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SERIES M: TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

Telecommunications management network

TMN management functions

ITU-T Recommendation M.3400

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION M.3400

TMN MANAGEMENT FUNCTIONS

Summary

This Recommendation is one of a series of Recommendations of the Telecommunications Management Network (TMN), providing specifications of TMN management functions and TMN management function sets. The content is developed in support of Task Information Base B (*Roles, resources and functions*), associated with Task 2 (*Describe TMN management context*) in the TMN interface specification methodology specified in Recommendation M.3020. When performing the analysis of TMN management context, it is desirable to consider maximal use of the TMN management function sets available in this Recommendation.

Source

ITU-T Recommendation M.3400 was revised by ITU-T Study Group 4 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 19th of April 1997.

Keywords

Guidelines for the Definition of TMN Management Functions (GDMF), OSI system management functions, Task Information Base, TMN management context, TMN management function, TMN management function set, TMN management function set group.

FOREWORD

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

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

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

NOTE

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

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As of the date of approval of this Recommendation, the ITU had/had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Recommendation M.3400

TMN MANAGEMENT FUNCTIONS

(1992; revised in 1997)

1 Scope

A TMN management function is a cooperative interaction between application processes in managing and managed systems for the management of telecommunications resources, and is the smallest functional part of a TMN management service as perceived by the TMN users.

Within the scope of TMN management context, TMN management services are defined by the descriptions of roles, related resources and TMN functions. The TMN management functions that belong together according to context are grouped into TMN management function sets (and the sets into groups) for the purpose of management information modelling. TMN management function sets may be reusable for TMN management services applied to different telecommunications managed areas.

TMN management function sets are described from the TMN users' perspective and they are independent from the individual protocols as well as management information modelling so that the applicability to the diversified protocols in TMN interfaces will be maintained.

The managers and agents identified in this Recommendation are capabilities of function blocks in TMN building blocks: Operations Systems (OSs), Mediation Devices, Network Elements (NEs), Work Stations, or Q Adaptors. Function blocks in NEs and Q Adaptors act as agents when interacting with function blocks in OSs and Mediation Devices. Further information is provided in specific Recommendations on TMN Management Services.

The applicability of any TMN management function set or TMN management function to any specific TMN interface remains to be determined, and will be documented in TMN management services Recommendations.

This Recommendation provides both generic and specialized TMN management function sets to support some of the most important TMN management services, using the template of the Guidelines for the Definition of TMN Management Functions (GDMF) provided in Annex B/M.3020. The TMN management function sets and TMN management functions listed in this Recommendation are considered to be of potential use or reuse in a number of TMN management services. When generating an M.3200-Series Recommendation, it is expected that functions listed in Recommendation M.3400 be reused as much as possible. Where it is found that new functions, not presently listed in Recommendation M.3400, need to be defined in order to complete an M.3200-Series Recommendation on a telecommunications managed area, these functions should also be examined as candidates for other future management services. If found suitable for this purpose, it is expected that they will be proposed for inclusion in Recommendation M.3400. TMN management function sets available in this Recommendation are classified into the following Management Functional Areas (MFAs), as listed in Recommendations M.3010, X.700 and X.701:

- Performance Management.
- Fault Management.
- Configuration Management.
- Accounting Management.
- Security Management.

In accordance with the GDMF template of Recommendation M.3020, each TMN management function set is described and subclauses may be provided for Management Requirements, General Functional Model and TMN Management Functions. For an example of a TMN management function set that has information for some of these subclauses, see the Alarm summary function set of the Alarm Surveillance group of Fault Management.

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

Appendix I contains a set of generic scenarios that depict the flow of information that is needed to achieve a number of management services.

2 References

2.1 Normative references

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation M.3000 (1994), *Overview of TMN Recommendations.*

– ITU-T Recommendation M.3010 (1996), *Principles for a telecommunications management network.*

– ITU-T Recommendation M.3020 (1995), *TMN interface specification methodology.*

The following ITU-T Recommendations should be referred to in connection with this Recommendation. Detailed information on the relationships to these and other Recommendations is described in Recommendation M.3020.

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

– CCITT Recommendation M.3180 (1992), *Catalogue of TMN management information*.

– ITU-T Recommendation M.3200 (1997), *TMN management services and telecommunications managed areas: Overview.*

2.2 Bibliographic references

A number of ITU-T Recommendations concerning OSI System Management Functions are listed in items [1] through [16] of these bibliographical references. These System Management Functions provide generic management controls and capabilities which can be used by specific TMN management services, components and functions.

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

[2] CCITT Recommendation X.701 (1992), *Information technology – Open Systems Interconnection – Systems management overview.*

[3] ITU-T Recommendation X.738 (1993), *Information technology – Open Systems Interconnection – Systems Management: Summarization function.*

[4] ITU-T Recommendation X.739 (1993), *Information technology – Open Systems Interconnection – Systems Management: Metric objects and attributes.*

[5] CCITT Recommendation X.734 (1992), *Information technology – Open Systems Interconnection – Systems Management: Event report management function.*

[6] CCITT Recommendation X.733 (1992), *Information technology – Open Systems Interconnection – Systems Management: Alarm reporting function.*

[7] CCITT Recommendation X.735 (1992), *Information technology – Open Systems Interconnection – Systems Management: Log control function.*

[8] ITU-T Recommendation X.737 (1995), *Information technology – Open Systems Interconnection – Systems Management: Confidence and diagnostic test categories.*

[9] ITU-T Recommendation X.745 (1993), *Information technology – Open Systems Interconnection – Systems Management: Test management function.*

[10] CCITT Recommendation X.730 (1992), *Information technology – Open Systems Interconnection – Systems Management: Object management function.*

[11] CCITT Recommendation X.731 (1992), *Information technology – Open Systems Interconnection – Systems Management: State management function.*

[12] CCITT Recommendation X.732 (1992), *Information technology – Open Systems Interconnection – Systems Management: Attributes for representing relationships.*

[13] ITU-T Recommendation X.742 (1995), *Information technology – Open Systems Interconnection – Systems Management: Usage metering function for accounting purposes.*

[14] CCITT Recommendation X.736 (1992), *Information technology – Open Systems Interconnection – Systems Management: Security alarm reporting function.*

[15] CCITT Recommendation X.740 (1992), *Information technology – Open Systems Interconnection – Systems Management: Security audit trail function.*

[16] ITU-T Recommendation X.741 (1995), *Information technology – Open Systems Interconnection – Systems Management: Objects and attributes for access control.*

[17] CCITT Recommendation M.20 (1992), *Maintenance philosophy for Telecommunication networks*.

[18] CCITT Recommendation X.800 (1991), *Security architecture for Open Systems Interconnection for CCITT applications*.

3 Definitions

This Recommendation defines the following terms.

3.1 agent: An entity that acts in a managed role. This term is intended, in the context of this Recommendation, to be generic: other terms may be used in the context of protocols. For example, while Agent is the equivalent term in the context of OSI/Common Management Information Service Element (see Recommendation M.3010), Responder is the equivalent term in the context of OSI/File Transfer, Access and Management.

3.2 manager: An entity that acts in a managing role. This term is intended, in the context of this Recommendation, to be generic: other terms may be used in the context of protocols. For example, while Manager is the equivalent term in the context of OSI/Common Management Information Service Element (see Recommendation M.3010), Invoker is the equivalent term in the context of OSI/File Transfer, Access and Management.

Definitions of the following terms may be found in Recommendation M.3020:

3.3 TMN management function

3.4 TMN management function set

3.5 TMN management function set group

4 Abbreviations

This Recommendation uses the following abbreviations.

CCSS Common Channel Signalling System
GDMF Guidelines for the Definition of TMN Management Functions
HTR Hard-To-Reach
HVAC Heating, Ventilation and Air Conditioning
IEC International Electrotechnical Commission
ITU International Telecommunication Union
ITU-T International Telecommunication Union – Telecommunication Standardization Sector
MFA Management Functional Area
M+N M working units + N spare units
NE Network Element
NE(s) One, several or a group of Network Elements
OS Operations System
OSF Operations System Function block
OSI Open Systems Interconnection
PM Performance Management (the Management Functional Area)
PM Performance Monitoring (the TMN Management Function Set Group)
QOS Quality of Service
RAS Reliability, Availability and Survivability
T&L Terminate test and Leave
TAP Test Access Path
TMN Telecommunications Management Network

5 Performance Management

Performance Management provides functions to evaluate and report upon the behaviour of telecommunication equipment and the effectiveness of the network or network element. Its role is to gather and analyse statistical data for the purpose of monitoring and correcting the behaviour and effectiveness of the network, NEs or other equipment and to aid in planning, provisioning, maintenance and the measurement of quality. As such, it is carrying out the performance measurement phase of Recommendation M.20 [17].

A TMN collects Quality of Service (QOS) data from NEs and supports 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 exception basis. At any time, the TMN may modify the current schedule and/or exception thresholds. Reports from the NE on QOS data may consist of raw data (data gathered in the course of providing telecommunication services) which is then analysed

externally to the NE, or the NE may be capable of carrying out part of the analysis of the data before the report is sent.

Quality of Service includes monitoring and recording of parameters relating to:

a) Connection establishment (e.g. call set-up delays, successful and failed call requests).

b) Connection retention.

c) Connection quality.

d) Billing integrity.

e) Keeping and examining of logs of system state histories.

f) 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.

g) Initiation of test calls to monitor QOS parameters.

Performance Management includes the following function set groups:

- Performance Quality Assurance.
- Performance Monitoring.
- Performance Control.
- Performance Analysis.

5.1 Performance Quality Assurance

Performance Quality Assurance supports decision processes that establish, as the state of the art expands and customer needs change, the quality measures that are appropriate to the area of Performance Management.

Performance Quality Assurance includes the following functions sets:

- QOS performance goal setting function set.
- Network performance goal setting function set.
- Subscriber service quality criteria function set.
- QOS performance assessment function set.
- Network performance assessment function set.
- NE(s) performance assessment function set.
- Data integrity check function set.

5.1.1 QOS performance goal setting function set

This set manages guidelines for the assessment of all Quality of Service (QOS) performance measures, by area and component(s).

5.1.2 Network performance goal setting function set

This set manages guidelines for the assessment of network performance quality and availability in order to support service assurance and service offerings.

5.1.3 Subscriber service quality criteria function set

This set provides a network management query feature for offering Performance Management information to a customer, such as grades of service options, performance monitoring thresholds, or the possible conditions under which rebates are awarded when service quality goals are not met.

5.1.4 QOS performance assessment function set

This set provides access to the assessment summary of all combined QOS performance measures, by area, by type of customer, by type of service and by network components, that compares measured quality with the quality goals.

5.1.5 Network performance assessment function set

This set provides access to the assessment summary of network performance quality and availability.

5.1.6 NE(s) performance assessment function set

This set provides access to analyses of NE quality and availability performance parameters in order to support service assurance and/or service offerings. This function set provides information to the Network performance characterization function.

5.1.7 Data integrity check function set

This set indicates that performance data, such as a count, has been compromised or invalidated by re-initialization (for example, the resetting of a clock), or internal equipment failure.

5.2 Performance Monitoring

Performance Monitoring (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 surveillance. 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 of impairment before signal quality has dropped below an acceptable level.

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

Performance Monitoring includes the following functions sets:

- Performance monitoring policy function set.
- Network performance monitoring event correlation and filtering function set.
- Data aggregation and trending function set.
- Circuit-specific data collection function set.
- Traffic status function set.
- Traffic performance monitoring function set.
- NE(s) threshold crossing alert processing function set.
- NE(s) trend analysis function set.
- Performance monitoring data accumulation function set.
- Detection, counting, storage and reporting function set.

5.2.1 Performance monitoring policy function set

This set establishes PM policy such as the values of threshold settings and schedules for data collection for specific kinds of circuits. These settings are to be applied during activation of such circuits. Different policies are likely to be created for special service circuits of various kinds, for message circuits, and for facilities.

5.2.2 Network performance monitoring event correlation and filtering function set

This set supports the reporting of the root cause of PM threshold crossing alerts and other PM events, as inferred by an event correlation process that uses knowledge of the topology and states of a network and its component NEs, to facilitate network alarm analysis. It provides access to information concerning identified root causes. It also generates non-redundant notifications of trails that are found to generate persistent threshold crossing alerts.

5.2.3 Data aggregation and trending function set

This set provides access to aggregated and correlated end-to-end current and history PM information to detect and aid in the sectionalization of network faults and impairments. It also provides access to trending information, which supports the extrapolation of historical data to predict future performance and to identify persistent or worsening impairments.

5.2.4 Circuit-specific data collection function set

This set collects all applicable data for a given circuit across multiple NEs. Information collected at the circuit level flows into the Data aggregation and trending function set.

5.2.5 Traffic status function set

This set provides current traffic status information of a subnetwork and its major components. Current traffic status may be reported to the operator directly by an NE, or may be provided to the operator by a manager, which collects the status information from one or more NEs.

5.2.5.1 Management requirements

5.2.5.2 General Functional Model

5.2.5.3 TMN Management Functions

1) *Report the service availability of NEs* – Agent provides manager with 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* – Agent provides manager with 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* – Agent automatically reports to manager the current busy/idle status of circuit groups for display on a terminal or other device.
4) *Report the congestion status of exchanges* – Agent automatically reports to manager the current congestion status of exchanges for display on a terminal or other device.
5) *Report the receipt of automatic congestion control signals* – Agent provides manager with 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* – Upon request by an operator, manager commands agent to assign or remove HTR status to destinations, and to override automatic HTR designations.
7) *Report hard-to-reach status of destinations on demand* – Upon request of an operator, agent reports to manager the HTR status of destinations.

8) *Report the congestion status of the common channel signalling network* – Agent automatically reports to manager the current congestion status of the common channel signalling network for display on a terminal or other device.

9) *Report the receipt of common channel signalling network management signals* – Agent provides to manager 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.

5.2.6 Traffic performance monitoring function set

This set reports current performance measurements of the traffic being offered and carried by one or more NEs. These measurements 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 for one or more NEs.

5.2.6.1 Management requirements

5.2.6.2 General Functional Model

5.2.6.3 TMN Management Functions

1) *Report circuit group data and parameters on a scheduled basis* – Agent reports to manager circuit group traffic data and calculated network management parameters automatically according to a schedule.

2) *Report circuit group data and parameters on demand* – Agent reports to manager circuit group traffic data and calculated network monitoring parameters in response to an operator request.

3) *Report exchange load measurements on a scheduled basis* – Agent reports to manager measurements of the traffic load on the exchange and its major components according to a schedule.

4) *Report exchange load measurements on demand* – Agent reports to manager 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* – Agent reports to manager measurements of exchange switching congestion according to a schedule.

6) *Report exchange congestion measurements on demand* – Agent reports to manager measurements of exchange switching congestion in response to an operator request.

7) *Report common channel signalling network load measurements on a scheduled basis* – Agent reports to manager measurements of CCSS traffic according to a schedule.

8) *Report common channel signalling network load measurements on demand* – Agent reports to manager CCSS traffic measurements in response to an operator request.

9) *Report common channel signalling network congestion measurements on a scheduled basis* – Agent reports to manager CCSS network congestion measurements according to a schedule.

10) *Report common channel signalling network congestion measurements on demand* – Agent reports to manager CCSS congestion measurements in response to an operator request.

11) *Report data on the performance of controls on a scheduled basis* – Agent reports to manager data on traffic affected by network management controls according to a schedule.

12) *Report data on the performance of controls on demand* – Agent reports to manager data on traffic affected by network management controls in response to an operator request.

5.2.7 NE(s) threshold crossing alert processing function set

This set provides access to the root cause of PM threshold crossing alerts and other PM events, as inferred by an event correlation process that uses knowledge of the internal topology and states of an NE or set of NEs in a subnetwork. It also provides access to processed NE threshold crossing alerts, that is those that are found to be persistent and that survive after those that are associated with alarms or threshold crossing alerts on supporting facilities are filtered out.

5.2.8 NE(s) trend analysis function set

This set supports reporting of trends that are detected by processing the historical data of an NE or group of NEs.

5.2.9 Performance monitoring data accumulation function set

This set includes reporting of processed and raw performance monitoring data.

5.2.9.1 Management requirements

5.2.9.2 General Functional Model

5.2.9.3 TMN Management Functions

1) *Request PM data* – Manager request the agent to send current PM data.
2) *Report PM data* – Agent sends performance data to the manager. It may be generated routinely by the agent, sent upon demand by the manager or by exception when a parameter threshold has been exceeded.
3) *Allow/inhibit PM data* – Manager directs the agent to start/stop the collection of PM data.
4) *Reset PM data* – Manager directs agent to reset storage registers for PM data.

5.2.10 Detection, counting, storage and reporting function set

This set supports the reporting of results of the continuous detection, collection, and reporting of performance primitives, i.e. data or measurements, associated with a transmission, traffic, or service entity. Storage implies that performance registers within an NE are readable on demand without resetting the count. Reporting implies that an NE report any performance parameters on demand, as well as report periodically via scheduling.

5.3 Performance Management Control

Performance Management Control supports the transfer of information to control the operation of the network in the area of Performance Management. For network traffic management, this includes the application of traffic controls that affect the routing of traffic and processing of calls. For transport performance monitoring, this group includes the setting of thresholds and data analysis algorithms and the collection of performance data but has no direct effect on the managed network.

Performance Management Control includes the following functions sets:

- Network traffic management policy function set.
- Traffic control function set.
- Traffic administration function set.
- Performance administration function set.
- Execution of traffic control function set.
- Audit report function set.

5.3.1 Network traffic management policy function set

This set manages domains of control over different parts of the network and establishes plans for anticipated conditions of congestion (for example, storm patterns that are typical of the region and focused demands that result from promotions and surveys).

5.3.2 Traffic control function set

This set creates and modifies routing patterns to relieve network congestion due to unusually high offered load, an unusual distribution of offered load, or one or more unprotected faults. This function set supports network traffic management. 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.

5.3.2.1 Management requirements

5.3.2.2 General Functional Model

5.3.2.3 TMN Management Functions

1) *Apply/modify/remove a manual control* – Upon request from an operator, manager directs agent to modify manual network management traffic controls.
2) *Establish/modify/remove an automatic control* – Upon request from an operator, manager directs agent to modify automatic network management traffic controls.
3) *Activate/deactivate an automatic control* – Manager directs agent to activate or deactivate an automatic control that has been previously established.
4) *Apply/modify/remove a special recorded announcement* – Upon request from an operator, manager directs agent to establish a special recorded announcement and to specify the type of traffic which is to be routed to the special announcement.

5.3.3 Traffic administration function set

This set manages schedules for traffic measurement and other data that support traffic measurements and traffic control.

5.3.3.1 Management requirements

5.3.3.2 General Functional Model

5.3.3.3 TMN Management Functions

1) *Establish/change/remove a measurement schedule* – Upon request from an operator, manager directs agent to establish, change or 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 database* – Manager directs agent to establish or update a database 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 HTR determination* – Upon request from an operator, manager directs agent to establish, change

or remove 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* – Upon request from an operator, manager directs agent to establish, change or remove schedules in the exchange or operations systems for the reporting of status and network performance data.

5) *Report routing table information on demand* – Upon request from an operator, manager directs agent to establish, change or remove routing table information which resides in the exchange of operations system in response to an operator request.

5.3.4 Performance administration function set

This set provides management of schedules, thresholds, and other attributes for Performance Monitoring and for Quality of Service test calls.

5.3.4.1 Management requirements

5.3.4.2 General Functional Model

5.3.4.3 TMN Management Functions

1) *Schedule Performance Monitoring (PM) data report* – Manager directs agent to establish a schedule for the reporting of PM data.

2) *Request PM data report schedule* – Manager directs agent to send the current PM data reporting schedule. Agent responds with the schedule.

3) *Set PM attributes* – Manager directs agent to assign designated values to PM attributes.

4) *Request PM attributes* – Manager requests agent to send current PM attributes.

5) *PM attributes report* – Agent sends the currently assigned PM attributes to manager.

6) *Assign PM thresholds* – Manager directs agent to set or change the PM parameter threshold.

7) *Suspend/resume a PM data collection* – Manager instructs agent to suspend/resume the PM data collection activity for a given monitored entity or set of monitored entities.

8) *Screen PM data storage* – Manager instructs the agent to originate historical data based on some screening criteria (e.g. suppress "all-zero" data).

9) *Assign PM data collection interval* – Manager instructs the agent about the duration of the PM data collection interval for a given entity or set of entities.

10) *Request PM thresholds* – Manager directs agent to send the current PM threshold.

11) *Schedule QOS test calls* – Manager directs agent to establish a schedule for the execution of QOS test calls.

12) *Request QOS test call schedule* – Manager directs agent to send the current QOS test call schedule.

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

14) *Set QOS rest call attributes* – Manager directs agent to set or change the attributes of QOS test calls.

15) *Start/stop QOS test calls* – Manager directs agent to start or stop sending test calls.

16) *Initialize QOS test calls* – Manager directs agent to reset the storage registers for test calls.

17) *Request QOS test call attributes* – Manager directs agent to send the current QOS test call attributes.

5.3.5 Execution of traffic control function set

This set supports commands to change traffic controls and provides access to data concerning status and execution of the controls.

5.3.6 Audit report function set

This set reports on control information available at the NE.

5.4 Performance Analysis

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

Performance Analysis includes the following functions sets:

- Recommendations for performance improvement function set.
- Exception threshold policy function set.
- Traffic forecasting function set.
- Customer service performance summary (excludes traffic) function set.
- Customer traffic performance summary function set.
- Traffic exception analysis function set.
- Traffic capacity analysis function set.
- Network performance characterization function set.
- NE(s) performance characterization function set.
- NE(s) traffic exception analysis function set.
- NE(s) traffic capacity analysis function set.

5.4.1 Recommendations for performance improvement function set

This set supports generation of recommended steps, such as changes in procedure, augmentation or redistribution of capital or labour, etc., to improve quality in the future, as determined by improvements in performance measurements.

5.4.2 Exception threshold policy function set

This set manages conditions for taking corrective actions for exceptions to acceptable performance measurements, together with a designation of the type of action to be taken.

5.4.3 Traffic forecasting function set

This set reports on predicted changes in demand, from a combination of extrapolation of history and an evaluation of business factors. The prediction is needed far enough into the future that action may be taken to maintain quality targets.

5.4.4 Customer service performance summary (excludes traffic) function set

This set supports the generation of reports on summaries of measurements for the purpose of evaluating the performance of a particular transport service or group of services. The customer can be provided access to the summary in order to verify that guaranteed service levels have been met, or to enable the customer to evaluate their own networks.

5.4.5 Customer traffic performance summary function set

This set provides access to a scheduled or exception report of offered traffic, usage and measures of congestion on a leased circuit, a group of leased circuits, a hunt group, or a leased physical or virtual network.

5.4.6 Traffic exception analysis function set

This set reports analysed traffic data from a network or part of a network in order to detect and report on exceptional conditions due to unusual demand or reduced capacity. Traffic exception analysis is analysis of traffic patterns to detect blocking conditions that exceed thresholds. Reports of traffic blocking conditions that exceed thresholds are generated. They provide sufficient supporting information to reveal the extent of congestion and to support a determination of remedial action (re-routing, improved maintenance, additional capacity in switches or interexchange circuits, public service emergency announcements, etc.).

5.4.7 Traffic capacity analysis function set

This set supports the generation of reports to estimate the level of offered traffic that can be carried by the current resources at the desired level of QOS.

5.4.8 Network performance characterization function set

This set supports the generation of reports to characterize end-to-end performance of dedicated digital networks, which includes Network Interface-to-Network Interface, and Network Interface-to-Inter-Network Interface (point of termination), in relation to long-term (i.e. 30 or more days) accuracy and availability objectives.

5.4.9 NE(s) performance characterization function set

This set reports processed and analysed performance data based on measurements such as current and history counts and threshold violations (threshold crossing alerts) in support of the evaluation of the performance level of the entity. Thresholding recognizes that a performance monitoring count has equalled or exceeded a predetermined level that has been set within the NE(s). The NE sends the type of threshold, threshold level, and register value as part of the threshold crossing alert message.

5.4.9.1 Management requirements

5.4.9.2 General Functional Model

5.4.9.3 TMN Management Functions

1) *Report PM data* – Agent reports PM data to manager.
2) *Report PM threshold violation* – Agent informs the manager of a PM parameter threshold violation having occurred in a specific monitored entity.

5.4.10 NE(s) traffic exception analysis function set

This set provides collection and analysis of traffic data from an NE or group of NEs. Reports on exceptional conditions due to unusual demand or reduced capacity.

5.4.11 NE(s) traffic capacity analysis function set

This set reports analysed traffic data from an NE or a group of NEs in order to determine the traffic capacity for the measured mix of types of usage.

6 Fault Management

Fault Management is a set of functions which enables the detection, isolation and correction of abnormal operation of the telecommunication network and its environment. It provides facilities for the performance of the maintenance phases from Recommendation M.20 [17]. The quality assurance measurements for Fault Management include component measurements for Reliability, Availability and Survivability (RAS).

Fault Management includes the following function set groups:

- RAS Quality Assurance.
- Alarm Surveillance.
- Fault Localization.
- Fault Correction.
- Testing.
- Trouble Administration.

6.1 RAS Quality Assurance

RAS Quality Assurance establishes the reliability criteria that guides the design policy for redundant equipment (a responsibility of Configuration Management), and the policies of the other function groups in this area.

RAS Quality Assurance includes the following function sets:

- Network RAS goal setting function set.
- Service availability goal setting function set.
- RAS assessment function set.
- Service outage reporting function set.
- Network outage reporting function set.
- NE(s) outage reporting function set.

6.1.1 Network RAS goal setting function set

This set provides access to quantitative goals that are set for the frequency and duration of network outages over a specified period of time.

6.1.2 Service availability goal setting function set

This set provides access to quantitative goals that are set for the frequency and duration of network outages over a specified period of time.

6.1.3 RAS assessment function set

This set provides access to quantitative goals that are set and provides access to reports of measurements of reliability, availability and survivability in comparison with goals.

6.1.4 Service outage reporting function set

This set provides access to a database of outage reports concerning an outage of services to multiple customers. The report may include the type of services affected, the number of customers affected, and the start and end times of the outage. Such reports include statistics concerning service outages by designated areas and over designated periods of time.

6.1.5 Network outage reporting function set

This set provides access to a database of outage reports concerning an outage of a network, or a major part of a network. Such reports include statistics concerning both NE outages and network outages by designated areas and over designated periods of time.

6.1.6 NE(s) outage reporting function set

This set provides access to a database of outage reports concerning an NE, or a major part of an NE, or a group of NEs. This type of report is created after outage has occurred and may be updated during and after the outage has been corrected. The final report should include the identification and location of the NE, the type of NE, the start time of the outage, the end time of the outage and the reason for the outage if known. Such reports are not made for protected faults.

6.2 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 database 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.

Alarm information can be reported at the time of occurrence, and/or logged for future access. An alarm may also cause further management actions within the NE that lead to the generation of other fault management data.

In order to enable the TMN to perform alarm surveillance, NEs must:

- Allow monitoring of alarm conditions in a near-real time or scheduled manner.
- Allow querying of alarm conditions existing on the NE.
- Allow logging and retrieval of historical alarm information.

Alarm Surveillance includes the following function sets:

- Alarm policy function set.
- Network fault event analysis, including correlation and filtering function set.
- Alarm status modification function set.
- Alarm reporting function set.
- Alarm summary function set.
- Alarm event criteria function set.
- Alarm indication management function set.
- Log control function set.
- Alarm correlation and filtering function set.
- Failure event detection and reporting function set.

6.2.1 Alarm policy function set

This set creates and updates tables assigning domains of alarm reporting (in terms of coverage of lists of NEs, as individuals or by location) to surveillance centres and systems. It also supports

network-level tables defining under what conditions an alarm is to be inhibited and the level of severity to be assigned to specific alarm conditions.

6.2.2 Network fault event analysis, including correlation and filtering function set

This set provides access to a summary of non-redundant alarms at the network level, which allows further reduction of redundancy beyond what can be accomplished by correlation and filtering alarms in the context of an NE or group of NEs. This function set also supports notifications of new filtered, correlated alarms, or changes in the status of a previously reported alarm: for example, notification that an alarm has been cleared.

6.2.3 Alarm status modification function set

This set allows a user to administer rules for the revision of the alarm status (major, minor, etc.) as received from an NE before it is displayed or processed further. The rules reflect alarm policy, which in turn reflects field experience.

6.2.4 Alarm reporting function set

This set reports alarms and related information. These functions support the asynchronous reporting of alarm conditions.

6.2.4.1 Management requirements

6.2.4.2 General Functional Model

Alarms are specific types of notifications concerning detected faults or abnormal conditions. An alarm notification results from an alarm condition which persists long enough to qualify as a non-transient condition as determined by some algorithm applied to the condition. Such an algorithm may be simple (e.g. "all occurrences of the condition shall be treated as alarms") or complex (e.g. by applying one of the defined threshold types to the condition). When an alarm condition exists, the affected managed object has an "ACTIVE-REPORTABLE" alarm status.

Similarly, when the alarm condition ceases to exist, an alarm notification is generated to report clearing of the alarm. The affected managed object’s alarm status is "CLEARED".

When some condition has been recognized but has not persisted long enough to qualify as a non-transient condition (as determined by some algorithm applied to the condition), the affected managed object’s alarm status becomes "ACTIVE-PENDING". In the case of a "null" algorithm (i.e. all occurrences of the condition are treated as non-transient), or when the transient conditions can occur too frequently to be meaningfully monitored, the "ACTIVE-PENDING" status will not exist.

Figure 1 illustrates the states and transitions related to the alarm status of managed objects.

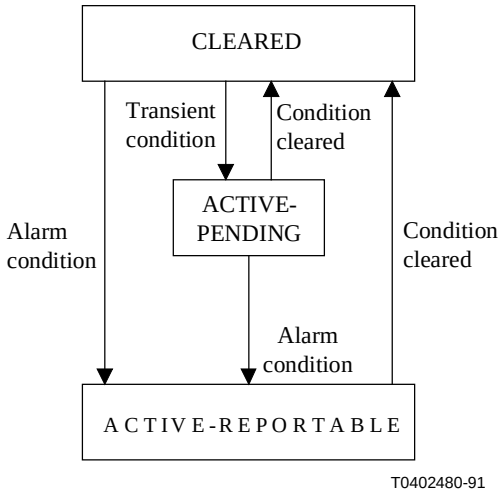

Figure 1/M.3400 – Status and transitions related to the alarm status of managed objects

An NE must provide a mechanism for the control of notification, e.g. whether an alarm condition results in an alarm report to the TMN. The requirements to be satisfied are:

- the definition of a flexible alarm report control mechanism which will allow systems to select which alarm reports are to be sent to the TMN;
- specification of the destination to which the alarm reports are to be sent;
- specification of a mechanism to control the forwarding of alarm reports, for example, by suspending and resuming their forwarding;
- the ability for the TMN to modify the conditions used in the reporting of alarm conditions.

6.2.4.3 TMN Management Functions

This subclause describes the NE Alarm reporting functions.

1) *Report Alarm* – Agent notifies manager of alarm information upon the occurrence of an alarm.

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

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

4) *Condition Alarm Reporting* – Manager instructs the agent to assign filtering criteria for alarm reporting.

5) *Request Alarm Report Control Condition* – Manager requests agent to send the current assignment of filtering criteria for alarm reporting; agent responds with the current assignment of the specified attributes.

6) *Allow/Inhibit Alarm Reporting* – Manager instructs the agent to allow/inhibit alarm reports to the manager.

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

6.2.5 Alarm summary function set

This set reports, and controls reporting, of a summary of the current alarm conditions of specified managed objects. These functions support the reporting of alarm conditions in a scheduled and/or on demand basis.

Features of this function set may include:

- The definition of a flexible current alarm summary control mechanism which will allow a system to provide a summary of current alarm conditions for specified managed objects to the TMN, periodically or upon request.
- The specification of the destination to which the alarm summary reports are to be sent.
- The specification of a mechanism to control the forwarding of alarm summary reports, for example, by suspending and resuming their forwarding.
- The ability for the TMN to modify the conditions used in the reporting of alarm summary reports.

6.2.5.1 Management requirements

6.2.5.2 General Functional Model

The model for current alarm summary reporting describes the conceptual components that provide for the collation of current alarms into a current alarm summary report. The alarms are received from specified managed objects and satisfy defined conditions. The reporting may be on a scheduled or on-demand basis.

The current alarm summary control is used to provide the current alarm summary report for the specified managed objects and condition. It is provided in response to a message from the management operation scheduler or a specific request from the TMN to retrieve the current alarm summary report.

Figure 2 is a schematic representation of the components involved in generating, and reporting current alarm summary reports.

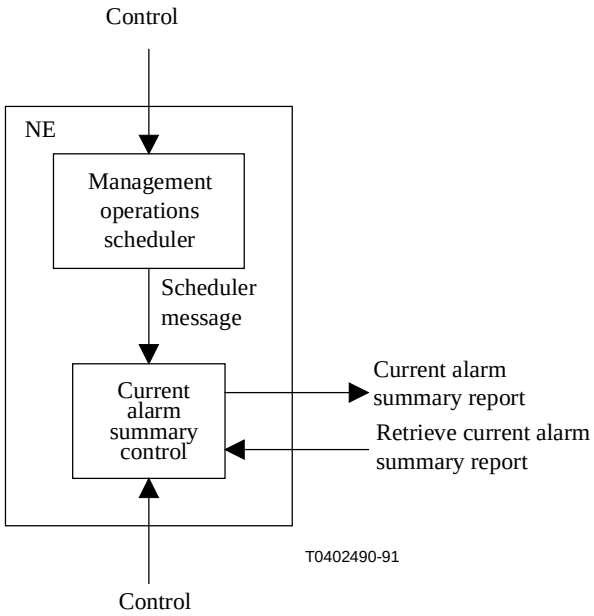

Figure 2/M.3400 – Current alarm summary report

6.2.5.3 TMN Management Functions

1) *Report current alarm summary* – Agent provides manager (based on a pre-defined schedule) with a current alarm summary.

2) *Route current alarm summary* – Manager specifies to the agent the destination address(es) for a specified set of current alarm summaries.

3) *Request current alarm summary route* – Manager requests agent to send the current assignment of the destination address(es) for a specified set of current alarm summaries; agent responds with the current assignment of destination address(es).

4) *Schedule current alarm summary* – Manager specifies a schedule for the agent 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* – Manager requests agent to send the current schedule information for Current Alarm Summary reporting; agent responds with the schedule information.

6) *Allow/inhibit current alarm summary* – Manager instructs the agent to allow/inhibit reporting of the scheduled current alarm summaries.

7) *Request current alarm summary* – Manager requests the agent to send a current alarm summary; agent responds with the summary. This function allows an agent to report alarm conditions of specified resources (severity, status, cause, etc.).

6.2.6 Alarm event criteria function set

This set manages the criteria used by a resource to determine when a certain condition is to be considered an alarm. The alarm event criteria functions allow for the assignment of specified attributes (e.g. thresholds, etc.) used by resources within the NE to determine if a condition is to be considered an alarm.

1) *Condition alarm event criteria* – Manager instructs the agent to assign specified alarm attributes (e.g. thresholds, etc.) used by resources accessed through the agent to determine if an event is to be considered an alarm.

2) *Request alarm event criteria* – Manager requests agent to report the current assignments of specified attributes (e.g. thresholds, etc.) used by the resources to determine if an event is to be considered an alarm; agent responds with the current assignment of the requested attributes, modes, or thresholds.

6.2.7 Alarm indication management function set

This set controls audible/visual alarm indications.

6.2.7.1 Management requirements

6.2.7.2 General Functional Model

6.2.7.3 TMN Management Functions

1) *Inhibit/allow audible/visual alarm indications* – Manager instructs the agent 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* – Manager instructs the agent to reset specified audible alarm indicator(s). This function momentarily removes any alarm indications, but allows further alarms to trigger audible/visual indicators.

6.2.8 Log control function set

This set controls logging and the retrieval of alarm history for an NE.

Features of this function set may include:

- The definition of a flexible log control mechanism which will allow selection of alarms that are to be logged by a management system in a particular log.
- The ability for the TMN to modify the criteria used in logging alarms.
- The ability for the TMN to determine whether the logging characteristics were modified or whether alarm records have been lost.
- The specification of a mechanism to control the time during which logging occurs, for example by suspending and resuming logging.
- The ability for the TMN to retrieve alarm records from the log.
- The ability for the TMN to create and delete logs.

Note that these features do not include the option of deleting alarm records from a log. This is to ensure that a complete audit trail of alarm reports is maintained.

6.2.8.1 Management requirements

6.2.8.2 General Functional Model

For the purpose of alarm surveillance, it is necessary to preserve information about alarm reports that have occurred as a result of alarm reports on managed objects. Alarm records, in the log, contain the information from their corresponding alarm reports.

The model for the log control functions describes the conceptual components that provide for the logging and retrieval of alarm information.

Figure 3 is a schematic description of the alarm logging capability.

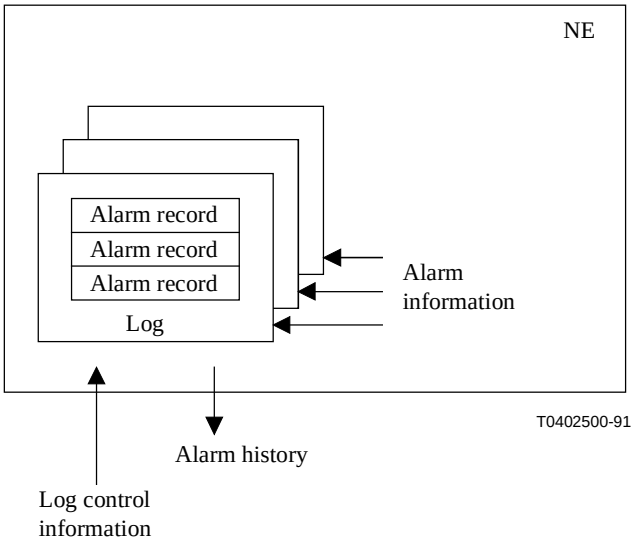

Figure 3/M.3400 – Alarm logging capability

6.2.8.3 TMN Management Functions

1) *Allow/inhibit logging* – Manager instructs the agent to allow/inhibit logging of log records.

2) *Condition logging* – Manager instructs the agent to assign log attributes as specified by the manager.

3) *Request log condition* – Manager requests agent to send the current assignment of specified log attributes; agent responds with the current assignment of the specified attributes.

6.2.9 Alarm correlation and filtering function set

This set supports alarm notifications. Notifications are sent to report alarms that are not redundant, within the scope of an NE or group of NEs.

6.2.9.1 Management requirements

6.2.9.2 General Functional Model

Correlation involves interpreting state changes which occur in networks, network elements, and operational equipment or systems, in the light of related conditions and circumstances. A state change may be meaningful of itself, or only when specific other state changes occur, possibly in a predefined time-order, or when specific other state changes do not occur.

State changes are normally manifested as events or notifications which are emitted spontaneously by the equipment or system where the state change occurred.

Events which are transient, redundant, implied or fit into a known pattern can be correlated, with only the interesting "master" root cause events presented to a network operator.

Events should be processed as close to their source as possible and immediately upon their arrival at the management system.

Note that an alarm is a special kind of event indicating a problem condition.

The following set of functions describe the general functional model.

- *Determine identity of event* – Identify event's unique identity.
- *Filter events* – Select specific event(s) from a general stream of events. Note that this filtering differs from the *event forwarding discriminator* which is used only to determine which event reports are to be forwarded to a particular destination during specified time periods. The TMN management function of *"Filter events"* can eliminate, that is, filter any user defined set of conditions.
- *Suppress transient events* – Suppress events which only occur on a rare and intermittent basis which are not of consequence to the network services.
- *Suppress redundant events* – Suppress redundant events, but count those events.
- *Suppress implied events* – Suppress all events which are implied by root cause event, but enhance information in root cause event.
- *Maintain event inter-dependencies* – Evaluate significance of event based on one or more other events which are generated and delivered independently.
- *Handle event arriving out of order* – Handle events, which due to different network transient delays or clock skew in the device and manager systems, arrive in a different order than their creation time order.
- *Handle environmental conditions* – Management system takes into account such environmental conditions as business rules, time of day, configuration values, affecting event significance.
- *Access external data sources* – Correlate events based on information stored externally.

- *Trigger automatic action* – Manager initiates an action to be taken based on event information.
- *Take action which is based on non-arrival of an event* – This function waits for the receipt of an event, and stimulates an action based on the non-arrival of the event within a specified period of time.

6.2.9.3 TMN Management Functions

1) *Determine identity of event* – Agent provides manager with event's unique identity.
2) *Filter events* – Manager requests agent to select specific event(s) from a general stream of events.
3) *Suppress transient events* – Manager requests agent to suppress events which only occur on a rare and intermittent basis which are not of consequence to the network services.
4) *Suppress redundant events* – Manager requests agent to suppress redundant events, but count those events.
5) *Suppress implied events* – Manager request agent to suppress all events which are implied by root cause event, but enhance information in root cause event.
6) *Maintain event inter-dependencies* – Manager requests agent to evaluate significance of event based on one or more other events which are generated and delivered independently.
7) *Handle event arriving out of order* – Manager handles events received from agent, which due to different network transient delays or clock skew in the device and manager systems, arrive in a different order than their creation time order.
8) *Handle environmental conditions* – Manager requests agent to correlate events based on environmental conditions such as business rules, time of day, configuration values, affecting event significance.
9) *Access external data sources* – Manager requests agent to correlate events based on information stored externally.
10) *Trigger automatic action* – Manager requests agent to initiate an action to be taken based on event information.
11) *Take action which is based on non-arrival of an event* – Manager requests agent to wait for the receipt of an event, and in turn initiates an action based on the non-arrival of the event within a specified period of time.
12) *Receive raw data* – Manager receives alarm and other events from agent.
13) *Root cause message* – Manager receives root cause notification from agent.
14) *Forward alarms* – Manager receives analysed, filtered alarms and other events from agent.

6.2.10 Failure event detection and reporting function set

This set provides access to the results of hardware and software checks that are made in the course of carrying out telecommunications functionality, on schedule and as background processing.

6.3 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 [17]).

Fault localization includes the following function sets:

- Fault localization policy function set.

- Verification of parameters and connectivity function set.
- Network fault localization function set.
- NE(s) fault localization function set.
- Running of diagnostic function set.

6.3.1 Fault localization policy function set

This set provides access to tables assigning domains of fault localization (in terms of coverage of lists of circuits, paths, facilities and NEs, as individuals or by location) to fault localization centres and systems. Also provides access to parameters of the procedures for escalation if a trouble is not resolved in an allowed time period.

6.3.2 Verification of parameters and connectivity function set

This set supports requests for verification and accesses of databases in other functions to verify that cross-connections and parameters of termination points are consistent with service features.

6.3.3 Network fault localization function set

This set supports notifications that a root cause of a fault has been found. A trouble ticket may be created in databases of other functions.

6.3.3.1 Management requirements

6.3.3.2 General Functional Model

The process to determine fault will be started by the information received by status management from the network; that is information such as alarm report, user message from customer, real-time status report by N/W carriers, status report by source vendors or test results by automatic or manual testing routines. Based on the fault information received, the trouble ticket is opened by ticket management and consolidated with trouble ticket related.

Event management will analyse the fault report, and there are four opportunities for reaching the next status: diagnosed, help required, suspended or went away.

After successful diagnosis, the problem will be "repaired", and the trouble ticket may be closed. Otherwise, the problem may be reselected. Problems, which disappear or are suspended, or when their time expires, may be changed to an "expired" status. After the problem is determined, the problem message is sent to the customer, for instance, outage equipment.

After this process, the database will be up to date and create a historical record. For special conditions, the system develops a hypothesis to solve a problem. Figure 4 shows the model of the Network fault localization TMN management function set.

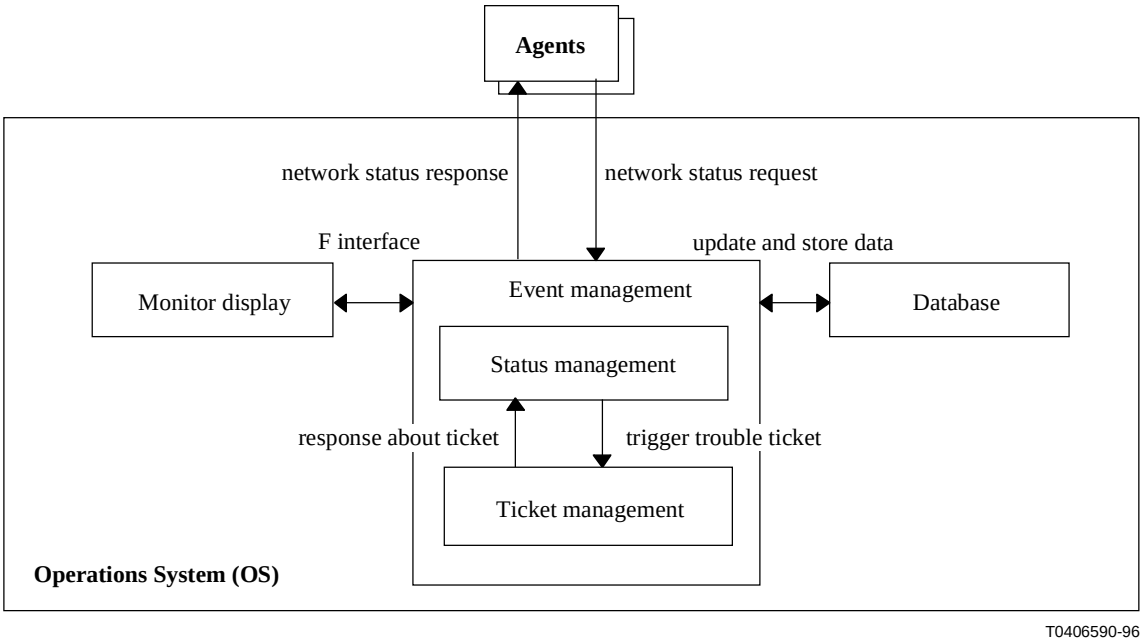

Figure 4/M.3400 – Network fault localization

6.3.3.3 TMN Management Functions

1) *Alarm* – Agent sends the alarm to manager.
2) *Customer message* – Agent sends the message to manager.
3) *Network carriers status report*– Agent reports the real-time status to manager.
4) *Vendors status report* – Agent sends the vendors status to manager.
5) *Test result* – Manager directs agent to report the result of automatic or manual testing routines.
6) *System open/close tickets* – Manager directs agent to open/close trouble ticket.
7) *Consolidation of related tickets* – Manager directs agent to consolidate with tickets related.
8) *Cancel/clear trouble tickets* – Manager directs agent to cancel/clear trouble ticket.
9) *Trouble status updated* – Manager directs agent to update trouble status.
10) *Create historical record* – Manager directs agent to create historical record.
11) *Send trouble ticket* – Manager directs agent to send trouble ticket to proper vendors.
12) *Choose proper procedure* – Manager directs agent to choose the proper procedure for determination process.
13) *Select alternative* – Manager directs agent to select procedure alternative.
14) *Institute back-up procedure* – Manager directs agent to perform back-up procedure.
15) *Breakdown diagnostic* – Manager directs to agent to breakdown diagnostic process.
16) *Selected problem* – Manager directs agent to select problem for diagnostic process based on priorities.
17) *Help required* – Manager directs agent to suspend diagnostic due to priorities.
18) *Suspended diagnosis* – Manager directs agent to suspend diagnostic due to priorities.
19) *Went away* – Manager directs agent to stop diagnostic since the problem has disappeared, and no further diagnosis is required.

20) *Timer control* – Manager directs agent to set up timer for monitoring whether a diagnostic process completes in an assigned time.

21) *Review the trouble database* – Manager directs agent to review trouble database.

22) *Develop hypothesis* – Manager directs agent to develop hypothesis in a special condition.

23) *Provision of detail information* – Manager directs agent to provide detailed information for further analysis.

24) *Loop test* – Manager directs agent to perform a loop test.

25) *Send message* – Manager directs agent to send message to customer about outage.

26) *Initiate remote test* – Manager directs agent to initiate a remote test.

6.3.4 NE(s) fault localization function set

This set provides the scheduling and reporting of a selected diagnostic, exercise, audit, etc.

6.3.4.1 Management requirements

6.3.4.2 General Functional Model

6.3.4.3 TMN Management Functions

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

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

3) *Diagnostic report* – Agent reports the results of a diagnostic sequence to the manager. 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* – Manager directs agent to establish a routine schedule for the initiation of a diagnosis.

5) *Request diagnostic schedule* – Manager requests agent to report the current schedule of diagnosis.

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

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

8) *Exercise report* – Agent sends the results of an exercise to manager.

9) *Stop exercise* – Manager directs agent to stop a particular exercise in progress.

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

11) *Request exercise report schedule* – Manager directs agent to send the current schedule of an exercise. Agent responds with the schedule.

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

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

14) *Hold network path* – Manager directs agent to hold a particular network path.

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

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

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

18) *Program trace report* – Agent automatically reports to manager the results of a trace.

19) *Start/stop audit* – Manager directs agent to start or stop an audit.

20) *Audit report* – Agent automatically reports to manager the results of an audit.

21) *Audit schedule* – Manager directs agent to establish a specified schedule for a given audit.

22) *Request audit schedule* – Manager requests agent to send the current audit schedule. Agent responds with the test schedule.

23) *Schedule loop insulation test* – Manager directs agent to schedule a loop insulation test.

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

25) *Request loop insulation rest schedule* – Manager requests agent to send a current loop insulation test schedule. Agent responds with the schedule.

26) *Schedule routine tests.*

27) *Start/stop routine tests*.

28) *Report routine test schedule*.

6.3.5 Running of diagnostic function set

This set supports reports of the result of a diagnostic (a test of hardware or and audit or other check of software within an NE) and provides the ability to request a diagnostic. It may be necessary to remove a unit from service in order to run a diagnostic.

6.4 Fault Correction

Fault Correction transfers data concerning the repair of a fault and for the control of procedures that use redundant resources to replace equipment or facilities that have failed.

Fault Correction includes the following function sets:

- Management of repair process function set.
- Arrangement of repair with customer function set.
- Scheduling and dispatch administration of repair forces function set.
- NE(s) fault correction function set.
- Automatic restoration function set.

6.4.1 Management of repair process function set

This set manages a database of the repair process, including staffing levels, work units, costs, mean-time-to-repair, scheduling effectiveness and efficiency.

6.4.2 Arrangement of repair with customer function set

This set supports contacting a customer to schedule dispatch to customer premises.

6.4.3 Scheduling and dispatch administration of repair forces function set

This set supports the creation of a work order, which may support repair, network growth or service activation.

6.4.4 NE(s) fault correction function set

This set manages redundant units (hot-standby) or isolates a unit with a fault. Reporting of automatic restoration processes carried within an NE or groups of NEs working together. A report is made of a successful restoration or an unsuccessful attempt at restoration.

6.4.4.1 Management requirements

6.4.4.2 General Functional Model

6.4.4.3 TMN Management Functions

1) *Automatic restoration report* – Agent reports to manager 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 manager.
2) *Hot standby procedure* – Manager requests agent 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* – Manager requests agent to reconstruct a service or a single system (main or standby) from a specified dump record.
4) *Reload report* – Agent reports to manager that it has reloaded a service or a single system (main or standby) from a dump.

6.4.5 Automatic restoration function set

This set provides for notification that a unit containing a fault has been removed from service, after a fault has been detected and the smallest protected unit containing the fault has been identified. Also provides for inhibition and override of automatic restoration functionality.

6.5 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.

Testing includes the following function sets:

- Test point policy function set.
- Service test function set.
- Circuit selection, test correlation and fault location function set.
- Selection of test suite function set.
- Test access network control and recovery function set.
- Test access configuration function set.
- Test circuit configuration function set.
- NE(s) test control function set.
- Results and status reporting function set.
- Test access path management function set.
- Test access function set.

6.5.1 Test point policy function set

This set administers tables that define the conditions for providing test access at various points along a circuit.

6.5.2 Service test function set

This set provides testing of a service feature or set of service features.

6.5.2.1 Management requirements

6.5.2.2 General Functional Model

6.5.2.3 TMN Management Functions

1) *Initiate service test* – Manager requests agent to test a service to ensure that it is available for operation.
2) *Report service test result* – Agent reports to manager the results of testing the operation state of a service.

6.5.3 Circuit selection, test correlation and fault location function set

This set supports requests for tests of an end-to-end circuit and supports the return of test results.

6.5.4 Selection of test suite function set

This set supports requests that a specific part of a circuit be tested and supports the return of results.

6.5.5 Test access network control and recovery function set

This set provides for setting up a suite of tests on a specific part of a circuit, determining the configuration of the appropriate test access points, and sending the appropriate commands.

6.5.5.1 Management requirements

6.5.5.2 General Functional Model

6.5.5.3 TMN Management Functions

1) *Report test system initialization* – Agent reports initialization of test system to manager.
2) *Report test access system initialization* – Agent reports initialization of test access system to manager.
3) *Initialize and restore access system* – Manager directs agent to release all existing test access connections in agent, and restore all TAPs involved to an idle state.

6.5.6 Test access configuration function set

This set provides for setting up the configuration of test access arrangements and access to status information.

6.5.6.1 Management requirements

6.5.6.2 General Functional Model

6.5.6.3 TMN Management Functions

1) *Connect test access* – Analogue, voiceband data, subrate digital data, and DS1, E1 or T1: manager directs agent 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: manager directs agent 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 or T1 either the monitor or split mode may be requested.

3) *Release test access* – Analogue, voiceband data, subrate digital data, and DS1, E1 or T1: manager directs agent to drop access to the circuit under test and return the circuit to its normal state.

6.5.7 Test circuit configuration function set

This set provides for setting up the configuration of test access arrangements and access to status information.

6.5.7.1 Management requirements

6.5.7.2 General Functional Model

6.5.7.3 TMN Management Functions

1) *Interexchange pairs* – Manager directs agent 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 or T1 on either the Equipment or Transmission Facility side of the test port.

2) *Change leads* – Manager directs agent to execute reversal of tip and ring leads of metallic transmission pair(s) on the circuit under test.

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

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

5) *Configure multipoint junction unit branches (select, restore, and block)* – Manager directs agent to perform various control functions such as block, select, unselect, and release, on the Multipoint Junction Unit in the circuit.

6) *Operate and release loopback equipment* – Manager directs agent to split the circuit under test and change the operate, release functions of digital network element latching loopback devices; or the manager directs the agent to change the activate, deactivate, and release functions of DS1/El loopback devices provided at network points and customer interfaces.

6.5.8 NE(s) test control function set

This set provides for controlling the performance of a test or a suite of tests.

6.5.8.1 Management requirements

6.5.8.2 General Functional Model

6.5.8.3 TMN Management Functions

1) *Control analogue test signal* – Manager directs agent to connect a test signal generator, and to change or remove a test signal on the circuit under test.

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

3) *Multimeter measurements* – Manager directs agent to measure multimeter characteristics including: alternating and direct current voltage, resistance, alternating and direct current, and capacitance.

4) *Signalling and supervision measurements* – Manager directs the agent to perform and report supervision in both directions for alternating and direct current signalling.

5) *Connect and disconnect monitor/talk line* – Manager directs agent 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* – Manager listens selectively to the circuit under test and monitors any transmission pair in either direction.

7) *Change monitor/talk level* – Manager directs agent to change the level of the monitor connection.

8) *Change monitor/talk filter* – Manager directs agent to remove or insert the single frequency notch filter placed in the monitor connection.

9) *Monitor digital data signals* – Manager establishes digital data monitor test access and determines the presence of network control codes or customer data.

10) *Test digital loopbacks* – Manager directs agent to provide a loopback on the circuit under test and perform a digital loopback test.

11) *Primary and secondary channel tests* – Manager directs agent to split the circuit under test and perform primary and secondary channel uses on specified equipment, such as multipoint junction units and channel service units.

12) *Digital tests* – Manager directs agent 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* – Manager requests agent to insert a controlled number of logical bit errors, cyclic redundancy check errors and line code violations into the digital bit stream in one or both directions of the circuit under tests.

14) *Simulated test* – Manager requests agent to simulate a specified failure and mark ensuing actions as dummies.

15) *Control DS1, E1 or T1 test signal* – Manager requests agent to change the test signal to the DS1, E1 or T1 under tests.

16) *Measure DS1, E1 or T1 signals* – Manager directs agent to measure the line signals on the DS1, E1 or T1 under test. These measurements may be made with the circuit in either the monitor mode or split mode.

17) *Terminate test measurement* – Manager directs agent 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, E1 or T1 signal measurement.

6.5.9 Results and status reporting function set

This set provides reporting of test results and status information.

6.5.9.1 Management Requirements

6.5.9.2 General Functional Model

6.5.9.3 TMN Management Functions

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

2) *Test Results Reporting* – Agent sends the results of a test to the manager.

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

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

6.5.10 Test access path management function set

This set provides management of Test Access Path (TAP) resources, and test resources such as signal generators and receivers.

6.5.10.1 Management requirements

6.5.10.2 General Functional Model

6.5.10.3 TMN Management Functions

1) *Establish loop around access* – Manager directs agent 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* – Manager directs agent to remove a TAP(s) from service.

4) *Restore TAP in service* – Manager directs agent to restore a TAP(s) into service.

5) *Connect and disconnect loop around* – Manager directs agent to apply or remove a loop around to the TAP(s) under test.

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

7) *Request TAP status* – Manager requests the status of all TAPs serving the agent.

8) *Report TAP status* – Agent reports the status of all TAPs to the manager.

6.5.11 Test access function set

This set supports requests for test access to a path or circuit supported by an NE. Test access may involve removing the path or circuit from service.

6.6 Trouble administration

Trouble administration transfers trouble reports originated by customers and trouble tickets originated by proactive failure detection checks. It supports action to investigate and clear the trouble and provides access to the status of services and the progress in clearing each trouble.

Trouble administration includes the following function sets:

- Trouble report policy function set.
- Trouble reporting function set.
- Trouble report status change notification function set.
- Trouble information query function set.
- Trouble ticket creation notification function set.
- Trouble ticket administration function set.

6.6.1 Trouble report policy function set

This set provides access to rules for verification and testing and for assigning a trouble to a dispatch administration agent. Parameters of a trouble report policy include timing for internal escalation of the resources applied to an outstanding trouble and conditions under which network configuration changes (as opposed to automatic restoration or protection switching) may be used to restore service.

6.6.2 Trouble reporting function set

This set supports reception of trouble reports from a customer, requests for actions to determine whether this is a new trouble and the entry of trouble reports into databases.

6.6.2.1 Management requirements

6.6.2.2 General Functional Model

6.6.2.3 TMN Management Functions

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.

6.6.3 Trouble report status change notification function set

This set supports notifications to a customer of a change in status of an existing trouble.

6.6.3.1 Management requirements

6.6.3.2 General Functional Model

6.6.3.3 TMN Management Functions

- *Report trouble status change* – A customer may be notified beforehand of changes in the trouble status.

6.6.4 Trouble information query function set

This set supports requests for tests of an end-to-end circuit and the return of test results.

6.6.4.1 Management requirements

6.6.4.2 General Functional Model

6.6.4.3 TMN Management Functions

1) *Check trouble status* – A customer may request status information on an open or closed customer trouble report.
2) *Review trouble history* – A customer may request information about past troubles reported for a particular service or circuit.
3) *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.

6.6.5 Trouble ticket creation notification function set

This set sends a notification to a customer of the creation of a new trouble ticket concerning the customer's services.

6.6.6 Trouble ticket administration function set

This set provides for access to all trouble reports and trouble tickets, whether created by customers, internal staff, or analysis of alarms or performance monitoring exceptions (trouble tickets, as opposed to trouble reports, reflect the results of analysis). Tracking reports are provided of the progress of fault correction and the clearing of trouble reports and trouble tickets.

7 Configuration Management

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

Configuration Management supports the following function set groups:

- Network Planning and Engineering.
- Installation.
- Service Planning and Negotiation.
- Provisioning.
- Status and Control.

7.1 Network Planning and Engineering

Network Planning and Engineering deals with the functions associated with determining the need for growth in capacity and the introduction of new technologies. It involves evaluation of alternate plans and the entry of chosen plans into a database that will support the Provisioning function group. Once a plan has been specified, the Provisioning function group will fill in further designed parameters and proceed toward implementation of the plan.

Network Planning and Engineering includes the following function sets:

- Product line budget function set.
- Supplier and technology policy function set.
- Area boundary definition function set.
- Infrastructure planning function set.
- Management of planning and engineering process function set.
- Demand forecasting function set.
- Network infrastructure design function set.
- Access infrastructure design function set.
- Facility infrastructure design function set.
- Routing design function set.
- NE(s) design function set.

7.1.1 Product line budget function set

This set provides access to data concerning capital and expenses allocated to provide funding for new resources and expansion of existing capacity for a specific set of services and supporting network capabilities.

7.1.2 Supplier and technology policy function set

This set provides access to data concerning guidelines for selecting technologies and associated hardware and software to be deployed in the network based on customer demand, positioning for competitive advantage, modernization of existing plant, etc. Generally, the guidelines consist of rules for definition of specifications and restrictions such as maximum capacity of a unit. It also provides access to data concerning guidelines for qualified suppliers based on product offering, price, features, capability limits of products, operations support, availability, etc.

7.1.3 Area boundary definition function set

This set provides access to information about the extent, expansion or redefinition of serving areas in terms of geographical boundaries or lists of NEs. Boundaries are designed to accommodate changes in demand type and volume, regional responsibility of work groups, applicable technology, etc.

7.1.4 Infrastructure planning function set

This set provides access to information about status, changes, additions, or removal of property, buildings, other structures, parking facilities, electric power, heating, ventilating and air conditioning equipment, etc.

7.1.5 Management of planning and engineering process function set

This set provides access to information about planning tools, and development of planning and engineering methods and procedures. It also provides access to information about the status, costs and schedules of planning and engineering jobs in progress.

7.1.6 Demand forecasting function set

This set provides access to estimates of new demand for specific services, typically over a 3-5 year period.

7.1.7 Network infrastructure design function set

This set supports requests to design the network infrastructure capacity to meet the forecast demand based on demand forecasts, traffic loads, and planned service offerings so that resource capacity will be available when service is required. It supports actions to carry out the design.

7.1.8 Access infrastructure design function set

This set supports requests to design access circuits, based on customer location, and the requested service features and route. It supports actions to carry out the design.

7.1.9 Facility infrastructure design function set

This set supports requests to design facilities based on the location of nodes, product line budget, requested service features, route, and demand forecasts. It supports actions to carry out the design.

7.1.10 Routing design function set

This set supports requests to determine the most efficient routing based on generic criteria for routing, such as traversing the least number of nodes, and customer specific criteria, such as alternate path routing. It supports responses that contain the proposed route.

7.1.11 NE(s) design function set

This set supports requests to design new or revised version of the software or hardware of NEs to meet the strategic demand for introduction of new technologies, new features or growth. It provides access to guidelines for technology policy, supplier policy and product line budget. It supports

actions to carry out the design. It provides access to information about the NE design. This set supports requests to design a group of NE(s), including their transmission media interconnections.

7.2 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 database 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.

Installation includes the following function sets:

- Procurement function set.
- Management of installation function set.
- Contracting function set.
- Real estate management function set.
- Arrangement of installation with customer function set.
- Network installation administration function set.
- Material management function set.
- Scheduling and dispatch administration of installation force function set.
- Installation completion reporting function set.
- Software administration function set.
- NE installation administration function set.
- Loading software into NEs function set.

7.2.1 Procurement function set

This set supports requests for procurement and provides access to information on the status of the procurement of equipment, tools, and supplies and negotiating for price and delivery date to meet corporate needs. It uses guidelines from Supplier policy, technology policy, etc.

7.2.2 Management of installation function set

This set provides access to information that can be used to monitor the installation process and the deliver of materials and coordinate contractors.

7.2.3 Contracting function set

This set supports requests for and provides access to status and other information concerning contracting services for installation. It supports management of the bidding process, contractor(s) selection, negotiation of job schedule and any special circumstances such as environmental concerns, job access restrictions, etc.

7.2.4 Real estate management function set

This set provides access to information about status, changes, additions or removal of property, buildings, other structures, parking facilities, etc. It provides access to information concerning the usage of space in buildings. It provides access to information about maintenance associated with the real estate.

7.2.5 Arrangement of installation with customer function set

This set supports requests for an agreed schedule for service down time, equipment installation, customer premises access, and pre-service testing as required for service installation. It supports responses with the agreed schedule.

7.2.6 Network installation administration function set

This set provides access to information about the coordination of hardware and software for new installations, upgrades, and maintenance changes across the network.

7.2.7 Material management function set

This set provides access to information for the management of the ordering, shipping, and receipt of material both hardware and software for the installation of resources and activation of services. It supports the electronic ordering, shipping and receipt of software.

7.2.8 Scheduling and dispatch administration of installation force function set

This set supports requests for the installation force to provide installation and pre-service testing support at the appropriate times with regard to equipment and customer access availability. It supports actions to dispatch the installation force. It provides access to the schedule and status of the work. It supports jeopardy reports.

7.2.9 Installation completion reporting function set

This set provides access to information about job status and supports notification of completion after acceptance testing as required. It also supports notification of failure to meet successful completion criteria, with the reason for unsuccessful completion. It also supports summary and exception reports for the management of installation jobs.

7.2.10 Software administration function set

This set provides for the acceptance of generic programs from suppliers (generic programs include applications, operating systems or middleware). It also supports administration of the versions of generic programs.

7.2.11 NE installation administration function set

This set provides access to information about the coordination of hardware and software for new installation, upgrades, and maintenance changes for individual NEs or a collection of NEs.

7.2.12 Loading software into NEs function set

This set provides for download of software to be stored in an NE. Loading includes initialization and testing that the load is successful and back-out of the software if the load is not successfully completed.

7.3 Service Planning and Negotiation

Service Planning and Negotiation deals with planning for the introduction of new services and with those customer contacts to establish new services, change service features and disconnect services.

Service Planning and Negotiation includes the following function sets:

- Service planning function set.
- Service feature definition function set.
- Marketing function set.

- Management of sales process function set.
- External relations (legal, stockholders, regulators, public relations) function set.
- Customer identification function set.
- Customer need identification function set.
- Customer service planning function set.
- Customer service feature definition function set.
- Solution proposal function set.

7.3.1 Service planning function set

This set provides access to a plan for service offerings on a generic basis for a wide range of customers. It also allows for the ongoing administration of those service offerings.

7.3.2 Service feature definition function set

This set provides access to descriptions of features that are used to characterize a particular service offering on a generic basis for a wide range of customers. It also allows for the ongoing administration of those service offerings.

7.3.3 Marketing function set

This set provides access to information about marketing methods, procedures and trained personnel to contact customers about service offerings to meet their business needs. It supports requests to gather and summarize information indicating existent, latent or potential needs of new or enhanced telecommunication services. It supports reports on such topics.

7.3.4 Management of sales process function set

This set provides access to information about sales skills, methods, procedures, trained personnel and automated tools to facilitate the selling of services to customers. It provides access to information about individual sales activities and campaigns including individual customer information, market segment, appointment schedule, mailings, telemarketing, advertising, responsible sales personnel, service presentation materials, etc.

7.3.5 External relations (legal, stockholders, regulators, public relations) function set

This set provides information about the status of negotiations and other interactions with stock holders, general public, regulators and other government agencies. It supports activities needed to raise awareness about telecommunications issues that directly or indirectly affect the public, maintaining and improving company image, and working with governmental and regulatory bodies to improve telecommunications.

7.3.6 Customer identification function set

This set supports interactions with the customer to determine the customer's name, address, and any distinguishing characteristics about the customer such as current services, line of business, and past usage. It supports updates of the customer database as appropriate.

7.3.7 Customer need identification function set

This set supports interactions with the customer to determine specific service requirements that will meet the customer's service needs and that align with the customer's willingness to pay for those services.

7.3.8 Customer service planning function set

This set provides access to a plan for specific service offerings and creation of services for a customer based on specific customer needs, marketing input and customer-specific demand forecasts. It allows for the ongoing administration of those service offerings.

7.3.9 Customer service feature definition function set

This set provides access to descriptions of features that are used to characterize a particular service offering for a customer and allows for the ongoing administration of those features. These features may be technology or customer specific to provide for the individual needs of a customer.

7.3.9.1 Management requirements

7.3.9.2 General Functional Model

7.3.9.3 TMN Management Functions

1) *Event reporting control* – Customer's OSF selects and controls the flow of notifications from the provider's OSF.
2) *Customize configuration* – Customer's OSF requests the provider's OSF to customize the configuration of service resources provided to customer.
3) *Log control* – Customer's OSF selects and controls the information the provider's OSF should log.

7.3.10 Solution proposal function set

This set provides access to information to develop a proposal to meet a particular customer's business need based on the resources that will be available when the customer needs them and at a fair market price. Service feature conflicts should be identified and resolved during the development of the solution proposal. It supports interactions with the customer to present the proposal.

7.4 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, standby, 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.

Provisioning includes the following function sets:

- Provisioning policy function set.
- Material management policy function set.
- Access route determination function set.
- Directory address determination function set.
- Leased circuit route determination function set.
- Request for service function set.
- Service status administration function set.
- Network resource selection and assignment function set.

- Interexchange circuit design function set.
- Access circuit design function set.
- Leased circuit design function set.
- Facility design function set.
- Manage pending network changes function set.
- Network connection management function set.
- Circuit inventory notification function set.
- Circuit inventory query function set.
- NE(s) configuration function set.
- NE(s) administration function set.
- NE(s) database management function set.
- Assignable inventory management function set.
- NE(s) resource selection and assignment function set.
- NE(s) path design function set.
- Loading program for service feature(s) function set.
- NE(s) inventory notification function set.
- NE(s) inventory query function set.
- Manage pending changes in NE(s) function set.
- Storage of parameters and cross-connects function set.
- Storage and execution of service features.
- Self-inventory function set.

7.4.1 Provisioning policy function set

This set provides access to guidelines for provisioning equipment. For example, certain NEs may be designated as pre-equipped during initial installation to facilitate "immediate" service activation. These guidelines provide rules for the selection of a set of service resources needed for a particular telecommunication service.

7.4.2 Material management policy function set

This set provides access to guidelines for the selection and use of materials.

7.4.3 Access route determination function set

This set supports requests for an access route for a specific service type. It supports responses that state an economic route from the customer point of presence to an appropriate transport network or switch.

7.4.4 Directory address determination function set

This set supports requests for a directory address. It supports responses that state a telephone number or other network address.

7.4.5 Leased circuit route determination function set

This set supports requests for a leased circuit route. It supports responses that state a route from, for example, a point of presence with another service provider to the end customer's location.

7.4.5.1 Management requirements

7.4.5.2 General Functional Model

7.4.5.3 TMN Management Functions

- *Set automatic switch to alternate routing on failure* – Manager requests agent to specify back-ups for connection.

7.4.6 Request for service function set

This set supports requests that the specified service and/or feature(s) be activated, changed, or deactivated as a result of the negotiated customer solution.

7.4.7 Service status administration function set

This set provides access to a database for the logging and tracking of service requests to ensure that all requests for service are met in a timely manner. It allows customers to access information about the services and features currently assigned to them.

7.4.7.1 Management requirements

7.4.7.2 General Functional Model

7.4.7.3 TMN Management Functions

1) *Report creation of service resource to customer* – When a service resource is created, an indication of creation is sent to the customer's OSF by the provider's OSF.
2) *Report deletion of service resources to customer* – When a service resource is deleted, an indication of deletion is sent to the customer's OSF by the provider's OSF.
3) *Report configuration change of service resource to customer* – When the configuration of a service resource is changed, an indication of configuration change is sent to the customer's OSF by the provider's OSF.
4) *Report service state change of service resource to customer* – When the service state of service resource is changed, an indication of the service state change is sent to the customer's OSF by the provider's OSF.
5) *Request of information about service resource by customer* – Customer's OSF requests provider's OSF to transmit the information of service resource to the customer's OSF.

7.4.8 Network resource selection and assignment function set

This set supports requests for network resources and responds with selected resources and the associated service features. It provides access to a network resource database. It supports requests for selection and assignment of resources and service features that meet any designated selection criteria. Network resources include facilities, switching and software such as service logic programs needed to provide service for a customer.

7.4.9 Interexchange circuit design function set

This set supports requests for the selection of an appropriate path for circuits that cross exchange boundaries (e.g. message trunks) based on routing design, facility design and demand forecast. It supports responses stating the selected resources.

7.4.10 Access circuit design function set

This set supports requests for access circuit design. It supports responses that state the access points from the customer to the network.

7.4.11 Leased circuit design function set

This set supports requests for leased circuit design. It supports responses that state the customer circuit endpoint(s) and the appropriate set of resources.

7.4.11.1 Management requirements

7.4.11.2 General Functional Model

7.4.11.3 TMN Management Functions

1) *Dynamic link configuration* – Manager requests agent to configure dynamic links.
2) *Dynamic link reconfiguration* – Manager requests agent to reconfigure dynamic links.
3) *Dynamic link endpoint configuration* – Manager requests agent to configure dynamic link endpoints.
4) *Connection configuration* – Manager requests agent to configure connections.
5) *Connection reconfiguration* – Manager requests agent to reconfigure connections.
6) *Connection endpoint configuration* – Manager requests agent to configure connection endpoints.

7.4.12 Facility design function set

This set supports requests for facility design, along a specified route. It supports responses that state the selected resources.

7.4.13 Manage pending network changes function set

This set supports requests for a coordinated set of changes in the connectivity and parameters of an end-to-end circuit at a specific future time. It supports actions to carry out the change. It supports confirmation and jeopardy reports. It supports confirmation of requests when all requested actions have been confirmed. It supports jeopardy reports as appropriate.

7.4.14 Network connection management function set

This set supports requests for a particular set of cross-connections required to implement a circuit design. It supports actions to request the cross-connections to be established in NEs or groups of NEs.

7.4.15 Circuit inventory notification function set

This set provides for the autonomous notification of changes in status of network resources and the features associated with those resources.

7.4.15.1 Management requirements

7.4.15.2 General Functional Model

7.4.15.3 TMN Management Functions

1) *Report creation of circuit resource* – When a circuit resource is created, an indication of creation is sent to manager from agent.
2) *Report deletion of circuit resource* – When a circuit resource is deleted, an indication of deletion is sent to manager from agent.
3) *Report configuration change of circuit resource* – When the configuration of a circuit resource is changed, an indication of configuration change is sent to manager from agent.

4) *Report service state change of circuit resource* – When the service state of circuit resource is changed, an indication of the service state change is sent to manager from agent.

7.4.16 Circuit inventory query function set

This set allows access to information about the current status of network resources and the features associated with those resources.

7.4.16.1 Management requirements

7.4.16.2 General Functional Model

7.4.16.3 TMN Management Functions

- *Request information of circuit resource for customer* – Manager requests agent to transmit the information of network resource.

7.4.17 NE(s) configuration function set

This set receives requests to arrange a series of service resources for response to a service order issued by a customer.

7.4.17.1 Management requirements

7.4.17.2 General Functional Model

7.4.17.3 TMN Management Functions

1) *Request configuration* – Manager requests that the agent report the current configuration of each entity.
2) *Configuration report* – For each entity, agent reports status, capacity of the entity, optional parameters, type of entity (in sufficient detail for manager identification) and the version and revision of the version.
3) *Grow* – Manager notifies agent of the presence of a newly installed entity.
4) *Prune* – Manager notifies agent of the disconnection of an entity.
5) *Restore* – Manager notifies agent to begin monitoring the newly installed entity.
6) *Assign* – Manager notifies agent that a previously unequipped entity is now equipped.
7) *Delete* – Manager notifies agent that a previously equipped entity is no longer equipped.
8) *Set service state* – Manager directs agent 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* – Manager requests that agent report the identity of each assigned entity. The request may be for a specified entity or for all equipped entities.
10) *Assignment reports* – Agent reports the identity of each assigned channel for each equipped entity or for a specified entity.
11) *Set parameters* – Manager directs agent to set parameters associated with a specified entity.
12) *Set service thresholds* – Manager directs agent to set performance thresholds for the specified channel.
13) *Add/drop* – Manager directs agent to insert or remove a channel from the complement of through-channels.
14) *Cross-connect* – Manager directs agent to interconnect two specified channels operating at the same rate.

15) *Disconnect* – Manager directs agent to remove the interconnection between two specified channels.

16) *Start transmission test* – Manager directs agent to begin a transmission test on a given circuit.

17) *Balance* – Manager directs agent to perform a balance test/adjustment.

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

19) *Set report periods* – The manager directs agent to set or change report periods.

20) *Request report periods* – The manager requests agent to send the current periods to the manager.

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

22) *Restart report* – Agent reports to manager 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 manager.

7.4.18 NE(s) administration function set

This set supports requests to synchronize, coordinate and authorize processes conforming to predetermined guidelines.

7.4.18.1 Management requirements

7.4.18.2 General Functional Model

7.4.18.3 TMN Management Functions

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

2) *Backup copy* – Manager directs agent to make a backup copy of the designated agent database file for purposes of archiving for future restoration.

3) *Terminate procedure* – Manager directs the agent to terminate a process between a manager and a agent.

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

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

7.4.19 NE(s) database management function set

This set supports requests to manage databases of NEs or a group of NEs that are used by business processes. It may also support management of fail-safe features of a database such as background mirroring, backup, etc.

7.4.19.1 Management requirements

7.4.19.2 General Functional Model

7.4.19.3 TMN Management Functions

1) *Initialize* – Manager configures a new database which is related to an agent. This may or may not be downloaded to the agent. This may also include loading a new program related to the agent.

2) *Reinitialize* – Manager reconfigures the database within a agent while it is in service.

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

4) *Query* – Manager reads agent for all or part of its database contents.

5) *Backup* – Manager keeps a copy of all or part of the database of a agent. In case of memory failure in the agent, the manager downloads the backup copy to the agent.

7.4.20 Assignable inventory management function set

This set provides access to information concerning NE resources that are assigned to services or that are currently available for assignment. It monitors utilization levels of resources and sends notifications when utilization exceeds thresholds. It responds to requests for utilization information.

7.4.21 NE(s) resource selection and assignment function set

This set supports requests for availability status of resources, requests for the selection and assignment of those resources, requests for the resources to change service state, and reports the assignments, as appropriate. These resources may be NEs, a group of NEs, or logical resources such as bandwidth or service logic programs.

7.4.22 NE(s) path design function set

This set supports requests for a path through an NE or a group of NEs that will allow for connection with other NEs or network interfaces to establish an end-to-end circuit connection. Selects and binds resources to form the required connection.

7.4.23 Loading program for service feature(s) function set

This set supports loading of software to activate service-specific features in NE components such as the downloading of software features to line cards at the time of activation of service. Loading includes support of reporting the results of testing that the load is successful and of back-out of the software features if the load is not successfully completed.

7.4.24 NE(s) inventory notification function set

This set supports notification from an NE about changes in the features that the NE supports.

7.4.25 NE(s) inventory query function set

This set provides access to information, as held in equipment that manages an NE, about the current resources of an NE and the features that an NE supports.

7.4.26 Manage pending changes in NE(s) function set

This set provides access to information about the management of individual NE connections and the removal of NE connections if end-to-end connections cannot be completed. It supports notification of changes that result from differences between assigned and installed NE configurations.

7.4.27 Access to parameters and cross-connects in NEs function set

This set provides access to NE information about its parameters and cross-connects.

7.4.28 Access to service features in NEs function set

This set provides access to NE information about its service feature settings and the capabilities defined by those settings.

7.4.29 Self-inventory function set

This set requests information from an NE about its equipment configuration.

7.5 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 restoration).

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.

Status and Control includes the following function sets:

- Priority service policy function set.
- Priority service restoration function set.
- Message handling systems network status function set.
- Leased circuit network status function set.
- Transport network status function set.
- NE(s) status and control function set.
- Access to state information function set.
- Notification of state changes by NEs function set.

7.5.1 Priority service policy function set

This set provides guidelines for determining which services have priority for restoration in the event of a catastrophic failure. For example, hospitals, police and emergency service would be designated as priority services for automatic restoration.

7.5.2 Priority service restoration function set

This set supports notifications of an out-of-service status of services that are designated to have priority service features. It supports actions for restoration of such services, where such actions may usurp resources from lower priority services, based on designated priority service features. For example, an emergency service would be designated as a priority service. It supports access to data concerning priority levels.

7.5.3 Message handling systems network status function set

This set provides access to status and supports requests to change status for a network of message handling systems and components of such a network such as switching nodes.

7.5.3.1 Management requirements

7.5.3.2 General Functional Model

7.5.3.3 TMN Management Functions

1) *Request message storage status data* – Manager requests agent to transmit the message storage status data of store-and-forward communication to manager.

2) *Message storage status data report* – Agent sends the status data to manager.

7.5.4 Leased circuit network status function set

This set provides access to status and receives requests to change status of a leased circuit network and its components such as a digital crossconnection node, a multiplexer, a server trail, etc.

7.5.4.1 Management requirements

7.5.4.2 General Functional Model

7.5.4.3 TMN Management Functions

1) *Request status of dynamic provisioning of leased circuit network* – Manager requests agent to transmit the status of dynamic provisioning to manager.

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

7.5.5 Transport network status function set

This set provides access to and supports requests to change the status of a transport network and its components such as a digital crossconnection node, multiplexer, regenerator, protection switch, transmission medium, etc.

7.5.5.1 Management requirements

7.5.5.2 General Functional Model

7.5.5.3 TMN Management Functions

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

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

7.5.6 NE(s) status and control function set

This set provides access to the status of service resources and receives requests for transitions. Examples for state attributes and their relationships can be found in ITU-T Recommendation X.731, "Open Systems Interconnection – Systems Management: State Management Function [11]."

7.5.6.1 Management requirements

7.5.6.2 General Functional Model

7.5.6.3 TMN Management Functions

1) *Request status* – Manager requests agent to send current status information.

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

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

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

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

6) *Allow/inhibit automatic restoration* – Manager directs agent to allow or inhibit automatic restoration in an *M+N* or duplex system.

7) *Operator/release automatic restoration* – Manager directs agent to switch a specified line or equipment to the redundant unit or release it from the redundant unit. For an *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.

8) *Control event report* – Manager selects and controls the flow of notifications from the agent to the manager.

7.5.7 Access to state information in NEs function set

This set supports access to the current state of a resource. This information should be available to queries and should also be used to determine the legality of requested state changes.

7.5.8 Notification of state changes by NEs function set

This set supports the reporting of changes of state as the result of recognition that a state has changed such as a change from "enabled" to "disabled" in the event of a failure. Automatic notification of change of state may be initiated by the NE.

8 Accounting Management

Accounting Management enables the measurement of the use of network services and the determination of costs to the service provider and charges to the customer for such use. It also supports the determination of prices for services.

Accounting Management includes the following function set groups:

- Usage Measurement.
- Tariffing/Pricing.
- Collections and Finance.
- Enterprise Control.

8.1 Usage Measurement

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.

Usage Measurements includes the following function sets:

- Planning of the usage measurement process function set.
- Management of the usage measurement process function set.
- Usage aggregation function set.
- Service usage correlation function set.

- Service usage validation function set.
- Usage distribution function set.
- Usage surveillance function set.
- Usage error correction function set.
- Usage testing function set.
- Measurement rules identification function set.
- Network usage correlation function set.
- Usage short-term storage function set.
- Usage long-term storage function set.
- Usage accumulation function set.
- Usage validation function set.
- Administration of usage data collection function set.
- Usage generation function set.

8.1.1 Planning of the usage measurement process function set

This set supports processes and systems to improve accurate and efficient usage measurement for products and services. It provides access to information concerning the metrics of the usage data stream.

8.1.2 Management of the usage measurement process function set

This set provides for the management of processes and systems to ensure accurate and efficient usage measurement for products and services. It provides management reports that may include total number of records, time criteria, lost records, multiple records, mutilate records, etc. It supports notifications as the reports are requested or defined.

8.1.3 Usage aggregation function set

This set provides access to summaries of service-level usage events by customer by service/product as described by specific carrier-defined criteria.

8.1.4 Service usage correlation function set

This set associates usage data based on provider-defined criteria related to a single product/service instance but possibly across multiple networks. Correlation may associate data related to a single usage event but collected from multiple sources across networks.

8.1.5 Service usage validation function set

This set provides access to usage data that have been edited and validated to ensure that they meet service-level integrity checks and conform to semantic and syntactic rules.

8.1.6 Usage distribution function set

This set distributes (sends notification of) the billable and informational formatted usage data to one or more processes, as requested or defined. Distribution is tracked for purposed of settlements, non-internal audits, etc. This function set differentiates usage data and determines the disposition/treatment of the usage measurements. It includes usage deletion functionality for usage information that will not continue in the data stream.

8.1.7 Usage surveillance function set

This set monitors all usage data to detect deviation from established norms. It provides access to a database containing records of translation errors, general software errors, usage information recording errors, network routing errors, and potential fraud.

8.1.8 Usage error correction function set

This set provides access to usage data records after investigation and correction of usage data records found to be suspect or in error. The correction may be based on customer and service information concerning the network resources or services that the user has requested. This function will send notification of failure to correct the usage data records.

8.1.9 Usage testing function set

This set provides access to the results of simulation of user input to the network and captures usage measurement output for the purpose of validating the processing of usage data, as well as the actual generation of the usage data. It supports notifications concerning the disposition of the test call.

8.1.10 Measurement rules identification function set

This set defines the set of usage measurement criteria to be applied to a usage event. It supports the criteria or rules by which function sets such as Usage aggregation, Usage correlation, Usage distribution, and Usage long-term storage classify or group usage data. It provides access to identification of customer account/configuration and identification of product/service.

8.1.11 Network usage correlation function set

This set provides access to usage data that have been correlated based on provider-defined criteria related to a single product/service instance within the network. Correlation may associate data related to a single usage event but collected from multiple sources within the network, or data from multiple usage events.

8.1.12 Usage short-term storage function set

This set provides access to usage data, records, errors, and reports for subsequent access by other functions or applications. Assists in business continuity and disaster recovery in the event that the communication path to downstream processes is corrupted or destroyed.

8.1.13 Usage long-term storage function set

This set provides access to raw usage data, records, errors (e.g. translation, software, recording, network routing, etc.), and reports. The storage requirements for this archive may be defined by regulatory, business, and/or service requirements.

8.1.14 Usage accumulation function set

This set provides for collection of usage data.

8.1.15 Usage validation function set

This set provides access to usage data that have been edited and validated to ensure that it meets specific integrity checks and conforms to semantic and syntactic rules. (For example, checking each usage element to verify that a valid value has been recorded.) It supports verification that usage data is collected from scheduled NE(s) in timely fashion. Upon the detection of errors, this function reports them to the Usage error correction function.

8.1.16 Administration of usage data collection function set

This set determines the disposition of logged usage data, provides access to the data, and schedules reporting of bulk usage data.

8.1.17 Usage generation function set

This set supports the generation of the usage data (call detail information) as the state of the call processing changes (e.g. call initiation, addition of a new calling party to a conference call, call completion, etc.) and records it for passing to the Usage accumulation and Usage validation function sets.

8.1.17.1 Management requirements

8.1.17.2 General Functional Model

8.1.17.3 TMN Management Functions

1) *Create a data collection* – Manager directs agent to set parameters to a charging data collection process.
2) *Delete a data collection* – Manager directs the agent to remove a charging data collection process.
3) *Activate a data collection* – Manager directs the agent to start up a defined charging data collection process.
4) *De-activate a data collection* – Manager directs the agent to stop a defined charging data collection process.
5) *Get data collection data* – Manager requests the agent to report data of the defined and/or activated data collections.
6) *Set a data collection* – Manager directs the agent to change parameters in a charging data collection definition.
7) *Get charging record* – Manager requests the agent to send a charging record, either a call record or a counter record or several records, according to the specification in the request. Agent replies with the data and saves the data.
8) *Transfer charging block* – Agent transfers automatically a charging block or several blocks to the manager according to the earlier activated data collection. Call records are deleted in the agent.
9) *Get coin-box status* – Manager requests the agent to report the status of the pay-phone coin-box. Agent sends the requested status data to the manager.

8.2 Tariffing/pricing

A 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.

A 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.

Tariffing/pricing includes the following function sets:

- Pricing strategy function set.
- Tariff and price administration function set.

- Costing function set.
- Settlements policy function set.
- Feature pricing function set.
- Provision of access to tariff/price information function set.
- Rating usage function set.
- Totalling usage charges function set.

8.2.1 Pricing strategy function set

This set supports the management of data tables reflecting corporate strategies for the pricing of product lines.

8.2.2 Tariff and price administration function set

This set supports the management of rate and price tables for products and services and supports filing them with regulatory bodies.

8.2.2.1 Management requirements

8.2.2.2 General Functional Model

8.2.2.3 TMN Management Functions

1) *Create tariff class* – Manager directs agent to create a tariff class corresponding to a certain service, origination and destination.
2) *Delete tariff class* – Manager directs agent to delete a tariff class.
3) *Set tariff class* – Manager directs agent to change a tariff class.
4) *Get tariff class data* – Manager requests the agent to report the defined tariff class data; agent replies with the data.
5) *Create a tariff* – Manager directs agent to create a tariff.
6) *Delete a tariff* – Manager directs the agent to delete a tariff.
7) *Set a tariff* – Manager directs the agent to change a tariff.
8) *Get tariff data* – Manager requests agent to report tariff data, agent replies with the data.
9) *Create tariff period of the day* – Manager directs the agent to create a new tariff period of the day.
10) *Delete tariff period of the day* – Manager directs the agent to delete an existing tariff period of the day.
11) *Set tariff period of the day* – Manager directs the agent to change a tariff period of the day.
12) *Set tariff period data of the day* – Manager requests agent to report tariff period of the day, agent replies with the data.
13) *Create day class* – Manager directs the agent to create a day class into the calendar table.
14) *Delete day class* – Manager directs the agent to delete a day class from the calendar table.
15) *Set day class* – Manager directs the agent to change a day class in the calendar table.
16) *Get day class data* – Manager requests the agent to report a calendar table data agent replies with the data.

8.2.3 Costing function set

This set provides for the costing (cost determination and analysis) of services and features (i.e. determination of basic switching costs, costs of Intelligent Network features, and network costs) for use in pricing and tariff filing. It may support reading of usage information from the Usage Measurements: Usage distribution function set as a component of cost tracking.

8.2.4 Settlements policy function set

This set provides access to guidelines for the apportionment of usage charges. The guidelines reflect negotiations based on revenue and pricing that are part of business relationships with other carriers/providers.

8.2.5 Feature pricing function set

This set supports the application of corporate strategies to the pricing of individual products/services. It supplies Usage Measurement functions with the pricing information necessary to generate billing data. It also supplies the Collections and Finance functions with the requisite information to answer customer pricing questions.

8.2.6 Provision of access to tariff/price information function set

This set provides a means by which the TMN and the public may determine rates and charges.

8.2.7 Rating usage function set

This set supports the financial components of the billable records. These components may be the internal costs, initial non-discounted rates, discounted rates, rates of special offerings, wholesale or retail rates, and/or final pricing. Rating information is applied to the usage data obtained from the Usage Measurement functionality. This function set supports notifications of failure to apply the financial components.

8.2.8 Totalling usage charges function set

This set supports reading bill line items, grouped by customer, and provides access to the total charge, after application of any appropriate discounts or surcharges.

8.3 Collections and Finance

The Collections and Finance group encompasses functionality to transfer financial data for the TMN for such purposes as administration of customer accounts, informing customers of balances and payment dates and receiving payments.

Collections and Finance includes the following function sets:

- Planning of the billing process function set.
- Management of the billing process function set.
- General accounting operations function set.
- General ledger function set.
- Accounts receivable function set.
- Accounts payable function set.
- Payroll function set.
- Benefits administration function set.
- Pension administration function set.
- Taxation function set.

- Human resources function set.
- Invoice assembly function set.
- Sending invoice function set.
- Customer tax administration function set.
- In-call service request function set.
- Storage of invoice function set.
- Receipt of payment function set.
- Inquiry response function set.
- Collections function set.
- Customer account administration function set.
- Customer profile administration function set.

8.3.1 Planning of the billing process function set

This set plans processes and systems to improve accurate and efficient billing and collections for products and services.

8.3.2 Management of the billing process function set

This set provides for the management of processes and systems to ensure accurate and efficient billing and collections for products and services.

8.3.3 General accounting operations function set

This set manages the base chart of accounts for categorization, tracking and reporting of financial expenditures. It supports the monitoring of financial operations to ensure compliance to proper accounting practices. It supports periodic reconciliation of account balances for the purpose of generating financial results.

8.3.4 General ledger function set

This set provides for the tracking of equity, income from operations, costs and expenses, non-operating income and expense, and taxes. It also provides for movement of costs to various accounts/projects for accurate statement of costs and for corrections of incorrectly booked costs.

8.3.5 Accounts receivable function set

This set provides for the tracking of receipts due (including the amount, the date and identification of the account) for products and services rendered and payments received. It supports posting of transactions into the ledger. It supports reading of invoice and payment data and provides access to summaries of such information.

8.3.6 Accounts payable function set

This set provides for payment to contractors, suppliers, other service providers, insurance, principal and interest, rents and leases, taxes, utilities.

NOTE – Compare to Purchasing, a Configuration Management function set.

8.3.7 Payroll function set

This set provides for the administration and payment of employee salary, etc.

8.3.8 Benefits administration function set

This set provides for the administration of employee benefits.

8.3.9 Pension administration function set

This set provides for the administration of employee pensions.

8.3.10 Taxation function set

This set provides for the management and reporting of corporate tax accounting, including the determination of the proper timing for reporting income and deductions for tax purposes.

8.3.11 Human resources function set

This set provides access to the organizational structure of the company, forecasting of staffing needs, administration of employment, management of compensation, employee relations, employee assignment, and employee development.

8.3.12 Invoice assembly function set

This set supports reading the current usage charge and combines it with recurring and one time charges as well as previous debits and credits to determine a customer's account balance at billing time.

8.3.13 Sending invoice function set

This set supports reading the assembled invoices and the preparation and distribution of the formatted invoices to customers.

8.3.14 Customer tax administration function set

This set provides access to tax tables for the computation of taxes for customer invoice components.

8.3.15 In-call service request function set

This set provides for on-demand, real-time request for usage information while a call is in progress or at its completion. It may initiate the processing of the usage information while the call proceeds (processing of the usage information may be destructive or non-destructive). It supports access to the complete usage information after the conclusion of the call. It supports a time and charges quotation at the request of the party being charged for the call.

8.3.16 Storage of invoice function set

This set provides access to the long and short term storage of billing data.

8.3.17 Receipt of payment function set

This set provides the customer interface through which customers may make valid forms of remuneration for services provided. It supports crediting the customer's account. It supports notifications of the received payment.

8.3.18 Inquiry response function set

This set provides the interface through which customers may have access to account balance, rating, and subscription information.

8.3.19 Collections function set

This set provides access to delinquent accounts. It supports requests for collection actions.

8.3.20 Customer account administration function set

This set provides access to the customer account, including account balance, one-time and recurring charges, and history. It supports the adjustment of customer balances according to credit, debit, and consumption information. It supports reading of a customer service profile.

8.3.21 Customer profile administration function set

This set supports input from Service Negotiation & Planning and provides access to a database for the list of services of each individual customer.

8.4 Enterprise Control

TMN Management Functions of the Enterprise Control group support the flow of data needed to exercise diligence over the proper flow of funds within the enterprise and between the enterprise and its owners and creditors. This group supports the fiducial responsibilities of the officers of the enterprise.

Enterprise Control includes the following function sets:

- Budgeting function set.
- Auditing function set.
- Cash management function set.
- Raising equity function set.
- Cost reduction function set.
- Profitability analysis function set.
- Financial reporting function set.
- Insurance analysis function set.
- Investments function set.
- Assets management function set.
- Tracking of liabilities function set.

8.4.1 Budgeting function set

This set provides access to the plan or schedule that adjusts costs (capital and expense) during a certain period (typically, the accounting year) to the estimated income for that period. It provides access to the annual (or other periodic) budget. It supports modification of the budget when variations between performance and objectives arise.

8.4.2 Auditing function set

This set provides for the regular examination, checking, and adjusting of financial records.

8.4.3 Cash management function set

This set supports cash flow analysis. It supports reconciliation between payments and receipts and the identification of the potential need for borrowing to bring them in line with the budget. It supports short-term cash management (acquisition of cash needed to run the business) by borrowing against lines of credit.

8.4.4 Raising equity function set

This set provides access to data and reports for long-term cash management through investments and the liquidation of assets. It supports determination for and management of stock offerings, including SEC filings and generation of prospectuses.

8.4.5 Cost reduction function set

This set provides access to corporate policies for reducing costs and the coordination of implementation plans.

8.4.6 Profitability analysis function set

This set provides access to data and reports concerning the assessment of the revenues and expenses of products to determine the profit or loss.

8.4.7 Financial reporting function set

This set provides access to financial information to be provided to employees, stockholders, government agencies, and the public.

8.4.8 Insurance analysis function set

This set provides access to data and plans for risk assessment and the determination of insurance needs.

8.4.9 Investments function set

This set supports the management of corporate investments.

8.4.10 Assets management function set

This set supports the tracking of current and long-term assets, including inventory and depreciation.

NOTE – Compare the Material management policy function in Configuration Management.

8.4.11 Tracking of liabilities function set

This set supports the tracking of current and long-term liabilities.

9 Security Management

Security Management provides for the management of security. In addition, security of management is required for all Management Functional Areas and for all TMN transactions. Security of management appears as part of the Security Function in Recommendation M.3010.

Security of Management functionality includes Security services for communications and Security event detection and reporting:

a) Security services for communications provides the set of security services for communications as defined in ITU-T Recommendation X.800 [18] for authentication, access control, data confidentiality, data integrity, and non-repudiation that may be exercised in the course of any communications between systems, between customers and systems, and between internal users and systems. In addition, a set of pervasive security mechanisms are defined that are applicable to any communication such as event detection, security audit trail management, and security recovery.

b) Security event detection and reporting reports to higher layers of security any activity that may be construed as a security violation (e.g. unauthorized user, physical tampering with equipment, etc.).

Security Management includes the following function set groups:

- Prevention.
- Detection.
- Containment and recovery.
- Security administration.

9.1 Prevention

Prevention function sets are those needed to prevent intrusion.

Prevention includes the following function sets:

- Legal review function set.
- Physical access security function set.
- Guarding function set.
- Personnel risk analysis function set.
- Security screening function set.

9.1.1 Legal review function set

This set provides access to data concerning legal review of corporate documents, service offerings and policies to protect the enterprise against claims and litigation.

9.1.2 Physical access security function set

This set supports coordination of the installation, maintenance and monitoring of all equipment used to restrict or validate access (e.g. electronic access systems requiring a coded badge or other device to validate person seeking access, metal detectors, etc.).

9.1.3 Guarding function set

This set supports human monitoring of access such as checking identification badges or checking bags and packages for people entering and leaving a building.

9.1.4 Personnel risk analysis function set

This set supports requests for checking the trustworthiness of current and prospective employees. The checks are similar to those for Security screening (for customers), but are usually more thorough.

9.1.5 Security screening function set

This set supports requests for validating that a customer is trustworthy (e.g. has a good credit rating that indicates an acceptable risk for providing service) and associated responses. It supports reading of appropriate databases.

9.2 Detection

Detection function sets are those needed to detect an intrusion.

Detection includes the following function sets:

- Investigation of changes in revenue patterns function set.
- Support element protection function set.
- Customer security alarm function set.

- Customer (external user) profiling function set.
- Customer usage pattern analysis function set.
- Investigation of theft of service function set.
- Internal traffic and activity pattern analysis function set.
- Network security alarm function set.
- Software intrusion audit function set.
- Support element security alarm reporting function set.

9.2.1 Investigation of changes in revenue patterns function set

This set supports the analysis of significant shifts in revenue that might indicate fraud or theft of service.

9.2.2 Support element protection function set

This set supports the determination of need, monitoring and analysis of alarm systems that support structures that house network equipment. These alarms may include power, HVAC (Heating, Ventilation, and Air Conditioning, fire, flood, and open-door-or-cabinet systems.

9.2.3 Customer security alarm function set

This set supports access by customers to security alarm information that indicates security attacks on their portion of the network.

9.2.4 Customer (external user) profiling function set

This set supports the management of profiles of customer usage data to be used in the analysis of customer activities to identify anomalies and irregularities that may indicate a breach of security or theft of service. It provides access to such data. A customer is considered to be any external user.

9.2.5 Customer usage pattern analysis function set

This set supports the reading of usage data and customer profiles from other functions. It supports the recording of service irregularities or anomalies such as billing and usage abnormalities. It provides access to such records.

9.2.6 Investigation of theft of service function set

This set supports investigation of customer and internal users whose usage patterns indicate possible fraud or theft of service. It may include requests for credit checking, and employment record checking.

9.2.7 Internal traffic and activity pattern analysis function set

This set supports the collection of audit trail information and the recording of anomalies or abnormalities that may indicate a breach of security or theft of customer services through employee action. It provides access to such data.

9.2.8 Network security alarm function set

This set allows an internal user access to security alarm information that indicates network security violations.

9.2.8.1 Management requirements

9.2.8.2 General Functional Model

9.2.8.3 TMN Management Functions

- *Report path security alarm* – Agent reports a security alarm on a path to a manager.

9.2.9 Software intrusion audit function set

This set supports checks for signs of software intrusion (e.g. the presence of a known virus) in the TMN. Such checks can apply to any TMN system. They can be regularly scheduled and/or they may be triggered by security events.

9.2.10 Support element security alarm reporting function set

This set provides access to report information about security alarms so that containment and recovery activities may be initiated. It may include the reporting of environment alarms (e.g. fire or moisture) and intrusion detection alarms.

9.3 Containment and Recovery

Containment and Recovery function sets are those needed to deny access to an intruder, to repair damage done by an intruder, and to recover losses.

Containment and Recovery includes the following function sets:

- Protected storage of business data function set.
- Exception report action function set.
- Theft of service action function set.
- Legal action function set.
- Apprehending function set.
- Service intrusion recovery function set.
- Administration of customer revocation list function set.
- Protected storage of customer data function set.
- Severing external connections function set.
- Network intrusion recovery function set.
- Administration of network revocation list function set.
- Protected storage of network configuration data function set.
- Severing internal connections function set.
- NE(s) intrusion recovery function set.
- Administration of NE(s) revocation list function set.
- Protected storage of NE(s) configuration data function set.

9.3.1 Protected storage of business data function set

This set supports access and mechanisms, such as maintaining back copies of data and monitoring for data corruption, to secure business data.

9.3.2 Exception report action function set

This set supports exception reports such as security alarms. It also supports requests for action to limit the security breach such as isolation of equipment or data so that corruption is not propagated and requests for restoration of any corrupted data or equipment.

9.3.3 Theft of service action function set

This set supports receiving input on usage anomalies to initiate action to limit the security breach (e.g. remove user's access privileges, etc.). It supports requests to restore any corrupted data or equipment. It may also support requests for the initiation of litigation against a perpetrator of an illegal action.

9.3.4 Legal action function set

This set supports litigation against a perpetrator of an illegal action. This may be done in cooperation with law enforcement agencies.

9.3.5 Apprehending function set

This set supports actions to catch an intruder. This may be done in cooperation with law enforcement agencies. It may support the identification of an intruder (for example, by analyzing security logs, monitoring targets of intrusion or feeding misinformation to a suspected intruder).

9.3.6 Service intrusion recovery function set

This set supports requests to access backup files in order to restore service after detection of a security violation.

9.3.7 Administration of customer revocation list function set

This set supports access to a list of all customer public keys and access control certificates for the current time period that are known or suspected of being invalid due to security violation (e.g. stolen secret keys) or administrative procedures (e.g. a customer has moved elsewhere).

9.3.8 Protected storage of customer data function set

This set provides for the backup and restoration of stored customer data that can be used in support of intrusion recovery.

9.3.9 Severing external connections function set

This set supports requests for the severance of connections with a customer in an attempt to contain data and system corruption as the result of a detected security violation. It supports commands to carry out the request.

9.3.10 Network intrusion recovery function set

This set supports requests for restoration of the network configuration after detection of a security violation.

9.3.11 Administration of network revocation list function set

This set provides access to a list of all network public keys and access control certificates for the current time period that are known or suspected of being invalid due to security violation (e.g. stolen secret keys) or administrative procedures (e.g. a system has been replaced).

9.3.12 Protected storage of network configuration data function set

This set supports storage of network configuration data that can be used in support of intrusion recovery. It allows for backup of such data, and for restoration of such backed up data upon request.

9.3.13 Severing internal connections function set

This set supports the severance of internal user connections in an attempt to contain data and system corruption as the result of a detected security violation.

9.3.14 NE(s) intrusion recovery function set

This set provides access to backup files in order to restore NE or element management information after detection of a security violation.

9.3.15 Administration of NE(s) revocation list function set

This set provides access to a list of all keys and access control certificates used for NE and element management access that are known or suspected of being invalid due to security violation (e.g. stolen secret keys) or administrative procedures (e.g. an element management system or NE has been replaced).

9.3.16 Protected storage of NE(s) configuration data function set

This set supports data storage and provides access to that data for backup in support of intrusion recovery.

9.4 Security Administration

Security Administration function sets are those needed for planning and administering security policy and managing security related information.

Security Administration includes the following function sets:

- Security policy function set.
- Disaster recovery planning function set.
- Manage guards function set.
- Audit trial analysis function set.
- Security alarm analysis function set.
- Assessment of corporate data integrity function set.
- Administration of external authentication function set.
- Administration of external access control function set.
- Administration of external certification function set.
- Administration of external encryption and keys function set.
- Administration of external security protocols function set.
- Customer audit trial function set.
- Customer security alarm management function set.
- Testing of audit trail mechanism function set.
- Administration of internal authentication function set.
- Administration of internal access control function set.
- Administration of internal certification function set.
- Administration of internal encryption and keys function set.

- Network audit trail management function set.
- Network security alarm management function set.
- NE(s) audit trail management function set.
- NE(s) security alarm management function set.
- Administration of keys for NEs function set.
- Administration of keys by an NE function set.

9.4.1 Security policy function set

This set provides access to company guidelines for establishing and maintaining a secure environment for personnel, hardware, and software.

9.4.2 Disaster recovery planning function set

This set supports access to methods and procedures to be used in restoring the network in the event of a security breach and the resulting corruption of data.

9.4.3 Manage guards function set

This set provides access to information about the management of physical and mechanized devices used to provide security.

9.4.4 Audit trail analysis function set

This set provides access to methods and procedures for audit trail information to be collected and evaluated to identify possible and/or potential security violations by individuals or groups of users.

9.4.5 Security alarm analysis function set

This set provides access to guidelines for the monitoring, evaluating, and correlating security alarms.

9.4.6 Assessment of corporate data integrity function set

This set provides access to information to determine the need for security, monitoring, and analysis of security measures instituted to protect corporate data from unauthorized access, altering, tampering, and/or corruption.

9.4.7 Administration of external authentication function set

This set supports requests for and distributes codes for verification that a customer or user of a peer Administration is who they present themselves to be. It also supports an authentication path involving external authenticators. If a customer has been authenticated by an authentication agent outside the TMN, this function supports the certification, if appropriate, that the external authentication agent is a valid entity for providing that kind of authentication.

9.4.8 Administration of external access control function set

This set supports requests for and distributes permissions (in accordance with security policy) for control over what a customer or user of a peer Administration can do with any given resource and includes establishing and validating customer permissions and credentials.

9.4.9 Administration of external certification function set

This set supports requests for and distributes permissions (in accordance with security policy) for control over what a customer or user of a peer Administration can do with any given resource and includes establishing and validating customer permissions and credentials.

9.4.10 Administration of external encryption and keys function set

This set supports requests for and distributes encryption keys to be used in communications between an external customer or user of a peer Administration and a TMN (such keys may be used for authentication, integrity, confidentiality and non repudiation).

9.4.11 Administration of external security protocols function set

This set provides for the management of joint implementation agreements with other jurisdictions to assure interoperability of security protocols; e.g. assuring that both communicating parties use the same encryption algorithm with the same set of options and parameters, agreement on the kind of security information that shall be provided for authentication. It also provides for the administration of external security protocols.

9.4.12 Customer audit trail function set

This set allows a customer to establish and configure audit trails to obtain information about service usage. It allows a customer access to usage and security event information related to their portion of the network.

9.4.13 Customer security alarm management function set

This set allows a customer access to security alarm information that indicates security attacks on their portion of the network.

9.4.14 Testing of audit trail mechanism function set

This set supports testing to ascertain that designated events are recorded in a security log.

9.4.15 Administration of internal authentication function set

This set receives requests for and distributes codes for verification that internal users are who they present themselves to be.

9.4.16 Administration of internal access control function set

This set supports requests for and distributes permissions (in accordance with security policy) for control over what an internal user can do with any given resource.

9.4.16.1 Management requirements

9.4.16.2 General Functional Model

9.4.16.3 TMN Management Functions

- *Change permission* – Manager requests agent to change a permission or set of permissions.

9.4.17 Administration of internal certification function set

This set supports requests for and distributes Access Control Certificates that permit internal users access to previously agreed upon sets of capabilities.

9.4.18 Administration of internal encryption and keys function set

This set supports requests for and distributes encryption keys to be used in communications between internal users (such keys may be used for authentication, integrity and confidentiality). It provides information on which encryption algorithms are to be used and in which mode.

9.4.19 Network audit trail management function set

This set allows for internal users, generally security personnel, to establish and configure audit trails to obtain information about network usage. This function collects and allows an internal user access to network usage and security event information.

9.4.20 Network security alarm management function set

This set supports the collection of security alarm information that indicates network security violations. It allows an internal user access to such data.

9.4.21 NE(s) audit trail management function set

This set allows internal users, generally security personnel, to establish and configure audit trails to obtain NE usage data. It allows an internal user access to NE reports on actions involving, for example, identification, authentication, user address space actions and administrative data.

9.4.21.1 Management requirements

9.4.21.2 General Functional Model

9.4.21.3 TMN Management Functions

- *Security audit request* – Manager requests agent to report security audit.

9.4.22 NE(s) security alarm management function set

This set supports the collection of security alarms detected by lower level functions. It provides access to such information, possibly including information resulting from the correlation of such alarms.

9.4.23 Administration of keys for NEs function set

This set supports requests for the generation of encryption keys to be used in communications between NEs or between an NE and an element management system or other building block. It also supports the distribution of these keys to NEs and communicating entities. Such keys may be used for authentication, integrity and confidentiality.

9.4.24 Administration of keys by an NE function set

This set supports requests for the generation within an NE of encryption keys to be used in communications between NEs or between an NE and an element management system or other building block. It also supports the distribution of these keys to communicating entities. Such keys may be used for authentication, integrity and confidentiality.

APPENDIX I

Examples of Generic Scenarios

Summary

The intent of this Appendix is to illustrate how the TMN Management Function Sets and TMN Management Functions work together to accomplish a business purpose of a TMN Management Service. The vehicle to relate TMN Management Functions to TMN Management Services is the generic scenario. A generic scenario is an information flow diagram that describes how a number of fully automated, generic TMN management roles work together in an integrated fashion to perform a business purpose. Each generic scenario describes part of a particular TMN Management Service. A generic scenario covers a typical end-to-end flow of information through a series of TMN

Management Functions and TMN Management Function Sets. Note that these generic scenarios are not the same as the management scenarios in the M.3200-Series of Recommendations. A generic scenario follows the flow of information, carried by TMN Management Functions, from one Management Application Function (MAF) to another, as described by Recommendation M.3010.

The MAFs associated with each TMN Management Function Set are shown, in the accompanying diagrams, in rounded rectangles. Interaction arrows represent one or more TMN Management Functions associated with specific TMN Management Function Sets. The numbers on the arrows are provided to indicate sequence and for reference purposes. The direction of the arrows indicates the principal direction of information flow. When an interaction arrow is not mapped, it is an indication of the need for one or more new TMN Management Functions to be defined.

Each generic scenario is associated with a primary Management Functional Area (MFA): the associated primary MFA is shown first after the title of the generic scenario, followed by other MFAs that support the primary one. MAFs from other than the primary MFA are shown in the diagrams in shadowed rounded rectangles. The association of MAFs within a rounded rectangle is informal and not intended to imply any particular physical packaging.

The generic scenarios provided are grouped by the Management Services of Recommendation M.3200 (see the table of contents at the beginning of this Recommendation).

I.1 Customer Administration

I.1.1 Service Activation (CM, PM, FM, AM, SM)

A possible service activation scenario is shown in Figure I.1. This scenario incorporates many activities associated with service activation. As a result, it is more of a reference scenario than a view of an actual sequence of activities. Other scenarios included in this subclause align more closely with actual flows for Configuration Management.

This flow is triggered by a customer request for service. While the scenario explicitly illustrates a request to activate new service, the flow is similar for making changes to existing service and discontinuing service. The request may be made by a person or via a machine-to-machine interface. This flow may require modification for specific services such as those of an Intelligent Network.

Pre-equipping and immediate activation will simplify this scenario considerably. See the scenario in I.1.2 for a streamlined service activation flow assuming pre-equipped resources and immediate service activation.

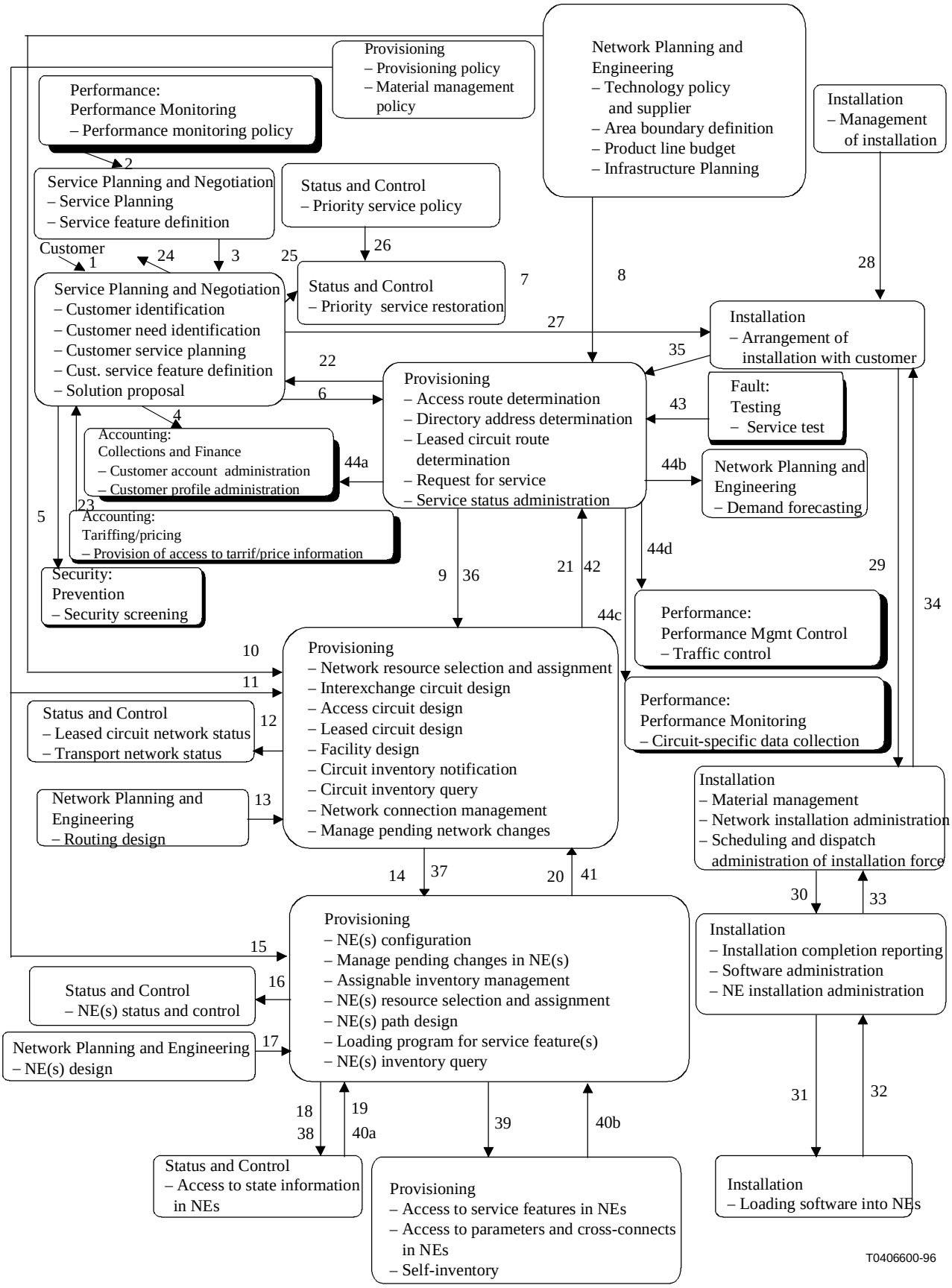

Figure I.1/M.3400 – Service activation

I.1.2 Immediate service activation with pre-equipped resources (CM, PM, FM, AM, SM)

A second, greatly simplified, service activation scenario is shown in Figure I.2. This flow assumes that all equipment is in place and that activation will occur at the time of assignment (i.e. immediately). As with the previous flow, this flow is triggered by a customer request for service. While the scenario explicitly illustrates a request to activate new service, the flow is similar for making changes to existing service and discontinuing service. The request may be made by a person or via a machine-to-machine interface. This flow may require modification for specific services such as those of an Intelligent Network.

Activities providing information that may be obtained in advance of the actual activation request, such as policy information, are not shown but are assumed to be already in place. Only "real time" activities are shown.

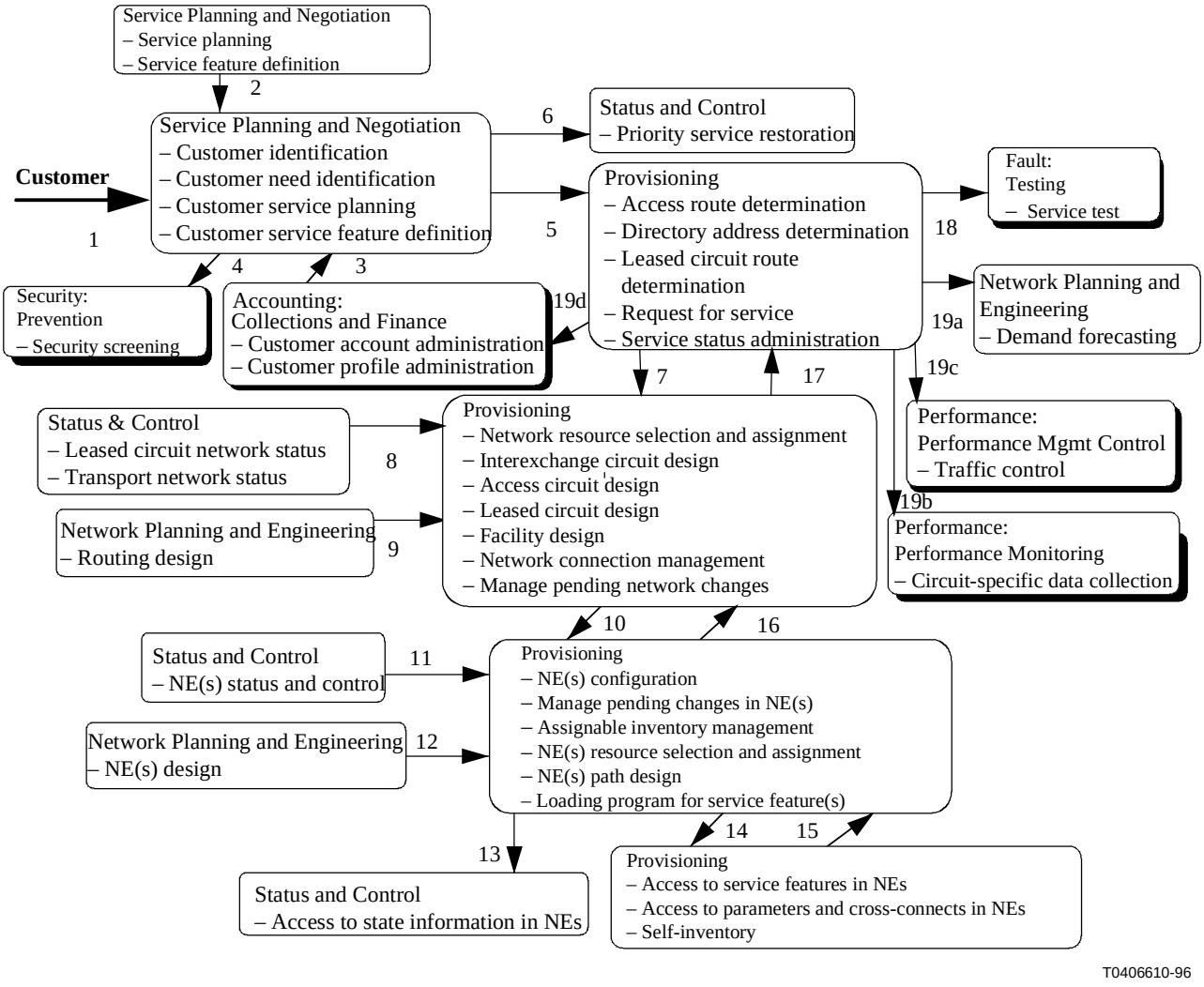

Figure I.2/M.3400 – Immediate service activation with pre-equipped resources

I.1.3 Customer request to activate capacity (CM, PM, AM, SM)

The following scenario, in Figure I.3, is an example of how a customer may make changes to the services under their control and how those changes may affect the network. This flow starts with a customer with network management capabilities initiating a request to activate existing capacity that has been designated for their use.

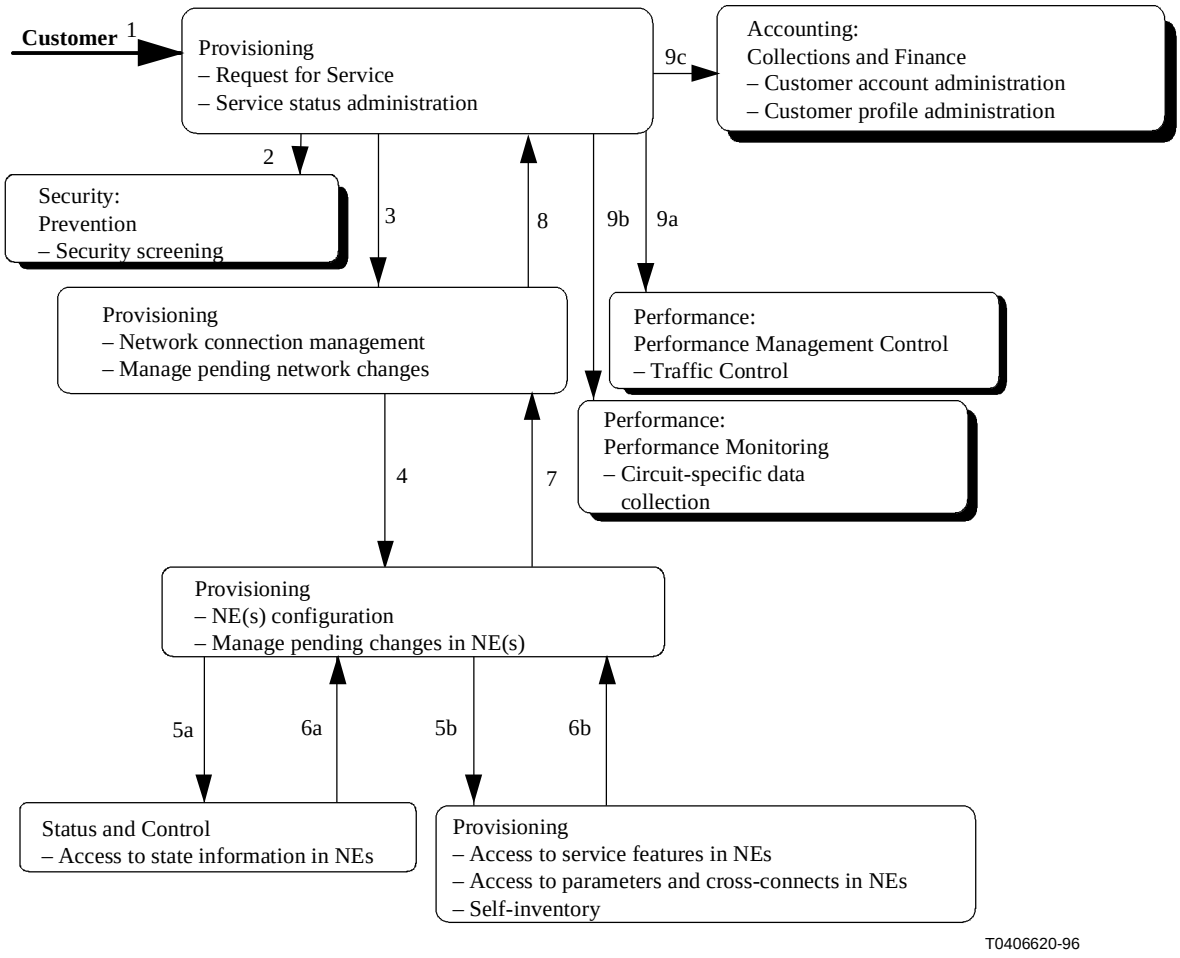

Figure I.3/M.3400 – Customer request to activate capacity

I.1.4 Request for network information (CM)

The following scenario, in Figure I.4, is an example of how a customer may request information about the status of the services and network resources under their control. This flow starts with a customer with network management capabilities initiating a request to see the status of their network. Note that the same scenario would apply if the customer was requesting Performance, Fault, Accounting, or Security information for their network, except that the information being passed would be different based on the type of information being requested.

A similar flow could be initiated by Notification of state changes in NEs and would be used to provide automatic notification of network information to the customer. The NE would initiate the flow and the information about the state change would flow up.

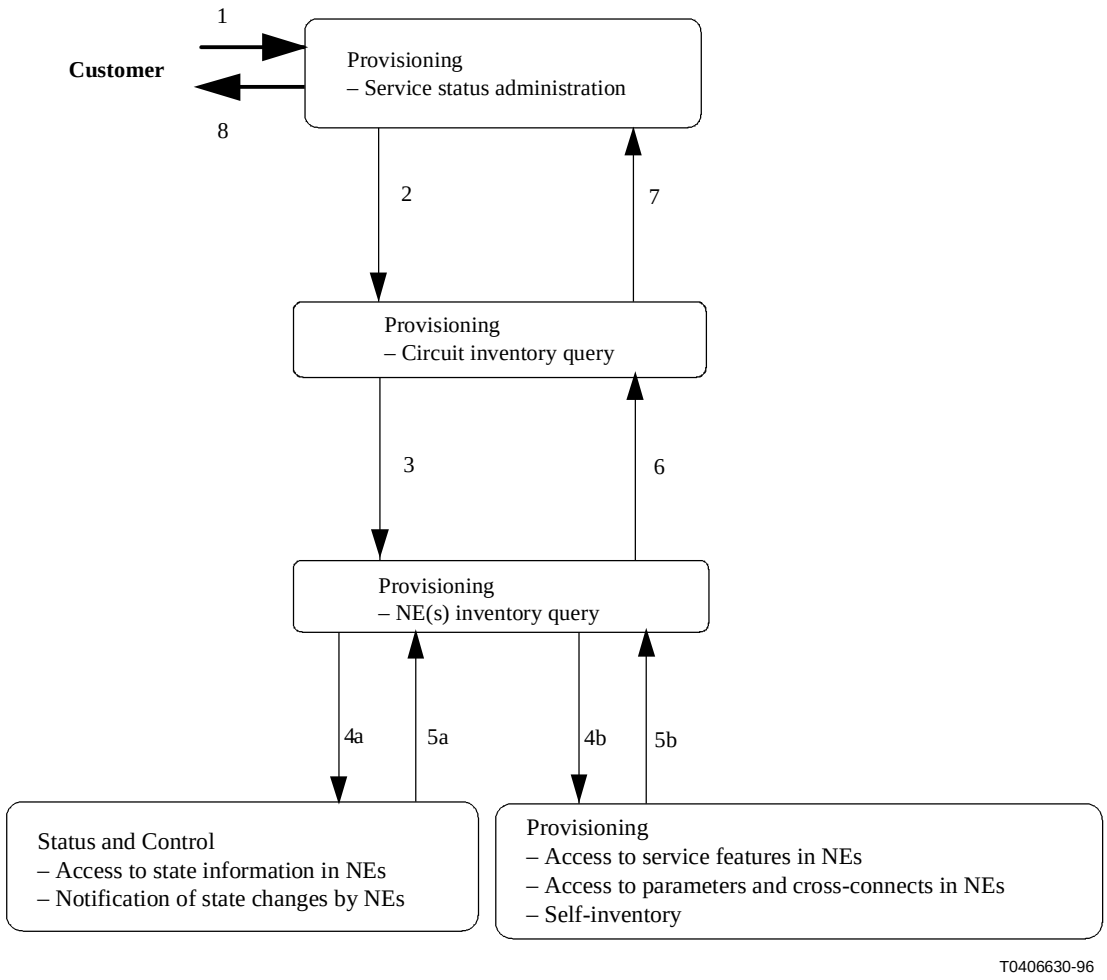

Figure I.4/M.3400 – Request for network information

I.1.5 Customer trouble report (FM, CM)

A possible customer trouble report flow is shown below, in Figure I.5. In this scenario, a customer reports a trouble to Trouble Administration. The service and underlying infrastructure is tested and reported, if appropriate to fault correction. This scenario is somewhat complex, with some branching of the flow. The scenario begins with a customer reporting a trouble (1) and ends with clearing of the fault (12).

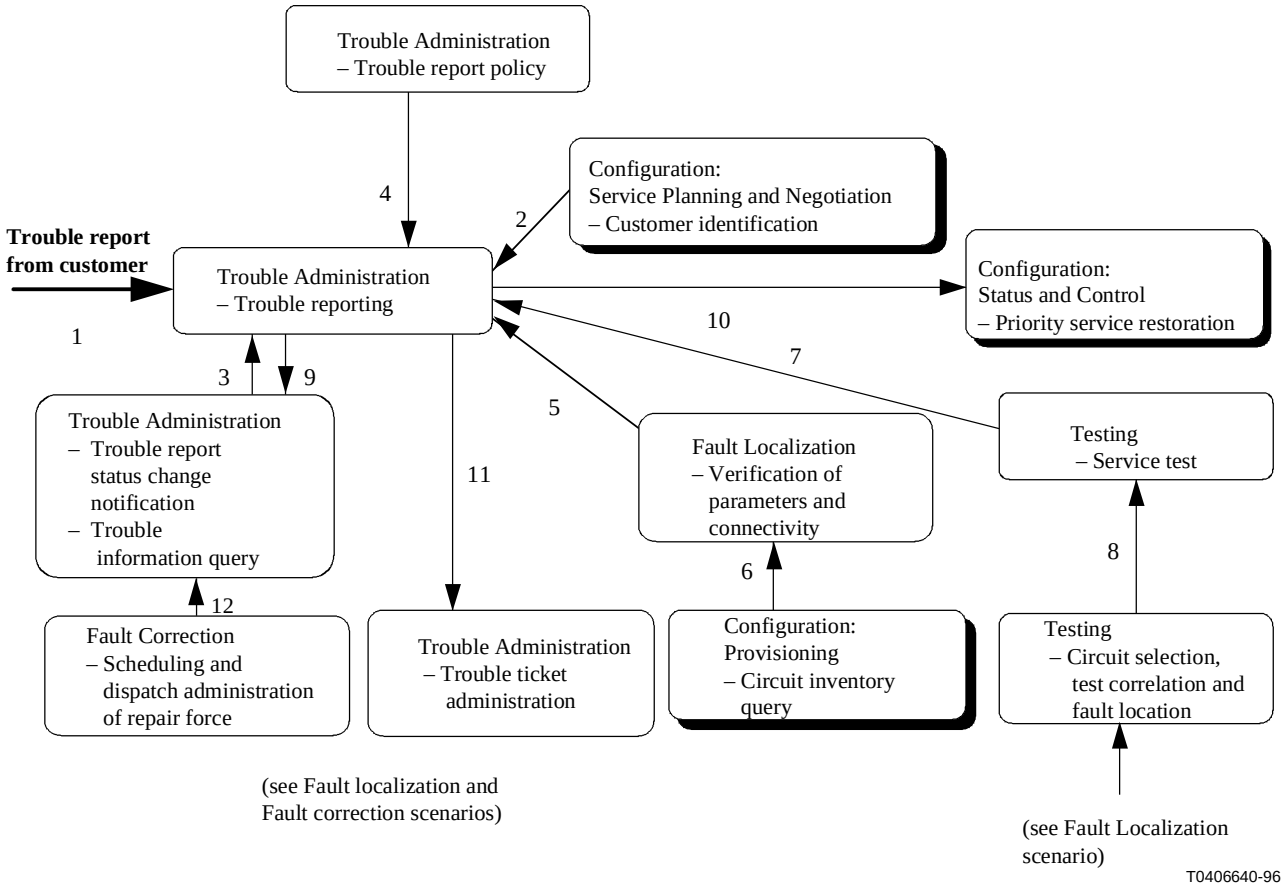

Figure I.5/M.3400 – Customer trouble report

I.2 Network provisioning management

I.2.1 Capacity provisioning for new and/or existing services (CM, AM)

The following scenario, in Figure I.6, is an example of how capacity is provided to accommodate new services or the enhancement of existing services. This flow starts with an identified opportunity to provide customers with new services or features that may trigger the need for resource capacity expansion.

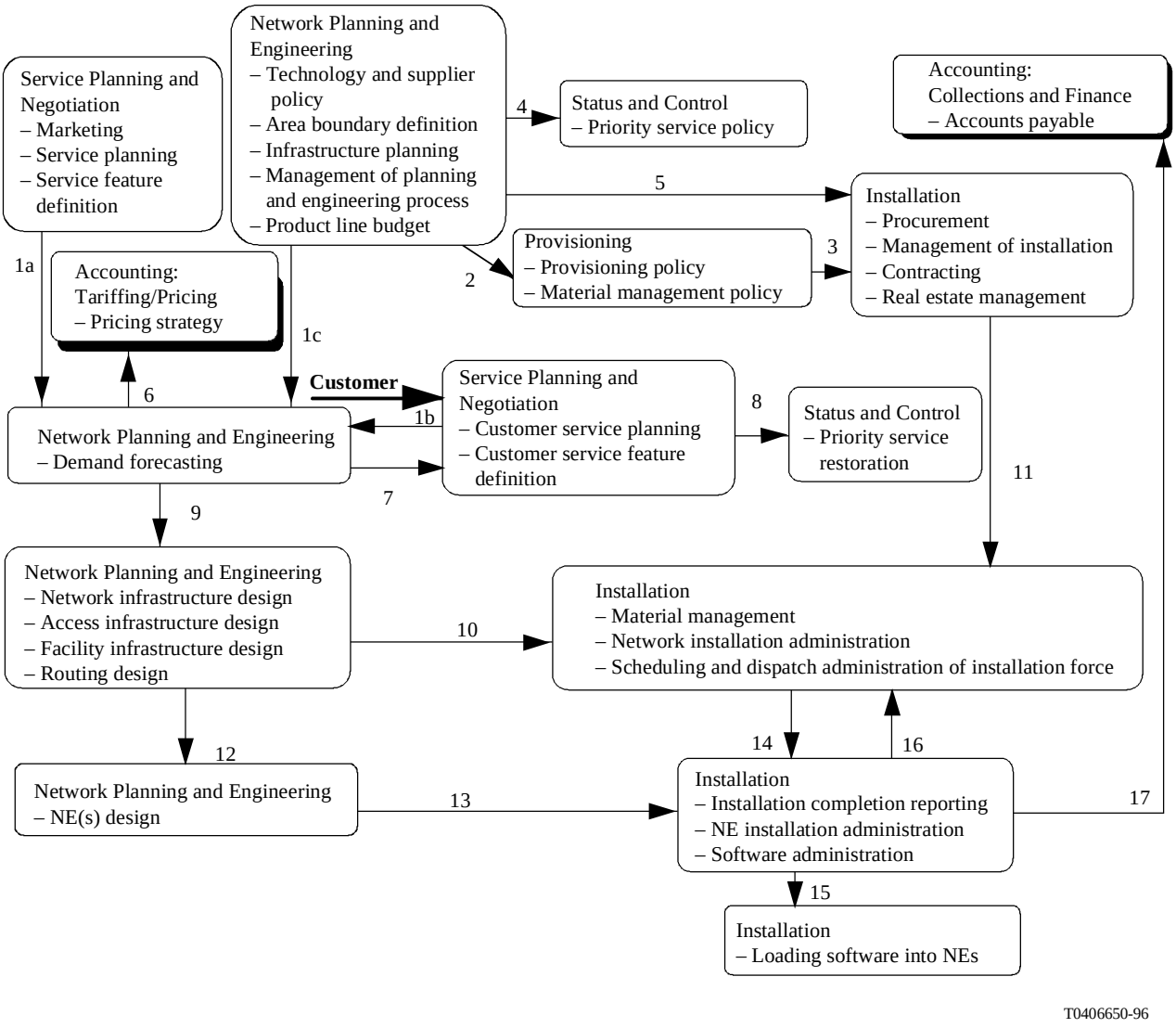

Figure I.6/M.3400 – Capacity provisioning for new and/or existing services

I.3 Work force management

I.3.1 Enterprise management (AM, FM, CM, SM)

The following diagram, in Figure I.7, illustrates the functionality involved in enterprise management. In this scenario, even more than in others, numbering of the arrows is used to identify the interactions without strong implications about the sequence of the actions.

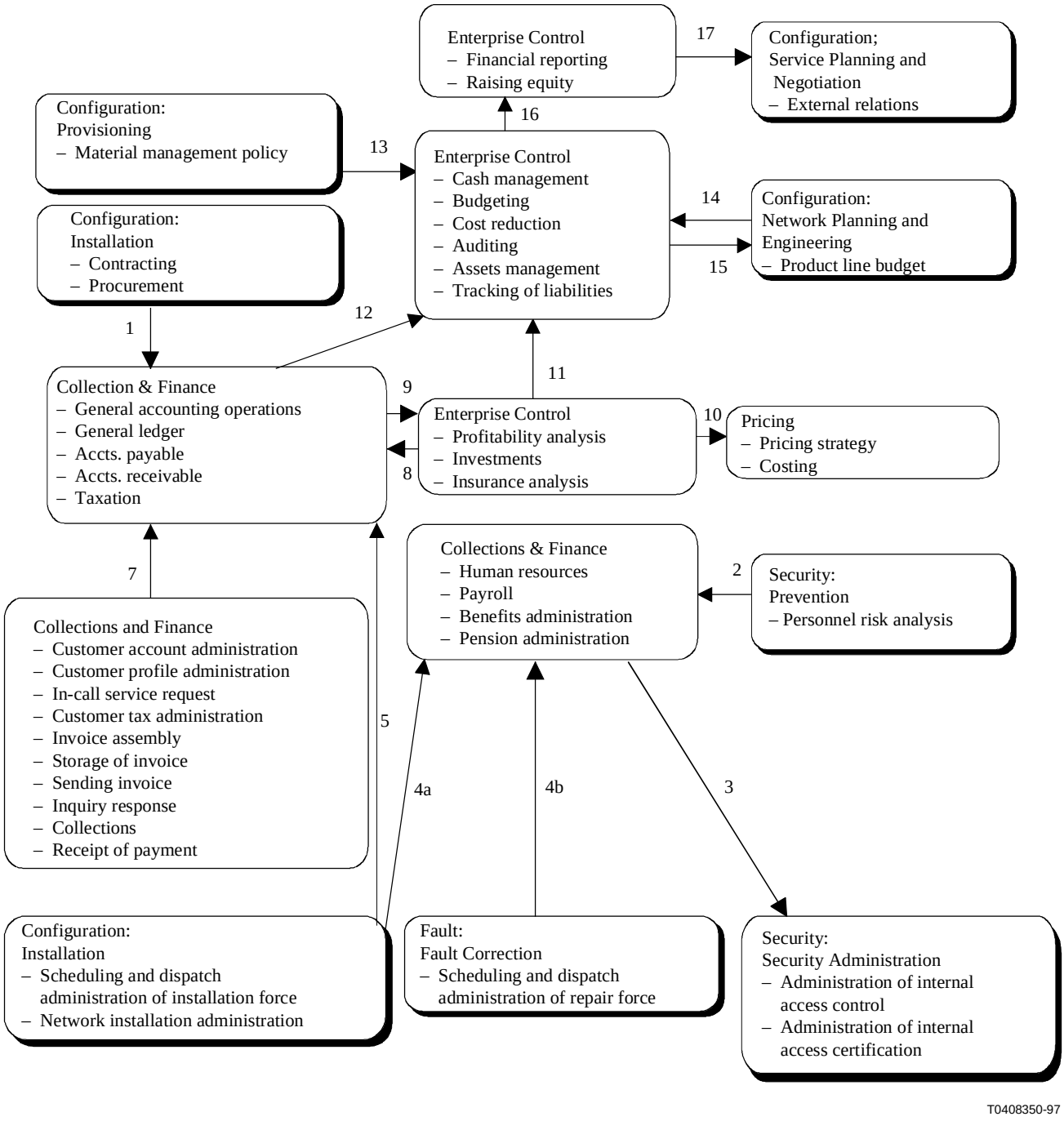

Figure I.7/M.3400 – Enterprise management

I.4 Tariff, charging and accounting administration

I.4.1 Pricing and billing process set-up (AM, CM)

The following diagram, in Figure I.8, illustrates the functionality involved in establishing the processes for rate-setting and usage measurement (in particular, testing) in preparation for billing.

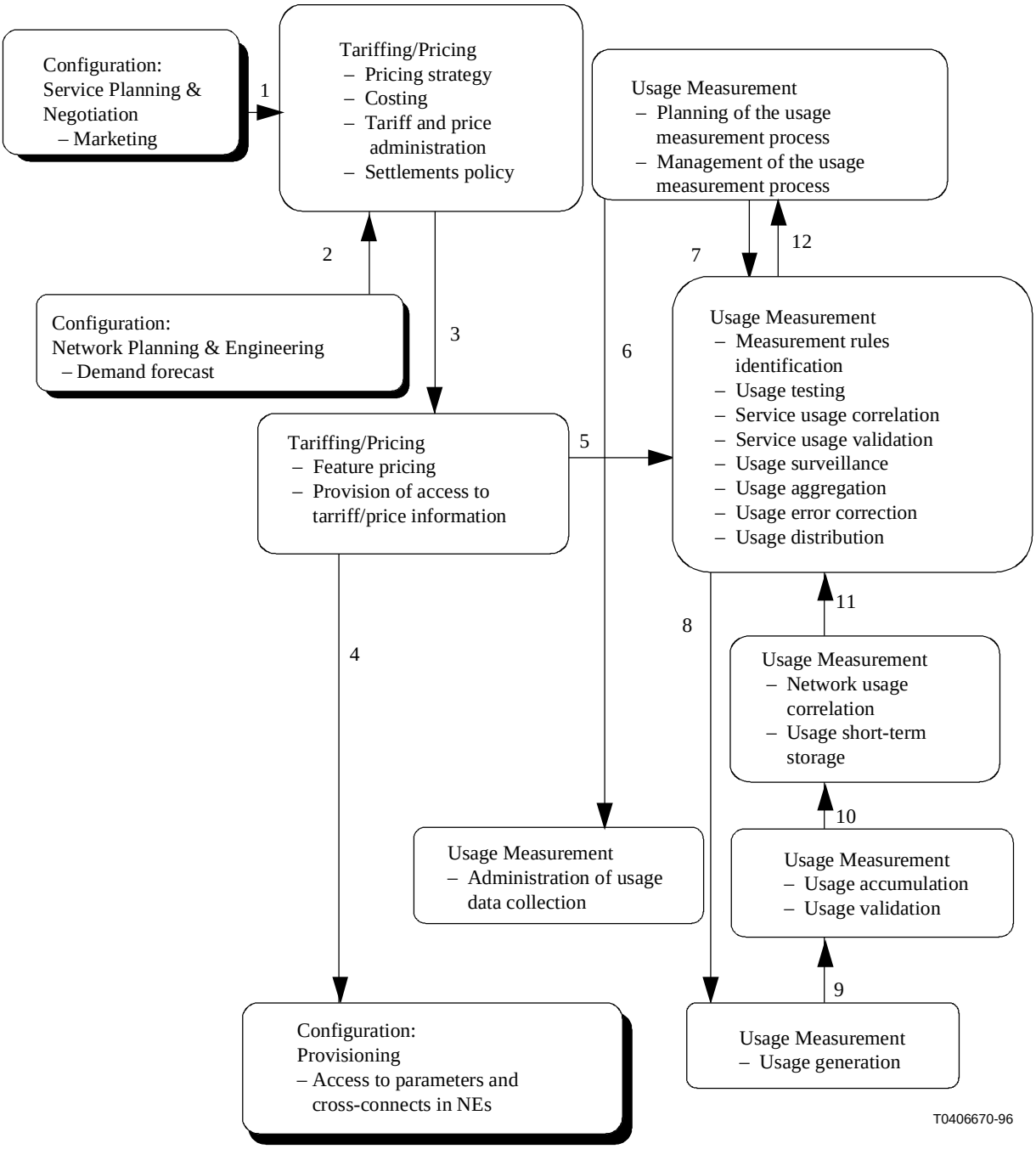

Figure I.8/M.3400 – Pricing and billing process set-up

I.4.2 Billing and collections (AM, PM, FM, CM, SM)

The following flow, in Figure I.9 depicts a scenario that begins with service activation and results in an invoice being generated and delivered to the customer for use of the service.

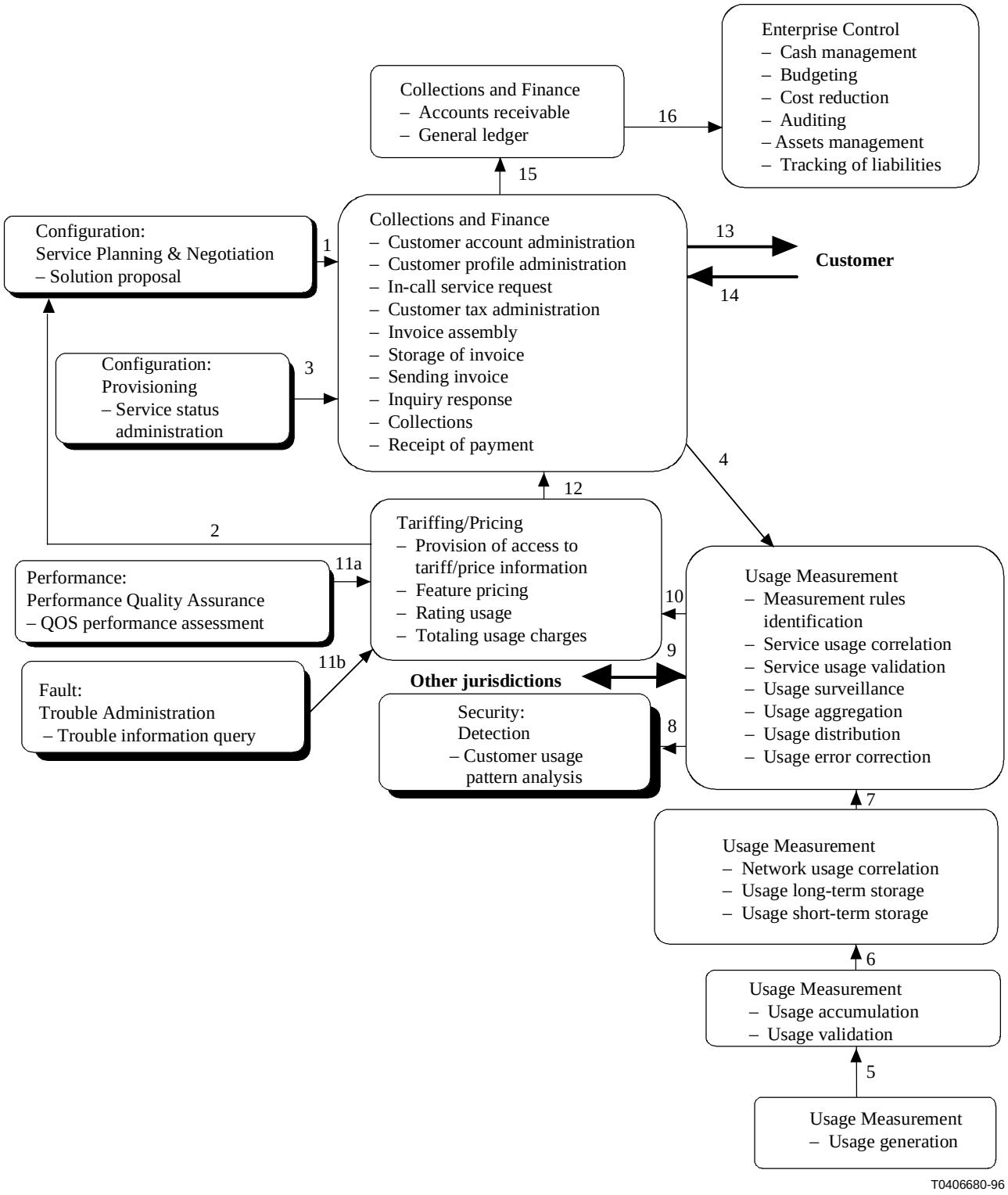

Figure I.9/M.3400 – Billing and collections

I.5 Quality of Service and network performance administration

I.5.1 Traffic quality assurance (PM, CM)

This scenario, in Figure I.10, shows how traffic data flows toward the functionalities that assess statistical QOS and the functionalities that summarize traffic performance of individual customers. A possible traffic QOS flow is shown below.

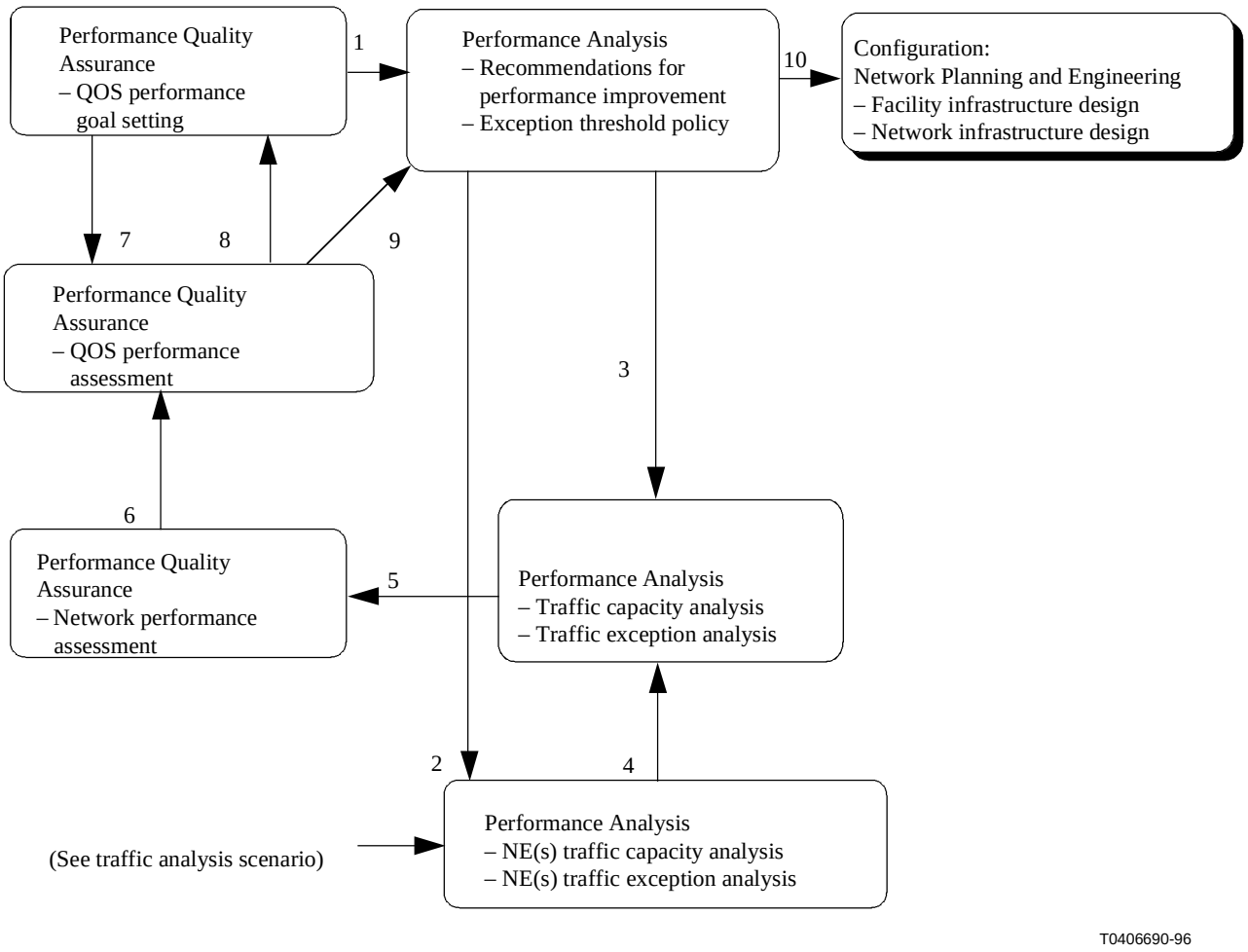

Figure I.10/M.3400 – Traffic quality assurance

I.5.2 Performance quality assurance (PM, CM, AM)

This scenario, in Figure I.11, depicts the assessment of transport network performance in general and the auditing of the performance of individual customer circuits against service-specific quality criteria. A possible flow is shown below in Figure I.11. This flow is intended to be generic in that it is not specific to any particular technology or service. Information of a "control" nature flows "downwards" in the diagram (1-3). Information representing data collected from the NEs flows "upwards" in the diagram (7-10). Interactions 12 and 13 show the delivery of proof of quality reports to customers. Interaction 14 is a hand-off of billing adjustments to Account Management. Interactions 17 and 18 show performance being analysed on a technical basis and fed back into the maintenance planning process.

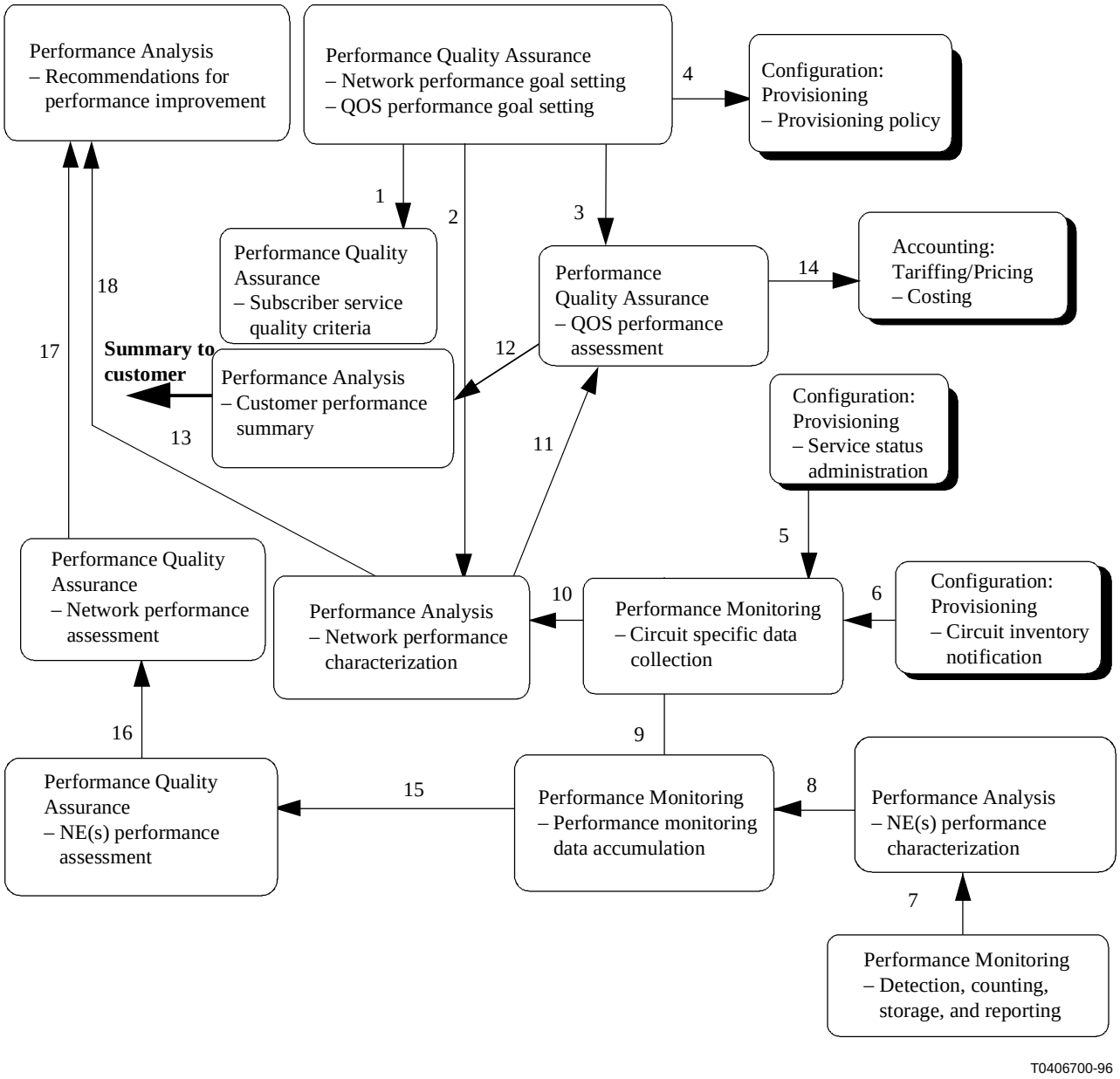

Figure I.11/M.3400 – Performance quality assurance

I.5.3 Reliability, Availability and Survivability Quality Assurance (FM)

A possible RAS quality assurance flow is shown below, in Figure I.12. The scenario starts with the input of fault information from NE(s) fault localization (1) and Network fault localization (3) and ends with RAS assessment receiving summarized information from Network outage reporting (4) and Service outage reporting (6).

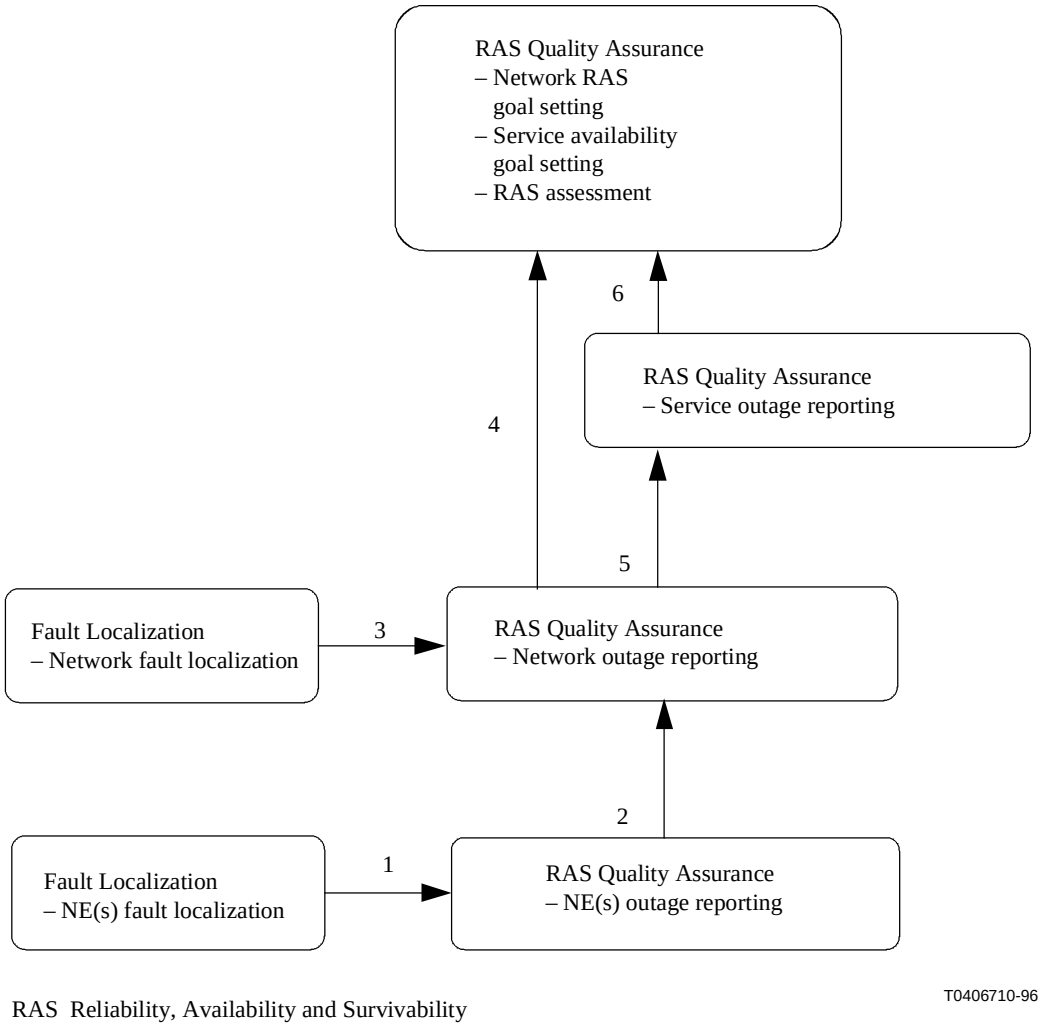

Figure I.12/M.3400 – Reliability, Availability and Survivability Quality Assurance

I.6 Traffic measurement and analysis administration

I.6.1 Traffic analysis (PM, CM)

This scenario, in Figure I.13, has three primary purposes: to guide changes in network and NE capacity by Configuration Management, to guide network controls, as described in the network traffic management scenario and to provide information to the assessment of QOS, as described in the traffic quality assurance scenario. A possible traffic analysis scenario is shown below. Interactions 1, 2, 6 and 8 describe the overall management of the flows. The flow of traffic data starts with interaction 3 and continues through interaction 5. Two applications of traffic data are shown: reports to customers (7 and 9) and forecast reports for the expansion or rearrangement of network capacity (10 and 11).

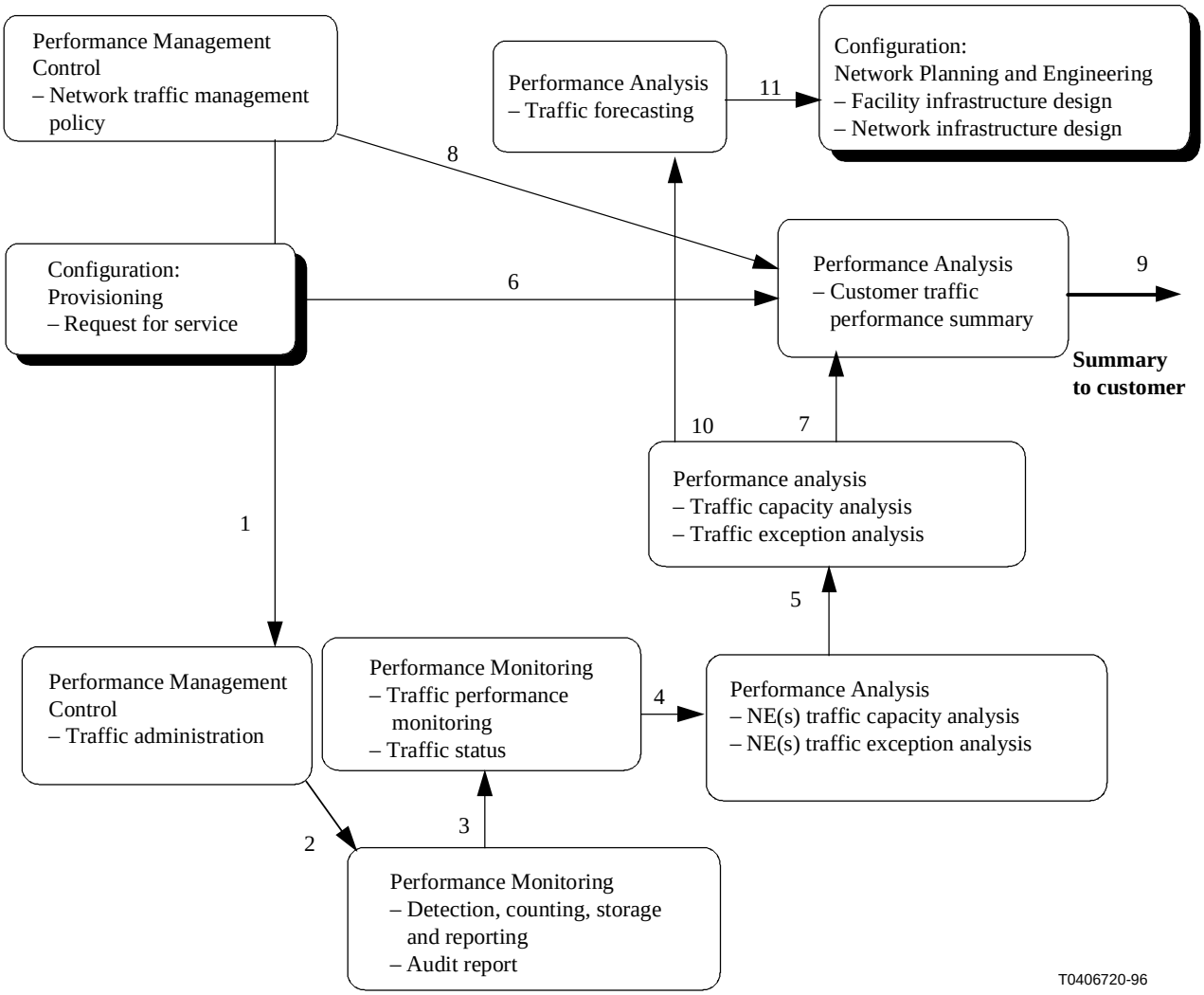

Figure I.13/M.3400 – Traffic analysis

I.7 Traffic management

I.7.1 Network traffic control (PM, FM, CM)

The purpose of this scenario, in Figure I.14, is to make rapid changes in network routing patterns to minimize loss of traffic in the event of an unexpected loss of switching or transport capacity or unusual changes in the amount or distribution of offered load. A possible network traffic control scenario is shown below. Interaction 1 is used to set up the network traffic control process. A scenario triggered by an extraordinary situation starts with the report of an overload by interaction 2.

Note that functionality of the Performance Monitoring group is used by this scenario as well as by the traffic analysis scenario. The combination of the Performance Monitoring group and Performance Management Control group is sometimes called traffic network management.

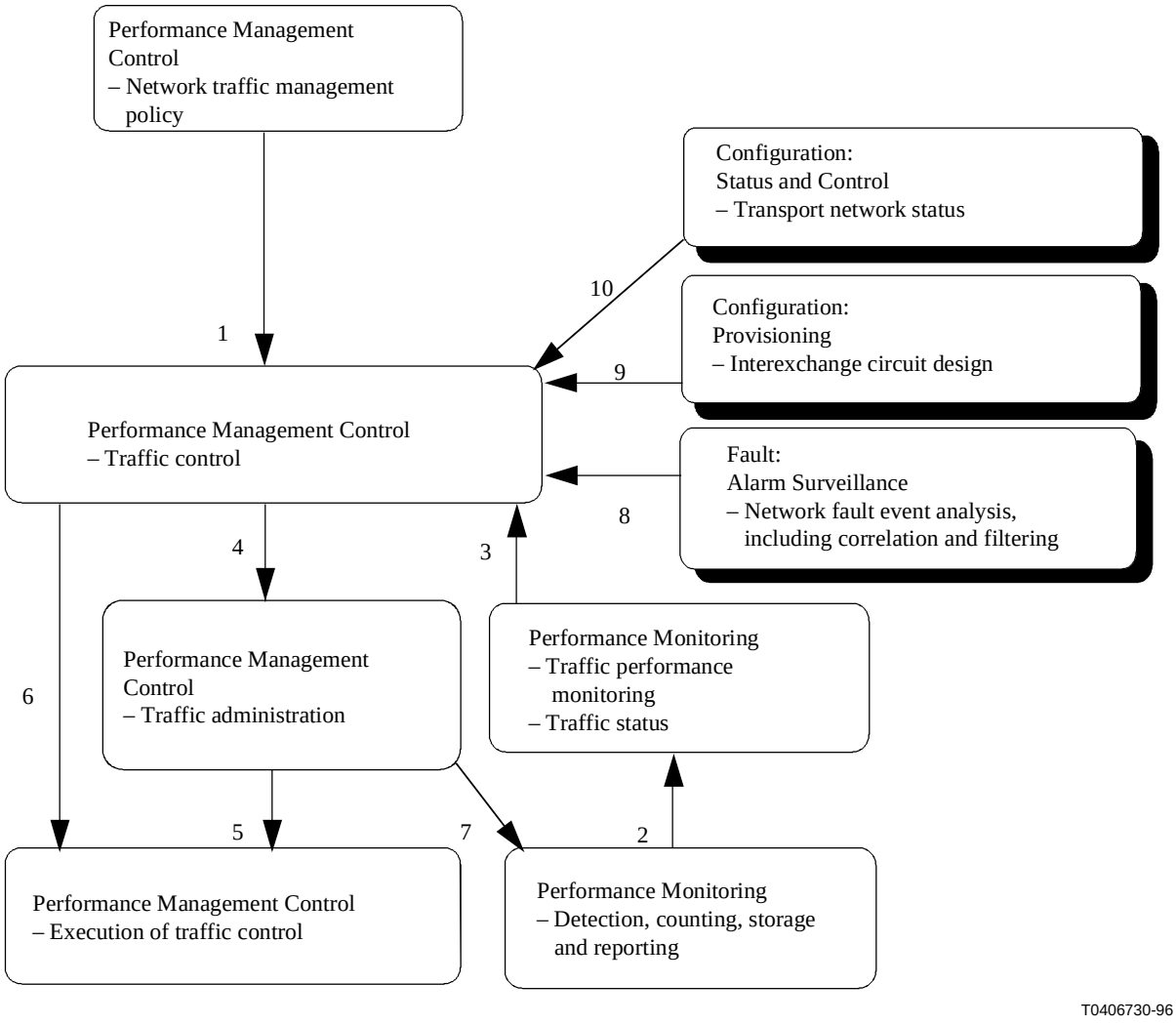

Figure I.14/M.3400 – Network traffic control

I.7.2 Customer-related traffic control (PM, CM)

The purpose of this scenario, in Figure I.15, is to avoid overload focused on individual customers, as happens when certain promotions and surveys are widely advertised. Controls block part of the offered traffic near its point of origin, at the request of the customer (in this case, the customer is the party who receives the calls). A possible scenario is shown below.

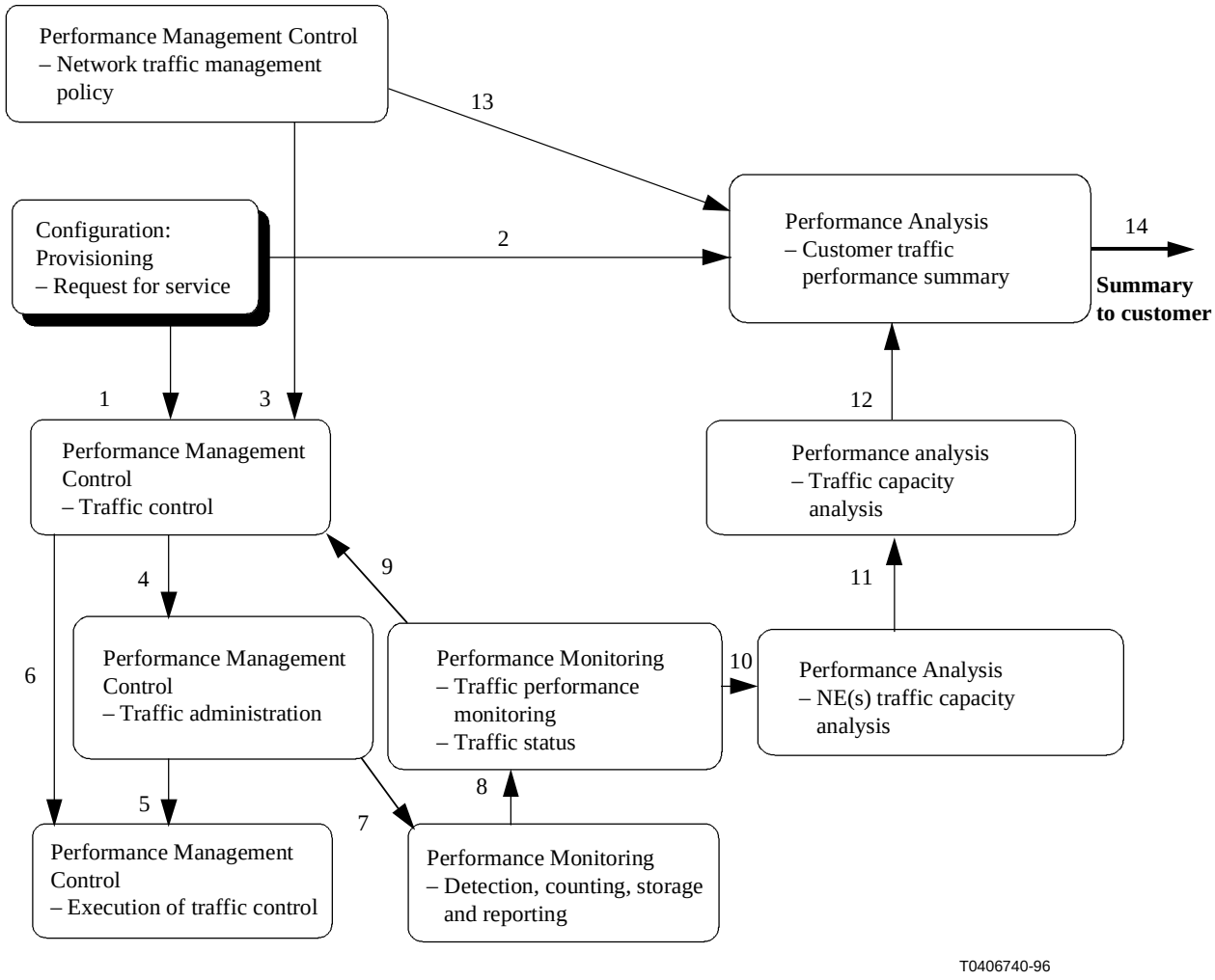

Figure I.15/M.3400 – Customer-related traffic control

I.8 Routing and digit analysis administration

For further study.

I.9 Maintenance management

I.9.1 PM Proactive Maintenance (PM, FM, CM)

PM Proactive Maintenance, in Figure I.16, depicts the primary short-term purpose of performance monitoring: to make use of performance monitoring impairment data to detect and correct possible maintenance problems (by feeding into the Fault Management process). It includes both traditional surveillance based on threshold crossing alarms and a more complicated early-warning surveillance based on pattern recognition and trending.

In interactions 1 through 9, policy information flows "downwards" to define and control the parameters of the proactive maintenance process. In interactions 10 through 17, information flows "upwards", is processed, and feeds the Fault Management process. In interactions 18 through 20 trends and patterns identified in the PM data are analysed and used to update the rules of the proactive maintenance process.

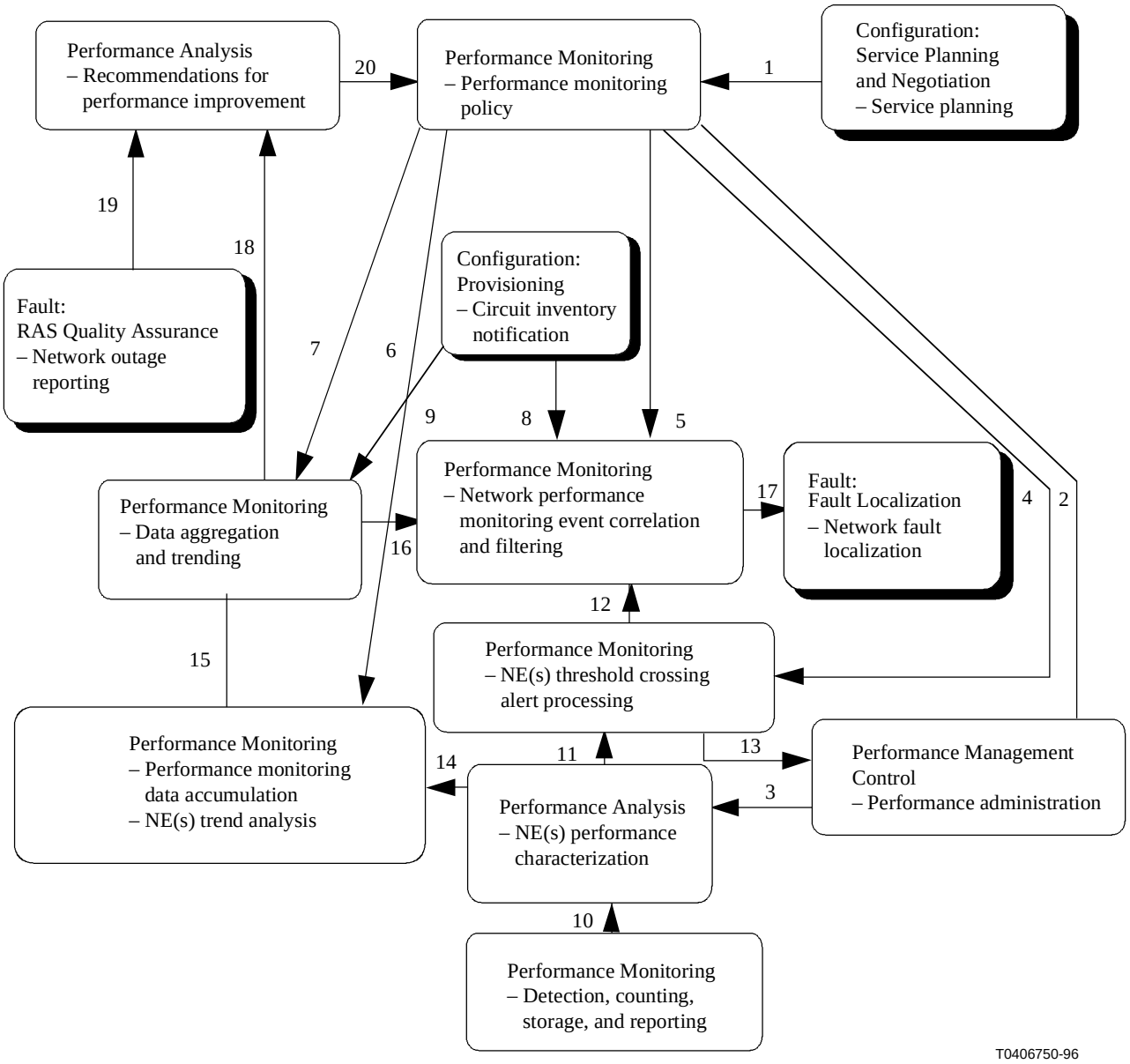

Figure I.16/M.3400 – PM Proactive Maintenance

I.9.2 Network detected trouble (FM, PM, CM, AM)

A possible proactive network detected trouble ticket flow is shown in Figure I.17. In this scenario, Alarm Surveillance or Performance Monitoring detects a fault and issues a trouble ticket to Fault Correction. This scenario starts with either an alarm report (1) or a performance monitoring report of persistent exceptions (5). One possible outcome is a notification to affected customers (8), another is restoration of a priority service (9), another is the clearing of the fault (11a and 11b) and another is allowing a rebate to affected customers (12).

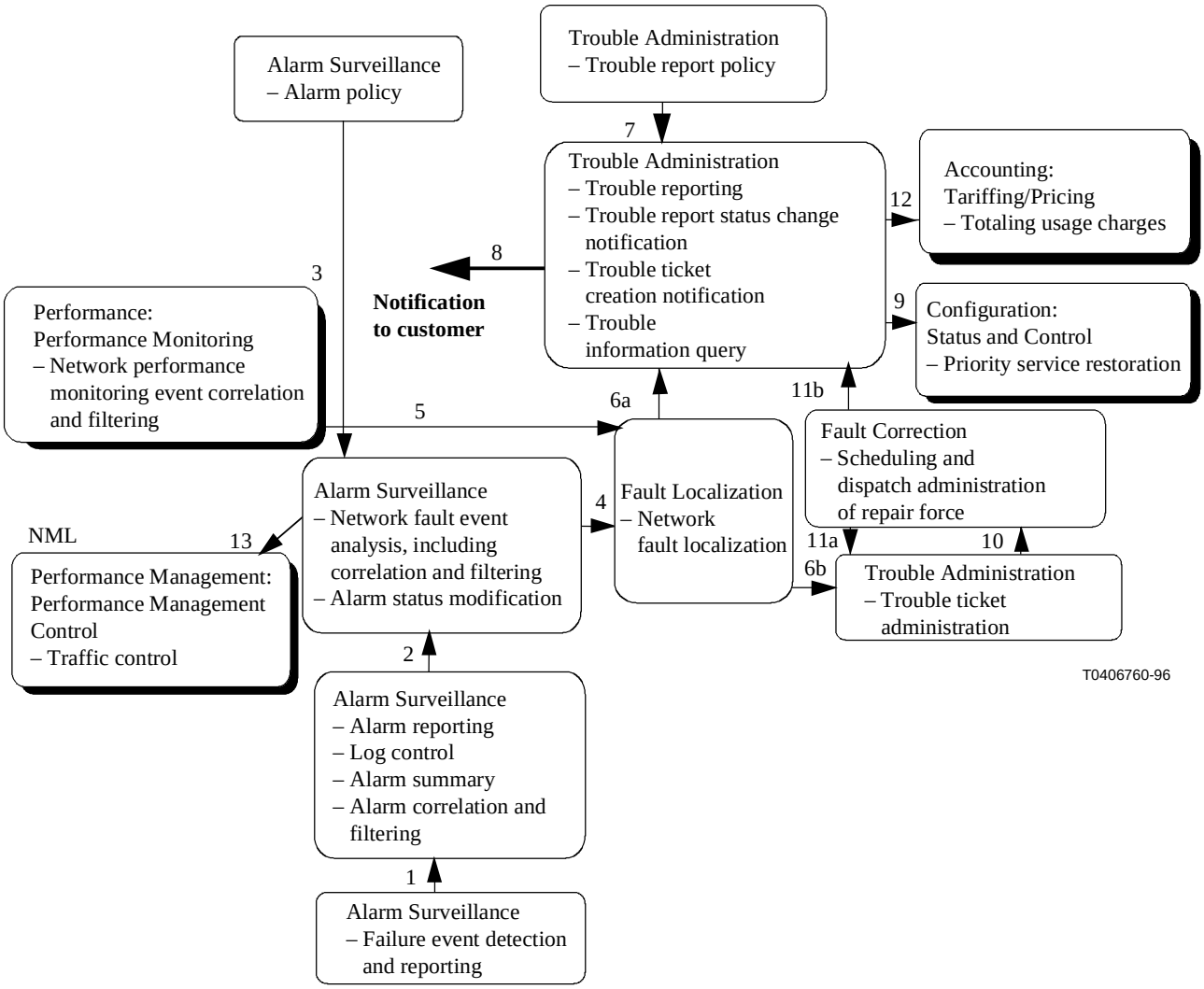

Figure I.17/M.3400 – Network detected trouble

I.9.3 Fault localization (FM, PM, CM)

A possible fault localization flow is shown in Figure I.18. In this scenario, a trouble has been detected by one or more means. All available data are examined and additional data may be requested. The root cause of the fault is inferred and a trouble ticket is issued.

This scenario has three possible starting points:

- Performance Monitoring may detect persistent exceptions (1).
- Alarm Surveillance may detect failures, or symptoms of failures (2).
- Scheduled diagnostics, exercises, or audits may detect faults (5).

The outcome of the scenario is the determination of the root cause and the creation of a trouble ticket (18).

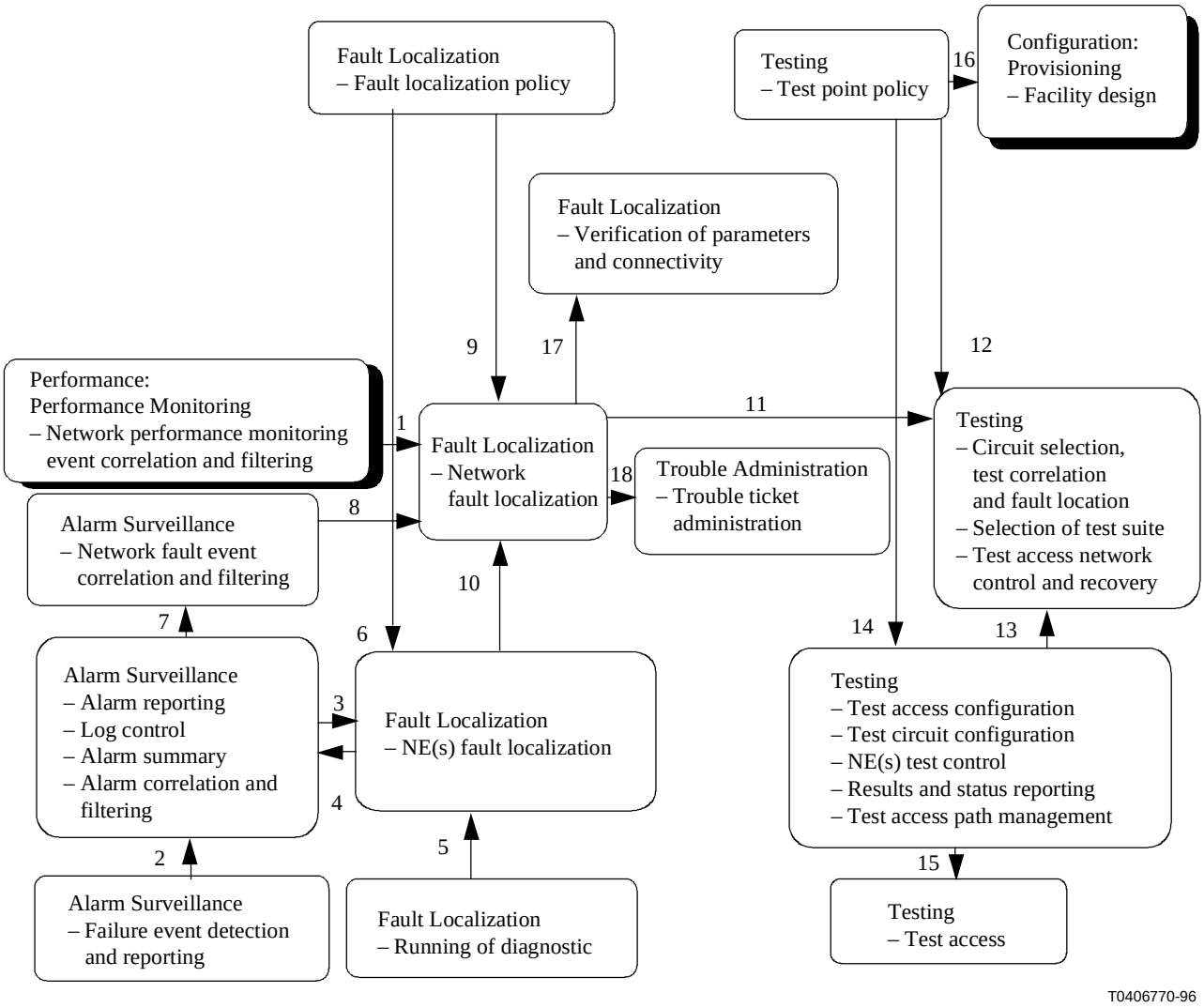

Figure I.18/M.3400 – Fault localization

I.9.4 Fault correction (FM, CM)

A possible fault correction flow is shown in Figure I.19. In this scenario, the root cause of a trouble has been located and a trouble ticket has been sent to Fault Correction. Further testing may be done to confirm the root cause and the trouble is repaired. Retesting verifies that the trouble has been cleared. Appropriate updates are made to Trouble Administration.

This scenario has two parts: the repair scenario, starting at interaction 1 or 2, and the automatic restoration scenario, starting at interaction 13. It should be noted that an automatic restoration action does not, in itself, start the repair activities: rather, it is the attendant alarm that starts repair, after the root cause of the trouble has been determined.

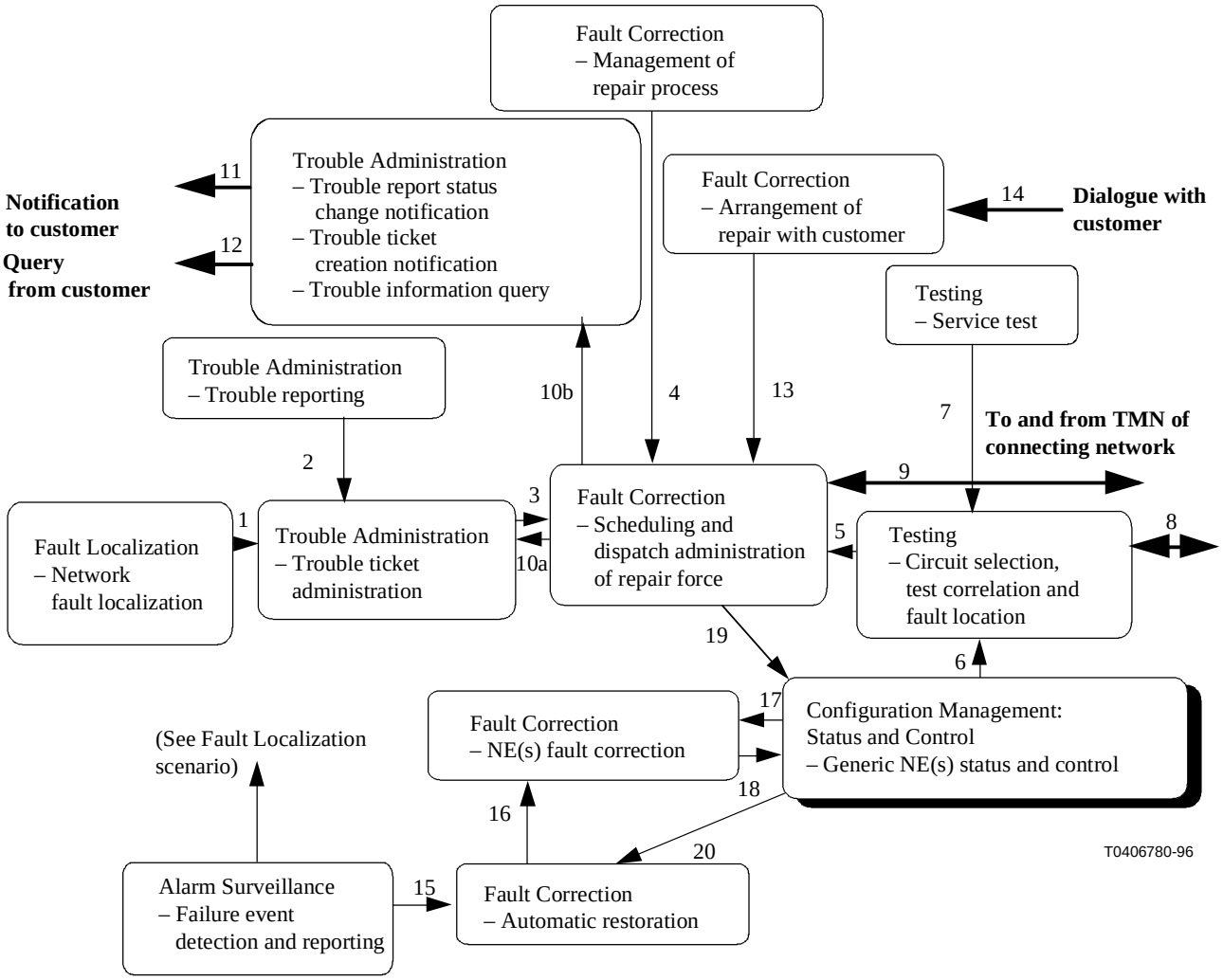

Figure I.19/M.3400 – Fault correction

I.10 Security administration

I.10.1 Establish/change privileges (SM)

The following scenario, in Figure I.20, depicts how customer (external user) permissions are established of changed. Note that a similar flow would apply to establishing or changing permissions for internal users.

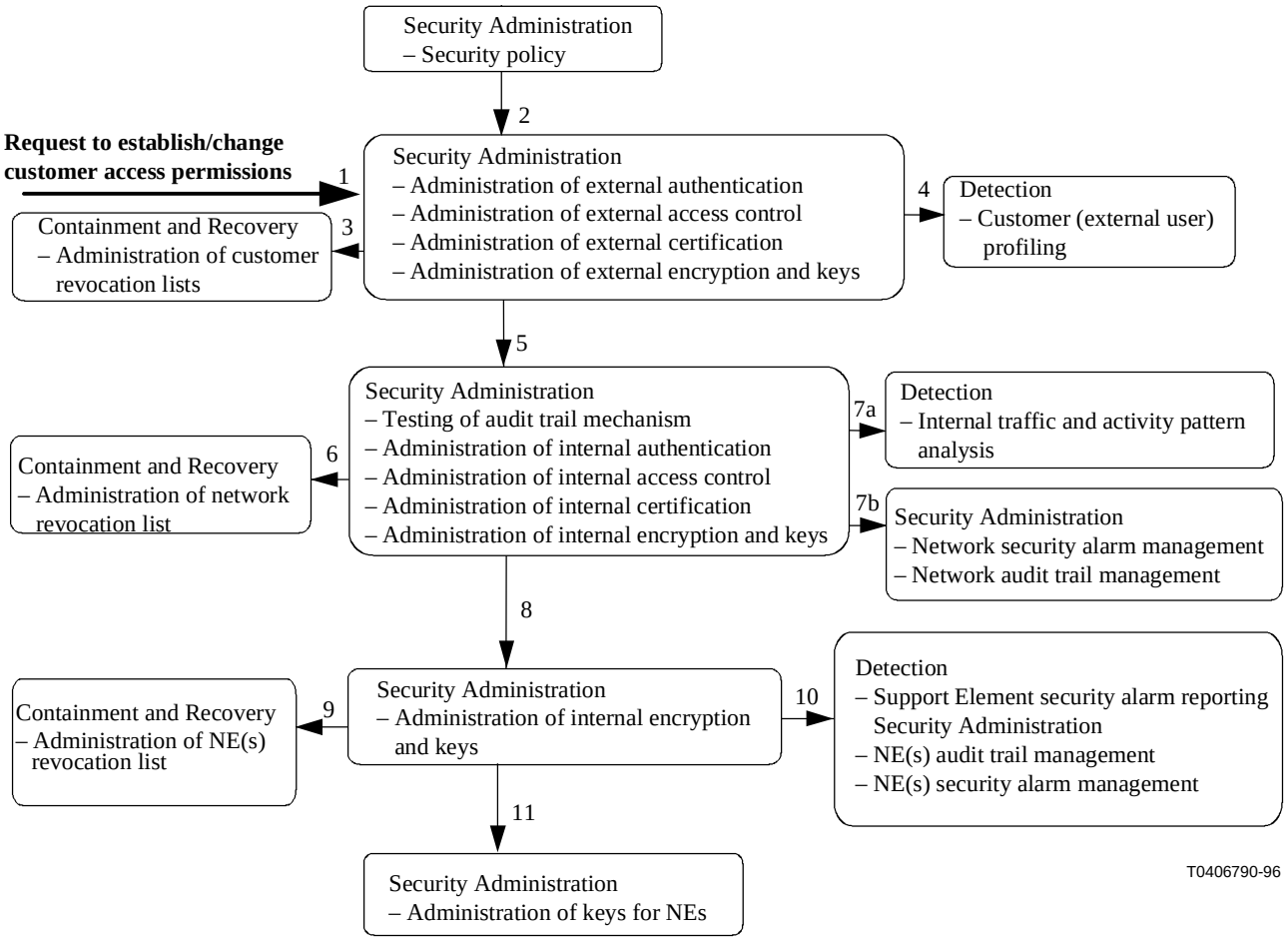

Figure I.20/M.3400 – Establish/change privileges

I.10.2 Audit detection of a security violation (SM, CM, AM)

The following scenario, in Figure I.21, shows the functions that might be invoked when a security violation is detected as the result of an audit. Because security violations have a wide variety of impacts on services and the network and may be detected via a wide range of security safeguards, this scenario should be viewed as illustrative rather than all-inclusive.

Some examples of detection may be the result of:

- Customer usage pattern analysis indicating a significant variation from normal usage patterns.
- Analysis of a customer audit trail placed on a customer suspected of security violations such as credit card fraud.
- Internal traffic and activity pattern analysis that results in the detection of a customer or user (external or internal) security violation.
- Analysis of a network audit trail placed on the network to detect a suspected security violation.
- Analysis of a NE audit trail placed on a NE to detect a suspected security violation.

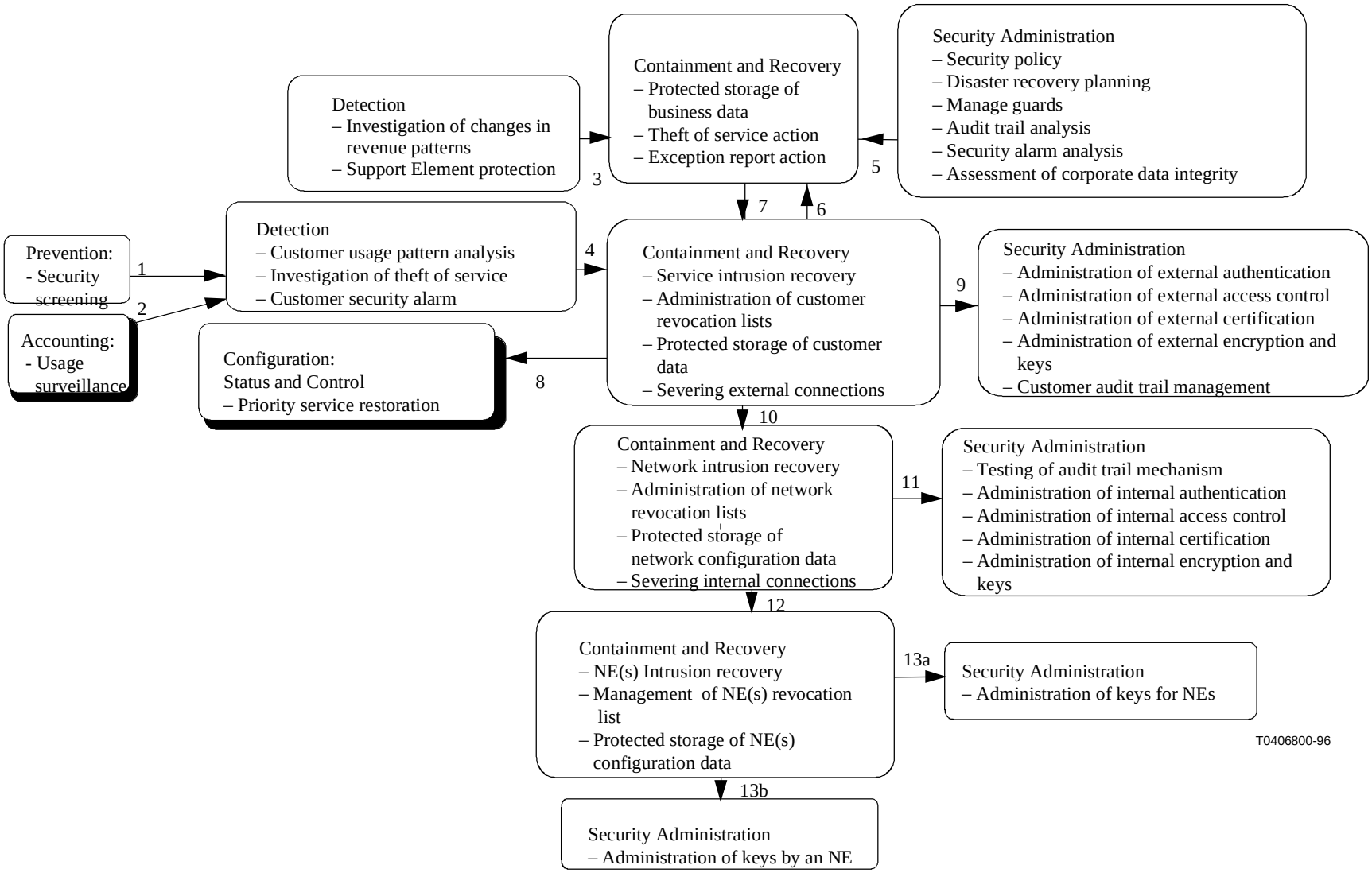

Figure I.21/M.3400 – Audit detection of a security violation

I.11 Logistics management

For further study.

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