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TMN MANAGEMENT FUNCTIONS

Recommendation M.3400

FOREWORD

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CCITT NOTE

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

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TMN MANAGEMENT FUNCTIONS

(1992)

Abstract

A TMN management function is the smallest part of the TMN management service as perceived by the user of the service. In reality it will generally consist of a sequence of actions on a defined managed object or objects.

TMN management functions specified in this Recommendation provide both the generic and specialized functionalities needed for all telecommunication activities (identified at this time) such as:

– circuit testing;
– alarm surveillance;
– traffic management, etc.

Keywords

– TMN management function;
– OSI systems management function.

1 General

A TMN management function is the smallest part of the TMN management service as perceived by the user of the service. In reality it will generally consist of a sequence of actions on a defined managed object or objects.

1.1 *Relationship to Recommendations M.3200* [15] *and M.3100* [16]

Recommendation M.3200 [15] contains a list of TMN management functions required to support a TMN management service. Recommendation M.3100 [16] describes the generic information model required to support TMN management functions. Detailed information on these relationships is provided in Recommendation M.3020 [17].

1.2 *Introduction*

A TMN is intended to support a wide variety of management functions which cover the planning of operations, administration, maintenance and provisioning of telecommunication networks and services.

These four categories have different meanings depending on the organization of an Administration. Moreover, some of the information which is exchanged over the TMN may be used in support of more than one management category. Therefore, the classification of the information exchange within the TMN is independent of the use that will be made of the information.

While it cannot claim to be complete, this section describes some of the most important management functions in terms of the OSI Management Functional Areas, expanded to fit the need of a TMN.

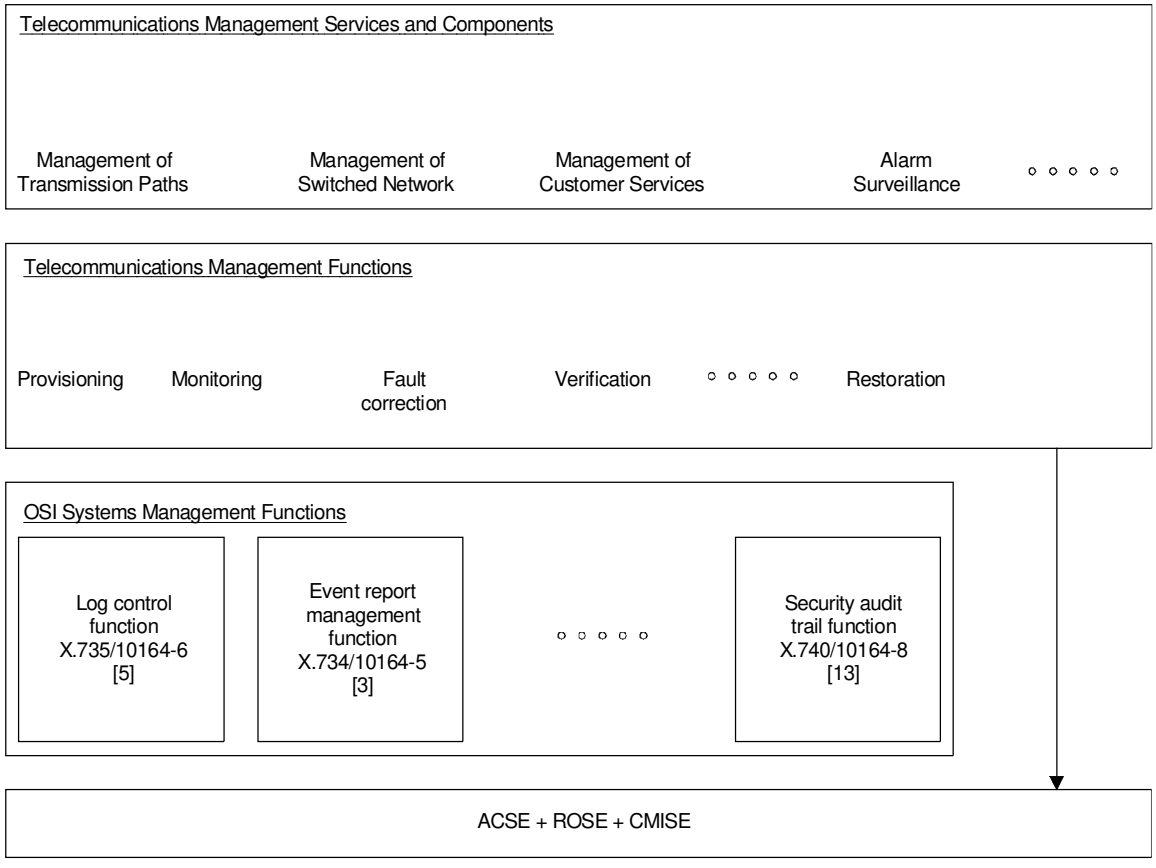
The management functions have been classified according to the field of use into five management functional areas (MFAs):

1) Performance management;
2) Fault (or maintenance) management;
3) Configuration management;
4) Accounting management;
5) Security management.

It should be noted that the functional configuration of the TMN will change depending on the phases in the life cycle and the momentary status of the related telecommunications equipment.

The management functions are not intended as requirements for any NE or TMN. Each function in the list is there because it may be necessary for some implementation of a related application. Some functions will be appropriate for a certain implementation of an interface application, but unnecessary or inconvenient for others.

The TMN approach is to standardize the interactions that can occur between those parts of management services that reside in different end systems. The part of a management service that resides in a single end system is called a management process. The management service must be able to perform the functions necessary to communicate any information the management processes need to convey to a remote peer. Therefore, the form and content of the management functions are fully dependent on the needs of the management process using these functions. Figure 1/M.3400 shows the relationships between TMN management services, components and functions.



ACSE Association Control Service Element
ROSE Remote Operation Service Element
CMISE Common Management Information Service Element

FIGURE 1/M.3400

Relationship between TMN management services and functions

The additional functionalities that have been identified in this figure include communications protocols and services, and OSI system management functions (SMFs). The OSI SMFs provide general management functionalities, such as alarm reporting or test management, which can be used for the specific management services. The mapping between specific OSI SMFs and individual TMN management functions (e.g. those SMFs which are used to fully or partly support/provide a management function) is for further study. Therefore, very short descriptions of the relevant OSI SFMs, along with proper references, are included in the Annex A.

The TMN Management functions specified in this Recommendation provide both generic and specialized functionalities needed for all telecommunications activities (identified at this time) such as circuit testing, alarm surveillance, traffic management etc., TMN management services are applicable for specific telecommunications areas such as exchange maintenance, traffic management, etc., and they are defined in Recommendation M.3200 [15].

1.3 *Object-oriented paradigm*

International standards for management of open systems, telecommunications networks and telecommunications services are based on object oriented techniques. Recommendation M.3010 [18] defines applicability of this approach to TMN principles and architecture.

2 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 statistical data for the purpose of monitoring and correcting the behaviour and effectiveness of the network, NE or equipment and to aid in planning and analysis. As such, it is carrying out the performance measurement phase of Recommendation M.20 [19].

A TMN collects Quality of Service (QOS) data from NEs and supports the improvements in QOS. The TMN may request QOS data reports to be sent from the NE, or such a report may be sent automatically on a scheduled or threshold basis. At any time, the TMN may modify the current schedule and/or thresholds. Reports from the NE on QOS data may consist of raw data which is processed in a TMN, or the NE may be capable of carrying out analysis of the data before the report is sent.

Quality of Service includes monitoring and recording of parameters relating to

– connection establishment (e.g. call set up delays, successful and failed call requests);

– connection retention;

– connection quality;

– billing integrity;

– keeping and examining of logs of system state histories;

– cooperation with fault (or maintenance) management to establish possible failure of a resource and with configuration management to change routing and load control parameters/limits for links etc.;

– initiation of test calls to monitor QOS parameters.

In general, Performance Management must provide tools to perform the following tasks:

– Performance monitoring;

– Performance control;

– Performance analysis.

2.1 *Performance Monitoring (PM)*

PM involves the continuous collection of data concerning the performance of the NE. Acute fault conditions will be detected by alarm surveillance methods. Very low rate or intermittent error conditions in multiple equipment units may interact resulting in poor service quality and may not be detected by alarm surveillances. Performance monitoring is designed to measure the overall quality, using monitored parameters in order to detect such degradation. It may also be designed to detect characteristic patterns before signal quality has dropped below an acceptable level.

The basic function of performance monitoring is to track system, network or service activities in order to gather the appropriate data for determining performance.

2.1.1 *Generic functions*

1) *Request PM data* – TMN request the NE to send current PM data.

2) *PM data report* – NE sends performance data to the TMN. It may be generated routinely by the NE, sent upon demand by the TMN or by exception when a parameter threshold has been exceeded.

3) *Start/stop PM data* – TMN directs the NE to start/stop the collection of PM data.

4) *Initialize PM data* – TMN directs NE to reset storage registers for PM data.

2.1.2 *Traffic status monitoring functions*

These functions provide current status of the network and its major elements. Current status may be reported to the operator directly by the NE, or may be provided to the operator by an Operations System (OS), which collects the status information from one or more NEs.

1) *Report the service availability of NEs* – This function provides the service availability status of the exchange and its major components and processors, common channel signalling systems, interface equipment and other major exchange equipment units. Such reports may be generated automatically, or in response to an operator request.

2) *Report the status of controls on demand* – This function provides the current status of traffic controls which have been applied by the operator, and automatic controls which have been established by the operator and applied by the exchange.

3) *Report the busy/idle status of circuit groups* – This function automatically reports the current busy/idle status of circuit groups for display on a terminal or other device.

4) *Report the congestion status of exchanges* – This function automatically reports the current congestion status of exchanges for display on a terminal or other device.

5) *Report the receipt of automatic congestion control signals* – This function provides current information on the hard-to-reach status of network destinations. Such information can be based on information received from distant exchanges or on information developed locally in the exchange.

6) *Manually add/remove hard-to-reach status of destinations* – This function allows an operator to manually assign or remove HTR status to destinations, and to override automatic HTR designations.

7) *Report the congestion status of the common channel signalling network* – This function automatically reports the current congestion status of the common channel signalling network for display on a terminal or other device.

8) *Report the receipt of common channel signalling network management signals* – This function provides an indication that a common channel signalling network management signal has been received by the exchange, including the identity of the signalling point for which the signal relates, the type of signal and the time of its receipt.

2.1.3 *Traffic performance monitoring functions*

These functions relate to the assessment of the current performance of the network and the traffic being offered and carried. Performance monitoring may be performed directly with the exchange or by an operations system which provides these functions with one or more NEs.

1) *Report circuit group data and parameters on a scheduled basis* – This function involves the reporting of circuit group traffic data and calculated network management parameters automatically according to a schedule.
2) *Report circuit group data and parameters on demand*[1)] – This function involves the reporting of circuit group traffic data and calculated Network Monitoring parameters in response to an operator request.
3) *Report exchange load measurements on a scheduled basis* – This function involves the reporting of measurements of the traffic load on the exchange and its major components according to a schedule.
4) *Report exchange load measurements on demand*[1)] – This function involves the reporting of measurements of traffic load on the exchange and its major components in response to an operator request.
5) *Report exchange congestion on a scheduled basis* – This function involves the reporting of measurements of exchange switching congestion according to a schedule.
6) *Report exchange congestion measurements on demand*[1)] – This function involves the reporting of measurements of exchange switching congestion in response to an operator request.
7) *Report common channel signalling network load measurements on a scheduled basis* – This function involves the reporting of measurements of CCSS traffic according to a schedule.
8) *Report common channel signalling network load measurements on demand*[1)] – This function involves the reporting of CCSS traffic measurements in response to an operator request.
9) *Report common channel signalling network congestion measurements on a scheduled basis* – This function involves the reporting of CCSS network congestion measurements according to a schedule.
10) *Report common channel signalling network congestion measurements on demand*[1)] – This function involves the reporting of CCSS congestion measurements in response to an operator request.
11) *Report data on the performance of controls on a scheduled basis* – This function involves the reporting of data on traffic affected by network management controls according to a schedule.
12) *Report data on the performance of controls on demand*[1)] – This function involves the reporting of data on traffic affected by network management controls in response to an operator request.

2.2 *Performance management control*

2.2.1 *Generic functions*

1) *Schedule Performance Monitoring (PM) data report* – TMN directs NE to establish a schedule for the reporting of PM data.
2) *Request PM data report schedule* – TMN directs NE to send the current PM data reporting schedule. NE responds with the schedule.

[1)] The function of reporting information on demand includes, by implication, the function of requesting the information. However, the request function is not shown for reasons of clarity.

3) *Set PM attributes* – TMN directs NE to assign designated values to PM attributes.

4) *Request PM attributes* – TMN requests NE to send current PM attributes.

5) *PM attributes report* – NE sends the currently assigned PM attributes to TMN.

6) *Set PM thresholds* – TMN directs NE to set or change the PM parameter threshold.

7) *Request PM thresholds* – TMN directs NE to send the current PM threshold.

8) *Schedule QOS test calls* – TMN directs NE to establish a schedule for the execution of QOS test calls.

9) *Request QOS test call schedule* – TMN directs NE to send the current QOS test call schedule.

10) *QOS test call report* – NE reports to TMN the result of QOS test calls. It may be sent on demand by TMN or on a scheduled basis.

11) *Set QOS rest call attributes* – TMN directs NE to set or change the attributes of QOS test calls.

12) *Start/stop QOS test calls* – TMN directs NE to start or stop sending test calls.

13) *Initialize QOS test calls* – TMN directs NE to reset the storage registers for test calls.

14) *Request QOS test call attributes* – TMN directs NE to send the current QOS test call attributes.

2.2.2 *Traffic control functions*

These functions relate to application, modification and removal of manual and automatic network management traffic controls. Manual controls may be manipulated by the operator directly with the exchange under control, or through an operations systems which interfaces with one or more exchanges. Automatic controls are applied automatically by the exchanges according to the operating parameters of the control. Operators may intervene either directly or through an operations system to establish, modify, remove or override an automatic control.

1) *Apply/modify/remove a manual control* – This function involves the manipulation of manual network management traffic controls by an operator.

2) *Establish/modify/remove an automatic control* – This function involves the manipulation of automatic network management traffic controls by an operator.

3) *Apply/modify/remove a special recorded announcement* – This function involves the operator functions necessary to establish a special recorded announcement and to specify the type of traffic which is to be routed to the special announcement.

2.2.3 *Traffic administrative functions*

These are functions and activities in the exchange and operations system which relate to the support of the network management function.

1) *Establish/change/remove a measurement schedule* – This function relates to the manipulation by the operator of the traffic measurement schedules in the exchange or operations system which set the type of measurements to be made, the periodicity of the measurements and the objects and entities for the measurements.

2) *Establish/update a network management data base* – This function relates to the establishment and updating of a data base in the exchange or operations system of network statistics and information necessary to perform the network management function.

3) *Establish/change/remove thresholds for status reporting, data reporting and H'TR determination* – This function involves the establishment and on-going maintenance by the operator of the values for the various thresholds in the exchange or operations system for data calculation and reporting, status reporting and automatic control activation.

4) *Establish/change/remove schedules for status and data reporting* – This function relates to the establishment and on-going maintenance by the operator of the schedules in the exchange or operations systems for the reporting of status and network performance data.

5) *Report routing table information on demand*[2] – This function involves the reporting to the operator of routing table information which resides in the exchange of operations system in response to an operator request.

2.3 *Performance analysis*

Performance data may require additional processing and analysis in order to evaluate the performance level of the entity.

2.3.1 *Generic functions*

– Report PM analysis;

– Request PM analysis.

3 Fault (or Maintenance) management

Fault (or maintenance) 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 Recommendation M.20 [19].

3.1 *Alarm surveillance*

A TMN provides the capability to monitor NE failures in near real time. When such a failure occurs, an indication is made available by the NE. Based on this, a TMN determines the nature and severity of the fault. For example, it may determine the effect of the fault on the services supported by the faulty equipment. This can be accomplished in either of two ways: a data base within a TMN may serve to interpret binary alarm indications from the NE, or if the NE has sufficient intelligence, it may transmit self-explanatory messages to a TMN. The first method requires little of the NE beyond a basic self-monitoring capability. The second method requires additionally that both the NE and a TMN support some type of message syntax which will allow adequate description of fault conditions.

3.1.1 *NE Alarm reporting functions*

This section describes the NE Alarm reporting functions.

1) *Report Alarm* – NE notifies TMN of alarm information upon the occurrence of an alarm.

2) *Route Alarm Report* – TMN specifies to the NE the destination address(es) for a specified set of alarm reports.

3) *Request Alarm Report Route* – TMN requests NE to send the current assignment of the destination address(es) for a specified set of alarm reports; NE responds with the current assignment of destination address(es).

4) *Condition Alarm Reporting* – TMN instructs the NE to assign Event Forwarding Discriminator attributes as specified by the TMN.

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[2] The function of reporting information on demand includes, by implication, the function of requesting the information. However, the request function is not shown for reasons of clarity.

5) *Request Alarm Report Control Condition* – TMN requests NE to send the current assignment of specified Event Forwarding Discriminator attributes; NE responds with the current assignment of the specified attributes.

6) *Allow/Inhibit Alarm Reporting* – TMN instructs the NE to allow/inhibit/ alarm reports to the TMN.

7) *Request Alarm History* – TMN requests the NE to send specified alarm information history; NE responds with the specified information.

3.1.2 *NE Alarm summary functions*

This section describes the Alarm summary functions.

1) *Report Current Alarm Summary* – NE provides TMN (based on a pre-defined schedule) with a Current Alarm Summary.

2) *Route Current Alarm Summary* – TMN specifies to the NE the destination address(es) for a specified set of Current Alarm Summaries.

3) *Request Current Alarm Summary Route* – TMN requests NE to send the current assignment of the destination address(es) for a specified set of Current Alarm Summaries; NE responds with the current assignment of destination address(es).

4) *Schedule Current Alarm Summary* – TMN specifies a schedule for the NE to establish for the reporting of Current Alarm Summaries. The schedule information specifies what should be reported as well as when it should be reported.

5) *Request Current Alarm Summary Schedule* – TMN requests NE to send the current schedule information for Current Alarm Summary reporting; NE responds with the schedule information.

6) *Allow/Inhibit Current Alarm Summary* – TMN instructs the NE to allow/inhibit reporting of the scheduled Current Alarm Summaries.

7) *Request Current Alarm Summary* – TMN requests the NE to send a Current Alarm Summary; NE responds with the summary. This function allows a NE to report alarm conditions of specified resources (severity, status, cause, etc.).

3.1.3 *NE Alarm event criteria functions*

This section describes the Alarm event criteria functions.

1) *Condition Alarm Event Criteria* – TMN instructs the NE to assign specified alarm attributes (e.g. thresholds, etc.) used by the NE to determine if an event is to be considered an alarm.

2) *Request Alarm Event Criteria* – TMN requests NE to report the current assignments of specified attributes (e.g. thresholds, etc.) used to determine if an event is to be considered an alarm; NE responds with the current assignment of the requested attributes, modes, or thresholds.

3.1.4 *NE Alarm indication management functions*

This section describes the Alarm indication management functions.

1) *Inhibit/Allow Audible/Visual Alarm Indications* – TMN instructs the NE to inhibit/allow the operation of specified alarm indication/recording devices such as lamps, speakers, printers, etc. In the inhibit mode, new alarms will not trigger audible/visual alarm indicators.

2) *Reset Audible Alarms* – TMN instructs the NE to reset specified audible alarm indicator(s). This function momentarily removes any alarm indications, but allows further alarms to trigger audible/visual indicators.

3.1.5 *NE Log control functions*

This section describes the NE Log control functions.

1) *Allow/lnhibit Logging* – TMN instructs the NE to allow/inhibit logging of Log Records.

2) *Condition Logging* – TMN instructs the NE to assign Log attributes as specified by the TMN.

3) *Request Log Condition* – TMN requests NE to send the current assignment of specified Log attributes; NE responds with the current assignment of the specified attributes.

3.2 *NE Fault localization*

Where the initial failure information is insufficient for fault localization it has to be augmented with information obtained by additional failure localization routines. The routines can employ internal or external test systems and can be controlled by a TMN (see Recommendation M.20 [19]).

1) *Request diagnostic data* – TMN requests NE to send the results of a diagnostic sequence.

2) *Stop diagnosis in progress* – TMN directs the NE to stop a particular diagnostic procedure in progress.

3) *Diagnostic report* – NE reports the results of a diagnostic sequence to the TMN. It may be used in conjunction with the request and stop functions and has applications where it may be necessary or desirable to repeat diagnostic tests for a period of time to "catch" a failure.

4) *Schedule diagnosis* – TMN directs NE to establish a routine schedule for the initiation of a diagnosis.

5) *Request diagnostic schedule* – TMN requests NE to report the current schedule of diagnosis.

6) *Diagnostic schedule report* – NE sends the current schedule of diagnosis.

7) *Request exercise report* – TMN requests NE to send the results of a particular exercise.

8) *Exercise report* – NE sends the results of an exercise to TMN.

9) *Stop exercise* – TMN directs NE to stop a particular exercise in progress.

10) *Exercise schedule* – TMN directs NE to establish a routine schedule for the initiation of an exercise.

11) *Request exercise report schedule* – TMN directs NE to send the current schedule of an exercise. NE responds with the schedule.

12) *Operate/release loopback* – TMN directs NE to establish or release a specific loopback. It may be activated either remotely by TMN or by local action.

13) *Test internal access path* – TMN directs NE to connect a termination on NE to another termination by a specified path within NE, then test the path.

14) *Hold network path* – TMN directs NE to hold a particular network path.

15) *Start/stop program traps* – TMN directs NE to start or stop a specific program trap.

16) *Program trap report* – NE automatically reports to TMN the occurrence of a program trap.

17) *Start/stop program trace* – TMN directs NE to start or stop a specific trace.

18) *Program trace report* – NE automatically reports to TMN the results of a trace.

19) *Start/stop audit* – TMN directs NE to start or stop an audit.

20) *Audit report* – NE automatically reports to TMN the results of an audit.

21) *Audit schedule* – TMN directs NE to establish a specified schedule for a given audit.

22) *Request audit schedule* – TMN requests NE to send the current audit schedule. NE responds with the test schedule.

23) *Schedule loop insulation test* – TMN directs NE to schedule a loop insulation test.

24) *Start/stop loop insulation test* – TMN directs NE to start or stop a loop insulation test.

25) *Request loop insulation rest schedule* – TMN requests NE to send current loop insulation test schedule. NE responds with the schedule.

26) *Schedule routine tests.*

27) *Start/stop routine tests (e.g. ATME).*

28) *Report routine test schedule.*

3.3 *Fault correction*

1) *Automatic restoration report* – NE reports to TMN that it has switched a specified line, service, system or equipment as part of its protection procedures. Such procedures may or may not have been initiated by the TMN.

2) *Hot standby procedure* – TMN requests NE to initiate or terminate hot-standby procedures for a service or a single system whereby a redundant unit can take over with the minimum disruption to traffic.

3) *Reload procedure* – TMN requests NE to reconstruct a service or a single system (main or standby) from a specified dump record.

4) *Reload report* – NE reports to TMN that it has reloaded a service or a single system (main or standby) from a dump.

3.4 *Testing*

Testing can be carried out in one of two ways. In one case, a TMN directs a given NE to carry out analysis of circuit or equipment characteristics. Processing is executed entirely within the NE and the results are automatically reported to the TMN, either immediately or on a delayed basis.

Another method is where the analysis is carried out within the TMN. In this case, the TMN merely requests that the NE provide access to the circuit or equipment of interest and no other messages are exchanged with the NE.

3.4.1 *Service test*

1) *Initiate service test* – TMN requests NE to test a service to ensure that it is in a fit state for operation.

2) *Report service test result* – NE reports to TMN the results of testing the operation state of a service.

3.4.2 *NE Test access configuration*

1) *Connect Test Access* – Analogue, Voiceband Data, Subrate Digital Data, and DS1/E1. TMN directs NE to provide test access for the circuit specified in agreement with the lead-pair assignment and configuration codes if applicable.

2) *Change Access Mode* – Analogue, Voiceband Data, Subrate Digital Data, and DS1. TMN directs NE to provide different access modes; such as, split the specified pair or pairs at the metallic or digital access point in a designated direction, or to clear all test conditions and restore the circuit to a monitor state. For DS1/E1 either the monitor or split mode may be requested.

3) *Release Test Access* – Analogue, Voiceband Data, Subrate Digital Data, and DS1/El. TMN directs NE to drop access to the circuit under test and return the circuit to its normal state.

3.4.3 *Test circuit configuration*

1) *Interexchange Pairs* – TMN directs NE to execute reversal of specified transmission pairs for 4- and 6-wire metallic circuits, or the interchange of the A and B transmission pairs of a DS1/E1 on either the Equipment or Transmission Facility side of the test port.

2) *Change Leads* – TMN directs NE to execute reversal of tip and ring leds of metallic transmission pair(s) on the circuit under test.

3) *Change Terminate test and Leave (T&L) Status* – TMN directs NE to change T&L status of the circuit under test and report the resulting T&L state to the TMN.

4) *Request Terminate test and Leave (T&L) Status* – TMN directs NE to report the T&L status of the circuit under test.

5) *Configure Multipoint Junction Unit (MJU) Branches (Select, Restore, and Block)* – TMN directs NE to perform various control functions such as block, select, unselect, and release, on the Multipoint Junction Unit (MJU) in the circuit.

6) *Operate and Release Loopback Equipment* – TMN directs NE to split the circuit under test and change the operate, release functions of digital network element latching loopback devices, or the TMN directs the NE to change the activate, deactivate, and release functions of DS1/El loopback devices provided at network points and customer interfaces.

3.4.4 *NE Test control*

1) *Control Analogue Test Signal* – TMN directs NE to connect a test signal generator, and to change or remove a test signal on the circuit under test.

2) *Analogue Transmission Measurements* – TMN directs NE to measure analogue transmission characteristics including: tone, noise, impulse noise, intermodular distortion, phase jitter, transients, and peak-to-average ratios.

3) *Multimeter Measurements* – TMN directs NE to measure multimeter characteristics including: AC and DC voltage, resistance, AC and DC current, and capacitance.

4) *Signalling and Supervision Measurements* – TMN directs the NE to perform and report supervision in both directions for AC and DC signalling.

5) *Connect and Disconnect Monitor/Talk Line* – TMN directs NE to establish talk and listen paths, or to remove any monitor or talk conditions between the circuit under test and the monitor/talk line.

6) Bridged Monitor and Listen – TMN listens selectively to the circuit under test and monitors any transmission pair in either direction.

7) *Change Monitor/Talk Level* – TMN directs NE to change the level of the monitor connection.

8) *Change Monitor/Talk Filter* – TMN directs NE to remove or insert the Single Frequency notch filter placed in the monitor connection.

9) *Monitor Digital Data Signals* – TMN establishes digital data monitor test access and determines the presence of network control codes or customer data.

10) *Test Digital Loopbacks* – TMN directs NE to provide a loopback on the circuit under test and perform a digital loopback test.

11) *Primary and Secondary Channel Tests* – TMN directs NE to split the circuit under test and perform primary and secondary channel uses on specified equipment, such as MJUs and Channel Service Units (CSUs).

12) *Digital Tests* – TMN directs NE to split the circuit under test and connect the required test modules that sends and receives test data to perform a test using both transmitter and receiver, or either transmitter or receiver.

13) *Insert Errors* – TMN requests NE to insert a controlled number of logical bit errors, CRC errors and line code violations into the digital bit stream in one or both directions of the circuit under tests.

14) *Simulated Test* – TMN requests NE to simulate a specified failure and mark ensuing actions as dummies.

15) *Control DS1/E1 Test Signal* – TMN requests NE to change the test signal to the DS1/E1 under tests.

16) *Measure DS1/E1 Signals* – TMN directs NE to measure the line signals on the DS1/E1 under test. These measurements may be made with the circuit in either the monitor mode or split mode.

17) *Terminate Test Measurement* – TMN directs NE to terminate continuous or repeating type measurements. This includes the reporting of results in the response format of the command being terminated, stopping the measurement, and returning the circuit under test to a specified state. Examples include stopping a straightaway test, or DS1/El signal measurement.

3.4.5 *Results and Status Reporting*

1) *Request Test Results* – TMN requests NE to report intermediate or final results from a measurement.

2) *Test Results Reporting* – NE sends the results of a test to the TMN.

3) *Request Transmission Facility Status* – TMN directs NE to send the state of the facility carrying the circuit under test.

4) *Test Transmission Facility Reporting* – NE sends the state of the facility carrying a specified circuit.

3.4.6 *Test Access Path (TAP) management*

1) *Establish Loop Around Access* – TMN directs NE to establish a test access to a metallic circuit by reserving the access point, selecting or providing a TAP and applying a loop around on the selected TAP.

2) *TAP Loopback Test* – The integrity of the metallic TAP provided by the "Establish" function is tested and calibrated from the test system.

3) *Remove TAP From Service* – TMN directs NE to remove a TAP(s) from service.

4) *Restore TAP In Service* – TMN directs NE to restore a TAP(s) into service.

5) *Connect and Disconnect Loop Around* – TMN directs NE to apply or remove a loop around to the TAP(s) under test.

6) *Diagnose TAP* – TMN directs NE to carry out a loop around test of the TAP(s) from the test system for the purpose of diagnosis.

7) *Request TAP Status* – TMN requests the status of all TAPs serving the NE.

8) *Report TAP Status* – NE reports the status of all TAPs to the TMN.

3.4.7 *Network Control/Recovery*

1) *Report Test System Initialization* – NE reports initialization of test system to TMN.

2) *Report Test Access System Initialization* – NE reports initialization of test access system to TMN.

3) *Initialize and Restore Access System* – TMN directs NE to release all existing test access connections in NE, and restore all TAPs involved to an idle state.

3.5 *Trouble administration*

1) *Enter Trouble* – A customer may request that a customer trouble report be created with the appropriate information.

2) *Add Trouble Information* – A customer may provide additional descriptive text for an open trouble report. This additional information will be appended to the description provided when the trouble was originally entered.

3) *Cancel Trouble* – A customer may attempt to close out a trouble report. Typically, the customer has resolved the trouble and wants to abort the trouble report.

4) *Check Trouble Status* – A customer may request status information on an open or closed customer trouble report.

5) Review Trouble History – A customer may request information about past troubles reported for a particular service or circuit.

6) *Report Trouble Status Change* – A customer may be notified beforehand of changes in the trouble status.

7) *Request Trouble Report Format* – A customer may request information on what conditional package of attributes apply to trouble reports for a particular circuit or service.

4 Configuration management

Configuration management provides functions to exercise control over, identify, collect data from and provide data to NEs.

4.1 *Provisioning*

Provisioning consists of procedures which are necessary to bring an equipment into service, not including installation. Once the unit is ready for service, the supporting programs are initialized via the TMN. The state of the unit, e.g. in service, out of service, stand-by, reserved, and selected parameters may also be controlled by provisioning functions.

Over the spectrum of network elements, the use of the provisioning functions can vary widely. For small transmission elements, these functions are used once and rarely again. Digital switching and cross-connect equipment may require frequent use of these functions as circuits are put up and dropped.

4.1.1 *NE Configuration*

1) *Request configuration* – TMN requests that the NE report the current configuration of each entity.

2) *Configuration report* – For each entity, NE reports status, capacity of the entity, optional parameters, type of entity (in sufficient detail for TMN identification) and the version and revision of the version.

3) *Grow* – TMN notifies NE of the presence of a newly installed entity.

4) *Prune* – TMN notifies NE of the disconnection of an entity.

5) *Restore* – TMN notifies NE to begin monitoring the newly installed entity.

6) *Assign* – TMN notifies NE that a previously unequipped entity is now equipped.

7) *Delete* – TMN notifies NE that a previously unequipped entity is no longer equipped.

8) *Set service state* – TMN directs NE to place the specified entity in one of the following states: in service (available for use), out of service (unavailable for use), standby (not faulty but not performing normal function), reserved.

9) *Request assignments* – TMN requests that NE report the identity of each assigned entity. The request may be for a specified entity or for all equipped entities.

10) *Assignment reports* – NE reports the identity of each assigned channel for each equipped entity or for a specified entity.

11) *Set parameters* – TMN directs NE to set parameters associated with a specified entity.

12) *Set service thresholds* – TMN directs NE to set performance thresholds for the specified channel.

13) *Add/drop* – TMN directs NE to insert or remove a channel from the complement of through-channels.

14) *Cross-connect* – TMN directs NE to interconnect two specified channels operating at the same rate.

15) *Disconnect* – TMN directs NE to remove the interconnection between two specified channels.

16) *Start transmission test* – TMN directs NE to begin a transmission test on a given circuit.

17) *Balance* – TMN directs NE to perform a balance test/adjustment.

18) *Start transponder test* – TMN directs NE to look for a transponder signal on the given circuit.

19) *Set report periods* – The TMN directs NE to set or change report periods.

20) *Request report periods* – The TMN requests NE to send the current periods to the TMN.

21) *Restart request* – TMN requests NE to restart an equipment, service or the system. The restart may be soft or hard.

22) *Restart report* – NE reports to TMN that it has undertaken a soft or hard restart as part of its recover procedures. Such procedures may or may not have been initiated by the TMN.

4.1.2 *NE Administrative functions*

1) *Set clock* – TMN directs NE to set NE system clock to current calendar, date and time.

2) *Backup copy* – TMN directs NE to make a backup copy of the designated NE data base file for purposes of archiving for future restoral.

3) *Terminate procedure* – TMN directs the NE to terminate a process between a TMN and a NE.

4) *Route messages* – TMN directs NE to route automatic messages generated by NE to one or multiple communications channels.

5) *Set service controls* – TMN directs NE to assign user access and functional capability.

4.1.3 *NE Data base management*

1) *Initialize* – TMN configures a new data base which is related to a NE. This may or may not be downloaded to the NE. This may also include loading a new program related to the NE.

2) *Reinitialize* – TMN reconfigures the data base within a NE while it is in service.

3) *Update* – TMN adds, changes or deletes one or more records in the data base of a NE. This can be done in a delayed activation mode or upon command entry. It may also be able to enter data base updates on a test basis prior to permanent entry.

4) *Query* – TMN reads NE for all or part of its data base contents.

5) *Backup* – TMN keeps a copy of all or part of the data base of a NE. In case of memory failure in the NE, the TMN downloads the backup copy to the NE.

4.2 *NE status and control*

The TMN provides the capability to monitor and control certain aspects of the NE on demand. Examples include checking or changing the service state of a NE or one of its sub-parts (in service, out of service, standby) and initiating diagnostics tests within the NE. Normally, a status check is provided in conjunction with each control function in order to verify that the resulting action has taken place. When associated with failure conditions, these functions are corrective in nature (e.g. service restoral).

Status and control functions can also be part of routine maintenance when executed automatically or on a scheduled periodic basis. An example is switching a channel out of service in order to perform routine diagnostic tests.

A TMN will enable the exclusion of faulty equipment from operation and as a result it may rearrange equipment or re-route traffic.

A TMN can enable the entry of a proposed configuration in order to automatically analyse the feasibility of that design before implementing it.

4.2.1 *Generic NE status and control functions*

1) *Request status* – TMN requests NE to send current status information.

2) *Status report* – NE reports to TMN the value of a monitored parameter. It may be sent on demand by TMN or on a scheduled basis.

3) *Schedule status report* – TMN directs NE to establish a schedule for the reporting of status information.

4) *Request status report schedule* – TMN directs NE to send the current schedule of status reporting NE responds with the schedule.

5) *Service availability timetable* – TMN sends NE timetable of when a specified service is to be available for use.

6) Allow/inhibit automatic restoration – TMN directs NE to allow or inhibit automatic restoration in a *M+N* or duplex system.

7) *Operator/release automatic restoration* – TMN directs NE to switch a specified line or equipment to the redundant unit or release it from the redundant unit For a *M+N* system, service is placed on the redundant unit and taken off the working unit For a duplex system the main unit becomes standby and the standby unit becomes the main unit.

4.2.2 *Message handling systems network status*

1) *Request message storage status data* – TMN requests NE to transmit the message storage status data of store and forward communication to TMN.

2) *Message storage status data report* – NE sends the status data to TMN.

4.2.3 *Leased circuit network status*

1) *Request status of dynamic provisioning of leased circuit network* – TMN requests NE to transmit the status of dynamic provisioning to TMN.

2) *Status report of dynamic provisioning of leased circuit networks* – NE sends the current status to TMN.

4.2.4 *Transmission network status*

1) *Request status of automatic transmission restoration* – TMN requests NE to transmit the switching activities and current status of automatic transmission restoration.

2) *Status report of automatic transmission restoration* – NE sends the current status of the switching operations to TMN.

4.3 *NE Installation*

The TMN can support the installation of equipment which makes up the telecommunication network. It covers also the extension or reduction of a system. Some NEs call for the initial exchange of data between themselves and the TMN. An example of another function is the installation of programs into NEs from data base systems within the TMN. In addition, administrative data can be exchanged between NEs and the TMN.

Acceptance testing programs can be done under control of, or supported by, the TMN.

A detailed list of operation functions for an SPC-exchange is provided in Recommendation Z.331, § 3.1 [1].

A detailed list of installation functions for an SPC-exchange is provided in Recommendation Z.331, § 3.3 [1].

5 Accounting management

Accounting management provides a set of functions which enables the use of the network service to be measured and the costs for such use to be determined. It provides facilities to

– collect accounting records;

– set billing parameters for the usage of services.

5.1 *Billing functions*

An OS within the TMN can collect data from NEs which is used to determine charges to customer accounts. This type of function may need extremely efficient and redundant data transport capabilities in order to maintain records of billing activity. Often the processing must be carried out in near real time for a large number of customers.

1) *Create a data collection* – TMN directs NE to set parameters to a charging data collection process.

2) *Delete a data collection* – TMN directs the NE to remove a charging data collection process.

3) *Activate a data collection* – TMN directs the NE to start up a defined charging data collection process.

4) *De-activate a data collection* – TMN directs the NE to stop a defined charging data collection process.

5) *Get data collection data* – TMN requests the NE to report data of the defined and/or activated data collections.

6) *Set a data collection* – TMN directs the NE to change parameters in a charging data collection definition.

7) *Get charging record* – TMN requests the NE to send a charging record, either a call record or a counter record or several records, according to the specification in the request. NE replies with the data and saves the data.

8) *Transfer charging block* – NE transfer automatically a charging block or several blocks to the TMN according to the earlier activated data collection. Call records are deleted in the NE.

9) *Get coin-box status* – TMN requests the NE to report the status of the pay-phone coin-box. NE sends the requested status data to the TMN.

5.2 *Tariffing functions*

Tariff is a set of data within a NE that is centralized within an Intelligent Network or distributed into the exchanges, or in an Operations System, used for the determination of the amount of payment for services used.

Tariff may include dependency on the tariff class, which is defined according to service, origination and destination, and on the tariff period and day class. These attributes may change during the call.

1) *Create tariff class* – TMN directs NE to create a tariff class corresponding to a certain service, origination and destination.

2) *Delete tariff class* – TMN directs NE to delete a tariff class.

3) *Set tariff class* – TMN directs a NE to change a tariff class.

4) *Get tariff class data* – TMN requests the NE to report the defined tariff class data, NE replies with the data.

5) *Create a tariff* – TMN directs NE to create a tariff.

6) *Delete a tariff* – TMN directs the NE to delete a tariff.

7) *Set a tariff* – TMN directs the NE to change a tariff.

8) *Get tariff data* – TMN requests NE to report tariff data, NE replies with the data.

9) *Create tariff period of the day* – TMN directs the NE to create a new tariff period of the day.

10) *Delete tariff period of the day* – TMN directs the NE to delete an existing tariff period of the day.

11) *Set tariff period of the day* – TMN directs the NE to change a tariff period of the day.

12) *Set tariff period data of the day* – TMN requests NE to report tariff period of the day, NE replies with the data.

13) *Create day class* – TMN directs the NE to create a day class into the calendar table.

14) *Delete day class* – TMN directs the NE to delete a day class from the calendar table.

15) *Set day class* – TMN directs the NE to change a day class in the calendar table.

16) *Get day class data* – TMN requests the NE to report a calendar table data, NE replies with the data.

6 Security management

The functions contained within Security management may differ from administration to administration. The purpose of this section is to list some of the aspects of security access relating to Management information that may need to be taken into account. Security management will include:

1) *Horizontal Access Security* – A customer should be permitted to manage only those domains belonging to that customer.

2) *Vertical Access Security* – A customer may be permitted to establish and modify the privileges of restricted login user types which are allowed access to only specified subsets of the customer's full capabilities.

3) *Audit Trails* – A customer may have access to usage and security event information.

4) *Security Alarms* – A customer may have access to security alarms which indicate security attacks.

5) *Test Audit Trail Mechanism* – The TMN requests audit trail mechanism test for data integrity.

6) *Report Audit Actions* – The TMN requests the NE to report on actions involving, for example, identification, authentication, user address space actions and administrative issues.

7) *Management of Audit Trails* – A customer may establish and configure audit trails and security alarms reporting capabilities.

8) *Intrusion Recovery* – A customer may be permitted access to backup files in order to restore service after a security violation.

9) *Request Credentials Information* – The NE requests the TMN for credentials and/or all related information.

10) *Send Credentials Information* – The TMN sends to the NE its credentials and related information as requested.

11) *Report Authentication Results* – The NE reports to the TMN the results of an authentication activity.

ANNEX A

(to Recommendation M.3400)

Short descriptions of the relevant OSI System Management Functions (SMFs)

This Annex contains very short descriptions of the relevant OSI System Management Functions (SFMs).

These OSI SMFs provide generic management controls and capabilities which can be used by specific TMN management services, components and functions.

A.1 *Measurement Summarization Function* [1]

Measurement Summarization Function observes managed objects attributes, such as estimates of means, estimates of variances, rejection rates, tidemarks, etc. It also provides for the establishment of the list of observations, the metric algorithms, estimation of statistical parameters, the schedules, the timestamping, and the reporting of the observations and summaries of the observations or derived measurements.

A.2 *Workload Monitoring Function* [2]

The Workload Monitoring Function defines that services for the manipulation of metric objects, and specifically for the Gauge Monitor and Mean Monitor metric object classes. The Workload Monitoring Function uses the State Management Function for the notification of state changes, the uses Object Management Function for the creation and deletion of managed objects, the retrieval of attributes and notification of attribute value changes, and the Alarm Report Function for the reporting of alarms.

A.3 *Event Report Management Function* [3]

The Event Report Management Function allows an Open System to establish and control the discrimination tests and the forwarding of event reports to other Open System. It is considered that systems should have the capability of modifying the operation of Event Forwarding Discriminators in other systems. In particular, the operations required, that can be applied to each instance of an event forwarding discriminator, are:

- creation of a discriminator;
- deletion of a discriminator;
- modification of discriminator attributes;
- suspension of the activity of the discriminator;
- resumption of the discriminator activity.

The Event Report Management function uses the services defined in State Management Function for the notification of state changes and the services defined in Object Management Function for the creation and deletion of discriminators, the retrieval of discriminator attributes, and the notification of attributes changes and object creations and deletions.

A.4 *Alarm Reporting Function* [4]

The Alarm Reporting Function provides service for conveying alarm related notification emitted by managed objects. The Alarm reporting service allows one user to notify another user of an alarm detected in a managed object. The originating user has to specify whether or not a reply is required. Initiation, termination, suspension and resumption of the Alarm reporting service is permitted using the services defined for Event Report Function, operating upon instances of the event forwarding discriminator. The notification defined by this function can report changes of state as defined in State Management Function, and can report instances of back up relationship as defined in Attributes for representing Relationships.

Alarm Reporting Function specifies a set of five generic “alarm” type notifications, their parameters and semantics:

- Communications Alarm;
- Quality of Service Alarm;
- Processing Alarm;
- Equipment Alarm;
- Environmental Alarm.

Also a number of probable causes are specified. Other parameters include: perceived severity, backed up status, trend indication, threshold information, state change, monitored attributes, repair actions, problem text, problem data, alarm record[3)], and others.

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3) Alarm record is a managed object class derived from the Event log record object class via subclassing.

A.5 *Log Control Function* [5]

The Log Control Function defines services for the manipulation of the managed object class. The operations required that can be applied to each instance of a log, are:

– creation of a log;

– deletion of a log;

– modification of log attributes;

– suspension of the activity of the log;

– deletion and retrieval of a log records; and

– resumption of the log activity.

The Log Control Function uses the services defined in State Management Function for the notification of state changes, the services defined in Object Management Function for the creation and deletion of managed objects, the retrieval of attributes and notification of attribute value changes and the services defined in Alarm Reporting Function for the reporting of log alarms.

A.6 *Confidence and Diagnostic Test Classes* [6]

The Confidence and Diagnostic Test Classes defines services for requesting test initiation, reporting results and resuming test for terminating tests. The following generic test classes are defined:

1) Internal Resource Tests;

2) Communications Integrity Tests:

   – Connectivity tests;
   – Data integrity tests;
   – Loopback tests;

3) Protocol Integrity Tests;

4) Capacity Tests:

   – Data saturation tests;
   – Connection saturation tests;
   – Response time tests.

Also, the following characteristics that are common to all test classes are identified:

1) Test state attribute:

   – Initiation;
   – Testing;
   – Idle;
   – Suspended;
   – Reporting;
   – Termination;

2) Purpose of Test;

3) Interactions between Managed Object under test and Associated objects;

4) Test Environment;

5) Test Class Identifier;

6) Initiation Specific to Test Class;

7) Reporting and Terminating Events;

8) Result Report;

9) Test Termination;

10) General Test Class Requirements.

A.7 *Test Management Function* [7]

The Test Management Function defines five services for requesting test initiation, reporting results and resuming test for terminating tests:

- TEST-REQUEST-ASYNC service;
- TEST-REQUEST-SYNC service;
- TEST-SUSPEND-RESUME service;
- TEST-TERMINATION service;
- TEST-RESULT service.

A.8 *Object Management Function* [8]

The Object management function provides ten services, six of which are pass through (PT) services:

- Object Creation Reporting service;
- Object Deletion Reporting service;
- Object Name Change Reporting service;
- Attribute Value Change Reporting service;
- PT-CREATE service;
- PT-DELETE service;
- PT-ACTION service;
- PT-SET service;
- PT-GET service;
- PT-EVENT-REPORT service.

A.9 *State Management Function* [9]

The State Management Function provides one service:

- State Change Reporting service.

The State Management Function uses the pass through services of the Object Management Function for managing the state attributes of the managed objects. The following generic states are defined:

1) Operational State:
   - Enabled;
   - Disabled;
2) Usage States:
   - Idle;
   - Active;
   - Busy;
   - Unknown;
3) Administrative States:
   - Unlocked;
   - Locked;
   - Shut Down;
4) Management States:
   - Read only. All above states.

In addition, the following Status attributes for the above states are defined:

1) Repair Status:

   – Under Repair;
   – Fault Report Outstanding;

2) Installation Status:

   – Not Installed;
   – Initialization Incomplete;
   – Initialization Required;

3) Availability Status:

   – In Test;
   – Failed;
   – Power Off;
   – Off Line;
   – Off Duty;
   – Dependency;
   – Degraded;

4) Control Status:

   – Subject to Test;
   – Read Only;
   – Part of Service Locked;
   – Reserved for Test;
   – Suspended.

A.10 *Relationships Management Function* [10]

This Function provides one service:

– Relationship Change Reporting service.

This Function uses the pass through services of the Object Management Function for managing the relationship attributes of managed objects.

A relationship is a set of rules that describe how the operation of one part of a system, network or service affects the operation of other parts of the system, network or service. A relationship exists among managed objects when the operation of one managed object affects the operation of the other managed objects.

Three categories of relationships are recognised by OSI management:

1) Containment Relationships (Superior MO-Subordinate MO):

   – Part of relationships;
   – Organizational hierarchies.

2) Reciprocal Relationships:

   – Service relationships (Provider-User);
   – Peer relationships (Peer-to-Peer);
   – Fallback relationships (Primary-Secondary);
   – Backup relationships (Backup-Backed up);
   – Group relationship (Owner-Member).

3) One-way Relationships (asymetric relationship between two MOs expressed in the value of the relationship attribute of only one member of the pair).

A.11 *Accounting Meter Function* [11]

The Accounting Meter Function uses Object Management Function, Event Report Management and Log Control Function.

A.12 Security Alarm Reporting Function [12]

The Security Alarm Reporting Function provides the ability to report to a security management user a security attack, security mechanism misoperation or other security threat detected by a managed object. Following is a list of generic types of security alarms:

1) *Integrity Violation* – An indication that a potential interruption in information flow has occurred, such that information may have been illegally modified, inserted or deleted.

2) *Physical Violation* – An indication that a breach of the physical resource has been detected.

3) *Security Service or Mechanism Violation* – An indication that a security attack has been detected by a security service or mechanism.

4) *Time Domain Violation* – An indication that an event has occurred outside the permitted time period.

Also, the following security alarm causes are defined:

1) *Duplicate information* – An indication that an item of information has been received more than once, and may be a replay attack.

2) *Information missing* – An indication that expected information has not been received.

3) *Information modification detected* – An indication by, for example a data integrity mechanism, that information has been modified.

4) *Information out of sequence* – An indication that information has been received in the incorrect sequence.

5) *Unexpected information* – An indication that information has been received that was not expected.

6) *Denial of service* – An indication that an otherwise valid request for service has been prevented or disallowed.

7) *Out of service* – An indication that a valid request for service could not be satisfied due to the unavailability of the service provider.

8) *Procedural error* – An indication that an incorrect procedure has been used in invoking a service.

9) *Cable tamper* – An indication that a physical violation of a communication medium has occurred.

10) *Intrusion detection* – An indication that the site on which the identified equipment is located may have been illegally entered.

11) *Authentication failure* – An indication that a request for an authentication has failed.

12) *Breach of confidentiality* – An indication that information may have been read by an unauthorised user.

13) *Unauthorised access attempt* – An indication that an access control mechanism has detected an illegal attempt to access a target.

14) *Delayed information* – An indication that information has been received later than expected.

15) *Key expired* – An indication that an out of date encipherment key has been presented or used.

16) *Out of hours activity* – An indication that system utilization has occurred at an unexpected time.

17) *Other reasons* – An indication that an unclassified violation of a security service or mechanism has occurred.

A.13 *Security Audit Trail Function* [13]

The Security Audit Trail Function provides the ability to report security-related events detected by a managed object.

Security Audit Trail has the following parameters:

1) Security Audit Trail type:

   – service report;
   – statistics report.

2) Service report cause:

- service request;
- service denial;
- service response;
- service failure;
- service recovery;
- other reason.

3) Security audit text (free form text).

4) Security audit data.

5) Other information.

A.14 *Objects and Attributes for Access Control* [14]

Two types of access control are specified:

1) Access control for a management association;

2) Access control for a management operation.

Access control names, rules and operations are specified.

References

[1] CCITT Recommendation X.738 *Measurement Summarization Function* (Second Working Draft), 1990 (see also ISO/IEC 10164-13).

[2] CCITT Recommendation X.739 *Workload Monitoring Function* (see also ISO/IEC 10164-11).

[3] CCITT Recommendation X.734 *Event Report Management Function* (see also ISO/IEC 10164-5).

[4] CCITT Recommendation X.733 *Alarm Reporting Function* (see also ISO/IEC 10164-4).

[5] CCITT Recommendation X.735 *Log Control Function* (see also ISO/IEC 10164-6).

[6] CCITT Recommendation X.737 *Confidence and Diagnostic Test Classes Function* (see also ISO/IEC 10164-edt).

[7] CCITT Recommendation X.745 *Test Management Function* (see also ISO/IEC 10164-12).

[8] CCITT Recommendation X.730 *Object Management Function* (see also ISO/IEC 10164-1).

[9] CCITT Recommendation X.731 *State Management Function* (see also ISO/IEC 10164-2).

[10] CCITT Recommendation X.732 *Attributes for representing relationships* (see also ISO/IEC 10164-3).

[11] CCITT Recommendation X. 742 *Accounting Metering Function* (see also ISO/IEC 10164-10).

[12] CCITT Recommendation X.736 *Security Alarm Reporting Function* (see also ISO/IEC 10164-7).

[13] CCITT Recommendation X.740 *Security Audit Trail Function* (see also ISO/IEC 10164-8).

[14] CCITT Recommendation X.741 *Objects and Attributes for Access Control* (see also ISO/IEC 10164-9).

[15] CCITT Recommendation M.3200 *TMN management services: overview.*

[16] CCITT Recommendation M.3100 *Generic network information model.*

[17] CCITT Recommendation M.3020 *TMN interface specification methodology.*

[18] CCITT Recommendation M.3010 *Principles for a Telecommunciations Management Network.*

[19] CCITT Recommendation M.20 *Maintenance philosophy for telecommunications networks.*