, which can be performed as part of LO ODU connection management:

MI_Label[1…M], MI_LSPType[1…M], MI_CoS[1…M], MI_PHB2TCMapping[1…M], MI_QoSEncodingMode[1…M], MI_TC2PHBMapping[1…M], MI_QoSDecodingMode[1…M], MI_LCK_Period[1…M], MI_LCK_CoS[1…M], MI_Admin_State, MI_AIS_Period[1…M], MI_AIS_CoS[1…M], MI_GAL_Enable[1…M]

– [14.3.y ODUkP-X-L/MT_A] see 11.2.2/G.8121 ODUkP-X-L/MT_A

PT=0x06. This PT value is the same as for ODUkP-X-L/ETH_A functions.

vcPT=0x05.

Additional control here is MI_SCCType. Further additional control is on a per PW/LSP basis, which can be performed as part of LO ODU connection management:

MI_Label[1…M], MI_LSPType[1…M], MI_CoS[1…M], MI_PHB2TCMapping[1…M], MI_QoSEncodingMode[1…M], MI_TC2PHBMapping[1…M], MI_QoSDecodingMode[1…M], MI_LCK_Period[1…M], MI_LCK_CoS[1…M], MI_Admin_State, MI_AIS_Period[1…M], MI_AIS_CoS[1…M], MI_GAL_Enable[1…M]

– [14.3.z ODUkP-h/MT_A] to be added to e.g., 11.2.3/G.8121 or 14.3.z/G.798

Not specified yet.

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