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Digital networks – Optical transport networks

Management aspects of the optical transport network element

ITU-T Recommendation G.874

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.874

Management aspects of the optical transport network element

Summary

This Recommendation addresses management aspects of the Optical Transport Network Element 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.

Source

ITU-T Recommendation G.874 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Management aspects of the optical transport network element

1 Scope

This Recommendation addresses management aspects of the optical transport network element 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, account management, performance management, and security management are to be 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 optical 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 (OLNE) refer to trail termination, adaptation, connection functions as described in ITU-T Rec. G.872,
– A network element may only contain optical layer network entities,
– A network element may contain both optical layer network entities (OLNE) and client layer network entities (CLNE),
– Client layer entities are managed as part of their own logical domain (e.g. SDH management network),
– CLNE and OLNE may or may not share common message communications function (MCF) and management application function (MAF) depending on application,
– CLNE and OLNE may or may not share 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; all 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.

– ITU-T Recommendation G.709/Y.1331 (2001), *Interfaces for the optical transport network*.
– ITU-T Recommendation G.784 (1999), *Synchronous digital hierarchy (SDH) management*.
– ITU-T Recommendation G.798 (2002), *Characteristics of optical transport network hierarchy equipment functional bocks*.
– ITU-T Recommendation G.7710/Y.1701 (2001), *Common equipment management function requirements*.

– ITU-T Recommendation G.7712/Y.1703 (2001), *Architecture and specification of data communication network*.

– ITU-T Recommendation G.806 (2000), *Characteristics of transport equipment – Description methodology and generic functionality*.

– ITU-T Recommendation G.826 (1999), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate*.

– ITU-T Recommendation G.872 (2001), *Architecture of optical transport networks*.

– ITU-T Recommendation G.874.1 (2002), *Optical transport network (OTN) protocol-neutral management information model for the network element view*.

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

– ITU-T Recommendation M.2120 (2000), *PDH path, section and transmission system and SDH path and multiplex section fault detection and localization procedures*.

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

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

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

– ITU-T Recommendation M.3100 (1995), *Generic network information model*.

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

– ITU-T Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) For CCITT Applications*.

– ITU-T Recommendation X.701 (1997), *Information technology – Open Systems Interconnection – Systems management overview*.

– ITU-T Recommendation X.721 (1992), *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information*.

– ITU-T Recommendation X.735 (1992), *Information technology – Open Systems Interconnection – Systems management: Log control function*.

– ITU-T Recommendation X.744 (1996), *Information technology – Open Systems Interconnection – Systems management: Software Management function*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 Optical Network Element (ONE): That part of a network element that contains entities from one or more OTN layer networks. An ONE may therefore be a standalone physical entity or a subset of a network element. It supports at least network element functions and may also support an operations system function and or a Mediation Function. It contains managed objects, a message communications function and a management application function. The functions of an ONE may be contained within an NE that also supports other layer networks. These layer network entities are considered to be managed separately from OTN entities. As such they are not part of the OMSN or OMN.

3.2 OTN management network (OMN): An OTN management network is a subset of a TMN that is responsible for managing those parts of a network element that contain OTN layer network entities. An OMN may be subdivided into a set of OTN management subnetworks.

3.3 OTN management subnetwork (OMSN): An OTN management subnetwork (OMSN) consists of a set of separate OTN ECCs and associated intra-site data communication links which have been interconnected to form a data communications network (DCN) within any given OTN transport topology.

3.4 The following terms are defined in ITU-T Rec. G.7710/Y.1701:

– Local craft terminal;

– Management application function.

3.5 The following terms are defined in ITU-T Rec. G.709/Y.1331:

– General communication channel;

– General management communications overhead.

3.6 The following term is defined in ITU-T Rec. G.784:

– Data Communications Channel.

3.7 The following terms are defined in ITU-T Rec. G.7712/Y.1703:

– Data Communications Network;

– Embedded Control Channel.

3.8 The following terms are defined in ITU-T Rec. G.806:

– Atomic function;

– Management point.

3.9 The following terms are defined in ITU-T Rec. G.872:

– Inter-domain interface;

– Intra-domain interface.

3.10 The following terms are defined in ITU-T Rec. M.3010:

– Network element;

– Network element function;

– Operations system (OS);

– Q-Interface;

– Workstation function.

3.11 The following term is defined in ITU-T Rec. M.3013:

– Message communications function.

3.12 The following terms are defined in ITU-T Rec. M.3100:

– Aggregate audible/visual indicators;

– Alarm reporting;

– Alarm report control interval;

– Alarm reporting control;

– Inhibited;

– Managed entity;

– Managed resource;
– Managed resource-specific;
– Management interface;
– Persistence interval;
– Qualified problem;
– Reset threshold report;
– Threshold report;
– Timed interval;
– Unit audible/visual indicator.

3.13 The following term is defined in ITU-T Rec. X.700:

– Managed object.

3.14 The following terms are defined in ITU-T Rec. X.701:

– Agent;
– Manager;
– Managed object class.

4 Abbreviations

This Recommendation uses the following abbreviations:

A	Agent
AF	Atomic Function
ALM	ALarM reporting
AP	Access Point
API	Access Point Identifier
ARC	Alarm Report Control
CLNE	Client Layer Network Entity
CMSN	Client Management Subnetwork
CN	Channel Number
COMMS OH	General Management Communications Overhead
CP	Connection Point
CTP	Connection Termination Point
CTPSk	CTP Sink
CTPSo	CTP Source
D&T	Date and Time
DCC	Data Communications Channel
DCN	Data Communications Network
ECC	Embedded Control Channel
FCAPS	Fault Management, Configuration Management, Account Management, Performance Management and Security Management

FFS	For Further Study
GCC	General Communication Channel
GNE	Gateway Network Element
IaDI	Intra-Domain Interface
IrDI	Inter-Domain Interface
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
LAN	Local Area Network
LCN	Local Communications Network
LCT	Local Craft Terminal
M	Manager
MAF	Management Application Function
MCF	Message Communications Function
MD	Mediation Device
MF	Mediation Function
MI	Management Information
MIB	Management Information Base
MO	Managed Object
MOC	Managed Object Class
MP	Management Point
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
NEL	Network Element Layer
NOFr	Non-OTN Fragment
OCh	Optical Channel
OEMF	Optical Equipment Management Function
OLNE	Optical Layer Network Entity
OMN	OTN Management Network
OMS	Optical Multiplex Section
OMSN	OTN Management Subnetwork
ONE	Optical Network Element
OOS	OTM Overhead Signal

OS	Operations System
OSC	Optical Supervisory Channel
OSF	Operations System Function
OTM	Optical Transport Module
OTN	Optical Transport Network
OTS	Optical Transmission Section
OXC	Optical cross connect
PMC	Performance Monitoring Clock
PMF	Performance Monitoring Function
PTI	Payload Type Identifier
RTC	Real Time Clock
RTR	Reset Threshold Report
SDH	Synchronous Digital Hierarchy
SMN	SDH Management Network
TCA	Threshold Crossing Alert
TCP	Termination Connection Point
TI	Trace Identifier
TIM	Trace Identifier Mismatch
TMN	Telecommunications Management Network
TP	Termination Point
TR	Threshold Report
TTI	Trail Trace Identifier
TTP	Trail Termination Point
TTPSk	TTP Sink
TTPSo	TTP Source
UTC	Coordinated Universal Time
WAN	Wide Area Network
WDM	Wavelength Division Multiplexing
WS	WorkStation

5 OTN management functions

5.1 Network management architecture

The transport layer networks of the optical transport network (OTN) are described in ITU-T Recs. G.872 and G.709. 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 of the optical transport network is based upon a multi-tiered distributed management system. Each tier provides a predefined level of network management capabilities. The lowest tier of this organizational model, illustrated in Figure 1, includes the optical network elements (ONEs) that provide the transport service. The management applications function (MAF) within the network elements communicates with, and provides management support to peer network elements and/or operations systems (OSs).

The communication process is provided via the message communications function (MCF) within each entity.

The MAF at each entity can include agents only, managers only, or both agents and managers. Entities that include managers are capable of managing other entities.

Each tier in the model can also provide additional management functionality. However, the message structure should remain the same. For example, a manager within an ONE may suppress alarms generated by one or more of its managed ONEs due to a common failure and replace them by a new alarm message, directed to the OS, identifying the source of the problem. The new alarm message format will be consistent with other alarm messages.

The message format will be maintained as messages are elevated up the hierarchy i.e. ONE to ONE messages will have the same structure as ONE to OS messages.

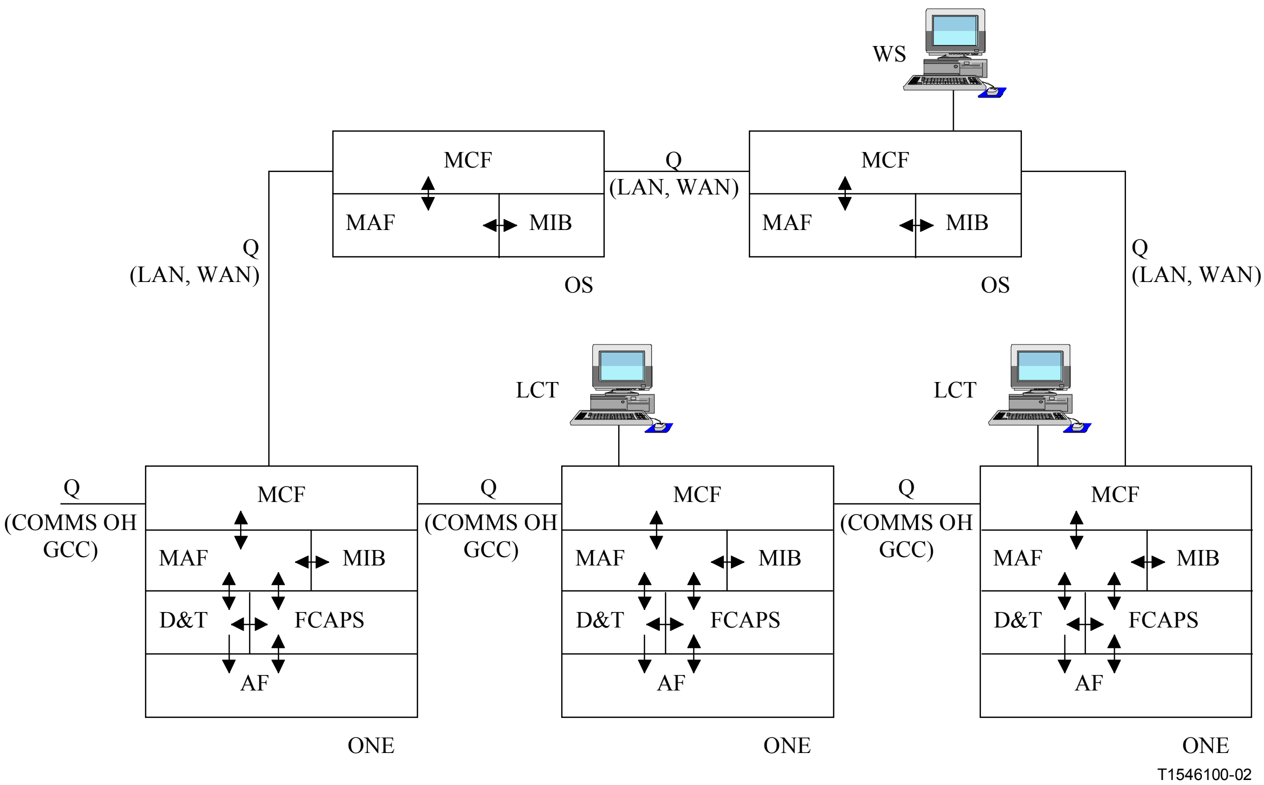

Figure 1/G.874 – OTN management organizational model

The local craft terminal (LCT) and its interface to ONE, shown in Figure 1, are not within the scope of this Recommendation.

5.1.1 Relationship between OMN, OMSN and TMN

The OTN management network (OMN) may be partitioned into OTN management subnetworks (OMSNs). The inter-relationship between a management network, its subnetworks and a TMN is described in ITU-T Rec.G.7710/Y.1701. The OMSN is a subset of the OMN which in turn is a subset of the TMN.

Figure 2 shows specific examples of OMN, OMSNs, and connectivity within an encompassing TMN.

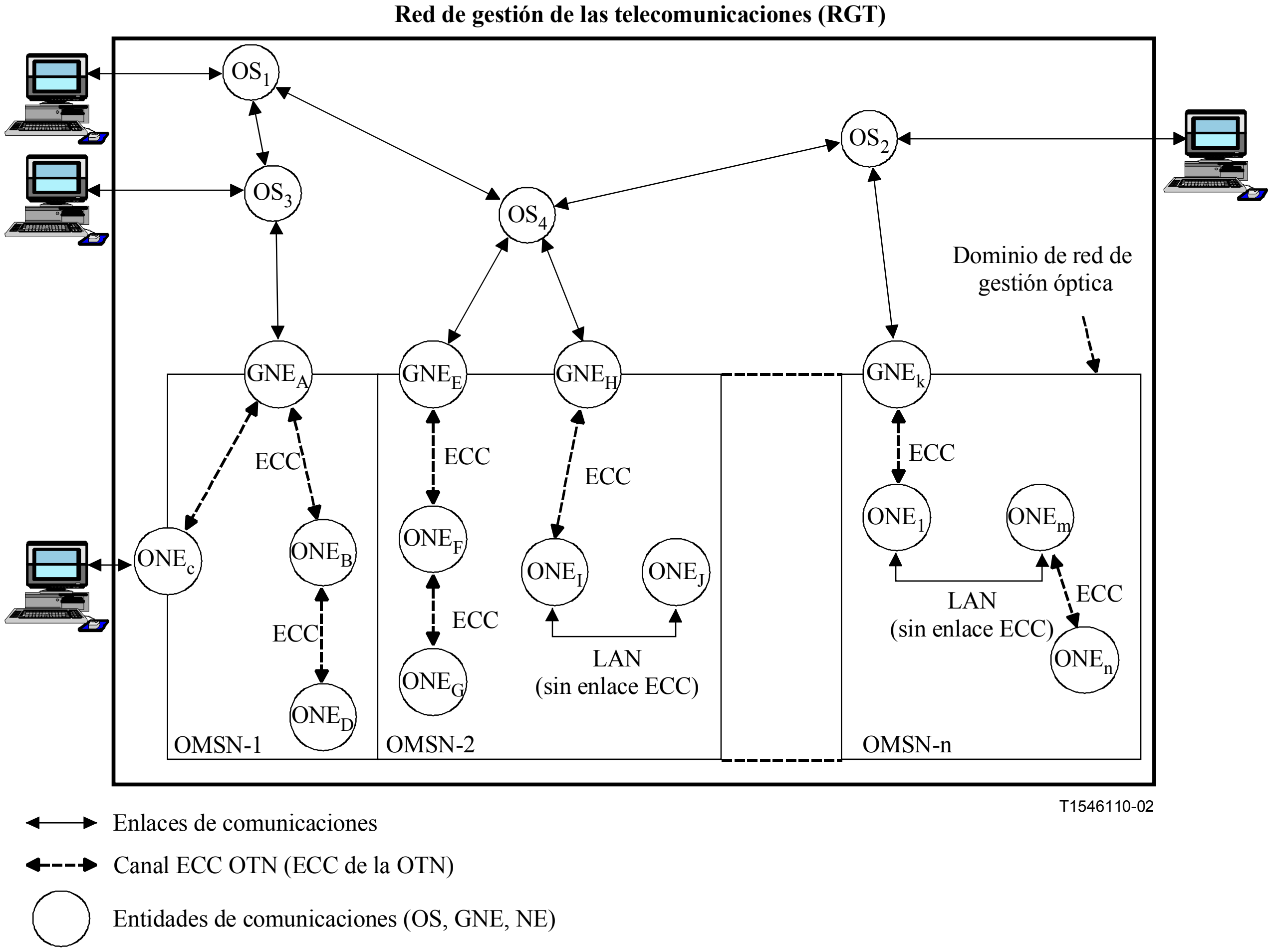

Figure 2/G.874 – Examples of TMN, OMN and OMSN configurations

The following subclauses describe the OMSN in more detail and address the following:

1) Access to the OMSN;
2) OMSN requirements;
3) OMSN data communications network;
4) Message routing.

5.1.2 Relationship between technology domains

In Figure 3, network elements either contain ONE functionality or they do not. The following cases are considered.

1) The network elements that contain no ONE functionality (NE A and NE B) are managed as part of the client management subnetwork (CMSN). This client management subnetwork manages non-OTN technologies.

2) The network elements that contain ONE functionality within an NE (NE C, ONE 1 and NE D) are managed as part of an OMSN.

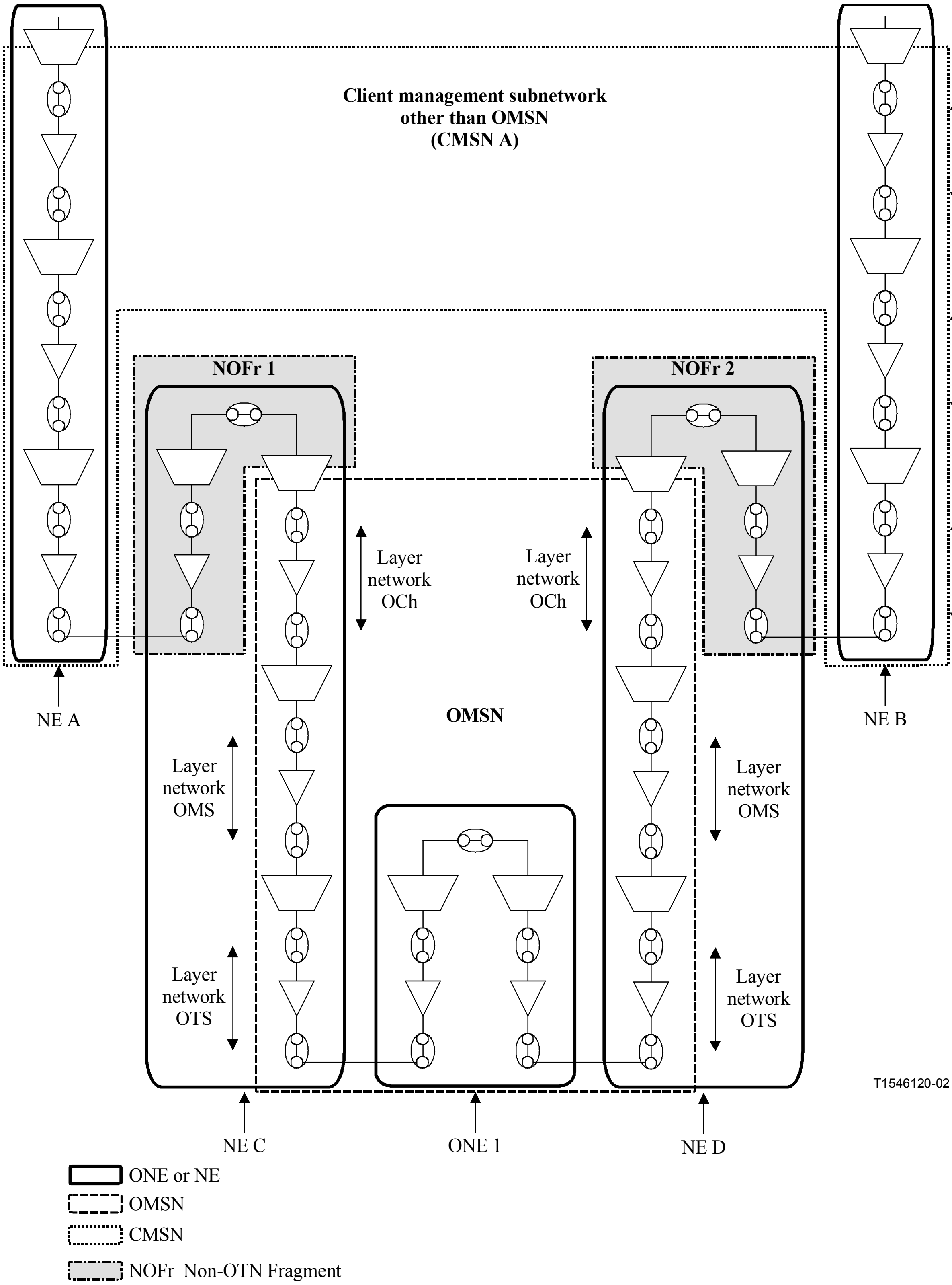

Figure 3/G.874 – Example of management network relationships

A network element may contain more than one technology and may therefore be part of more than one type of management subnetwork. Network elements C and D contain OTN layer network entities and client layer network entities. The latter are contained within a non-OTN fragment (NOFr) of the network element.

This fragment can be treated in one of the following ways:

1) As an entity that is managed by an CMSN OSF;

2) As an entity that is managed by an OMSN OSF;

3) As a standalone fragment which is not managed except as an equipment fragment.

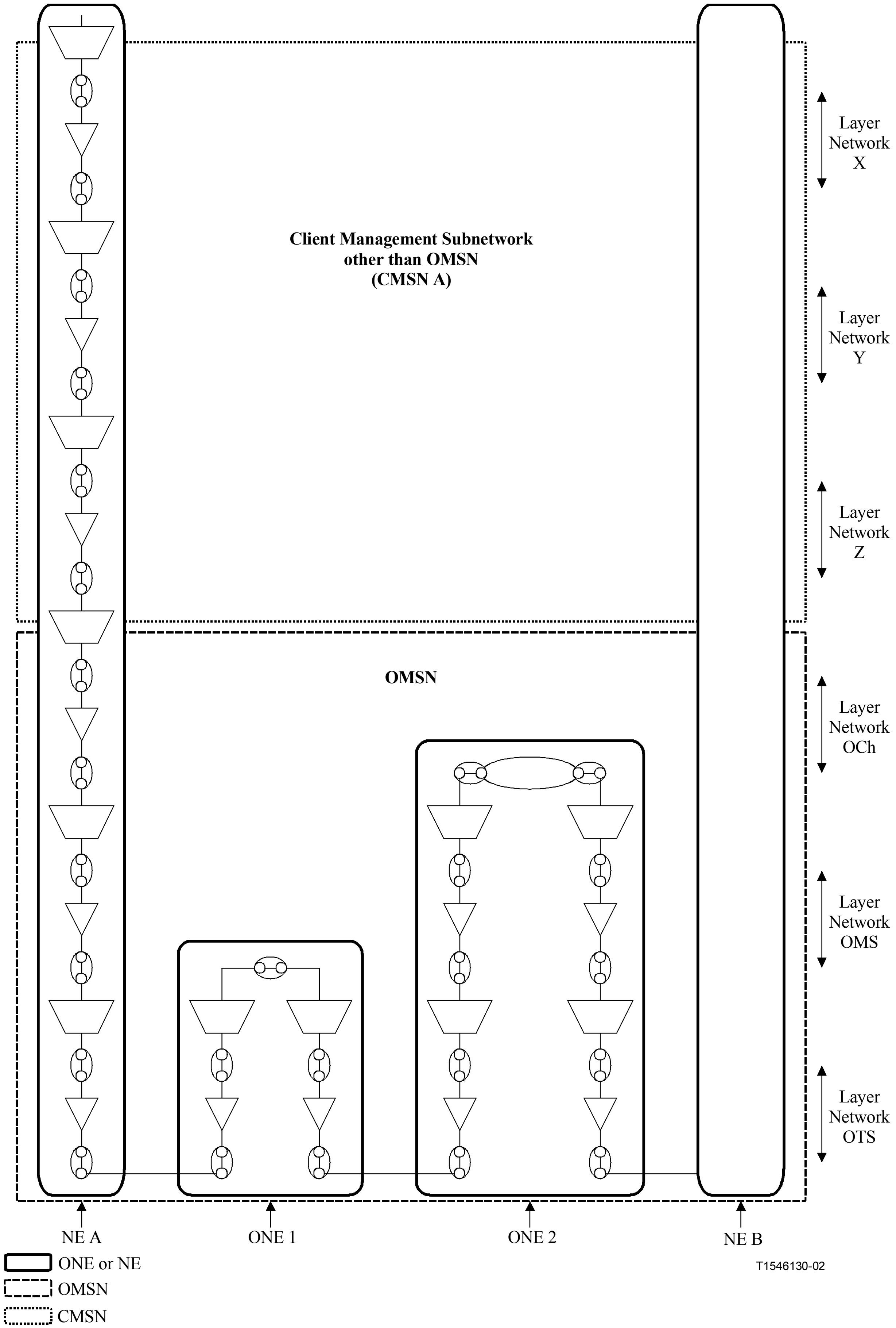

Figure 4/G.874 – Example of management network relationships

In Figure 4, all of the network elements contain ONE functionality. There are two management domains illustrated: the OMSN that manages the optical layer network entities, and the client management subnetwork (CMSN) that manages the client layer network entities. Within such a network element there may be one or more agents using one or more protocols to communicate with their respective OSF's. In this example there is a separate OSF (one for the CMSN and one for the OMSN) for each domain which may or may not be collocated in the same physical operations system.

5.1.3 Access to the OMSN

Access to the OMSN is always by means of an ONE functional block. The ONE may be connected to other parts of the TMN by means of the following sets of interfaces:

1) Workstation interface(s);
2) Operations system interface(s);
3) Site-related information interface(s).

The functionality required to be supported by the ONE will depend upon the type of interface that is provided.

5.1.4 OMSN requirements

The OMSN allows for the support of the following:

1) Multiple ONEs at a single site, i.e. multiple addressable ONEs may be present at a single physical location.
2) ONEs must support management communications functions. The message communications function of an ONE 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. In addition:
   - All ONEs are required to terminate the COMMS OH, see 5.1.8. In OSI terms, this means that each NE must be able to perform the functions of an end system.
   - ONEs may also be required to forward management messages between ports according to routing control information held in the ONE. In OSI terms, this means that some ONEs may be required to perform the functions of an intermediate system.
   - In addition to supporting interfaces for the COMMS OH, an ONE may also be required to support other DCN interfaces.
3) OTN inter-site communications. The inter-site or inter-office communications link between ONEs will normally be formed from the COMMS OH.
4) OTN Intra-site communications. Within a particular site, ONEs may communicate via an intra-site COMMS OH or via an LAN.

Each OTN management subnetwork (OMSN) must have at least one ONE/mediation device that is connected to an OS. This ONE 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 OMSN. 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 5.1.7.

5.1.5 OMSN data communications network

It is the intention of this Recommendation not to place any restriction on the physical transport topology that supports management communications. Thus, it is expected that the supporting data communications network (DCN) may contain string (bus), star, ring or mesh topologies.

See ITU-T Rec. G.7712/Y.1703 for management data communications networks architectures and specifications.

5.1.6 Network layer protocol

Specifications for the network layer protocol to be used within the OMN are found in ITU-T Rec. G.7712/Y.1703.

5.1.7 Physical and data link layers and protocols

5.1.7.1 General communication channel

The OTN supports three general communication channels (GCC):

1) GCC0

2) GCC1

3) GCC2

Figure 5 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 Rec. G.709/Y.1331, 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.

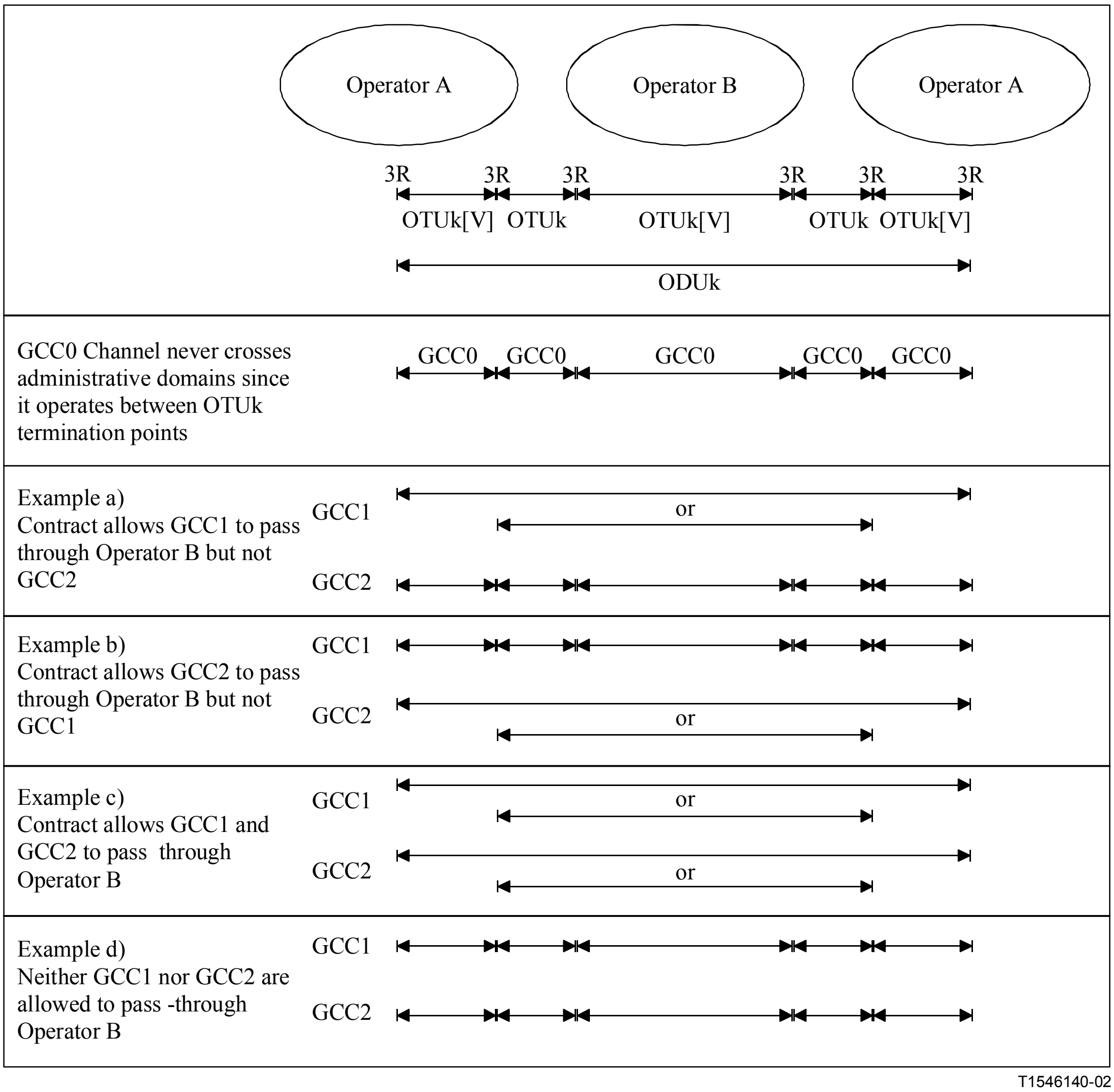

Figure 5/G.874 – GCC contract scenarios

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.

5.1.7.2 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.

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.

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.

5.1.7.3 GCC data link layer protocol

When used for management applications, the GCC data link protocols will be specified in this Recommendation or in its amendments.

5.1.7.4 General management communications overhead

The General management communications overhead (COMMS OH) is defined in ITU-T Rec. G.709/Y.1331.

5.1.7.5 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.

5.1.7.6 COMMS OH data link layer protocol

When required, the COMMS OH data link protocols will be specified in this Recommendation or in its amendments.

5.1.7.7 Local area network

The specifications for the Local Area Networks (LANs) used within an OMN are found in ITU-T Rec. G.7712/Y.1703. Note that local craft terminals are not within the scope of this Recommendation.

5.1.8 DCN management

Optical NEs communicate via the DCN. In order to have the DCN operate properly, a number of management functions are required. Examples are:

1) Retrieval of network parameters to ensure compatible functioning, e.g. packet size, timeouts, quality of service, window size, etc.;
2) Establishment of message routing between DCN nodes;
3) Management of network addresses;
4) Retrieval of operational status of the DCN at a given node;
5) Capability to enable/disable access to the DCN.

5.1.9 Remote log-in

For further study.

5.2 Equipment management function

This clause provides an overview of the minimum functions which are required to support inter-vendor ONE management including single-ended maintenance of ONEs within an OTN management subnetwork OMSN, or between communicating peer ONEs across a network interface. See the Performance Management Applications clause (10.1/G.7710/Y.1701) for a description of single ended maintenance.

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

The OEMF interacts with the other atomic functions by exchanging information across the management point (MP) reference points. See ITU-T Recs. G.806 and G.798 for more information on atomic functions and on management points. The OEMF 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.

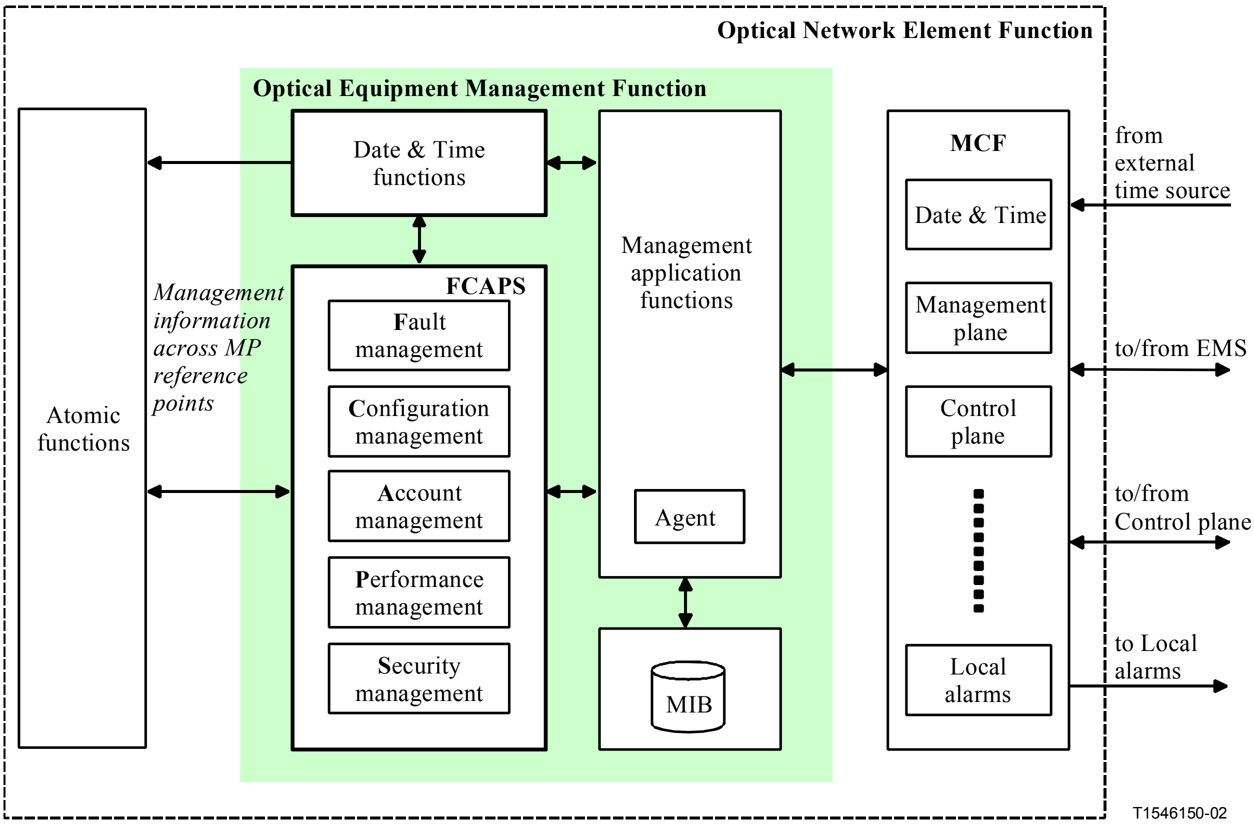

Figure 6/G.874 – Optical equipment management function

Network element resources provide event processing and storage. The MAF process 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.

5.2.1 Information flows over management points

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 ONE 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 ITU-T Rec. G.798. Note that these information flows and associated functions apply equally to both client and supervisory channel due to the independent nature of these signals. This does not imply that the supervisory channel shall provide all the functions described and ITU-T Rec. G.798 will provide the details of which functions are available.

The information flow over the MP reference points that arises from configuration and provisioning data is described in ITU-T Rec. G.798. The information listed under Set refers to configuration and provisioning data that is passed from the OEMF to the atomic functions. The information listed under Get refers to status reports made in response to a request from the OEMF for such information.

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

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

6 Date and time

The Date and Time Functions within the OEMF comprise the local real time clock (RTC) function and the Performance Monitoring Clock (PMC) function. The message communication function within ONEF 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 that need date and time information, e.g. to time stamp event reports, obtain this information from the Date and Time Function.

6.1 Date and time applications and requirements

ITU-T Rec. G.7710/Y.1701 identifies four data and time applications. These are:

– Time stamping,
– Real time clock alignment with external time reference,
– Performance monitoring clock signals,
– Activity scheduling.

The ONEF functional requirements for these applications are specified in the following subclauses.

6.1.1 Time stamping

See ITU-T Rec. G.7710/Y.1701 for a description of the time-stamping application.

The following time-stamping requirements apply to ONEs:

1) Events, performance reports, and registers containing event counts that require time stamping shall be time stamped with a resolution of one second relative to the NE local real time clock.
2) The time stamp for fault events (declaration/clearing) shall indicate the start of the fault cause prior to failure integration time. See the fault cause persistency function in Figure 9 for additional information.
3) The time stamp for Threshold Report (TR) declaration and Reset Threshold Report (RTR) declaration shall indicate the time of the event according to the Performance Monitoring Clock. This is consistent with ITU-T Rec. M.2120
4) The time stamp for Threshold Crossing Alert (TCA) declaration and clearing (if applicable) shall indicate the crossing/clearing of the threshold.
5) All other request and reports shall contain the time stamp associated with the actuation.

The start of 15-minute and 24-hour counts should be accurate to within ±10 s with respect to the ONE real time clock as specified in ITU-T Rec. G.7710/Y.1701. For example, a 15-minute register may begin its 2:00 count between 1:59:50 and 2:00:10

The symbol Z in Figure 7 represents the difference between the time that a prescribed event is detected by the NE and the time that the NE assigns to this event. For ONEs, the value of Z shall be less than or equal to 1 second.

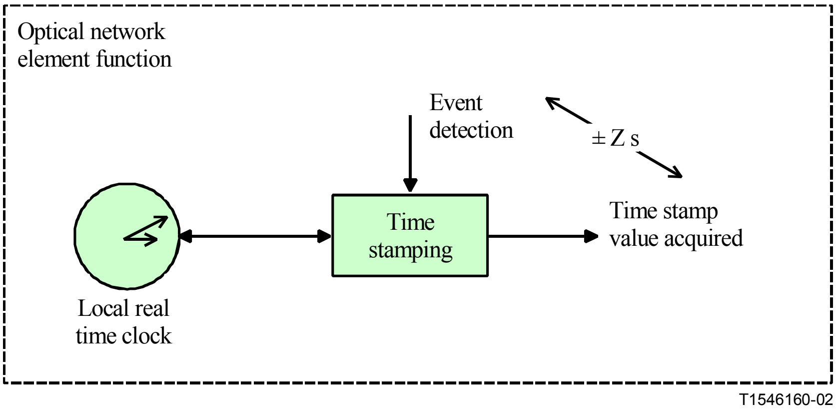

Figure 7/G.874 – Illustration of time stamping

6.1.2 Real time clock alignment with external time reference

An optional feature of Optical Network Elements is the capability to align its real time clock with an external time source.

Figure 8 depicts the relationship between an Optical Network Element's (ONE) Real Time Clock (RTC) function and an external time reference.

In Figure 8, the symbol X represents the propagation time between the external time reference clock and the ONE. Thus specifications for values of X are also outside of the scope of this Recommendation.

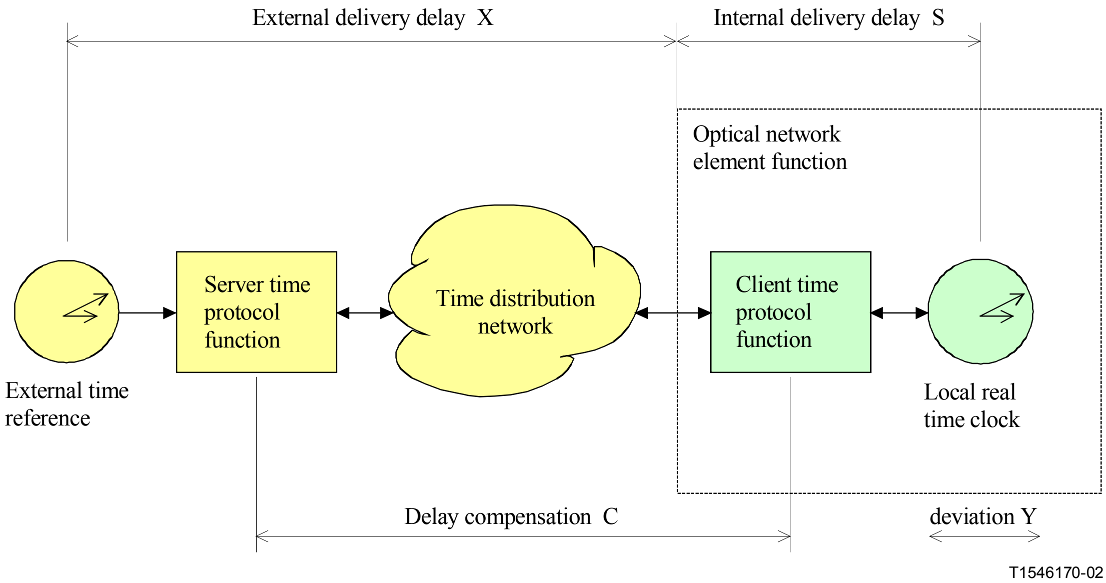

Figure 8/G.874 – RTC alignment with an external time reference

The symbol S represents the difference in time between the arrival of the time signal at the edge of the Optical Network Element and the time the corrective actions start on the local Real Time Clock function. S accounts for time accuracy losses introduced in the Client Time Protocol Function (e.g. signal acceptance and decoding). S shall be less than or equal to 0.3 s.

The symbol Y represents the drift of the local Real Time Clock function within a 24-hour interval of the External Time Reference, under the condition that no time-resets have occurred during the 24-hour interval. For ONEs, it is required that the value of Y is such that $S + Y + Z$ is less than or equal to 1.5 s.

The symbol C represents the adjustment in time to compensate for delivery delay.

With the previous definitions the difference in time between the local Real Time Clock function and the External Time Reference within 24 hours after a reset local clock shall not exceed $X + S - C \pm Y$.

To compensate for the drift Y the local Real Time Clock function is to be realigned with the External Time Reference on a regular basis. This realignment period should be determined such that the correction is less than 10 seconds to prevent all active Performance Monitoring Functions (PMFs) from declaring suspect intervals.

6.1.3 Performance monitoring clock signals

Performance Monitoring Functions are responsible for the summation of 1-second event counts during 15-minute and 24-hour intervals. The start of such an interval is equal to the end of the previous interval. Consequently, there is a need to have a signal that indicates the start/end of a 1-second interval, a signal that indicates the start/end of a 15-minute interval and a signal that indicates the start/end of a 24-hour interval. As required in ITU-T Rec. G.7710/Y.1701, the 15-minute intervals are aligned with the quarter of an hour, i.e. 00:00, 15:00, 30:00 and 45:00. The 24-hour interval starts by default at midnight (00:00:00).

To determine Unavailable Time, the Performance Monitoring functions need a clock which is set to 10 seconds delay with respect to the local Real Time Clock. Refer to 10.2 or the calculation of Unavailable Time.

6.1.4 Activity scheduling

A feature of Network Elements is the capability to schedule activities in advance.

Examples of scheduled activities are integrity checking to be performed at regular intervals, and the provisioning of a cross connection at a certain date and time.

The Activity List contains the activities along with their activation date and time. The latter may be indicated by a specific date and time (e.g. at 8.00 am Monday October 15, 2001) or by a repetition (e.g. at 8.00 am Mondays).

The Scheduler continuously compares the date and time of the local Real Time Clock with the activation date and time indicators in the Activity List. When there is a match, the related activity is activated.

6.2 Date and time functions

There are two Date and Time functions defined. The local real time clock (RTC) function is required for time stamping and activity scheduling. The Performance Monitoring Clock (PMC) function, in addition to RTC, is typical for digital counter measurements.

6.2.1 Real time clock function

The local real time clock functions are specified in ITU-T Rec. G.7710/Y.1701.

6.2.2 Performance monitoring clock function

The performance monitoring clock functions are specified in ITU-T Rec. G.7710/Y.1701.

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 Rec. M.20. The quality assurance measurements for fault management include component measurements for reliability, availability and survivability.

7.1 Fault management applications

7.1.1 Supervision

The supervision process describes the way in which the actual occurrence of a disturbance or fault is analyzed with 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 Recs. G.805 and G.872 and the alarm reporting function of ITU-T Rec. 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 Rec. G.7710/Y.1701 for additional discussion of these categories.

7.1.1.1 Transmission supervision

See ITU-T Rec. G.7710/Y.1701 for a description of transmission supervision.

7.1.1.2 Quality of Service supervision

See ITU-T Rec. G.7710/Y.1701 for a description of quality of service supervision.

7.1.1.3 Processing supervision

See ITU-T Rec. G.7710/Y.1701 for a description of processing supervision.

7.1.1.4 Equipment supervision

See ITU-T Rec. G.7710/Y.1701 for a description of equipment supervision.

7.1.1.5 Environment supervision

See ITU-T Rec. G.7710/Y.1701 for a description of environment supervision.

7.1.2 Validation

See ITU-T Rec. G.7710/Y.1701 for a description of fault cause validation.

7.1.3 Severity

See ITU-T Rec. G.7710/Y.1701 for a description of severity categories.

7.1.4 Alarm report control

Alarm Report 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 substate 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 substate 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 Amendment 3/M.3100.

7.1.5 Reportable failures

See ITU-T Rec. G.7710/Y.1701 for a description of reportable failures.

7.1.6 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 of 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.

7.1.7 Testing

See ITU-T Rec. G.7710/Y.1701 for a description of testing.

7.2 Fault management functions

Figure 9 contains the functional model of Fault Management inside the OEMF. This model is consistent with the alarm flow functional model, specified in Amendment 3/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 9 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.

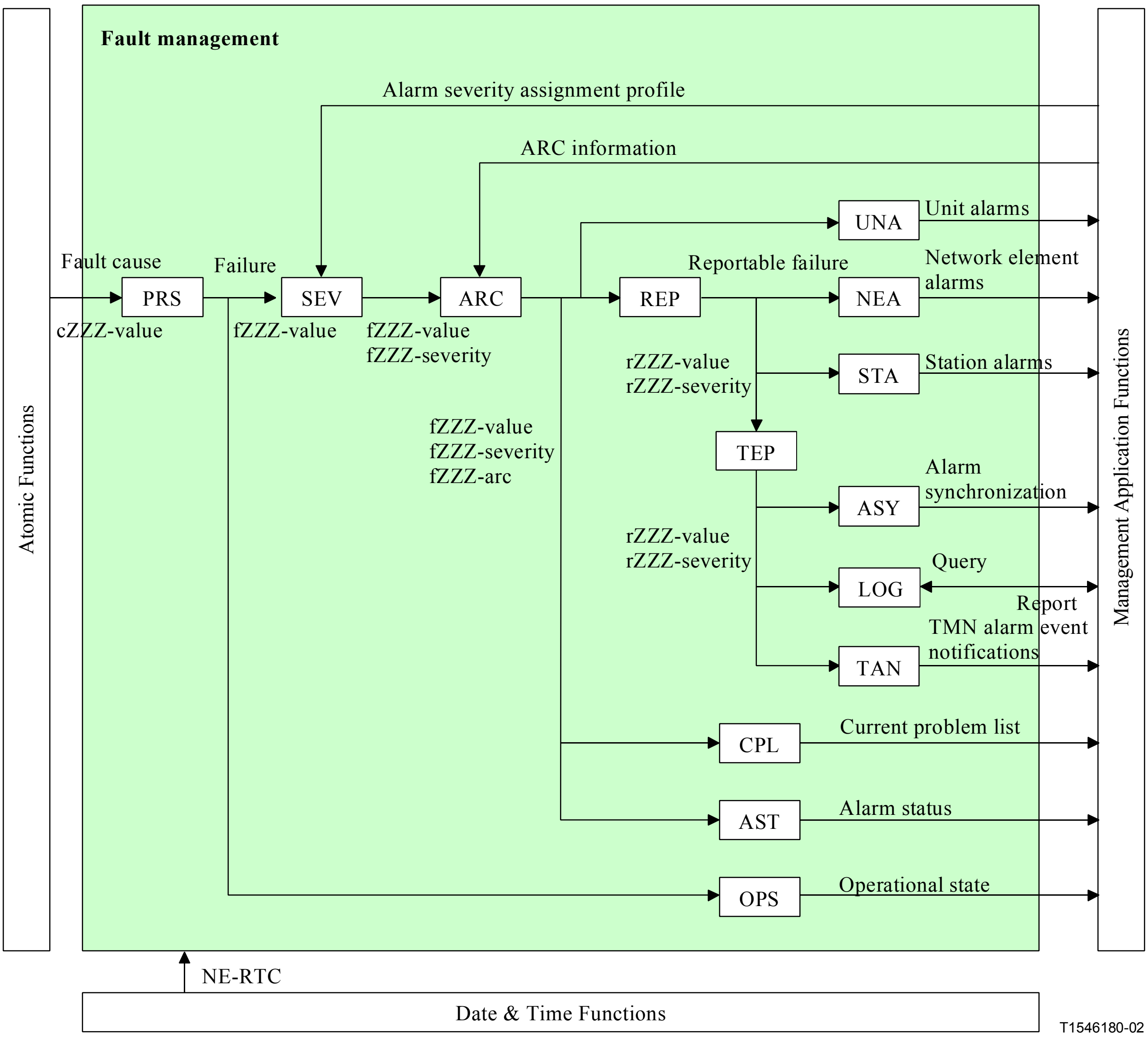

Figure 9/G.874 – Fault management within the ONEF

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. 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 10.

Symbol

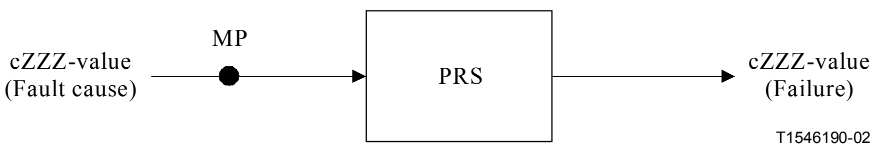

Figure 10/G.874 – Fault cause persistency function

Inputs and outputs

Table 1/G.874 – Inputs/outputs for the fault cause persistency function

Process	Input	Output
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
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	cLOS cLOM	fLOS fLOM
OCh/OTUk-b_A_Sk	cLOS cLOM	fLOS fLOM
OCh/OTUkV_A_Sk	cLOS cLOM	fLOS 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
ODUkP_TT_Sk	cOCI cTIM cDEG cBDI cSSF cLCK	fOCI fTIM fDEG fBDI fSSF fLCK

Table 1/G.874 – Inputs/outputs for the fault cause persistency function

Process	Input	Output
ODUkP/CBRx_A_Sk	cPML	fPML
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
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
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 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 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

7.2.3 Alarm report control function ARC

Table 2/G.874 – OTSn_TT_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
OTSn_TT_Sk				NALM-CD	NALM-NR
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOS-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOS-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 3/G.874 – OMSn_TT_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
OMSn_TT_Sk				NALM-CD	NALM-NR
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOS-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 4/G.874 – OPSnP_TT_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
OPSnP_TT_Sk				NALM-CD	NALM-NR
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 5/G.874 – OPSn_TT_Sk ARC states

OPSn_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.					
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 6/G.874 – OCh_TT_Sk ARC states

OCh_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOS-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-O	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fOCI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.					
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 7/G.874 – OChr_TT_Sk ARC states

OChr_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF-P	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.					
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 8/G.874 – OCh/OTUk-a_A_Sk ARC states

OCh/OTUk-a_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.					
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 9/G.874 – OCh/OTUk-b_A_Sk ARC states

OCh/OTUk-b_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 10/G.874 – OCh/OTUkV_A_Sk ARC states

OCh/OTUkV_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 11/G.874 – OCh/RSn_A_Sk ARC states

OCh/RSn_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 12/G.874 – OTUk_TT_Sk ARC states

OTUk_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fDEG	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 13/G.874 – OTUkV_TT_Sk ARC states

OTUkV_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fDEG	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 14/G.874 – ODUkP_TT_Sk ARC states

ODUkP_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fOCI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fDEG	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLCK	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 15/G.874 – ODUkP/CBRx_A_Sk ARC states

ODUkP/CBRx_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fPML	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 16/G.874 – ODUkP/VP_A_Sk ARC states

ODUkP/VP_A_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fPML	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLCD	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 17/G.874 – ODUkP/NULL_A_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
ODUkP/NULL_A_Sk				**NALM-CD**	**NALM-NR**
fPML	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 18/G.874 – ODUkP/PRBS_A_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
ODUkP/PRBS_A_Sk				**NALM-CD**	**NALM-NR**
fPML	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLSS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 19/G.874 – ODUkP/RSn_A_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
ODUkP/RSn_A_Sk				**NALM-CD**	**NALM-NR**
fPML	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLOF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 20/G.874 – ODUkT_TT_Sk ARC states

	ALM	NALM	NALM-TI	NALM-QI	
ODUkT_TT_Sk				**NALM-CD**	**NALM-NR**
fOCI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fDEG	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLCK	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLTC	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI. NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.					

Table 21/G.874 – ODUkTm_TT_Sk ARC states

ODUkTm_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fOCI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fTIM	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fDEG	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fBDI	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fSSF	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLCK	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2
fLTC	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported: NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 22/G.874 – OSx_TT_Sk ARC states

OSx_TT_Sk	ALM	NALM	NALM-TI	NALM-QI	
				NALM-CD	NALM-NR
fLOS	Required	Note 1	Note 1	Notes 1, 2	Notes 1, 2

NOTE 1 – At least one of the following states must be supported : NALM, NALM-TI, or NALM-QI.
NOTE 2 – If NALM-QI is supported, then NALM-NR is required and NALM-CD is optional.

Table 23/G.874 – ARC specifications for the OTN

	Qualified Problems	QoS Reporting	Default State Value Constraints
OTSn_TT_Sk	FFS	FFS	FFS
OMSn_TT_Sk	FFS	FFS	FFS
OPSn_TT_Sk	FFS	FFS	FFS
OCh_TT_Sk	FFS	FFS	FFS
OChr_TT_Sk	FFS	FFS	FFS
OCh/OTUk-a_A_Sk	FFS	FFS	FFS
OCh/OTUk-b_A_Sk	FFS	FFS	FFS
OCh/OTUkV_A_Sk	FFS	FFS	FFS
OCh/RSn_A_Sk	FFS	FFS	FFS
ODUkP_TT_Sk	FFS	FFS	FFS
ODUkP/CBRx_A_Sk	FFS	FFS	FFS
ODUkP/VP_A_Sk	FFS	FFS	FFS
ODUkP/NULL_A_Sk	FFS	FFS	FFS
ODUkP/PRBS_A_Sk	FFS	FFS	FFS
ODUkP/RSn_A_Sk	FFS	FFS	FFS
OTUk_TT_Sk	FFS	FFS	FFS
OTUkV_TT_Sk	FFS	FFS	FFS
ODUk_TT_Sk	FFS	FFS	FFS
ODUkTm_TT_Sk	FFS	FFS	FFS
OSx_TT_Sk	FFS	FFS	FFS

7.2.4 Reportable failure function – REP

See ITU-T Rec. G.7710/Y.1701 for a description of the reportable failure function.

7.2.5 Unit alarm function – UNA

See ITU-T Rec. G.7710/Y.1701 for a description of the unit alarm function.

7.2.6 Network alarm function – NAF

See ITU-T Rec. G.7710/Y.1701 for a description of the network alarm function.

7.2.7 Station alarm function – STA

See ITU-T Rec. G.7710/Y.1701 for a description of the station alarm function.

7.2.8 TMN event pre-processing function – TEP

See ITU-T Rec. G.7710/Y.1701 for a description of the TMN event pre-processing alarm function.

7.2.9 Alarm synchronization function – ASY

See ITU-T Rec. G.7710/Y.1701 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 Rec. X.735 for additional details.

See ITU-T Rec. G.7710/Y.1701 for a description of the logging function.

7.2.11 TMN alarm event notification function – TAN

See ITU-T Rec. G.7710/Y.1701 for a description of the TMN alarm event notification function.

7.2.12 Current problem list function – CPL

See ITU-T Rec. G.7710/Y.1701 for a description of the current problem list function

7.2.13 Alarm status function – AST

See ITU-T Rec. G.7710/Y.1701 for a description of the alarm status function

7.2.14 Operational state function – OPS

See ITU-T Rec. G.7710/Y.1701 for a description of the operational state function.

8 Configuration management

Configuration management provides functions to exercise control over, identify, collect data from and provide data to NEs. Configuration management supports network planning and engineering, installation, service planning and negotiation, provisioning, and status and control.

Network elements may support several functions, which can be operated only in exclusivity of each other.

Besides such configuration provisioning, provisioning is needed for parameters in individual processes within a NE. Examples are protection switching, trace identifier, matrix connection, error defect thresholds, and reporting of consequential defects/failures.

8.1 Configuration management applications

The configuration management applications addressed in this Recommendation are limited to provisioning, control and status reporting. The applications descriptions include the provisioning of the ONE's hardware and software. It includes the provisioning of atomic functions by means of MI signals as specified by ITU-T Rec. G.798. Also addressed are the provisioning of some of the FCAPS functions, such as performance monitoring thresholds, and protection switching schemes.

8.1.1 Equipment

See ITU-T Rec. G.7710/Y.1701 for a description of equipment configuration.

8.1.2 Software

See ITU-T Rec. G.7710/Y.1701 for a description of software configuration.

8.1.3 Protection switching

See ITU-T Rec. G.7710/Y.1701 for a description of protection switching configuration.

8.1.4 Trace identifier

See ITU-T Rec. G.7710/Y.1701 for a description of trace identifier configuration.

8.1.5 Payload structures

See ITU-T Rec. G.7710/Y.1701 for a description of payload structures configuration.

8.1.6 Multiplex structures

See ITU-T Rec. G.7710/Y.1701 for a description of multiplex structures configuration.

8.1.7 Matrix connections

See ITU-T Rec. G.7710/Y.1701 for a description of matrix connections configuration.

8.1.8 DEG thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of DEG thresholds configuration.

8.1.9 EXC thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of EXC thresholds configuration.

8.1.10 Port Mode and TP Mode

Port Mode and TP Mode are not applicable to ONEs.

8.1.11 XXX_Reported

XXX_Reported is not applicable to ONEs.

8.1.12 Alarm severity

See ITU-T Rec. G.7710/Y.1701 for a description of alarm severity.

8.1.13 Alarm report control

See ITU-T Rec. G.7710/Y.1701 for a description of alarm report control.

8.1.14 PM thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of PM thresholds configuration.

8.1.15 TCM activation

See ITU-T Rec. G.7710/Y.1701 for a description of TCM activation configuration.

8.2 Configuration management functions

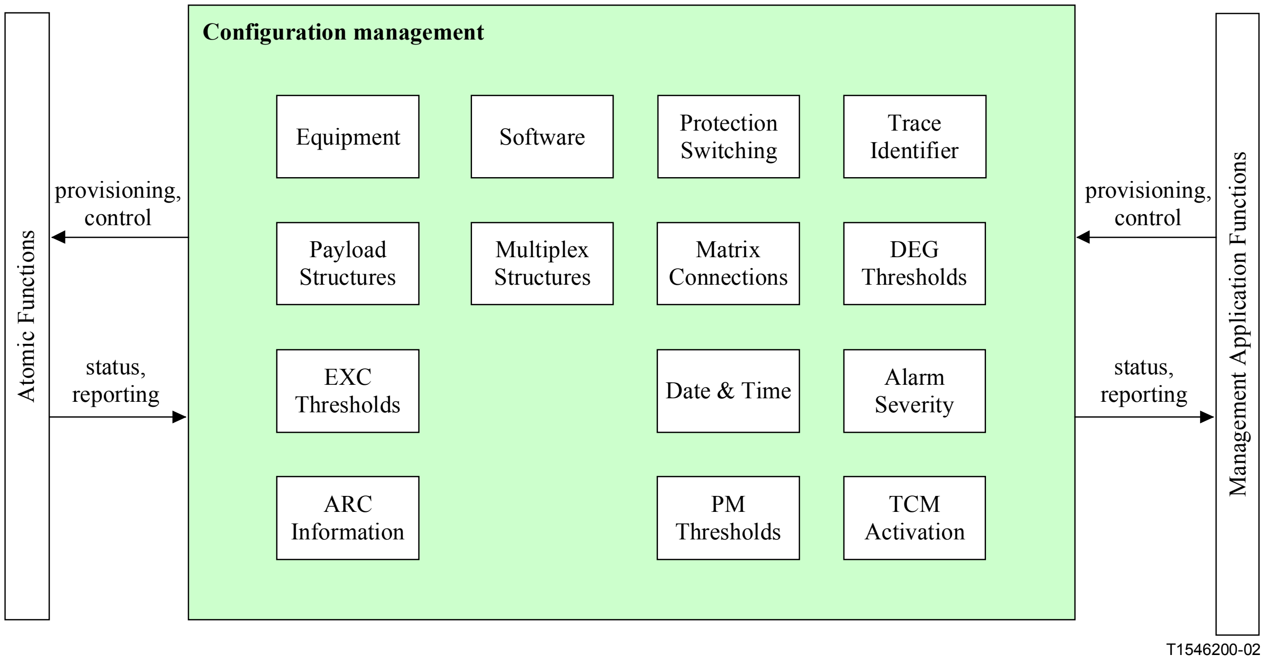

Figure 11/G.874 – Configuration management functions within the EMF

8.2.1 Equipment

See ITU-T Rec. G.7710/Y.1701 for a description of equipment configuration.

8.2.2 Software

ONEs shall support the software management requirements specified in clause 6/X.744.

ONEs shall support in-service software upgrades, at minimum, between two consecutive versions of a software release.

NOTE – During Control Software switch over, some management services may be impacted. For example creation of new services during this period may not be allowed.

All managed object instances within an ONE shall be stored in a Management Information Base (MIB). The following functions are required regarding the MIB.

1) *Get MIB of NE*

   This function allows the OS to get the list of all object instances stored in the MIB of the ONE. The list contains the objects and their relationships, i.e. connectivity pointers and containment relations (name binding).

   This function should be used by the OS to maintain its NEL-OS database.

   It is generally used for a NEL-OS database initialization at network installation phase, or for a database recovery due to a discrepancy with the NE MIB after a network upgrade.

2) *Report NE MIB changes to the OS*

   This management function reports a new resource to the OS when it is inserted in the equipment, or to dismiss an entity when it is removed. When changing the hardware in the NE by adding or removing a resource (e.g. port, card), the MIB in the OS has to be updated.

   The removing of a resource from an ONE, and the deletion of the affected managed object instances, shall be reported to the OS.

See ITU-T Rec. G.7710/Y.1701 for additional descriptions of software configuration.

8.2.3 Protection switching

See ITU-T Rec. G.7710/Y.1701 for a description of protection switching configuration.

8.2.3.1 Provisioning

Network elements may support one or more types of protection, each of which can be characterized by the set (or a subset) of the following parameters:

- Protection architecture;
- Switching Type, e.g. unidirectional/single ended, bidirectional/dual ended;
- Operation type (non-revertive, revertive);
- Automatic Protection Switch (APS) channel (provisioning, usage, coding);
- Protection switch requests;
- Protection switch performance;
- Protection switch state machine.

The protection-switching scheme of an OTN network element can be setup autonomously by the network element, according to its makeup and mode of operation, or it may be done by means of external provisioning.

8.2.3.2 Status and control

The general facility of protection switching is defined as the substitution of a standby or backup facility for a designated facility. The functions that allow the user to control the traffic on the protection line are:

- Operate/release manual protection switching;
- Operate/release force protection switching;
- Operate/release lockout;
- Request/set automatic protection switching (APS) parameters.

8.2.4 Trace identifier processes

A Trail Trace Identifier at the OTS layer is useful to ensure proper fiber 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 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 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 network element level to detect wrong fiber 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 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.

8.2.4.1 Provisioning

The functions that allow a user to provision the operation of a trace identifier process are:

1) Provisioning of source TTI;
2) Provisioning of the expected TTI;
3) Enable/disable detection of trace identifier mismatch (TIM);
4) Enable/disable TIM consequent action.

TTI shall be supported as specified in Table 24.

The source TTI and the expected TTI are communicated to the Trail Termination Functions from the OEMF via management signals at the management points.

The detection mode for TIM is communicated to an atomic function from the OEMF via the management signals at the management points.

An atomic function shall report, at the request of the OEMF, the value of the received and accepted TTI via the management signals at the management points. The TIM consequent action enabling/disabling control signal is communicated to an atomic function from the OEMF via management signals at the management points.

Table 24/G.874 – Trace identifier related provisioning and reporting

MI Signal	Value Range	Default Value
OTSn_TT_So_MI_TxTI	According to G.709/Y.1331	Not Applicable
OTSn_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
OTSn_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable
OTSn_TT_Sk_MI_TIMDetMo	According to G.798	FFS
OTSn_TT_Sk_MI_TIMActDis	Enabled, disabled	disabled
OTUk_TT_So_MI_TxTI	According to G.709/Y.1331	Not Applicable
OTUk_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
OTUk_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable
OTUk_TT_Sk_MI_TIMDetMo	According to G.798	FFS
OTUk_TT_Sk_MI_TIMActDis	Enabled, disabled	disabled
OTUkV_TT_So_MI_TxTI	According to G.709/Y.1331	Not Applicable
OTUkV_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
OTUkV_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable
OTUkV_TT_Sk_MI_TIMDetMo	According to G.798	FFS
OTUkV_TT_Sk_MI_TIMActDis	Enabled, disabled	disabled
ODUkP_TT_So_MI_TxTI	According to G.709/Y.1331	Not Applicable
ODUkP_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
ODUkP_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable
ODUkP_TT_Sk_MI_TIMDetMo	According to G.798	FFS
ODUkP_TT_Sk_MI_ TIMActDis	Enabled, disabled	disabled
ODUkT_TT_So_MI_TxTI	According to G.709/Y.1331	Not Applicable
ODUkT_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
ODUkT_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable

Table 24/G.874 – Trace identifier related provisioning and reporting

MI Signal	Value Range	Default Value
ODUkT_TT_Sk_MI_TIMDectMo	According to G.798	FFS
ODUkT_TT_Sk_MI_TIMActDis	Enabled, disabled	disabled
ODUkTm_TT_Sk_MI_ExSAPI	According to G.709/Y.1331	Not Applicable
ODUkTm_TT_Sk_MI_ExDAPI	According to G.709/Y.1331	Not Applicable
ODUkTm_TT_Sk_MI_TIMDectMo	According to G.798	FFS
ODUkTm_TT_Sk_MI_TIMActDis	Enabled, disabled	disabled

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).

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 activation/deactivation of adaptation functions is via MI_Active signals. This situation is applicable to the OMS AP. In the case of the OTS AP, the access point is connected to only one adaptation function, therefore it supports only one client signal, and the MI_Active signal is fixed as active.

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

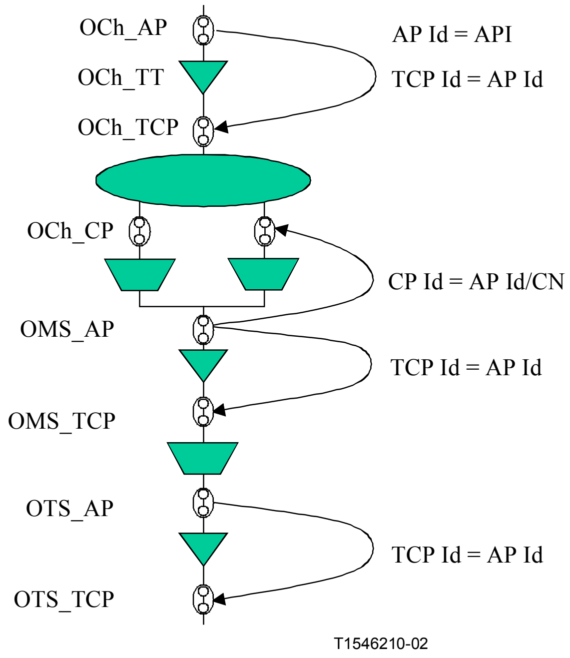

Figure 12/G.874 – CP and TCP identification scheme

Table 25/G.874 – Provisioning and reporting for adaptation functions

MI Signal	Value Range	Default Value
OCh/OTUk-a_A_So_MI_Active	True, false	false
OCh/OTUk-b_A_So_MI_Active	True, false	false
OCh/OTUk-a_A_Sk_MI_FECEn	FFS	FFS
OCh/OTUk-a_A_Sk_MI_Active	True, false	false
OCh/OTUk-b_A_Sk_MI_Active	True, false	false
OCh/OTUkV_A_So_MI_Active	True, false	false
OCh/OTUkV_A_Sk_MI_Active	True, false	false
OCh/CBRx_A_So_MI_Active	True, false	false
OCh/CBRx_A_Sk_MI_Active	True, false	false
OCh/RSn_A_So_MI_Active	True, false	false
OCh/RSn_A_Sk_MI_Active	True, false	false
OTUk/COMMS_A_So_MI_Active	True, false	false
OTUk/COMMS_A_Sk_MI_Active	True, false	false
OTUkV/COMMS_A_So_MI_Active	True, false	false
OTUkV/COMMS_A_Sk_MI_Active	True, false	false
ODUkP/CBRx-a_A_So_MI_Active	True, false	false
ODUkP/CBRx-b_A_So_MI_Active	True, false	false
ODUkP/CBRx_A_Sk_MI_Active	True, false	false
ODUkP/VP_A_So_MI_Active	True, false	false

Table 25/G.874 – Provisioning and reporting for adaptation functions

MI Signal	Value Range	Default Value
ODUkP/VP_A_Sk_MI_Active ODUkP/VP_A_Sk_MI_CellDiscardActive ODUkP/VP_A_Sk_MI_TPusgActive ODUkP/VP_A_Sk_MI_HECactive ODUkP/VP_A_Sk_MI_GFCactive ODUkP/VP_A_Sk_MI_DTDLuseEnabled ODUkP/VP_A_Sk_MI_VPI-KActive ODUkP/VP_A_Sk_MI_VPIK_SAISActive	FFS	FFS
ODUkP/NULL-a_A_So_MI_Active	True, false	false
ODUkP/NULL_A_Sk_MI_Active	True, false	false
ODUkP/PRBS-a_A_So_MI_Active	True, false	false
ODUkP/PRBS_A_Sk_MI_Active	True, false	false
ODUkP/RSn-a_A_So_MI_Active	True, false	false
ODUkP/RSn-b_A_So_MI_Active	True, false	false
ODUkP/RSn_A_Sk_MI_Active	True, false	false
ODUkP/COMMS_A_So_MI_Active	True, false	false
ODUkP/COMMS_A_So_MI_GCCAccess	FFS	FFS
ODUkP/COMMS_A_Sk_MI_Active	True, false	false
ODUkP/COMMS_A_Sk_MI_GCCAccess	FFS	FFS
ODUk/COMMS_AC_So_MI_Active	True, false	false
ODUk/COMMS_AC_So_MI_GCCAccess	FFS	FFS
ODUk/COMMS_AC_Sk_MI_Active	True, false	false
ODUk/COMMS_AC_Sk_MI_GCCAccess ODUk/COMMS_AC_Sk_MI_GCCCont	FFS	FFS

8.2.4.2 Reporting

The following OTS reporting functions are required:

1) Get otsTTIsent attribute of a otsTTPsource;
2) Get otsTTIexpected attribute of a otsTTPsink;
3) Get otsTTIreceived attribute of a otsTTPsink;
4) Report Attribute Value Change notification when otsTTIsent has changed;
5) Report Attribute Value Change notification when otsTTIexpected has changed;
6) Report Attribute Value Change notification when otsTTIreceived has changed;
7) Report OTS-TTI mismatch.

The following OCh reporting functions are required:

1) Get ochTTIsent attribute of a ochTTPsource;
2) Get ochTTIexpected attribute of a ochTTPsink or a ochCTPsink;
3) Get ochTTIreceived attribute of a ochTTPsink or a ochCTPsink;
4) Replace ochTTIsent attribute of a ochTTPsource;
5) Replace ochTTIexpected attribute of a ochTTPsink or a ochCTPsink;
6) Report Attribute Value Change notification when ochTTIsent has changed;

7) Report Attribute Value Change notification when ochTTIexpected has changed;
8) Report Attribute Value Change notification when ochTTIreceived has changed;
9) Report OCH-TTI mismatch.

8.2.5 Payload structures

See ITU-T Rec. G.7710/Y.1701 for additional information on Payload structure configuration management.

8.2.6 Multiplex structures

See ITU-T Rec. G.7710/Y.1701 for a description of Multiplex Structures configuration.

8.2.7 Matrix connections

8.2.7.1 Provisioning

A connection function is delimited by Connection Points (CP) and Termination Connection Points (TCP). Each TCP is identified via the API associated with its Trail Termination function, and each CP is identified via the API associated with its adaptation function. In the case of an OCh CP the API is extended, where applicable, with a channel number (CN) or its equivalent.

A matrix is therefore characterized by its (T)CP Id's which are communicated between the OEMF and the atomic function via the MI signals. See ITU-T Rec. G.798.

Table 26/G.874 – Provisioning and reporting for connection functions

MI Signal	Value Range	Default Value
OMSnP_C_MI_OperType OMSnP_C_MI_WTR OMSnP_C_MI_HoTime OMSnP_C_MI_ExtCMD	FFS	FFS
MI_MatrixControl Per protection group: OCh_C_MI_OperType OCh_C_MI_WTR OCh_C_MI_HoTime OCh_C_MI_ExtCMD	FFS	FFS
ODUk_C_MI_MatrixControl Per protection group: ODUk_C_MI_ProtType ODUk_C_MI_OperType ODUk_C_MI_WTR ODUk_C_MI_HoTime ODUk_C_MI_ExtCMD	FFS	FFS

8.2.7.2 OCh matrix management

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 doesn't carry a signal through the optical core network, but it can be useful for loop back test purpose.

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 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 purpose)

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.

8.2.8 DEG thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of DEG thresholds configuration.

8.2.9 EXC thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of EXC thresholds configuration.

8.2.10 Port Mode and TP Mode

Port Mode and TP Mode are not applicable to ONEs.

8.2.11 XXX_Reported

XXX_Reported is not applicable to ONEs.

8.2.12 Alarm severity

See ITU-T Rec. G.7710/Y.1701 for a description of alarm severity configuration functions.

8.2.13 Alarm reporting control

See ITU-T Rec. G.7710/Y.1701 for a description of alarm reporting control configuration functions.

8.2.14 PM thresholds

See ITU-T Rec. G.7710/Y.1701 for a description of PM thresholds configuration functions.

8.2.15 TCM activations

See ITU-T Rec. G.7710/Y.1701 for a description of TCM activations configuration functions.

9 Account management

Account management is for further study.

10 Performance management

Performance Management provides functions to evaluate and report upon the behaviour of telecommunication equipment and the effectiveness of the network or network element. Its role is to gather and analyze statistical data for the purpose of monitoring and correcting the behaviour and effectiveness of the network, NEs or other equipment, and to aid in planning, provisioning, maintenance and the measurement of quality. As such, it is carrying out the performance measurement phase of ITU-T Rec. M.20.

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 of the ODUkT and the OTUk trail. This frame slip will result in bit error detection at the trail termination skin, 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 value 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

The four basic Performance Management applications according ITU-T Rec. M.3400 are:

1) Performance Quality Assurance;
2) Performance Monitoring;
3) Performance Management Control;
4) Performance Analysis.

See ITU-T Rec. G.7710/Y.1701 for additional information on these applications.

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

See ITU-T Rec. G.7710/Y.1701 for a description of near-end and far-end concepts.

10.1.2 Maintenance

See ITU-T Rec. G.7710/Y.1701 for a description of performance management for maintenance.

10.1.3 Bringing into service

See ITU-T Rec. G.7710/Y.1701 for a description of bringing into service.

10.1.4 Quality of service

See ITU-T Rec. G.7710/Y.1701 for a description of quality of service.

10.1.5 Availability

See ITU-T Rec. G.7710/Y.1701 for a description of availability.

10.1.6 Reporting

See ITU-T Rec. G.7710/Y.1701 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 a clear threshold is undercrossed for the performance measurement. 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

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 Rec. M.2120, i.e. based on information of each direction of transport independently. This type is further referred to as performance data collection for maintenance purposes.
– The collection as specified in ITU-T Rec. G.826, i.e. based on information of both directions of transport together. This type is further 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 Rec. G.7710/Y.1701 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 Rec. 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 Rec. G.7710/Y.1701 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 a clear threshold is undercrossed for the performance measurement. 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.

10.2 Performance management functions

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

The performance monitoring events processing processes the information available from one of the second windows and reported across the MP reference points. See Figure 13.

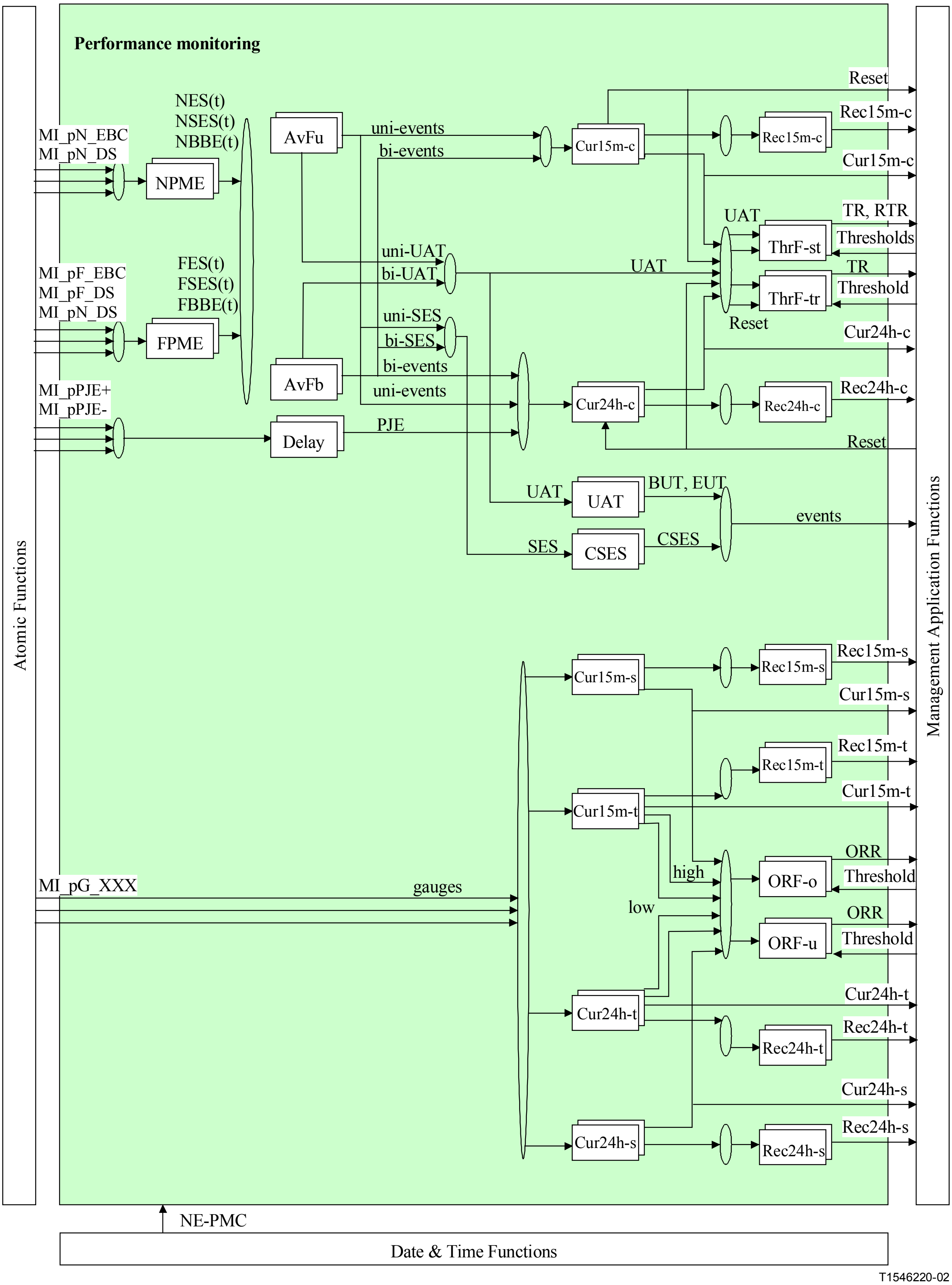

Figure 13/G.874 – Performance monitoring inside the OEMF

10.2.1 Near-end performance monitoring event function

See ITU-T Rec. G.7710/Y.1701 for a description of the near-end performance monitoring event function.

10.2.2 Far-end performance monitoring event function

See ITU-T Rec. G.7710/Y.1701 for a description of the far-end performance monitoring event function.

10.2.3 Delay function

See ITU-T Rec. G.7710/Y.1701 for a description of the delay function.

10.2.4 Unidirectional availability filter function

See ITU-T Rec. G.7710/Y.1701 for a description of the unidirectional availability filter function.

10.2.5 Bidirectional availability filter function

See ITU-T Rec. G.7710/Y.1701 for a description of the bidirectional availability filter function.

10.2.6 Consecutive severely errored second function

See ITU-T Rec. G.7710/Y.1701 for a description of the consecutive severely errored second function.

10.2.7 Begin/End of unavailable time event generation function

See ITU-T Rec. G.7710/Y.1701 for a description of the begin/end of unavailable time event generation function.

10.2.8 Current 15-minute counter register function

See ITU-T Rec. G.7710/Y.1701 for a description of the current 15-minute counter register function.

10.2.9 Current 15-minute snapshot register function

See ITU-T Rec. G.7710/Y.1701 for a description of the current 15-minute snapshot register function.

10.2.10 Current 15-minute tidemark register function

See ITU-T Rec. G.7710/Y.1701 for a description of the current 15-minute tidemark register function.

10.2.11 Recent 15-minute register functions

See ITU-T Rec. G.7710/Y.1701 for a description of the recent 15-minute register function.

10.2.12 Current 24-hour counter register function

See ITU-T Rec. G.7710/Y.1701 for a description of the current 24-hour counter register function.

10.2.13 Current 24-hour snapshot register function

See ITU-T Rec. G.7710/Y.1701 for a description of the current 24-hour snapshot register function.

10.2.14 Current 24-hour tidemark register function

See Recommendation G.7710/Y.1701 for a description of the current 24 hour tidemark register function.

10.2.15 Recent 24-hour register functions

See Recommendation G.7710/Y.1701 for a description of the recent 24 hour register function.

10.2.16 Transient condition threshold function

See Recommendation G.7710/Y.1701 for a description of the transient condition threshold function.

10.2.17 Standing condition threshold function

See ITU-T Rec. G.7710/Y.1701 for a description of the standing condition threshold function.

10.2.18 Out of range function for gauge overflow detection

See ITU-T Rec. G.7710/Y.1701 for a description of the out of range function for gauge overflow detection function.

10.2.19 Out of range function for underflow detection

See ITU-T Rec. G.7710/Y.1701 for a description of the out of range function for underflow detection function.

11 Security management

For further study.

Appendix I

Management termination points

I.1 State management

The ONE 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).

I.2 Location of TPs inside an ONE

Figure I.1 show possible locations of TPs inside a network element (the network elements are **just examples**; it is not necessary to define specific NE types):

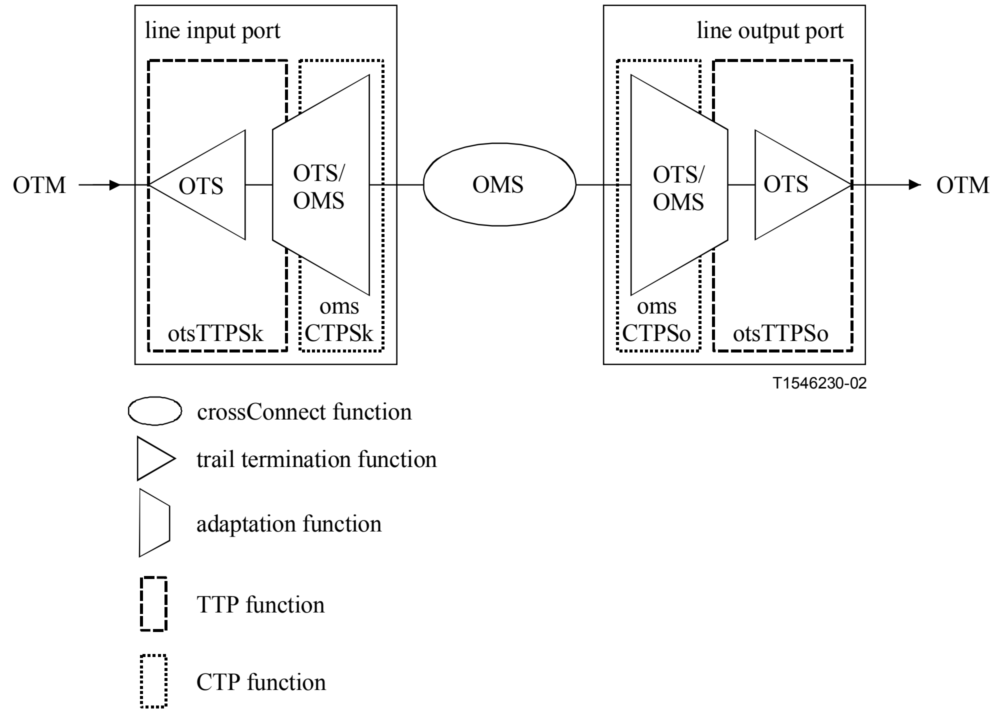

Figure I.1/G.874 – Example of TPs in an optical amplifier

I.3 Definitions of ONE termination points

An **otsTTPSource** originates a WDM transmission trail between two adjacent optical network elements. This object class represents the point where the optical line signal outgoes from the NE. There is always one instance of an otsTTPSource per line output port.

An **otsTTPSink** terminates a WDM transmission trail between two adjacent optical network. This object class represents the point where the optical line signal incomes into the NE. There is always one instance of an otsTTPSink per line input port.

An **omsCTPSource** originates an optical multiplex section link connection between two adjacent optical network elements. There is one instance (for the time being; in future there may be more) of an omsCTPSource per line output port.

An **omsCTPSink** terminates an optical multiplex section link connection between two adjacent optical network elements. There is one instance (for the time being; in future there may be more) of an omsCTPSink per line input port.

An **omsTTPSource** originates an optical multiplex section trail between two (not necessarily adjacent) optical network elements. There is one instance (for the time being; in future there may be more) of an omsTTPSource per line output port.

An **omsTTPSink** terminates an optical multiplex section trail between two (not necessarily adjacent) optical network elements. There is one instance (for the time being; in future there may be more) of an omsTTPSink per line input port.

An **ochCTPSource** originates an optical channel link connection between two (not necessarily adjacent) optical network elements. There is one instance of an ochCTPSource per wavelength channel in a line output port.

An **ochCTPSink** terminates an optical channel link connection between two (not necessarily adjacent) optical network elements. There is one instance of an ochCTPSource per wavelength channel in a line input port.

An **ochTTPSource** originates an optical channel trail between two (not necessarily adjacent) optical network elements. There is one instance of an ochTTPSource per OCh adapter.

An **ochTTPSink** terminates an optical channel trail between two (not necessarily adjacent) optical network elements. There is one instance of an ochTTPSink per OCh adapter.

Appendix II

OTN maintenance signal descriptions

Table II.1 describes the current set of OTN maintenance signals.

Table II.1/G.874 – OTN Maintenance Signals

Problem	Declare Triggers (Event(s))	Clear Triggers (Event(s), Immediate)	Affect on Operability (Enabled, Disabled, Degraded)	Affect on Supported entities operability (e.g. clients)	Clearing Report (Explicit, Implicit)
OMS-FDI-P	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
OMS-FDI-O	Indication received at termination point sink	Indication no longer received at termination point sink	Degraded	Degraded	Explicit
OCH-OCI	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
OCH-FDI-P	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
OCH-FDI-O	Indication received at termination point sink	Indication no longer received at termination point sink	Degraded	Degraded	Explicit
ODUk-OCI	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
ODUk-AIS	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
ODUk-LCK	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
OTUk-AIS	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit
generic-AIS	Indication received at termination point sink	Indication no longer received at termination point sink	Disabled	Disabled	Explicit

Appendix III

Management information for CM

Table III.1/G.874 – CM Management Information

CM Management Information	G.798 Function
OTSn_TT_So_MI_TxTI OTSn_TT_So_MI_APRCntrl	OTSn_TT_So
OTSn_TT_Sk_MI_ExSAPI OTSn_TT_Sk_MI_ExDAPI OTSn_TT_Sk_MI_TIMDetMo OTSn_TT_Sk_MI_TIMActDis OTSn_TT_Sk_MI_1second	OTSn_TT_Sk
OMSnP_C_MI_OperType OMSnP_C_MI_WTR OMSnP_C_MI_HoTime OMSnP_C_MI_ExtCMD	OMSnP1+1u_C_Sk
MI_MatrixControl Per protection group: OCh_C_MI_OperType OCh_C_MI_WTR OCh_C_MI_HoTime OCh_C_MI_ExtCMD	OCh_C
OCh/OTUk-a_A_So_MI_Active	OCh/OTUk-a_A_So
OCh/OTUk-b_A_So_MI_Active	OCh/OTUk-b_A_So
OCh/OTUk-a_A_Sk_MI_FECEn OCh/OTUk-a_A_Sk_MI_Active OCh/OTUk-a_A_Sk_MI_1second	OCh/OTUk-a_A_Sk
OCh/OTUk-b_A_Sk_MI_Active	OCh/OTUk-b_A_Sk
OCh/OTUkV_A_So_MI_Active	OCh/OTUkV_A_So
OCh/OTUkV_A_Sk_MI_Active OCh/OTUkV_A_Sk_MI_1second	OCh/OTUkV_A_Sk
OCh/CBRx_A_So_MI_Active	OCh/CBRx_A_So
OCh/CBRx_A_Sk_MI_Active	OCh/CBRx_A_Sk
OCh/RSn_A_So_MI_Active	OCh/RSn_A_So
OCh/RSn_A_Sk_MI_Active	OCh/RSn_A_Sk
OTUk_TT_So_MI_TxTI	OTUk_TT_So i
OTUk_TT_Sk_MI_ExSAPI OTUk_TT_Sk_MI_ExDAPI OTUk_TT_Sk_MI_TIMDetMo OTUk_TT_Sk_MI_TIMActDis OTUk_TT_Sk_MI_DEGThr OTUk_TT_Sk_MI_DEGM OTUk_TT_Sk_MI_1second	OTUk_TT_Sk
OTUkV_TT_So_MI_TxTI	OTUkV_TT_So
OTUkV_TT_Sk_MI_ExSAPI OTUkV_TT_Sk_MI_ExDAPI OTUkV_TT_Sk_MI_TIMDetMo	OTUkV_TT_Sk

Table III.1/G.874 – CM Management Information

CM Management Information	G.798 Function
OTUkV_TT_Sk_MI_TIMActDis OTUkV_TT_Sk_MI_DEGThr OTUkV_TT_Sk_MI_DEGM OTUkV_TT_Sk_MI_1second	
OTUk/COMMS_A_So_MI_Active	OTUk/COMMS_A_So
OTUk/COMMS_A_Sk_MI_Active	OTUk/COMMS_A_Sk
OTUkV/COMMS_A_So_MI_Active	OTUkV/COMMS_A_So i
OTUkV/COMMS_A_Sk_MI_Active	OTUkV/COMMS_A_Sk
ODUk_C_MI_MatrixControl 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
ODUkP_TT_So_MI_TxTI	ODUkP_TT_So
ODUkP_TT_Sk_MI_ExSAPI ODUkP_TT_Sk_MI_ExDAPI ODUkP_TT_Sk_MI_TIMDetMo ODUkP_TT_Sk_MI_ TIMActDis OTUk_TT_Sk_MI_DEGThr OTUk_TT_Sk_MI_DEGM OTUk_TT_Sk_MI_1second	ODUkP_TT_Sk
ODUkP/CBRx-a_A_So_MI_Active	ODUkP/CBRx-a_A_So
ODUkP/CBRx-b_A_So_MI_Active	ODUkP/CBRx-b_A_So
ODUkP/CBRx_A_Sk_MI_Active	ODUkP/CBRx_A_Sk
ODUkP/VP_A_So_MI_Active ODUkP/VP_A_So_MI_CellDiscardActive ODUkP/VP_A_So_MI_TPusgActive ODUkP/VP_A_So_MI_GFCActive ODUkP/VP_A_So_MI_VPI-KActive	ODUkP/VP_A_So
ODUkP/VP_A_Sk_MI_Active ODUkP/VP_A_Sk_MI_CellDiscardActive ODUkP/VP_A_Sk_MI_TPusgActive ODUkP/VP_A_Sk_MI_VPIrange ODUkP/VP_A_Sk_MI_HECactive ODUkP/VP_A_Sk_MI_GFCactive ODUkP/VP_A_Sk_MI_DTDLuseEnabled ODUkP/VP_A_Sk_MI_VPI-KActive ODUkP/VP_A_Sk_MI_VPI-K_SAISActive	ODUkP/VP_A_Sk
ODUkP/NULL-a_A_So_MI_Active	ODUkP/NULL-a_A_So
ODUkP/NULL_A_Sk_MI_Active	ODUkP/NULL_A_Sk
ODUkP/PRBS-a_A_So_MI_Active	ODUkP/PRBS-a_A_So
ODUkP/PRBS_A_Sk_MI_Active	ODUkP/PRBS_A_Sk
ODUkP/RSn-a_A_So_MI_Active	ODUkP/RSn-a_A_So
ODUkP/RSn-b_A_So_MI_Active	ODUkP/RSn-b_A_So

Table III.1/G.874 – CM Management Information

CM Management Information	G.798 Function
ODUkP/RSn_A_Sk_MI_Active	ODUkP/RSn_A_Sk
ODUkP/COMMS_A_So_MI_Active ODUkP/COMMS_A_So_MI_GCCAccess	ODUkP/COMMS_A_So
ODUkP/COMMS_A_Sk_MI_Active ODUkP/COMMS_A_Sk_MI_GCCAccess	ODUkP/COMMS_A_Sk
ODUk/COMMS_AC_So_MI_Active ODUk/COMMS_AC_So_MI_GCCAccess	ODUk/COMMS_AC_So
ODUk/COMMS_AC_Sk_MI_Active ODUk/COMMS_AC_Sk_MI_GCCAccess ODUk/COMMS_AC_Sk_MI_GCCCont	ODUk/COMMS_AC_Sk i
ODUkT_TT_So_MI_TxTI	ODUkT_TT_So
ODUkT_TT_Sk_MI_ExSAPI ODUkT_TT_Sk_MI_ExDAPI ODUkT_TT_Sk_MI_TIMDectMo ODUkT_TT_Sk_MI_TIMActDis ODUkT_TT_Sk_MI_DEGThr ODUkT_TT_Sk_MI_DEGM ODUkT_TT_Sk_MI_1second	ODUkT_TT_Sk
ODUkTm_TT_Sk_MI_Level ODUkTm_TT_Sk_MI_ExSAPI ODUkTm_TT_Sk_MI_ExDAPI ODUkTm_TT_Sk_MI_TIMDectMo ODUkTm_TT_Sk_MI_TIMActDis ODUkTm_TT_Sk_MI_DEGThr ODUkTm_TT_Sk_MI_DEGM ODUkTm_TT_Sk_MI_1second	ODUkTm_TT_Sk
ODUkT/ODUk_A_So_MI_AdminState	ODUkT/ODUk_A_So
ODUkT/ODUk_A_Sk_MI_AdminState	ODUkT/ODUk_A_Sk
ODUkT_TCMCm_MI_Level ODUkT_TCMCm_MI_ModeSo ODUkT_TCMCm_MI_ModeSk	ODUkT_TCMCm
OSx_TT_So_MI_APRCntrl	OSx_TT_So

Appendix IV

Management information for PM

Table IV.1/G.874 – PM Management Information

PM Management Information	G.798 Function
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
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
OPSn_TT_Sk_MI_pN_DS-P	OPSn_TT_Sk
OCh/OTUk-a_A_Sk_MI_pFECcorrErr	OCh/OTUk-a_A_Sk
OCh/OTUkV_A_Sk_MI_pFECcorrErr	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	TOTUk_TT_Sk
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 OTUkV_TT_Sk_MI_pIAE	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
ODUkP/PRBS_A_Sk_MI_pN_TSE	ODUkP/PRBS_A_Sk
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_pBIAE ODUkT_TT_Sk_MI_pIAE	ODUkT_TT_Sk
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
OSx_TT_Sk_MI_pN_DS	OSx_TT_Sk

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