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

Digital terminal equipments – Principal characteristics of multiplexing equipment for the synchronous digital hierarchy

Management aspects of synchronous digital hierarchy (SDH) transport network elements

Recommendation ITU-T G.784

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Recommendation ITU-T G.784

Management aspects of synchronous digital hierarchy (SDH) transport network elements

Summary

Recommendation ITU-T G.784 addresses management aspects of synchronous digital hierarchy (SDH) network elements containing transport functions of one or more of the layer networks of the SDH transport network. The management of the SDH layer networks is separable from that of its client layer networks so that the same means of management can be used regardless of the client. The management functions for fault management, configuration management and performance monitoring are specified.

The 2008 revision of this Recommendation has updated the management information to align with Recommendations ITU-T G.783, ITU-T G.781 and ITU-T G.7712/Y.1703, reorganized the clauses to align with the structure of Recommendation ITU-T G.7710/Y.1701, and replaced the generic text with pointers to Recommendation ITU-T G.7710/Y.1701.

Source

Recommendation ITU-T G.784 was approved on 29 March 2008 by ITU-T Study Group 15 (2005-2008) under Recommendation ITU-T A.8 procedure.

Keywords

Alarm reporting control, configuration management function, degraded performance, equipment management function, fault management functions, management application function, message communications function, performance management, performance monitoring functions, persistency, severity, thresholding.

FOREWORD

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Management aspects of synchronous digital hierarchy (SDH) transport network elements

1 Scope

This Recommendation addresses management aspects of synchronous digital hierarchy (SDH) network elements containing transport functions of one or more of the layer networks of the SDH transport network. The management of the SDH 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.

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

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

– SDH layer network entities (SLNEs) refer to trail termination, adaptation and connection functions as described in [ITU-T G.803],

– a network element may only contain SDH layer network entities,

– a network element may contain both SDH layer network entities (SLNEs) and client layer network entities (CLNEs),

– client layer entities are managed as part of their own logical domain (e.g., PDH management network),

– CLNEs and SLNEs may or may not share common message communications function (MCF) and management application function (MAF) depending on application,

– CLNEs and OLNEs may or may not share the same agent.

The SDH management subnetwork (S.MSN) architecture, SDH embedded control channel (ECC) functions, and SDH ECC protocols are specified. Detailed message sets are for further study.

The management of SDH equipment should be seen as a subset of the telecommunications management network (TMN) described in [ITU-T M.3000], and reference is made to [ITU-T Q.811] and [ITU-T Q.812] for the specification of protocol suites to be used at external (Q) management interfaces.

This Recommendation specifies for fault management, performance monitoring and configuration management a library of basic equipment management function (EMF) building blocks and a set of rules by which they are combined in order to describe a digital transmission equipment's EMF functionality. The library defined in this Recommendation forms part of the set of libraries defined furthermore in [ITU-T G.783].

Not every function defined in this Recommendation is required for every application. Different subsets of functions may be assembled in different ways to provide a variety of different capabilities. Network operators and equipment suppliers may choose which functions must be implemented for each application.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the

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

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

[ITU-T G.774] Recommendation ITU-T G.774 (1992), *Synchronous digital hierarchy (SDH) – Management information model for the network element view.*

[ITU-T G.774.1] Recommendation ITU-T G.774.1 (2001), *Synchronous digital hierarchy (SDH) – Bidirectional performance monitoring for the network element view.*

[ITU-T G.774.6] Recommendation ITU-T G.774.6 (1997), *Synchronous digital hierarchy (SDH) unidirectional performance monitoring for the network element view.*

[ITU-T G.781] Recommendation ITU-T G.781 (1999), *Synchronization layer functions.*

[ITU-T G.783] Recommendation ITU-T G.783 (2006), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks.*

[ITU-T G.803] Recommendation ITU-T G.803 (2000), *Architecture of transport networks based on the synchronous digital hierarchy (SDH).*

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

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

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

[ITU-T G.827] Recommendation ITU-T G.827 (2003), *Availability performance parameters and objectives for end-to-end international constant bit-rate digital paths.*

[ITU-T G.7710] Recommendation ITU-T G.7710/Y.1701 (2007), *Common equipment management function requirements*.

[ITU-T G.7712] Recommendation ITU-T G.7712/Y.1703 (2003), *Architecture and specification of data communication network.*

[ITU-T G.7714] Recommendation ITU-T G.7714/Y.1705 (2005), *Generalized automatic discovery for transport entities.*

[ITU-T G.7714.1] Recommendation ITU-T G.7714.1/Y.1705.1 (2003), *Protocol for automatic discovery in SDH and OTN networks.*

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

[ITU-T M.2100] Recommendation ITU-T M.2100 (2003), *Performance limits for bringing-into-service and maintenance of international multi-operator PDH paths and connections.*

[ITU-T M.2101] Recommendation ITU-T M.2101 (2003), *Performance limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections.*

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

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

[ITU-T M.3000] Recommendation ITU-T M.3000 (2000), *Overview of TMN Recommendations.*

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

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

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

[ITU-T M.3300] Recommendation ITU-T M.3300 (1998), *TMN F interface requirements.*

[ITU-T M.3400] Recommendation ITU-T M.3400 (2000), *TMN management functions.*

[ITU-T Q.811] Recommendation ITU-T Q.811 (2004), *Lower layer protocol profiles for the Q and X interfaces.*

[ITU-T Q.812] Recommendation ITU-T Q.812 (2004), *Upper layer protocol profiles for the Q and X interfaces.*

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

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

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

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

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

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 agent: [ITU-T X.701]

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

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

3.1.4 atomic function (AF): [ITU-T G.806]

3.1.5 data communication channel (DCC): [ITU-T G.707]

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

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

3.1.8 F interface: [ITU-T M.3300]

3.1.9 local craft terminal: [ITU-T G.7710]

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

3.1.11 managed object (MO): [ITU-T X.700]

3.1.12 managed object class (MOC): [ITU-T X.701]

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

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

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

3.1.16 manager: [ITU-T X.701]

3.1.17 message communications function (MCF): [ITU-T M.3013]

3.1.18 network element (NE): [ITU-T M.3010]

3.1.19 network element function (NEF): [ITU-T M.3010]

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

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

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

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

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

3.1.25 SDH management network (S.MN): [ITU-T G.780]

3.1.26 SDH management subnetwork (S.MSN): [ITU-T G.780]

3.1.27 SDH network element (S.NE): [ITU-T G.780]

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

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

3.1.30 workstation function (WF): [ITU-T M.3010]

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 agent: Part of the MAF which is capable of responding to network management operations issued by a manager and may perform operations on managed objects, issuing events on behalf of managed objects. The managed objects can reside within the entity or in another open system. Managed objects from other open systems are controlled by a distant agent via a local manager. All S.NEs will support at least an agent. Some S.NEs will provide managers and agents (being managed). Some S.NEs (e.g., regenerators) will only support an agent.

3.2.2 data communication channel (DCC): Within an STM-N signal there are two DCC channels, comprising bytes D1-D3, giving a 192 kbit/s channel, and bytes D4-D12, giving a

576 kbit/s channel. D1-D3 (DCC_R) are accessible by all S.NEs whereas D4-D12 (DCC_M), not being part of the regenerator section overhead, are not accessible at regenerators. It is recommended to have both DCC_M and DCC_R available in backbone STM-16 (and higher order) network sections. DCC_M is used to forward data over the multiplex sections (using the OSI-routing protocols), and DCC_R is used to forward data to the regenerators within the destination MS span. DCC_M can be regarded as the backbone, while DCC_R and LAN are used to interconnect this backbone to equipment that cannot be accessed through DCC_M, e.g., regenerators and non-SDH equipment.

DCC_M and DCC_R can be used to carry two independent, possibly proprietary management applications. An S.NE can choose to throughconnect DCC_M on the physical level, or to terminate the DCC_M and route the PDUs, while using the DCC_R for interconnection within a subnetwork.

3.2.3 managed object (MO): The management view of a resource within the telecommunication environment that may be managed via the agent. Examples of SDH managed objects are: equipment, receive port, transmit port, power supply, plug-in card, virtual container, multiplex section and regenerator section.

3.2.4 manager: Part of the MAF which is capable of issuing network management operations (i.e., retrieve alarm records, set thresholds) and receiving events (i.e., alarms, performance). S.NEs may or may not include a manager while SDH OS/MDs will include at least one manager.

3.2.5 operations system function or mediation function (OSF/MF): A telecommunications management network (TMN) entity that processes management information to monitor and control the SDH network. In the SDH sub-portion of the TMN, no distinction is made between the operations system function and the mediation function; this entity being a MAF containing at least a manager.

3.2.6 operations system or mediation device (OS/MD): A stand-alone physical entity that supports OSF/MFs but does not support NEFs. It contains a message communication function (MCF) and a MAF.

3.2.7 trail segment: A segment for which one end is a trail termination.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

A	Agent
ACSE	Association Control Service Element
AcSL	Accepted Signal Label
AcTI	Accepted Trace Identifier
AF	Application Function
AF	Atomic Function
AIS	Alarm Indication Signal
AITS	Acknowledged Information Transfer Service
ALM	ALarM reporting
AP	Access Point
APDU	Application Protocol Data Unit
API	Access Point Identifier
APS	Automatic Protection Switching

ARC	Alarm Reporting Control
ASE	Application Service Element
ASN.1	Abstract Syntax Notation One
CC	Connect Confirm
CLNE	Client Layer Network Entity
CLNP	Connectionless Network layer Protocol
CLNS	Connectionless Network layer Service
CLR	Clear
CMIP	Common Management Information Protocol
CMISE	Common Management Information Service Element
CMSN	Client Management Subnetwork
CONP	Connection Oriented Network-Layer Protocol
CP	Connection Point
CR	Connection Request
CSES	Consecutive Severely Errored Seconds
CV	Code Violation
DCC	Data Communications Channel
DCN	Data Communication Network
DEG	Degraded detect
DS	Defect Second
EB	Errored Block
EBC	Errored Block Count
ECC	Embedded Control Channel
EMF	Equipment Management Function
EML	Equipment Management Layer
ES	Errored Second
ESA	Errored Seconds type A
ESB	Errored Seconds type B
EXC	Excessive errors
EXER	Exercise
ExTI	Expected Trace Identifier
FBBE	Far-end Background Block Error
FC	Failure Counts
FCAPS	Fault, Configuration, Accounting, Performance and Security management
FDS	Far-end Defect Second
FEBC	Far-end Errored Block Count
FEBE	Far-End Block Error

FES	Far-end Errored Second
FFS	For Further Study
FLS	Frame Loss Second
FOP	Failure of Protocol
FSES	Far-end Severely Errored Second
FPME	Far-end Performance Monitoring Event
FSw	Forced Switch
FU	Functional Unit
GNE	Gateway Network Element
HO	Hold Off
IFU	Interworking Functional Unit
IP	Interworking Protocol
IS	Intermediate System
LAD	Layer Adjacency Discovery
LAN	Local Area Network
LCN	Local Communications Network
LCT	Local Craft Terminal
LO	Lockout of protection
LOF	Loss of Frame
LOM	Loss of Multiframe
LOP	Loss of Pointer
LOS	Loss of Signal
LOW	Lockout of Working
LTC	Loss of Tandem Connection
M	Manager
MAF	Management Application Function
MAINTREG	MAINTenance REGisters
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
MS	Multiplex Section
MSOH	Multiplex Section Overhead

MSw	Manual Switch
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
NBBE	Near-end Background Block Error
NDS	Near-end Defect Second
NE	Network Element
NEBC	Near-end Errored Block Count
NEF	Network Element Function
NEL	Network Element Layer
NES	Near-end Errored Second
NLR	Network Layer Relay
NPDU	Network Protocol Data Unit
NPME	Near-end Performance Monitoring Event
NSAP	Network Service Access Point
NSES	Near-end Severely Errored Second
OAM&P	Operations, Administration, Maintenance and Provisioning
ODI	Outgoing Defect Indication
OEI	Outgoing Error Indication
OFS	Out-of-Frame Second
OH	Overhead
OOF	Out of Frame
OS	Operations System
OSF	Operations System Function
OSF	Outgoing Signal Fail
OSI	Open Systems Interconnection
P	Protection
PDH	Plesiochronous Digital Hierarchy
PDU	Protocol Data Unit
PERFREG	PERFormance REGisters
PJC	Pointer Justification Count
PJE	Pointer Justification Event
PLM	PayLoad Mismatch
PMC	Performance Monitoring Clock
PMON	Performance Monitoring

PPDU	Presentation Protocol Data Unit
PSN	Packet Switched Network
QoS	Quality of Service
RDI	Remote Defect Indication
REI	Remote Error Indication
ROSE	Remote Operations Service Element
RS	Regenerator Section
RSOH	Regenerator Section Overhead
RTC	Real Time Clock
RTR	Reset Threshold Report
SAPI	Service Access Point Identifier
SD	Signal Degrade
SDH	Synchronous Digital Hierarchy
SEMF	Synchronous Equipment Management Function
SES	Severely Errored Second
SF	Signal Fail
SLNE	SDH Layer Network Entity
S.MN	SDH Management Network
S.MSN	SDH Management Subnetwork
SNDCF	SubNetwork Dependent Convergence Function
S.NE	SDH Network Element
SPDU	Session Protocol Data Unit
SSD	Server Signal Degrade
SSF	Server Signal Fail
STM	Synchronous Transport Module
SVC	Switched Virtual Circuit
TCP	Termination Connection Point
TEI	Terminal End-point Identifier
TI	Trace Identifier
TIM	Trace Identifier Mismatch
TMN	Telecommunications Management Network
TP	Termination Point
TPDU	Transport Protocol Data Unit
TR	Threshold Report
TSAP	Transport Service Access Point
TSD	Trail Signal Degrade
TSF	Trail Signal Fail

TSN	Time Slot Number
TTI	Trail Trace Identifier
TTP	Trail Termination Point
TxTI	Transmitted Trace Identifier
UAS	Unavailable Second
UAT	UnAvailable Time
UI	Unnumbered Information
UITS	Unacknowledged Information Transfer Service
UTC	Coordinated Universal Time
VC	Virtual Container
W	Working
WAN	Wide Area Network
WS	WorkStation
WTR	Wait to Restore

5 Conventions

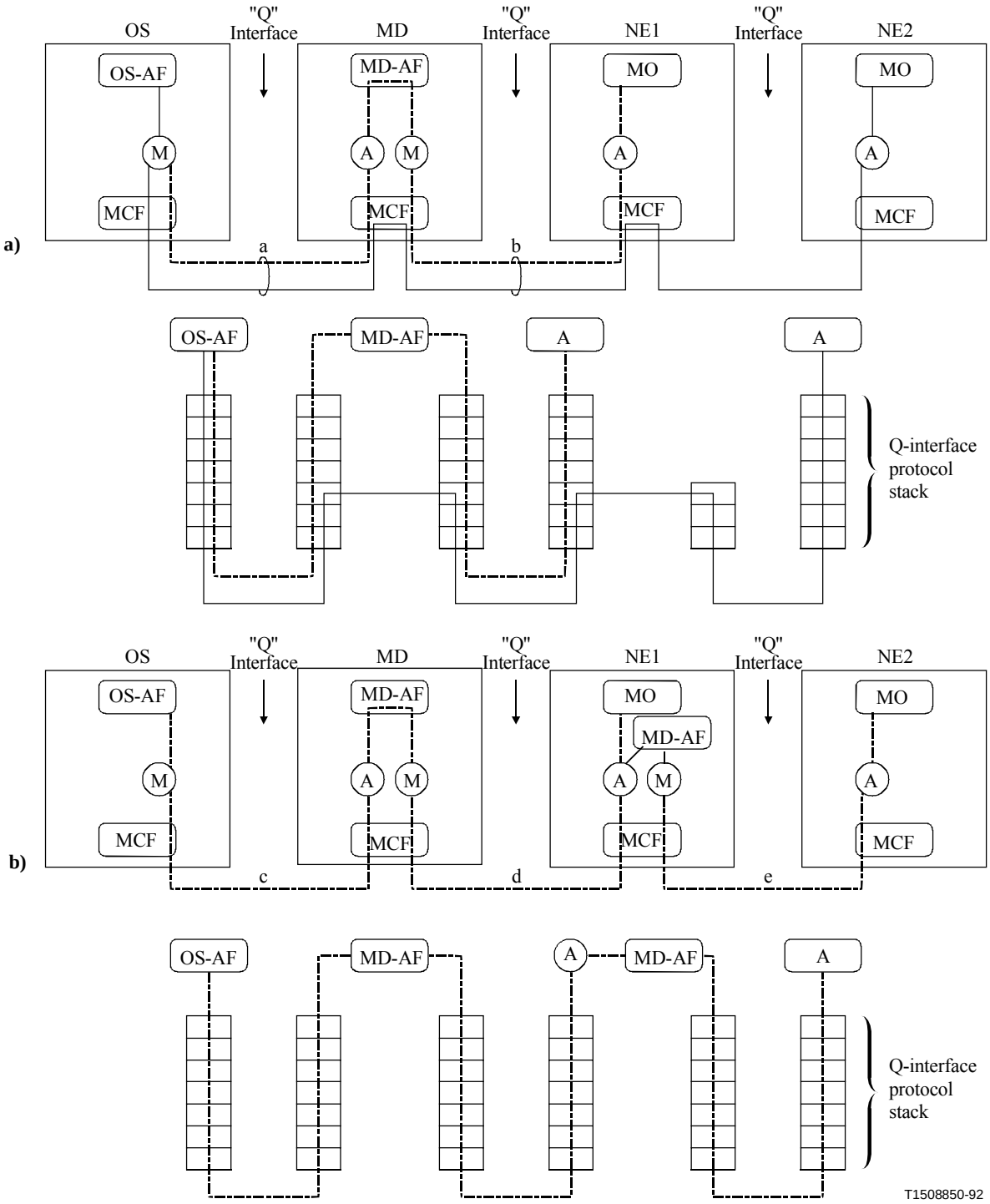
In this Recommendation, S.MN stands for SDH management network, S.MSN for SDH management subnetwork, and S.NE for SDH network element.

6 SDH management

6.1 SDH network management architecture

The transport layer networks of the SDH transport network are described in [ITU-T G.803] and [ITU-T G.707]. The management of the SDH layer networks is separable from that of their client layer networks so that the same means of management can be used regardless of the client.

See clause 6 of [ITU-T G.7710] for the generic management architecture.



OS	Operations system
MD	Mediation device
NE	Network element
OS-AF	OS-application function
MD-AF	MD-application function
MCF	Message communications function
A	Agent
M	Manager
MO	Managed object

Figure 6-1 – SDH management examples

Figure 6-1a illustrates examples of management communication using a Q interface implemented in the MCF where logically independent communications are provided over a single physical interface:

– between a manager in the OS and two different agents; one in the MD and one in NE2 (interface a);

– between a manager in the MD and an agent in NE1; between a manager in the OS and an agent in NE2 (interface b).

Figure 6-1b illustrates examples of management communication using Q interface protocols implemented in the MCF:

– between a manager in the OS and an agent in the MD (interface c);

– between a manager in the MD and an agent in NE1 (interface d);

– between a manager in NE1 and an agent in NE2 (interface e).

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

The SDH management network (S.MN) may be partitioned into SDH management subnetworks (S.MSNs). The inter-relationship between a management network, its subnetworks and a TMN as generically described in clause 6.1 of [ITU-T G.7710] is applicable to OTN.

6.1.1.1 Operations interfaces

6.1.1.1.1 Q interface

For interconnection with the TMN, the S.MSN will communicate through a Q interface having a protocol suite, CONS1, CLNS2 or CLNS1 as defined in [ITU-T Q.811] and [ITU-T Q.812]. The selection of which of the three protocol suites to adopt is a network provider's decision.

6.1.1.1.2 F interface

See [ITU-T M.3300].

The following subclauses describe the S.MSN in more detail.

6.1.2 Access to the S.MSN

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

6.1.3 S.MSN requirements

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

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

S.NEs must support management communications functions. The message communications function of an S.NE initiates/terminates (in the sense of the lower protocol layers), routes/forwards, or otherwise processes management messages over ECCs, or over other data communications network interfaces.

i) All S.NEs are required to terminate the ECC (see clause 6.1.5). In OSI terms, this means that each S.NE must be able to perform the functions of an end system.

ii) S.NEs may also be required to forward management messages between ports according to routing control information held in the S.NE. In OSI terms, this means that some S.NEs may be required to perform the functions of an intermediate system.

iii) In addition to supporting interfaces for the DCC, S.NEs may also be required to support DCN interfaces (Q and F interfaces).

The use of the data communication channels (DCC) for management communications is within the scope of this Recommendation, see clause 6.1.5.

6.1.4 S.MSN data communications network for SDH management

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

6.1.5 Management of DCN

See clause 6.1.5 of [ITU-T G.7710] for the generic requirements.

6.1.6 Remote log-in

See clause 6.1.6 of [ITU-T G.7710] for the generic requirements.

6.1.7 Relationship between technology domains

See clause 6.1.7 of [ITU-T G.7710] for the generic requirements.

6.2 Synchronous equipment management function

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

It should be noted that the management functions have been categorized according to the classifications given in [ITU-T M.3000].

Detailed specifications of the management functions, in terms of managed objects classes, attributes and message specification, are given in ITU-T G.774.x-series Recommendations.

The synchronous equipment management function SEMF (see Figure 6-2) provides the means through which the synchronous network element function (NEF) is managed by an internal or external manager. If a network element (NE) contains an internal manager, this manager will be part of the SEMF.

The SEMF interacts with the other atomic functions (refer to [ITU-T G.783]) by exchanging information across the MP reference points. See [ITU-T G.806] and [ITU-T G.783] for more information on atomic functions and on management points. The SEMF 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 applications functions (MAFs) which represent this information as managed objects.

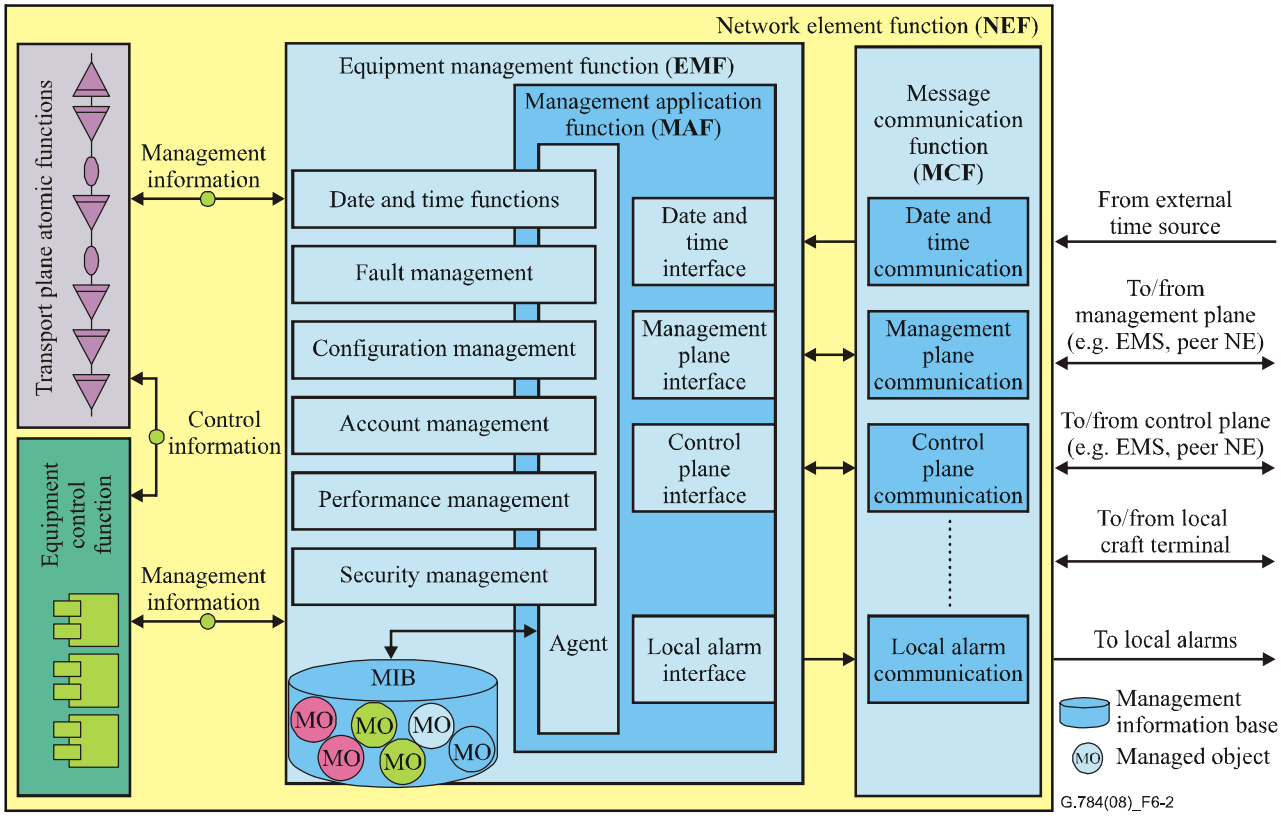


Figure 6-2 – Synchronous equipment management function

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

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

6.3 Information flows over management points (MPs)

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

The information flow over the MP reference points that arises from anomalies and defects detected in the atomic functions is described in specific detail for each atomic function in [ITU-T G.783].

The information flow over the MP reference points that arises from configuration and provisioning data is described in specific detail for each atomic function in [ITU-T G.783]. The information listed under Set refers to configuration and provisioning data that is passed from the SEMF to the atomic functions. The information listed under Get refers to status reports made in response to a request from the SEMF for such information.

As an example, we may consider the higher order path trace. The higher order path termination may be provisioned for the higher order path trace ID that it should expect by a "Set_Rx_HO_path_trace_ID" command received from the manager. If the higher order path trace that is received does not match the expected higher order path trace, this will give rise to a report of

a mismatch of the higher order path trace across the hp_nm reference point. Having received this mismatch indication, the S.NE stores it for access by the manager.

7 Fault (maintenance) management

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

7.1 Fault management applications

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

7.1.1 Supervision

The supervision process describes the way in which the actual occurrence of a disturbance or fault is analysed for the purpose of providing an appropriate indication of performance and/or detected fault condition to maintenance personnel. The supervision philosophy is based on the concepts underlying the functional model of [ITU-T G.805] and [ITU-T G.803] and the alarm reporting function of [ITU-T X.733].

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

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

7.1.1.1 Transmission supervision

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

7.1.1.2 Quality of service supervision

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

7.1.1.3 Processing supervision

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

7.1.1.4 Equipment supervision

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

7.1.1.5 Environment supervision

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

7.1.2 Validation

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

7.1.3 Alarm handling

7.1.3.1 Severity Assignment

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

7.1.3.2 Alarm reporting control

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

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

ALM ALarM reporting; alarm reporting is turned on.

NALM No ALarM reporting; alarm reporting is turned off.

NALM-CD No ALarM reporting, CountDown; this is a sub-state of NALM-QI and performs the persistence timing countdown function when the managed entity is qualified problem free.

NALM-NR No ALarM reporting, NotReady; this is a sub-state of NALM-QI and performs a wait function until the managed entity is qualified problem free.

NALM-QI No ALarM reporting, Qualified Inhibit; alarm reporting is turned off until the managed entity is qualified problem free for a specified persistence interval.

NALM-TI No ALarM reporting, Timed Inhibit; alarm reporting is turned off for a specified timed interval.

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

7.1.3.3 Reportable failures

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

7.1.3.4 Alarm reporting

Alarm surveillance is concerned with the detection and reporting of relevant events and conditions which occur in the network. In a network, events and conditions detected within the equipment and incoming signals should be reportable. In addition, a number of events external to the equipment should also be reportable. Alarms are indications that are automatically generated by an S.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:

– autonomous reporting of alarms;
– request for reporting of all alarms;
– reporting of all alarms;
– allow or inhibit autonomous alarm reporting;
– reporting on request status of allow or inhibit alarm reporting;
– enabling and disabling (via MI_XXX_Reported) the declaration of AIS, RDI and ODI fault causes in the atomic functions. Refer to [ITU-T G.783];
– control of the termination point mode of termination points. Refer to [ITU-T G.783];
– optionally, control of the port mode of termination points. Refer to [ITU-T G.783];
– reporting of protection switch events.

7.1.3.4.1 Local reporting

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

7.1.3.4.2 TMN reporting

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

7.2 Fault management functions

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

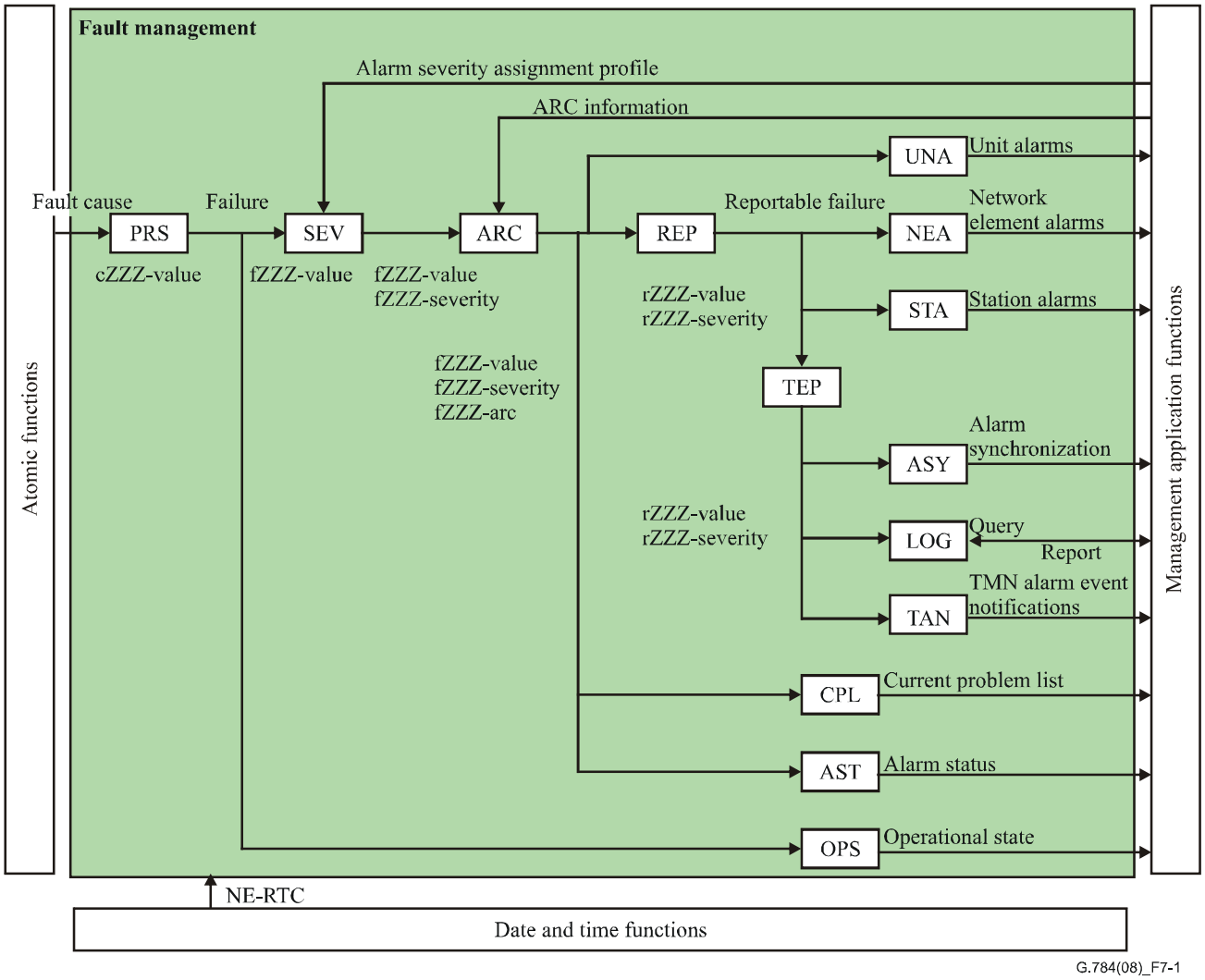


Figure 7-1 – Fault management within the SDH NEF

7.2.1 Fault cause persistency function – PRS

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

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

Symbol

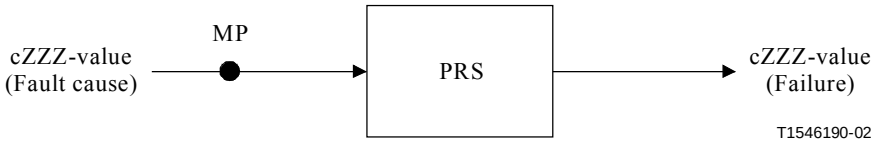


Figure 7-2 – Fault cause persistency function

Inputs and outputs

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

Process (see [ITU-T G.783])	Input	Output
OSn-Xy.z_TT_Sk	cLOS	fLOS
ES1_TT_Sk	cLOS	fLOS
OSn/RSn_A_Sk	cLOF	fLOF
ES1/RS1_A_Sk	cLOF	fLOF
RSn_TT_Sk	cTIM cSSF	fTIM fSSF
MSn_TT_Sk	cEXC cAIS cDEG cRDI cSSF	fEXC fAIS fDEG fRDI fSSF
MSn/Sn_A_Sk	cAIS cLOP	fAIS fLOP
MSnP_C	cFOP	fFOP
MSnP_TT_Sk	cSSF	fSSF
MSnP2fsh_TT_Sk	cSSF	fSSF
MSnP4fsh_TT_Sk	cSSF	fSSF
Sn_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Snm1_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Snm2_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF

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

Process (see [ITU-T G.783])	Input	Output
Sns_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Sn/Sm_A_Sk	cPLM cLOM	fPLM fLOM
Sn/Pqx_A_Sk	cPLM	fPLM
SnP_TT_Sk	cSSF	fSSF
SnD_TT_Sk	cLTC cTIM cUNEQ cDEG cRDI cODI cSSF cIncAIS	fLTC fTIM fUNEQ fDEG fRDI fODI fSSF fIncAIS
SnDm_TT_Sk	cLTC cTIM cUNEQ cDEG cRDI cODI cSSF cIncAIS	fLTC fTIM fUNEQ fDEG fRDI fODI fSSF fIncAIS
SnT_TT_Sk	cUNEQ cDEG cIncAIS	fUNEQ fDEG fIncAIS
SnTm_TT_Sk	cUNEQ cDEG cIncAIS	fUNEQ fDEG fIncAIS
Sn-Xv/Sn-X_A_Sk	cLOM cSQM cLOA	fLOM fSQM fLOA
Sn-X_TT_Sk	cSSF	fSSF
Sn-X_TT_Sk	cTIM cUNEQ cSSF cLOM cSQM cLOA	fTIM fUNEQ fSSF fLOM fSQM fLOA
Sm_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF

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

Process (see [ITU-T G.783])	Input	Output
Smm1_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Smm2_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Sms_TT_Sk	cTIM cUNEQ cEXC cDEG cRDI cSSF	fTIM fUNEQ fEXC fDEG fRDI fSSF
Sm/Pqx_A_Sk	cPLM	fPLM
Sm/Pqs_A_Sk	cPLM	fPLM
SmP_TT_Sk	cSSF	fSSF
SmD_TT_Sk	cLTC cTIM cUNEQ cDEG cRDI cODI cSSF cIncAIS	fLTC fTIM fUNEQ fDEG fRDI fODI fSSF fIncAIS
SmDm_TT_Sk	cLTC cTIM cUNEQ cDEG cRDI cODI cSSF cIncAIS	fLTC fTIM fUNEQ fDEG fRDI fODI fSSF fIncAIS
Sm-X_TT_Sk	cSSF	fSSF
Sm/Sm-X_A_Sk	cLOM cSQM cLOA	fLOM fSQM fLOA

Process

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

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

The specific set of failures associated with each atomic function are listed in Table 7-1.

NOTE – A complementary list is available in [ITU-T M.3100].

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

7.2.2 Severity assignment function – SEV

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

7.2.3 Alarm reporting control function – ARC

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

The alarms that can be controlled with this function are defined for each atomic function in [ITU-T G.783].

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

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

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

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

7.2.4 Reportable failure function – REP

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

7.2.5 Unit alarms function – UNA

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

7.2.6 Network element alarm function – NEA

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

7.2.7 Station alarm function – STA

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

7.2.8 TMN event pre-processing function – TEP

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

7.2.9 Alarm synchronization function – ASY

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

7.2.10 Logging function – LOG

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

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

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

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

7.2.11 TMN alarm event notification function – TAN

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

7.2.12 Current problem list function – CPL

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

7.2.13 Alarm status function – AST

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

7.2.14 Operational state function – OPS

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

8 Configuration management

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

8.1 Hardware

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

8.2 Software

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

8.3 Protection switching

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

8.3.1 Linear STM-N MS protection

The functions which allow the user to provision the configuration of the protection scheme are:

– establishment of protection, indicating the protection switching mode (uni-/bidirectional) operation mode (revertive/non-revertive), extra traffic (supported, not supported), the entities participating in the protection, their role (working/protection), and possibly their priority;
– modification of protection, adding or removing entities and/or modifying their protection characteristics;
– suppression of protection;
– wait-to-restore time;
– SF and SD priority;

This information is conveyed between the EMF and an AF via the MI_SWtype, MI_OPERtype, MI_EXTRAtraffic, MI_WTRtime, MI_SFpriority, MI_SDpriority (see Table 8-1).

Table 8-1 – Linear MSP-related provisioning

MI signal	Value range	Default value
Switching type (MI_SWtype)	Unidirectional, bidirectional	No default defined
Operation type (MI_OPERtype)	Revertive, non-revertive	No default defined
Extra traffic (MI_EXTRAtraffic)	True, false	No default defined
Wait-to-restore time (MI_WTRtime)	0,1,..,12 minutes	5 minutes
Priority of SF and SD conditions in 1:n MSP (MI_SFpriority, MI_SDpriority)	High, low	High

8.3.2 STM-N MS SPring protection

For further study.

8.3.3 Linear 1+1 SNC protection

The functions which allow the user to provision the configuration of the protection scheme are:

– establishment of protection, indicating the operation mode (revertive/non-revertive), SNC protection type (SNC/I, SNC/N), the entities participating in the protection, their role (working/protection);

– modification of protection, adding or removing entities and/or modifying their protection characteristics;

– suppression of protection;

– wait-to-restore time, hold-off time.

This information is conveyed between the EMF and an AF via the MI_OPERtype, MI_WTRtime, MI_HOtime, MI_PROTtype (see Table 8-2).

Table 8-2 – Linear SNCP-related provisioning

MI signal	Value range	Default value
Operation type (MI_OPERtype)	Revertive, non-revertive	Non-revertive
Protection type (MI_PROTtype)	SNC/I, SNC/N	No default defined
Wait-to-restore time (MI_WTRtime)	0,1,..,12 minutes	5 minutes
Hold-off time (MI_HOtime)	0, 100 ms, 200 ms,..,10 s	0

8.3.3.1 Linear 1+1 VC trail protection

The functions which allow the user to provision the configuration of the protection scheme are:

– establishment of protection, indicating the protection operation mode (revertive/non-revertive), the entities participating in the protection, their role (working/protection);

– modification of protection, adding or removing entities and/or modifying their protection characteristics;

– suppression of protection;

– wait-to-restore time, hold-off time.

This information is conveyed between the EMF and an AF via the MI_OPERtype, MI_WTRtime, MI_HOtime (see Table 8-3).

Table 8-3 – Protection-related provisioning

MI signal	Value range	Default value
Operation type (MI_OPERtype)	Revertive, non-revertive	Non-revertive
Wait-to-restore time (MI_WTRtime)	0,1,..,12 minutes	5 minutes
Hold-off time (MI_HOtime)	0, 100 ms, 200 ms,..,10 s	0

8.3.3.2 Status and control

The status and control information is conveyed between the EMF and an AF via the MI_EXTCMD signal (see Table 8-4).

Table 8-4 – Protection-related control provisioning

MI signal	Value range	Default value
External command (MI_EXTCMD)	CLR, LO, FSw, MSw, EXER	None

8.4 Trail termination

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

8.4.1 Provisioning

8.4.1.1 Trail trace identifier

The trail trace identifier (TTI) is defined in the regenerator section layer and the path layer and is transported in the Jx-bytes (x = J0, J1, J2) of the section and path overhead.

The TTI may be used in two different applications for:

– connection verification as defined in the 1999 version of this Recommendation to ensure proper connection between network elements; or

– optionally, if instructed by the management plane, for layer adjacency discovery (LAD) which allows discovery of the association between two TCPs in a particular layer network (see [ITU-T G.7714] for a description of the generalized automatic discovery mechanism). See [ITU-T G.7714.1] for a description of the protocol for automatic discovery in SDH networks and Amendment 1 to [ITU-T G.7714.1] for a description of the usage of the different discovery mechanisms.

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

TTI shall be supported as specified in Table 8-5.

Table 8-5 – Trace identifier related provisioning and reporting

MI signal	Value range	Default value
RSn_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
RSn_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
RSn_TT_Sk_MI_ExTImode	16-byte, 1-byte According to [ITU-T G.783]	16-byte
RSn_TT_Sk_MI_TIMAISdis	True, false	False
RSn_TT_Sk_MI_TIMdis	True, false	True
Sn_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
Sn_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable

Table 8-5 – Trace identifier related provisioning and reporting

MI signal	Value range	Default value
Sn_TT_Sk_MI_ExTImode	16-byte, 1-byte	16-byte
Sn_TT_Sk_MI_TIMAISdis	True, false	False
Sn_TT_Sk_MI_TIMdis	True, false	True
Snm1_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Snm1_TT_Sk_MI_TIMdis	True, false	True
Snm2_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Snm2_TT_Sk_MI_TIMdis	True, false	True
Sns_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
Sns_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Sns_TT_Sk_MI_TIMdis	True, false	True
SnD_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
SnD_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
SnD_TT_Sk_MI_TIMdis	True, false	True
SnDm_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
SnDm_TT_Sk_MI_TIMdis	True, false	True
S4-Xc>S4-Xv_I_MI_TxTI	According to [ITU-T G.707]	Not applicable
S4-Xv>S4-Xc_I_MI_ExTI	According to [ITU-T G.707]	Not applicable
S4-Xv>S4-Xc_I_MI_TIMdis	True, false	True
Sm_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
Sm_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Sm_TT_Sk_MI_TIMAISdis	True, false	False
Sm_TT_Sk_MI_TIMdis	True, false	True
Smm1_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Smm1_TT_Sk_MI_TIMdis	True, false	True
Smm2_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Smm2_TT_Sk_MI_TIMdis	True, false	True
Sms_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
Sms_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
Sms_TT_Sk_MI_TIMdis	True, false	True
SmD_TT_So_MI_TxTI	According to [ITU-T G.707]	Not applicable
SmD_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
SmD_TT_Sk_MI_TIMdis	True, false	True
SmDm_TT_Sk_MI_ExTI	According to [ITU-T G.707]	Not applicable
SmDm_TT_Sk_MI_TIMdis	True, false	True

8.5 Adaptation

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

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

client. The activation/deactivation of adaptation functions is via MI_Active signals. In the case where the access point is connected to only one adaptation function (i.e., it supports only one client signal) the MI_Active signal is fixed as active.

Table 8-6 – Provisioning and reporting for adaptation functions

MI signal	Value range	Default value
MSn/Sn_A_So_MI_Active	True, false	False
MSn/Sn_A_So_MI_pPJE+	FFS	FFS
MSn/Sn_A_So_MI_pPJE–	FFS	FFS
MSn/Sn_A_Sk_MI_Active	True, false	False
MSn/Sn_A_Sk_MI_AIS_Reported	True, false	False
Sn/Sm_A_So_MI_Active	True, false	False
Sn/Sm_A_Sk_MI_Active	True, false	False
Sn/Sm_A_Sk_MI_AcSL	FFS	FFS
Sn/Pqx_A_So_MI_Active	True, false	False
Sn/Pqx_A_Sk_MI_Active	True, false	False
Sn/Pqx_A_Sk_MI_AcSL	FFS	FFS
Sm/Pqx_A_So_MI_Active	True, false	False
Sm/Pqx_A_Sk_MI_Active	True, false	False
Sm/Pqx_A_Sk_MI_AcSL	FFS	FFS
Sm/Pqs_A_So_MI_Active	True, false	False
Sm/Pqx_A_Sk_MI_Active	True, false	False
Sm/Pqs_A_Sk_MI_AcSL	FFS	FFS

8.6 Connection

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

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

The MI signals listed in Table 8-7 are communicated from the EMF to the connection process through the management point.

Table 8-7 – Provisioning and reporting for connection functions

MI signal	Value range	Default value
For connection points W and P: MSnP_C_MI_SFpriority MSnP_C_MI_SDpriority Per function: MSnP_C_MI_SWtype MSnP_C_MI_EXTRAtraffic MSnP_C_MI_WTRTime MSnP_C_MI_EXTCMD	FFS	FFS

Table 8-7 – Provisioning and reporting for connection functions

MI signal	Value range	Default value
MSnP2fsh_CI_MI_EXTRAtraffic MSnP2fsh_CI_MI_NUTraffic MSnP2fsh_C_MI_WTRTime MSnP2fsh_C_MI_EXTCMD MSnP2fsh_C_MI_RingNodeID MSnP2fsh_C_MI_RingMap	FFS	FFS
MSnP4fsh_CI_MI_EXTRAtraffic MSnP4fsh_CI_MI_NUTraffic MSnP4fsh_C_MI_WTRTime MSnP4fsh_C_MI_EXTCMD MSnP4fsh_C_MI_RingNodeID MSnP4fsh_C_MI_RingMap	FFS	FFS
Per input and output connection point: Sn_C_MI_ConnectionPortIds Per matrix connection: Sn_C_MI_ConnectionType Sn_C_MI_Directionality Per SNC protection group: Sn_C_MI_PROTtype Sn_C_MI_OPERtype Sn_C_MI_WTRtime Sn_C_MI_Hotime Sn_C_MI_EXTCMD	FFS	FFS
For connection point P: SnP_C_MI_OPERType SnP_C_MI_WTRTime SnP_C_MI_HOTime SnP_C_MI_EXTCMD	FFS	FFS
Per input and output connection point: Sm_C_MI_ConnectionPortIds Per matrix connection: Sm_C_MI_ConnectionType Sm_C_MI_Directionality Per SNC protection group: Sm_C_MI_PROTtype Sm_C_MI_OPERtype Sm_C_MI_WTRtime Sm_C_MI_HOtime Sm_C_MI_EXTCMDODUk_C_MI_MatrixControl	FFS	FFS
For connection point P: SmP_C_MI_OPERType SmP_C_MI_WTRTime SmP_C_MI_HOTime SmP_C_MI_EXTCMD	FFS	FFS

The EMF shall support the following functions:

– provisioning of the connection management information;

– retrieving the connection management information;

– notifying the changes of the connection management information.

8.7 EXC/DEG thresholds

The thresholds of Poisson-based excessive and degraded defect detector processes, and the threshold and monitor period of the burst-based degraded defect process require provisioning. This information is communicated between the EMF and an AF via the MI_EXC_X, MI_DEG_X (Poisson case) and MI_DEGTHR, MI_DEGM (burst case) signals (see Table 8-8).

Table 8-8 – Error defect detection-related provisioning

MI signal	Value range	Default value
Poisson-based excessive defect threshold selection (MI_EXC_X)	10^{-3},10^{-4}, 10^{-5}	10^{-3}
Poisson-based degraded defect threshold selection (MI_DEG_X)	10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}	10^{-6}
Burst-based degraded defect interval threshold selection (MI_DEGTHR)	0..100% or 0..N EBs (Note)	SES threshold
Burst-based degraded defect monitor period selection (MI_DEGM)	2..10	7
NOTE – The granularity for the degraded defect threshold selection is for further study. See [ITU-T G.783].		

The granularity of these signals is outside the scope of this Recommendation. Examples are:

– global per network element;

– global per network layer in the network element;

– global per server/aggregate signal in the network element;

– individual per trail/signal in the network element.

The two extremes are "provisioning per individual signal" and "provisioning per network element". The first example offers full flexibility with relatively high complexity in equipment and in management. The second example offers low complexity in equipment and in management with very limited flexibility.

An equipment will support one or more of these options depending on the intended application of the equipment in the network.

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

8.8 Port mode and TP mode

The TPmodes and Portmodes (see [ITU-T G.783]) of trail termination sink functions (i.e., the end-to-end path termination, non-intrusive monitor, supervisory-unequiped termination, end-to-end tandem connection termination, and tandem connection non-intrusive monitor) require provisioning. This information is communicated between the EMF and an AF via the MI_Portmode and/or MI_TPmode signals (see Table 8-9).

When supported, the Portmode may change automatically from AUTO state to MON state on clearing of the port's LOS defect.

Table 8-9 – Port and termination point mode-related provisioning

MI signal	Value range	Default value
Port mode control (MI_Portmode)	MON, (AUTO), NMON	AUTO (if supported) otherwise NMON
Termination point mode control (MI_TPmode)	MON, NMON	NMON

8.9 XXX_Reported

The reporting of the following defects is an option: AIS, RDI, ODI. These defects are "secondary defects" in that they are the result of a consequent action on a "primary defect" in another network element. This is controlled by means of the parameters MI_AIS_Reported, MI_RDI_Reported and MI_ODI_Reported (see Table 8-10).

Table 8-10 – Consequential defect/failure related provisioning

MI signal	Value range	Default value
MI_AIS_Reported	True, false	False
MI_RDI_Reported	True, false	False
MI_ODI_Reported	True, false	False

See also clause 8.8 of [ITU-T G.7710] for the generic requirements.

8.10 Alarm severity

See clause 8.9 of [ITU-T G.7710] for a description of alarm severity.

8.11 Alarm reporting control (ARC)

See clause 8.10 of [ITU-T G.7710] for a description of alarm reporting control.

8.12 PM thresholds

See clause 8.11 of [ITU-T G.7710] for a description of PM thresholds configuration.

8.13 TCM activation

See clause 8.12 of [ITU-T G.7710] for a description of TCM activation configuration.

8.14 Synchronization provisioning and reporting

The management access (provisioning and reporting) to the synchronization atomic functions supported by the S.NEs is defined in [ITU-T G.781] and [ITU-T G.783].

8.15 Date and time

See clause 8.13 of [ITU-T G.7710] for the generic requirements.

8.15.1 Date and time applications

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

– time-stamping;
– real time clock alignment with external time reference;
– performance monitoring clock signals;
– activity scheduling.

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

8.15.1.1 Time-stamping

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

8.15.1.2 Performance monitoring clock signals

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

8.15.1.3 Activity scheduling

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

8.15.2 Date and time functions

See [ITU-T G.7710] for a description of the date and time functions.

9 Account management

Account management is for further study.

10 Performance management

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

NOTE – This clause defines the performance monitoring-related equipment specifications based on the network level specifications in [ITU-T M.2100], [ITU-T M.2101], [ITU-T M.2120], [ITU-T G.826] and [ITU-T G.827].

10.1 Performance management applications

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

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

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

10.1.2 Maintenance

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

10.1.3 Bringing-into-service

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

10.1.4 Quality of service

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

10.1.5 Availability

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

10.1.6 Reporting

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

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

Performance data stored in the S.NE may be collected by the OS for analysis without affecting the content of the register.

Performance data shall be reportable across the NE/OS interface on demand when requested by the OS.

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

Data collection may be performed periodically to support trend analysis to predict future failure or degraded conditions. On request of the OS, performance data of specific ports shall be reportable periodically.

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.

10.1.6.1 Performance data collection

Counter-based performance data collection refers to the measurement counting associated with each of the performance measurements (BBE, ES, SES as defined in [ITU-T G.826]), and any additional performance parameter defined in this Recommendation.

Two types of performance data collection are defined:

– The collection as specified in [ITU-T 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 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.

When performance data is collected for maintenance purposes, counts are taken over fixed time periods of 15 minutes and 24 hours. Counting is stopped during unavailable time (see 10.1.6.1.1).

When performance data is collected for error performance assessment purposes, counts are taken over fixed time periods of 24 hours only. Counting is stopped during unavailable time (see 10.1.6.1.1).

It shall be possible to reset an individual current register to zero by means of an external command. The modularity of this command shall be as specified in [ITU-T G.774.1] and [ITU-T G.774.6].

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 are 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 S.NE or in mediation devices associated with the S.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[1].

10.1.6.1.1 Performance data collection during unavailable time

The onset and exit of unavailable time is defined in Annex A of [ITU-T G.826] and in [ITU-T M.2120].

Performance monitoring event counting for ES, SES and BBE shall be inhibited during unavailable time:

– In the performance data collection process for maintenance purposes, the unavailability of a single direction (see clause A.1 of [ITU-T G.826]) shall inhibit the counting for that direction only.

– In the performance data collection process for error performance assessment purposes, the unavailability of the bidirectional path (see clause A.2 of [ITU-T G.826]) shall inhibit the counting for both directions simultaneously.

10.1.6.1.2 Availability data collection

When a period of unavailability occurs, the beginning and ending of this period should be stored in a log in the S.NE and, as a consequence, time stamped. The time stamp shall contain day, month, year, hour, minute, second information (refer to clause 5.3.8.2 of [ITU-T M.2120]).

The S.NE should be able to store these data in a log (see [ITU-T G.774.1]).

NOTE – The information in a log is not restricted to a single 24-hour period. For example, a log may contain periods of unavailability which are on the same day or on different days.

As an option, an additional unavailable second (UAS) count may be provided. Each second in unavailable time is defined to be an unavailable second. UASs are counted in 15-minute and in 24-hour counters.

In the performance data collection process for maintenance purposes, UAS counters exist per direction.

In the performance data collection process for error performance assessment purposes, only one UAS counter for both directions exists.

If a ten-second qualifying period preceding the entry/exit of unavailability spans a register boundary, unavailability shall be entered/exited independently of the register boundary. This shall result in the entry/exit of unavailability, and associated inhibiting, at the beginning of the ten-second qualifying period.

[1] This implies that all 24-hour data is discarded after 24 hours.

The entry case is illustrated by:

Period A	Period B
- - - x_1 x_2 x_3 x_4	x_5 x_6 x_7 x_8 x_9 x_{10} x_{11} x_{12}

Register boundary

"x" = SES, "-" = non-SES, x_1 to x_4 are in UAS register for period A, x_5 to x_{12} are in UAS register for period B.

10.1.6.2 History storage suppression

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

10.1.7 Thresholding

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

Specific information is contained in [ITU-T M.2101] and [ITU-T M.2120]. The thresholding mechanism is applicable only for the maintenance-based collection.

10.1.7.1 Threshold setting

The thresholds may be set in the S.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 with a range between 0 and a maximum value specified hereafter.

The maximum values for the number of measurements are[2]:

– 900 for the ES and SES measurements;

– $2^{16} – 1$ for the BBE event in the case of VC-11 up to VC-4 paths;

– $2^{24} – 1$ for the BBE event in the case of contiguous concatenated VC-4-Xc and STM-N ($X \leq 16$ and $N \leq 16$);

– $2^{16} – 1$ for each positive and negative counts of AU PJE.

The maximum values for the number of measurements evaluated over the 24-hour period shall be $2^{16} – 1$. The threshold value should be programmable between 0 and $2^{16} – 1$.

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.

---

[2] The maximum values for BBE events for VCs and STM-Ns is smaller than the maximum number of BBEs that could theoretically be detected in a 15-minute period.

10.1.7.3 Evaluation for counters

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

10.1.7.4 Evaluation for gauges

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

10.1.8 Additional monitored events

Additional counts such as OFS, AU PJE, CSES, ESA, ESB and FC may be useful. Their implementation is optional (see Table 10-1). The OFS, AU PJE, ESA, ESB, and FC event counts may be stored in 15-minute and 24-hour registers, as detailed in clause 10.1.6.

The out-of-frame second (OFS) is declared when the STM-N frame alignment process is in the OOF state at least once in the second. Refer to [ITU-T G.783]. The AF communicates this via the MI_pOFS signal to the EMF.

If AU PJE counters are provided, then positive and negative PJEs shall be counted separately on one selectable AU within an STM-N signal, after the AU has been resynchronized to the local clock. Refer to [ITU-T G.783]. The number of positive and negative outgoing PJEs per second is communicated from the AF to the EMF via the MI_pPJE+ and MI_pPJE– signals.

The CSES event occurs when a sequence that contains X or more consecutive SES is detected. The sequence is terminated by an unavailable period or when a second that is not an SES is encountered. The S.NE should be able to store these time-stamped CSES data in a log (see [ITU-T G.774.1]); the time stamp shall indicate the time of the first SES in the sequence. The value of X may be configured by an OS in the range of 2 to 9. When a sequence of consecutive SESs is terminated by the entry into an unavailable period, the CSES event is not recorded.

The following PM parameters may also be provided: errored seconds type A (ESA), errored seconds type B (ESB) and failure counts (FC). These parameters are defined in Annex A, and their implementation is optional per country.

ESA and ESB can be used in addition to errored seconds (ESs) to delineate dribbling error patterns from short burst error patterns. At international boundaries, they are only used if there is mutual agreement among the network operators involved to provide these parameters, and if the participating countries also support them.

Failure counts can be used to determine whether a UAS or SES count is the result of a single failure or multiple failures. At international boundaries, it is only used if there is mutual agreement among the network operators involved to provide this parameter, and if the participating countries also support it.

Table 10-1 – SDH additional monitored events

Monitored events	RS	MS	Path higher order VC	Path lower order VC
OFS	O			
CSES	O	O	O	O
AU PJE			O	
ESA		OC	OC	OC

Table 10-1 – SDH additional monitored events

Monitored events	RS	MS	Path higher order VC	Path lower order VC
ESB		OC	OC	OC
FC		OC	OC	OC

O	Optional
OC	Optional per Country and per Carrier
AU PJE	Administrative Unit Pointer Justification Event
OFS	Out-of-Frame Second
CSES	Consecutive SES counts configurable in the range of 2 to 9 SES
ESA	Errored Seconds type A
ESB	Errored Seconds type B
FC	Failure Counts

10.1.9 Performance monitoring resource assignment

Performance monitoring within a network element is a set of processes that can be completely absent, 100% present, or available for a limited percentage. Figure 10-1 illustrates that:

– there is the set of trail termination sink functions within the network element (shown at the left side of the figure);

– a (sub)set of the termination sink functions is connected with the performance monitoring resource assignment function (a kind of "connection" function);

– there is a set of performance monitoring processes (right side of the figure) within the network element;

– within the limitations of this network element, connections can be made and removed between termination sink functions and performance monitoring processes.

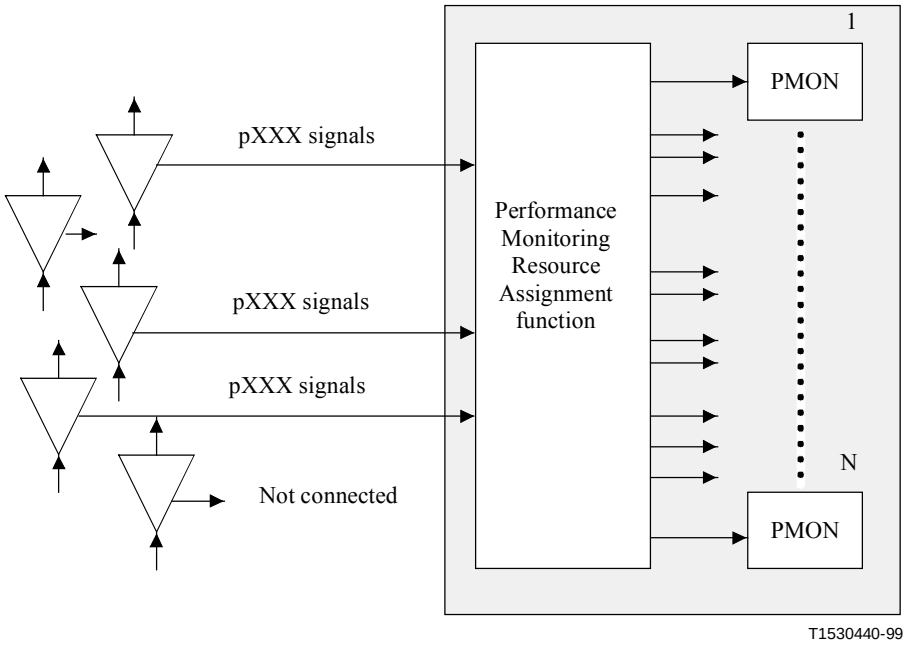


Figure 10-1 – Performance monitoring resource assignment

Several types of performance monitoring processing are specified differing in characteristics such as: unidirectional or bidirectional, near-end or far-end, terminating node or intermediate node. The SEMF may support one or more of these types.

10.2 Performance monitoring functions

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

11 Security management

For further study.

Annex A

Definitions of errored seconds types A and B and failure counts

(This annex forms an integral part of this Recommendation)

A.1 Introduction

This annex provides definitions of the following optional performance management parameters: errored seconds type A (ESA), errored seconds type B (ESB) and failure counts (FC).

A.2 Errored seconds types A and B

The optional ESA and ESB parameters can be used in addition to errored seconds (ES) and severely errored seconds (SESs) to help maintain quality of service by delineating dribbling error patterns from short burst error patterns. ESA and ESB separate errored seconds that have one error from those that have more than one error (but not enough errors to become SES). Two applications of ESA and ESB are provided below.

Example 1: Proactive maintenance

To provide high quality service to customers, extra maintenance measures need to be employed. Waiting until a facility fails outright does not satisfy customers in general. Different types of facilities have distinct failure and error patterns, and in many cases the failures occur only after a protracted period of errored seconds. By monitoring these ESA, ESB and SES occurrences, and knowing the failure signature of a given facility, maintenance of the system can be scheduled in a timely manner well in advance of a hard failure.

Example 2: Work lists

There are often more facility problems that occur than the available maintenance technical force can handle. Thus, a means is needed to determine which facility problems are worked first. The analysis of ESA, ESB and SES provides one of these means. For example, given two facilities with errors, one with type A and the other with type B, a technician would select the facility with type B errors to repair first because it is causing a more degraded service to a customer than the system with type A errored seconds.

Definitions

ESA and ESB for both multiplex sections and VC path layers are defined below.

Errored seconds type A (ESA): This parameter is a count of the 1-second intervals containing a single errored block, and none of the specific defects listed below:

– OOF, LOS for regenerator sections.
– AIS for multiplex section near-end.
– RDI for multiplex section far-end.
– AIS, LOP for higher order and lower order virtual containers.
– RDI for higher order and lower order virtual containers.

Errored seconds type B (ESB): This parameter is a count of the 1-second intervals containing more than a single errored block, less than the number of errored blocks that is required to declare an SES, and none of the specific defects listed below:

– OOF, LOS for regenerator sections.
– AIS for multiplex section near-end.
– RDI for multiplex section far-end.

– AIS, LOP for higher order and lower order virtual containers.

– RDI for higher order and lower order virtual containers.

These two parameters follow the same rules as ESs with regard to count increments during unavailable time.

A.3 Failure counts

The optional failure counts are used to determine whether a UAS or SES count is the result of a single failure or multiple failures. For example, during a 15-minute interval, 600 s of unavailable time are counted, and the failure count indicates 20 failures. In such a scenario, because the unavailable time is not due to a single failure, the maintenance craft considers the failure as more severe, and generally takes a more time-consuming fault analysis approach.

Definitions

The failure counts and the corresponding failure events for both multiplex section and VC path layers are defined below.

Near-end failure count: This parameter is a count of the number of occurrences of near-end failure events, and is incremented by one each time a near-end failure event begins.

As an example, MS near-end failure events begin when an MS-AIS is declared, and path near-end failure events begin when a LOP or path-AIS is declared.

Far-end failure count: This parameter is a count of the number of occurrences of far-end failure events, and is incremented by one each time an RDI event begins.

Failure counts are incremented during unavailable time.

Appendix I

Management information for CM

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

Regarding configuration management, the SDH network elements can be configured via the following management information (MI) signals that are defined per atomic function in [ITU-T G.783]:

– <atomic function name>_MI_AcSL
– <atomic function name>_MI_AcSQ[1..X]
– <atomic function name>_MI_AcTI
– <atomic function name>_MI_AcTI[1..X]
– <atomic function name>_MI_Active
– <atomic function name>_MI_AIS_Reported
– <atomic function name>_MI_ConnectionPortIds
– <atomic function name>_MI_ConnectionType
– <atomic function name>_MI_Directionality
– <atomic function name>_MI_EXTCMD
– <atomic function name>_MI_ExTI
– <atomic function name>_MI_ExTI[1..X]
– <atomic function name>_MI_ExTImode
– <atomic function name>_MI_EXTRAtraffic
– <atomic function name>_MI_HOtime
– <atomic function name>_MI_NUTraffic
– <atomic function name>_MI_ODI_Reported
– <atomic function name>_MI_OPERType
– <atomic function name>_MI_PortMode
– <atomic function name>_MI_PROTtype
– <atomic function name>_MI_RDI_Reported
– <atomic function name>_MI_RingMap
– <atomic function name>_MI_RingNodeID
– <atomic function name>_MI_SDpriority
– <atomic function name>_MI_SFpriority
– <atomic function name>_MI_SSF_Reported
– <atomic function name>_MI_SWtype
– <atomic function name>_MI_TIEn
– <atomic function name>_MI_TIMAISdis
– <atomic function name>_MI_TIMdis
– <atomic function name>_MI_TIMdis[1..X]
– <atomic function name>_MI_TPmode
– <atomic function name>_MI_TxTI
– <atomic function name>_MI_TxTI[2..X]
– <atomic function name>_MI_WTRtime

Appendix II

Management information for PM

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

Regarding performance management, the SDH network elements can be configured via the following management information (MI) signals that are defined per atomic function in [ITU-T G.783]:

– <atomic function name>_MI_1second
– <atomic function name>_MI_DEG_X
– <atomic function name>_MI_DEGM
– <atomic function name>_MI_DEGTHR
– <atomic function name>_MI_Delay
– <atomic function name>_MI_EXC_X
– <atomic function name>_MI_FEC
– <atomic function name>_MI_M0_Generated
– <atomic function name>_MI_M0_ignored
– <atomic function name>_MI_M1_ignored

Regarding performance management, the SDH network elements can provide the performance data via the following management information (MI) signals that are defined per atomic function in [ITU-T G.783]:

– <atomic function name>_MI_pF_DS
– <atomic function name>_MI_pF_EBC
– <atomic function name>_MI_pFDS
– <atomic function name>_MI_pFEBC
– <atomic function name>_MI_pN_DS
– <atomic function name>_MI_pN_EBC
– <atomic function name>_MI_pNDS
– <atomic function name>_MI_pNEBC
– <atomic function name>_MI_pOF_DS
– <atomic function name>_MI_pOF_EBC
– <atomic function name>_MI_pOFS
– <atomic function name>_MI_pON_DS
– <atomic function name>_MI_pON_EBC
– <atomic function name>_MI_pPJE–
– <atomic function name>_MI_pPJE+

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