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Foreword

This final draft second edition European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

This ETS comprises seven parts with the generic title "Radio Equipment and Systems (RES); Enhanced Radio MEssage System (ERMES)". The title of each part is listed below:

Part 1: "General aspects";

Part 2: "Service aspects";

Part 3: "Network aspects";

Part 4: "Air interface specification";

Part 5: "Receiver conformance specification";

Part 6: "Base station specification";

Part 7: "Operation and maintenance aspects".

This part, ETS 300 133-7, specifies the network management of the Enhanced Radio MEssage System (ERMES) system, specifically the Operations and Maintenance (O&M) aspects, including performance and Quality of Service (QOS) management.

ETSI Interim Intellectual Property Rights (IPR) Policy

The attention of ETSI has been drawn to the Intellectual Property Rights (IPRs) listed below which are, or may be, or may become, essential to the present ETS. The IPR owner has undertaken to grant irrevocable licences on fair, reasonable and non-discriminatory terms and conditions to these IPRs pursuant to the ETSI Interim IPR Policy. Further details pertaining to these IPRs can be obtained directly from the IPR owner.

The present information is accurate to the best of ETSI's knowledge. Pursuant to the ETSI Interim IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs, which are, or may be, or may become, essential to the present ETS.

IPRs:

EP Patent No. 0090851:	Decoder for Transmitted Message Activation Codes;
EP App. No. 89909668,9:	Multiple Frequency Message System;
EP App. No. 89913131,2:	Power Conservation Method and Apparatus for a Portion of Information Signal;
EP App. No. 92901376,1:	Multiple Format Signalling Protocol for a Selective Call Receiver;
EP App. No. 90915018,7:	Nationwide Paging with Local Modes of Operation;
EP App. No. 91904526,0:	Multiple Frequency Scanning.

IPR owner:

MOTOROLA Ltd, 110 Bath Road, Slough, GB-BERKSHIRE SL1 3SZ

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Date of latest announcement of this ETS (doa):	3 months after ETSI publication
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1 Scope

This ETS, describes the operations and maintenance aspects of the Enhanced Radio MEssage System (ERMES). It defines and describes the architecture of the telecommunication management network and also the network management functions. Telecommunication management network entities and the functional interfaces between these entities and the network elements are defined and described.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] prETS 300 133-3 (1997): "Radio Equipment and Systems (RES); Enhanced Radio MEssage System (ERMES) Part 3: Network aspects".

[2] prETS 300 133-2 (1997): "Radio Equipment and Systems (RES); Enhanced Radio MEssage System (ERMES) Part 2: Service aspects".

[3] ITU-T Recommendation M.60: "Maintenance terminology and definitions".

[4] ITU-T Recommendation G.106: "Terms and definitions related to quality of service availability and reliability".

[5] ITU-T Recommendation M.20: "Maintenance philosophy for telecommunication networks".

[6] ITU-T Recommendation M.30 (1990): "Principles for a telecommunication management network".

[7] ITU-T Recommendation X.219: "Remote operations: model, notation and service definitions".

[8] ITU-T Recommendation X.217: "Association control service definition for open systems interconnection".

[9] ITU-T Recommendation X.213: "Network service definition for open systems interconnection".

[10] ITU-T Recommendation X.208: "Specification of abstract syntax notation one (ASN.1)".

[11] ITU-T Recommendation X.209: "Specification of basic encoding rules for abstract syntax notation one (ASN.1)".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this ETS, the following definitions apply:

basic Operations System Functions (OSF): The operations system function which controls a network element.

data communication function: The means for telecommunication management data exchange between function blocks.

ERMES Telecommunication Management Network (TMN): The operations and maintenance part of the overall ERMES paging network.

interface Operations and Maintenance Centre (OMC) - Base Station (BS): The functional interface between the operations and maintenance centre and a base station.

interface OMC - Paging Area Controller - Operations System (PAC-OS): The functional interface between the operations and maintenance centre and the operations system of a paging area controller.

interface OMC - Paging Network Controller - Operations System (PNC-OS): The functional interface between the operations and maintenance centre and the operations system of a paging network controller.

IOMC (OMC - OMC): The interface between different network operators' OMCs.

maintenance: The technical, administrative and supervisory actions intended to keep an item in, or restore it to, a state in which it can perform its defined function.

Maintenance Entity (ME): An equipment of the telecommunication network which is defined between two or more interfaces as an object of the network management strategy. The main MEs are the Paging Network Controller (PNC), the Paging Area Controller (PAC) and the BS.

mediation device: A stand alone device which performs mediation functions.

mediation functions: Functions which act on information passing between network element functions and operator system functions. Major mediation functions include communication control, protocol conversion and data handling, communication of primitive functions, processes involving decision making and data storage.

network element: An element of the operator network.

network operations system: A system which performs the network basis telecommunication management network application functions by communicating with the basic operations system functions.

operations: The combination of technical and administrative actions that enables an item to perform a given function.

operations and maintenance centre: The control and data collection entity associated with a telecommunication management network.

operations system: The stand alone system which performs operations system functions.

Operations Systems Functions (OSF): Functions performed by the operations system. The OSFs process information related to telecommunication management to support and/or control the realization of various telecommunication management functions.

paging area controller - operations system: The basic operations system dealing with the paging area controller.

paging network controller - operations system: The basic operations system dealing with the paging network controller.

PNC throughput: The number of elementary operations performed by a PNC in a time unit. The term "elementary operation" indicates the processing of an Address Code (AdC) or an information request message or a complete message. The throughput offers an idea of load distribution within the network. It can be used for singling out network bottle-necks, hence giving information for management and design purposes.

Quality Of Service (QOS): A combination of traffic performance, availability, service integrity, service support and service operability.

telecommunication management network: The operations and maintenance part of an operator network. It provides management functions to the telecommunication network and offers communications between itself and the telecommunication network.

work station function: The function providing communications between function blocks and the user.

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

ACSE	Association Control Service Element
AdC	Address Code
ASN	Abstract Syntax Notation
BS	Base Station
DCF	Data Communication Functions
DCN	Data Communication Network
EOM	End of Message
ERMES	Enhanced Radio Message System
FSI	Frequency Subset Indicator
FSN	Frequency Subset Number
GA	Geographical Area
HW	Hardware
LCN	Local Communication Network
MD	Mediation Device
ME	Maintenance Entity
MEF	Maintenance Entity Function
MF	Mediation Function
MHS	Message Handling System
NE	Network Element
NEF	Network Element Function
NM	Network Management
O&M	Operations and Maintenance
OMC	Operations and Maintenance Centre
OS	Operations System
OSF	Operations System Functions
OSI	Open System Interconnect
PA	Paging Area
PAC	Paging Area Controller
PAC-OS	Paging Area Controller - Operations System
PDU	Protocol Data Unit
PNC	Paging Network Controller
PNC-H	Paging Network Controller - Home
PNC-I	Paging Network Controller - Input
PNC-OS	Paging Network Controller - Operations System
PNC-T	Paging Network Controller - Transmit
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
QAF	Q-Adapter Function
QOS	Quality of Service
ROSE	Remote Operations Service Element
RP	Reference Point
SDU	Service Data Unit
SEF	Support Entity Function
SW	Software
TLC	Telecommunication
TMN	Telecommunication Management Network
TO	Tone Only
TX	Transmitter
WSF	Work-Station Function

3.3 Symbols

For the purposes of this ETS, the following symbols apply:

ACK/NACK	Positive/Negative acknowledgement
I2	Interface PAC-BS
I3	Interface PNC-PAC
IOMC	Interface OMC-OMC

4 ERMES telecommunication management network architecture

The ERMES system functional architecture is shown in figure 1. The Telecommunication (TLC) and Telecommunication Management Network (TMN) environments are clearly separated.

The network management actions and functions required to support this network can be grouped in three categories:

- operations;
- maintenance;
- performance and Quality of Service (QOS) management.

A further category covering network administration is the responsibility of individual network operators and does not come within the scope of this ETS.

Within each operator network the following network elements are the object of operations and maintenance actions:

- the Paging Network Controller (PNC);
- the Paging Area Controller (PAC);
- the Base Station (BS);
- the interconnection links.

Three classes of Operations System Functions (OSFs) can be identified in the network. The basic OSFs are associated with a particular network element. The network OSFs are responsible for management actions involving the entire network. The service OSFs are responsible for transactions between operator networks and interaction with service providers.

The entities which deal with the TMN part of the operator network are Operations and Maintenance Centre (OMC), PNC-OS, PAC-OS and Mediation Device (MD). In particular:

- the OMC deals with the network Operations System (OS) and service OS functions. The OMC controls all the Operations and Maintenance (O&M) functions in the operator network and exchanges data with other OMCs;

- the PNC-OS and PAC-OS deal with the basic OSFs related to the associated telecommunication entity;

- the MD handles the mediation functions for the connected BSs. It implements concentration, distribution and protocol conversion.

OS and MD can be functionally separated from the related network elements and they may be implemented together.

Each OS can have its own database where information about the entity status is stored. If lower level entities exist, some O&M information about them should also be stored in the database. This database may also contain information required by the telecommunication network.

Every network element should contain maintenance entity functions and support entity functions involved in the transfer of maintenance information, the failure handling process and basic traffic measurements. General aspects and the philosophy of operations, maintenance and performance management are described in annex B along with Network Management Functions (NMFs) contained in the network elements and the OSFs.

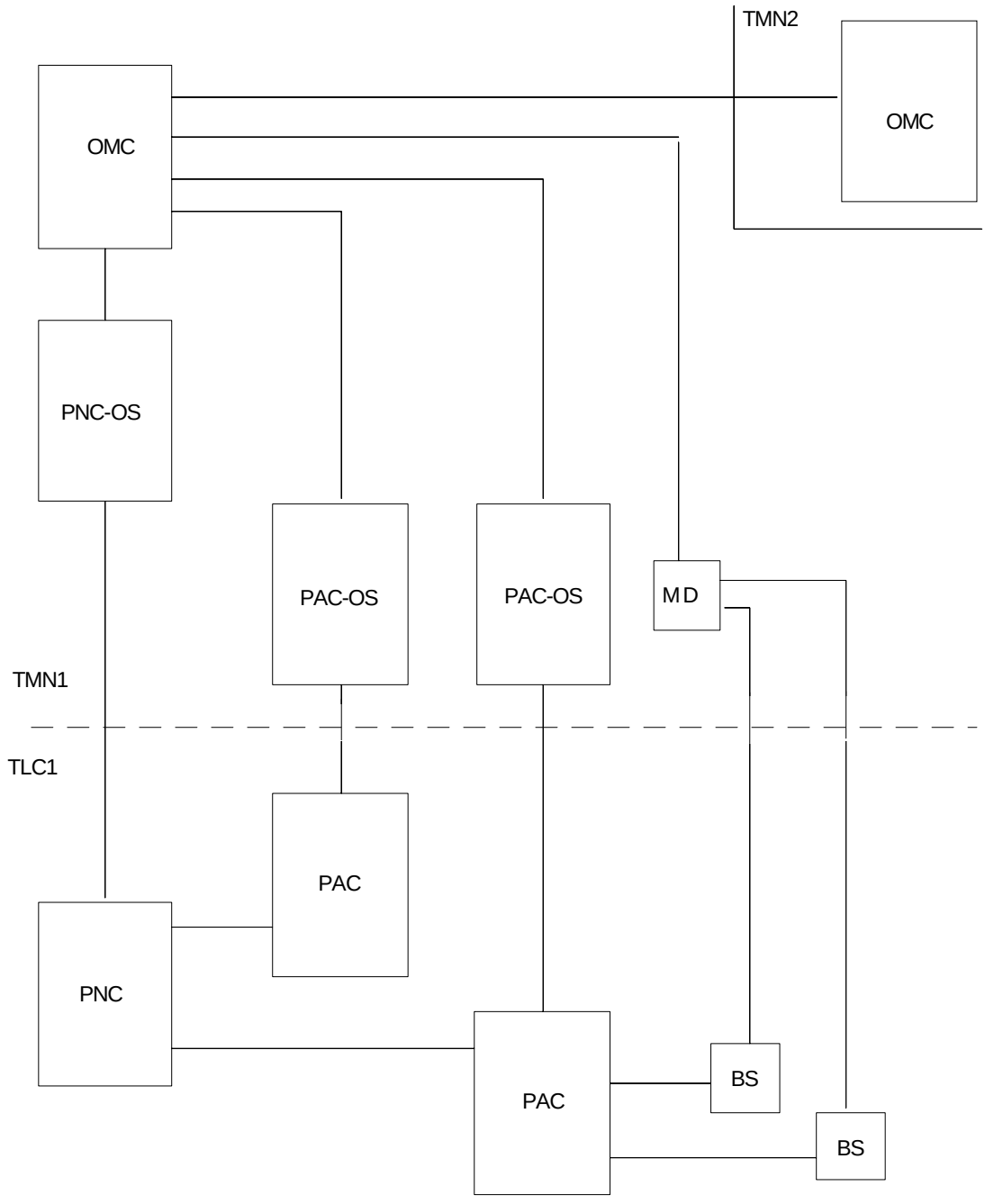


Figure 1: ERMES system functional architecture

5 Network management functions

5.1 General

The network management functions identified in clause 4 are defined in this clause and other information which aids understanding of their characteristics and objectives, are described.

5.2 Operations

The term operations is intended to include configuration management as well as some of the more classical concepts such as status handling and recording functions.

5.2.1 Subscriber data management

Subscriber data management, as an administrative function, is mainly a network operator matter.

The subscription status database for both mobile and fixed subscribers is associated with the PNC as described in ETS 300 133-3 [1], subclauses 12.2.1 to 12.2.5.

The OMC can add or delete subscribers to the PNC database and modify the subscription status according to operator needs or user requests.

The operator may collect administrative and traffic demand data not directly related to the telecommunication process.

5.2.2 System configuration management

This operations function performs modifications, updating and integration of the hardware/software resources. System configuration changes can impact either on the devices (or parts of them) which are the object of the modification, or act at network level, if the change also implies a data re-arrangement in contiguous network elements.

Three functions can be identified:

- control of the network elements;
- upgrades of the network elements;
- network or network element reconfiguration.

For both upgrades and reconfigurations, the following operations sequence should be followed:

- the network element is isolated from service;
- the new software is loaded or a new part of the element is installed;
- the network elements directly interworking with the modified element, are informed of the modification;
- system testing is performed in order to ensure correct working mode of the modified element;
- the network element is restored to service and the appropriate network elements informed.

In particular cases some of the above actions can be avoided or the order changed.

Upgrades and reconfigurations refer to both hardware and software entities and, in general, they are performed through:

- local actions (status updating, software loading, hardware installation);
- OMC (centralized) actions, such as software downloading, status and configuration updating, testing of the upgraded facilities.

The OMC shall keep a record of the current version of the network configuration, specifying the installed elements and the interconnection resources. All upgrades and network element reconfigurations shall be registered by the OMC (even if they are performed locally). Hence the OMC is continuously updated about the software and hardware versions installed in the network. For back up purposes, a copy of the running programs should be available.

The system configuration management requires some capabilities to be implemented in the TMN. This impacts on the specification of the OMC and Network Elements (NEs), namely:

- request/report of the configuration status (OMC $\rightarrow$ NE / NE $\rightarrow$ OMC);

- modification command and notification (OMC $\leftrightarrow$ NE) assignment or cancellation of internal entities;

- request/report of the internal assignments (OMC ↔ NE);

- setting of service parameters and thresholds (OMC → NE);

- time co-ordination and network synchronization control (OMC ↔ NE).

5.2.3 Status control

This operations function is strictly tied to the maintenance environment. As a result of maintenance action, any change of the network element functionality is registered as a service state change.

The same procedure applies if an item is removed from service for diagnostic tests.

Accordingly every hardware/software entity can be characterized by its:

- operations state (in service, out of service, busy for maintenance);
- working state (working, busy, unloaded);
- access state (the entity can/cannot be reached for use in the network).

Control of the device state should act both locally and through the OMC by means of the following functions:

- status request (OMC → NE);

- status report (NE → OMC);

- scheduling of the status report (OMC → NE);

- allow/inhibit automatic restoration, if present (OMC → NE);

- set the operations state of a network element, i.e. in service, out of service, busy for maintenance (OMC → NE).

5.2.4 Traffic records for charging and accounting

The information required for charging can be retrieved from the OMC database. Basic accounting data, e.g. that related to international traffic can be exchanged between operators. It is up to the operators to choose the communication means and the information to be exchanged.

5.3 Maintenance

Maintenance aspects of the ERMES network are considered in three categories, namely alarm management, corrective maintenance and preventive maintenance.

Alarm management includes all system characteristics involved in the process of detecting, displaying and communicating the occurrence of a failure and storing the relevant information.

Corrective maintenance refers to the set of actions which should be taken by the network operator as soon as information about a failure occurrence is available.

Preventive maintenance deals with all functions required to check the system functionality in the absence of a specific fault indication, with the objective of decreasing the overall system failure rate. Routine tests are an example of such functions.

5.3.1 Alarm management

The PNC, PAC and BS should each contain autonomous supervision functions which are managed in parallel with the normal telecommunication functions.

Generally they are too dependent on hardware and software design to be standardized.

5.3.1.1 Alarm generation

The alarms can be classified as:

- urgent alarms;
- deferred alarms;
- anomaly indications.

The allocation of an appropriate alarm depends on the controlled hardware and software configuration as well as on the operator policy.

The PNC, PAC and BS can contain the following capabilities:

- autonomous alarm generation according to the previous categories;

- alarm report to the OMC. The report rules are influenced by the alarm importance;

  Urgent alarms should be immediately sent to the OMC while deferred alarms or anomalies may be detected, stored, grouped and then sent to the OMC according to a less severe report requirement.

- generation of a response message to an Alarm Status Information Request, explicitly produced by the OMC;

- modification of internal alarm criteria, such as thresholds and alarm state definition. This feature is activated by an explicit request from either the OMC or a local human intervention. In the latter case, the OMC should be notified of the new alarm configuration;

- modification of alarm report rules, e.g. the report frequency for deferred alarms or anomaly indications.

The complementary alarm management capabilities of the OMC are described in clause 7.

All alarm messages and alarm reports shall contain:

- originating maintenance entity;
- alarm identification;
- detection time;
- additional information for fault localization (if available).

5.3.1.2 Alarm processing and logging

The OMC should contain alarm correlation capabilities in order to isolate the induced malfunctioning from the original faults. Such filtering and synthesis functions are normally performed through human intervention and the use of correlation and analysis programs located in the OMC.

The alarms autonomously generated by the maintenance entity as well as those explicitly requested by the OMC shall be registered and possibly stored in the OMC for deferred utilization. Storage rules should allow efficient subsequent retrieval by the operator according to a classification based on the alarm message attributes.

5.3.2 Corrective maintenance

When an urgent or deferred alarm is generated, a corrective maintenance action should follow with an intervention policy which depends on the alarm gravity and on the possible consequences on the service quality. Corrective maintenance is a serial process generally carried out in the following order.

5.3.2.1 Failed unit isolation

After failure detection the faulty unit(s) shall be isolated (if appropriate) to prevent the system from failure propagation or simply to allow for switching to redundancy, when provided by the system design. The impact on the system behaviour of this action concerns operations, since the configuration associated with the faulty maintenance entity should be first of all recorded in the OMC, so that the network functionality state is always available at a centralized point.

Other actions can follow if the system is capable of reacting with some kind of dynamic management. One example is redundancy intervention which can be automatic or commanded manually, either locally or from the OMC.

5.3.2.2 Fault localization

Efficient repair action depends on the availability of procedures for localizing the fault to a small set of repairable units (e.g. boards or functions) where the failure has occurred. Fault localization programs are heavily dependent on system design and on the hardware and software design of the maintenance entity.

In general such programs can either be located in the individual equipment or centralized in the OMC. In any case, the operator should be given the possibility of:

- activating/deactivating the procedure;

- defining a diagnostics plan, together with the report of the results obtained by running the localization programs.

5.3.2.3 Repair and replacement phases

Definition and the consequent duration of these phases depends on the operator organization and the maintenance policy (repair crews and logistic structure, spare parts allocation and provisioning). Basic system design also affects the repair time since modularity, provisioning of diagnostic tools, etc. can help human intervention and limit the degradation period. Even if the repair and replacement phases heavily impact on system availability they are not a standardization object.

5.3.2.4 Test functions

When the repair has been completed specific tests aimed at verifying functional correctness of the maintained element should be carried out. One of the possible outcomes is that the spare unit itself is faulty. The activation of test procedures should be possible on site or remotely from the OMC. The first alternative is most common in the case of direct human intervention while the second seems applicable when switching to a redundant unit has been commanded from the OMC.

The following test functions should be provided within network elements following either a local or a remote command:

- test activation;
- test reporting;
- definition or modification of the test parameters.

5.3.2.5 Restoration to service

After successful completion of the repair phase, the repaired unit should be restored to service (or to a redundancy role). Any change of network configuration should be logged. If some dynamic management actions have been decided after fault isolation, the changed parameters should be restored to the initial value.

5.3.3 Preventive maintenance

Every maintenance entity should be equipped with appropriate procedures capable of performing routine tests on all repairable units so that (at least) a subset of deviations from the operational behaviour can be detected before a real malfunction occurs. The procedures for performing routine tests are logically connected to the system design, even if it is an operator concern to define the most appropriate policy for running such tests (frequency, etc.). Test paging messages can be sent to check the correct operation of the network.

5.4 Performance and QOS management

In this subclause traffic data collection, QOS and network performance parameters, and traffic management actions are addressed. These follow the performance management concepts described in annex B.

The measurements needed for estimating the traffic and performance parameters are classified by:

a) the measurement planning; in this sense a measurement can be:

- permanent, when performed continuously by the operator;
- periodic, when performed according to a regular time plan;
- on request.

b) the measurement rules; in this sense there can be:

- sampled measurements, defined with a specified sampling rate;
- continuous measurements, normally used to measure time intervals spent in given system states;
- discrete measurements, performed by incrementing a counter when a given event occurs.

5.4.1 Traffic data

Traffic data can be collected to provide the operator with some tools for network planning and for verifying the correct working environment of the devices. Normally specific statistical tools are needed to process the collected data.

Each traffic parameter is characterized by its definition, the applied measurement plan, and the adopted measurement rules. In general, traffic parameters are associated with the network entities, the access network or the type of service.

5.4.1.1 Average rate of input requests

This traffic data is based on a permanent - discrete measurement, consisting of incrementing a counter whenever an "AdC for message transmission" is received.

The average is taken by dividing the counter content by the relevant collection time (typically ranging from 15 minutes to one hour).

It is categorized:

- per access network (Public Switched Telephone Network (PSTN), Telex, Message Handling System (MHS), etc.) and in this case it applies to the Input PNC (PNC-I);

- per originating operator network (from another PNC). In this case it applies to Home PNC (PNC-H).

5.4.1.2 Average rate of call not accepted or conditionally accepted ACK

This traffic data is based on a permanent - discrete measurement. A counter is incremented whenever a "call not accepted ACK" is sent towards the calling party.

The averaging time ranges from 15 minutes to one hour.

It is categorized:

- per access network. In this case it applies to PNC-I;

- per originating operator network (from another PNC). In this case it applies to PNC-H;

- according to the reason of refusal, i.e.:

    - mobile user subscription state (after the check with PNC-H);
    - time-out expired before response from PNC-H;
    - wrong or interrupted user-network dialogue;
    - network status for call acceptance (availability and delay) and in this case it applies to PNC-I.

5.4.1.3 Average rate of input messages

This is a permanent - discrete measurement. The counter is incremented whenever an End of Message (EOM) pattern is received, closing a message input by the calling party.

The averaging time ranges from 15 minutes to one hour.

It is categorized:

- per access network, in PNC-I;
- per originating operator network. In this case it applies to Transmit PNC (PNC-T);
- per kind of service (numeric, alphanumeric or transparent data);
- according to the correctness of the message (in order to distinguish between valid and invalid messages).

5.4.1.4 Average rate of outgoing page messages

This is a permanent - discrete measurement. A counter is incremented whenever an EOM pattern is transmitted by the PNC.

The averaging time ranges from 15 minutes to one hour.

It is categorized according to:

- the destination network:

    - the message is routed in the same network as the transmitting PNC; it is measured in PNC-T towards the I3 interface and the results are classified per destination PAC;
    - the message is routed towards another operator network, in this case the measure is applied to both PNC-H and PNC-I;

- per kind of service (Tone Only (TO), Numeric, Alphanumeric, Transparent data).

5.4.1.5 Average message length

This continuous measurement can be planned as a permanent or an on-request observation. A counter accumulates the length of the messages accepted for transmission.

The average is taken by dividing the counter content by the number of valid input page messages, known by measurement from subclause 5.4.1.3.

The averaging time ranges from 15 minutes to one hour.

It is categorized according to:

- the kind of service (numeric characters, alphanumeric characters or transparent data bits) in PNC-I and PNC-H;

- the originating operator network. In this case, in PNC-T, the measurement results are classified per destination PAC.

5.4.1.6 Number of requests for subscriber feature and supplementary services

This is a permanent - discrete measurement. A counter is incremented whenever a service number for a subscriber feature or a supplementary service request is received.

The typical measurement time is one day.

It is categorized according to:

- the access network;
- the required service facility or supplementary service;
- activation/deactivation/modification request of the service facility.

5.4.1.7 Roaming data

This is a permanent and continuous measurement. It can be performed by accumulating in a counter the global roaming time (volume of the roaming periods). The counter content is then divided by the accumulation period (typically one day) to give the average number of roaming users. Through more specific measurements, it may be possible to calculate the average roaming time per user, average traffic per roaming user, or traffic per external operator.

Such parameters apply to PNC-H and PNC-T and are characterized by the geographical area requested for roaming.

5.4.2 QOS and network performance parameters

The QOS and network performance parameters can be collected to quantify the QOS offered to the user and to verify the working conditions of the devices. Those parameters associated with the call acceptance feature (such as call delivery delay) belong to this category.

As in the case of traffic data, parameters are defined and a measurement plan and measurement rules specified. The network entities involved in the measurement are also identified.

When the QOS and the network performance parameters are evaluated by making use of traffic measurements, they should refer to the same measurement period.

The system response delay (see ETS 300 133-2 [2], subclause 6.2.4) and the correct message transmitted probability (see ETS 300 133-2 [2], subclause 6.2.10) can not be evaluated by the O&M network. External equipment is needed to perform these measurements.

5.4.2.1 Average call accepted acknowledgement delay

This represents the time spent by an input request in the input queue.

This is a sampling measurement on request or permanent.

It is calculated by sampling the number of waiting input requests in PNC-I (i.e. the number of AdCs to be analysed by PNC-H) and by accumulating such number in a counter. After an assigned period (15 minutes to one hour) the counter content is divided by the number of samples collected in that period. The result is the mean number of waiting input requests.

The average call accepted acknowledgement delay is then obtained by dividing the mean number of waiting input requests by the average rate of input requests obtained in the same period according to the measurement described in subclause 5.4.1.1.

It is categorized:

- per access network in PNC-I. If PNC-I does not coincide with the PNC-H of the requested receiver, then the delay also takes into account the time needed to receive a response (call accepted or not accepted message) coming from PNC-H. In this case a distinction of the two figures is recommended;

- per originating operator network (from another PNC). In this case it applies to PNC-H.

5.4.2.2 Average page accepted acknowledgement delay

This is a sampling measurement on request or permanent.

The number of messages not yet acknowledged with a page accepted (or not accepted) message, is sampled and the result accumulated in a counter for a given period (15 minutes to one hour). After that period the counter content is divided by the number of samples to get the mean number of waiting page requests (a page request enters the waiting state as soon as the EOM pattern is received by the PNC).

The average page accepted acknowledgement delay is then obtained by dividing the mean number of waiting page requests by the average rate of input messages obtained in the same time period according to subclause 5.4.1.3.

It applies to PNC-I and it is characterized according to the access network.

The same mechanism applies for calculating the average subscriber feature acknowledgement delay.

5.4.2.3 Average waiting time for transmission in PNC

This is a permanent sampling measurement.

This is one component of the message delivery time and should be estimated for, and associated to, any call entering the ERMES network.

It is calculated by sampling the number of messages waiting in the transmission queue and by accumulating this number in a counter. The mean number of waiting messages is then obtained by dividing the content of the counter by the number of samples performed within the observation time (15 minutes to 1 hour). Then the average waiting time for transmission is calculated by dividing the mean number of waiting messages by the average rate of input messages (see subclause 5.4.1.3).

It applies to PNC-I, PNC-H, PNC-T and for the last case it is categorized per destination paging area.

5.4.2.4 Average waiting time for transmission in PAC

This is a permanent sampling measurement.

This item is the major component of the message delivery time. It depends on the operator policy concerning radio resource planning and on the PAC operations mode. The first concept involves both the radio channels assigned to the base stations as well as the subsequences used. The second concept refers to the batch management of the radio interface, i.e. to the rules used by the PAC for scheduling the paging address and message transmissions.

Once the mean number of waiting page messages has been evaluated according to the mechanism defined in subclause 5.4.2.3, the rate of outgoing messages (from PNC-T) successfully received by PAC is used for calculating the average waiting time for transmission (see subclause 5.4.1.4).

It applies to PAC and is categorized by:

- the kind of service (TO, numeric, alphanumeric, transparent data);
- the priority assigned to the message;
- the radio channel.

5.4.2.5 Average message delivery time

This figure is calculated by summing the waiting times evaluated in subclauses 5.4.2.3 and 5.4.2.4. Nevertheless, for the call acceptance mechanism (see ETS 300 133-3 [1], subclause 12.6) it is assumed that the major contribution to the message delivery time is due to the PAC.

The sum should be taken per paging area.

5.4.2.6 PNC throughput

This measure has been implicitly defined in the traffic parameter section. It depends on parameters defined in subclauses 5.4.1.1, 5.4.1.2 and 5.4.1.3.

The global throughput can be calculated by summing the three rates. If, on the contrary, these parameters are kept separate, then they represent a throughput measure for PNC-I, PNC-H and PNC-T respectively.

5.4.3 Traffic management actions

The actions described in this subclause rely on measured quantities defined in subclauses 5.4.1 and 5.4.2. The aim is to:

- protect the operator network against unexpected overloads;
- enhance traffic handling capability.

Both protective and option expanding actions are considered.

5.4.3.1 Flow control

This is a fundamental action since it does not simply belong to the performance management environment but is the basis of call acceptance mechanisms.

According to ETS 300 133-3 [1], subclause 12.6, a percentage delay is assigned to a paging area on the basis of delay distribution of messages transmitted by the PAC. Such a distribution is measured by sampling the delays suffered by paging messages before transmission, sorting the collected samples in decreasing order and counting them. The operation is repeated for all priority classes. At the end of the measurement period, the 90 % delay time (i.e. the time within which 90 % of calls are transmitted from receipt by the PAC) is expressed by the delay of that particular messages that occupies the m-th position in the ordered list; m is the minimum value that satisfies the following relation:

$$m = \min_{n}\left\{ n : \frac{n}{N} \geq 0{,}1 \right\}$$

where N is the total number of samples and n is the order number in the defined sequence.

The resulting 90 % delay time F_{nil} (as defined in ETS 300 133-3 [1]) is then compared with a flow control threshold tf, whose value is an operator concern. If $F_{n,l}$ exceeds tf, a flow control mechanism is activated towards the l-th PAC of the PNCn with the result that the latter does not accept any further message destined to the former as long as the flow control state holds.

The normal PNC working mode is re-entered when a second threshold, lower than or equal to the former, is crossed in the opposite way at the end of another measurement period. The evaluation of $F_{n,l}$ is accomplished by PAC-OS that is also responsible for communicating the measured value to the OMC.

Such evaluation and the consequent flow control mechanism can be applied both to the active channels and, within channel, to any single batch.

When the OMC, through the threshold comparison, decides to apply flow control to the l-th paging area, for whatever reason, it declares the l-th PAC unavailable. Accordingly, the OMC:

- updates the set A (defined in ETS 300 133-3 [1], subclause 12.6) of the PACs accessible within its own network and informs its PNC (H role) of the new availability situation; the unavailability of the PAC must also be known by PNC-T, which must avoid the transmission of any message in that direction (the network in fact, according to the call acceptance mechanisms, can still accept messages involving the unavailable PAC);

- calculates the new availability status of the Geographical Area(s) (GA) containing the Paging Area (PA) under flow control; then it sends the new figure(s) to the other OMCs of the ERMES system.

It is recalled that the batch overloads, or load imbalances, can be recovered by other traffic management actions (see subclause 5.4.3.3).

5.4.3.2 Active channels re-arrangement

The number of channels available to every PAC can be increased or decreased by the OMC, on operator's decision, in order to relieve local overloads. The new channel configuration must obey frequency re-use constraints as well as time constraints, if only a part of the available subsequences are moved to/from the PAC.

The decision appears particularly complex, probably not suitable for automatic processing, but rather for an operator's intervention in the OMC. Implementation requires the conversion table from Frequency Subset Number (FSN) to Frequency Subset Indicator (FSI) in the PAC to be updated. At the same time a new correspondence between FSI and the channel to be used by the transmitter is added.

To decide upon activation of such management action, the most appropriate measurement should be the average waiting time for transmission in PAC, calculated according to subclause 5.4.2.4.

5.4.3.3 Modification of control parameters in PAC

PAC functionality depends on working modes or parameters that are specified in ETS 300 133-3 [1] . Two of them can be the object of traffic management actions, namely:

- the priority class management;
- the decision interval n_d (see ETS 300 133-3 [1], subclause 13.5.5.1).

6 Interfaces

6.1 General

This clause describes the O&M functional interfaces which deal with the logical data passed between a network element and the OMC as indicated in figure 1. The relevant data exchange is carried by the I2, I3 and OMC-PNC interfaces as shown in figure 2. The I2 and I3 interfaces are specified in ETS 300 133-3 [1] and their conformance to the O&M requirements is analysed in annex C of this ETS.

Each internal interface can be described in terms of the functional messages sent by the originating entity. Consequent responses are expected but will not be described.

The interface between OMCs is defined in subclause 6.3 and is normative.

6.2 Functional interfaces (internal to the network operation)

Every interface shall provide the capability for the required exchange of data between involved entities.

The described message generates in the opposite sense a response message which in its simplest form may be just an Positive Acknowledgement (ACK) or a Negative Acknowledgement (NACK). The protocol for the exchange of messages are not described.

Each functional message is described by a list of commands and/or data and is informative.

6.2.1 OMC to PNC-OS functional interface

6.2.1.1 OMC to PNC-OS messages

The OMC to PNC-OS commands are as follows:

a) control commands:

- switch on/off units;
- activate stand-by units;
- block/unblock traffic to PAC(s) (for flow control);
- control the time reference;

b) configuration modifications:

- update addresses and passwords;
- update HardWare (HW) and SoftWare (SW) configurations;
- update of paging areas, the network availability and network average delay;
- setting of alarm and traffic data report rules;
- set and update alarm thresholds and test attributes;
- set and update interworking parameters;
- management of the subscriber database;

c) status request:

- PNC internal status;
- PNC external interfaces status;
- alarm status;

d) software loading:

- telecommunication SW;
- control and supervision SW;
- diagnostic temporary SW.

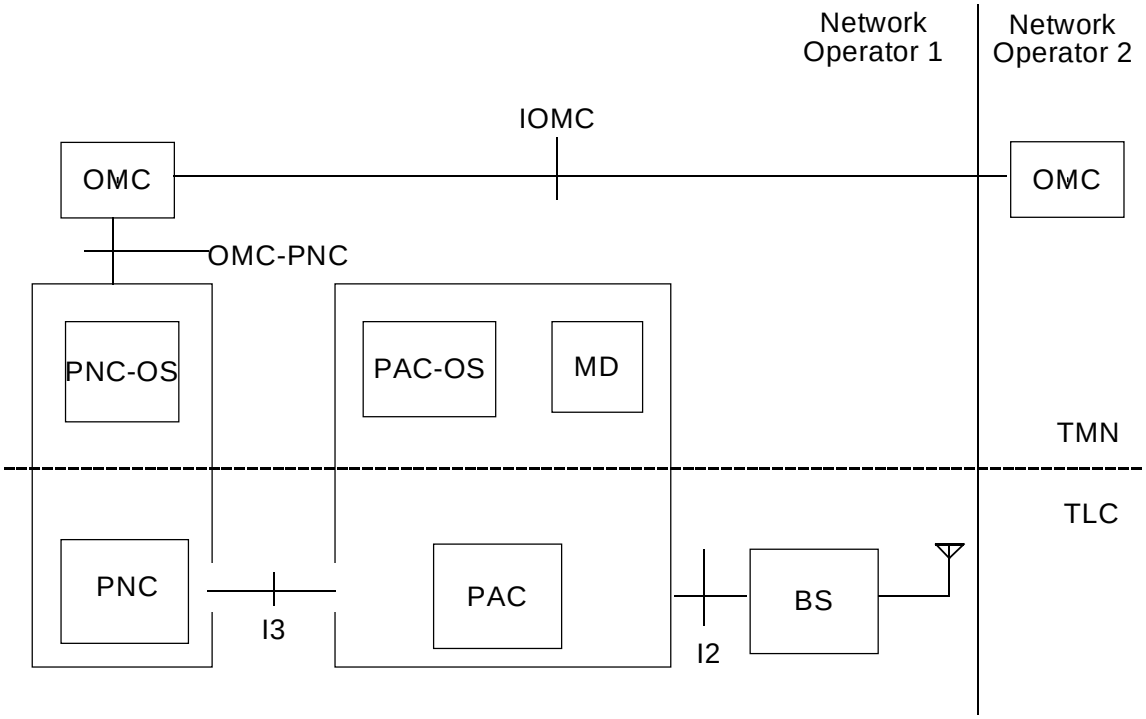


Figure 2: O&M interfaces

6.2.1.2 PNC-OS to OMC messages

The PNC-OS to OMC messages are as follows:

a) traffic information:

- traffic and queue parameters;
- network and queue parameters;
- QOS and network performance parameters;

b) autonomous alarms:

- failure of Hardware (HW) units;
- failures in the operation processes;

c) per call traffic data.

6.2.2 OMC to PAC-OS interface

6.2.2.1 OMC to PAC-OS messages

The OMC to PAC-OS messages are as follows:

a) control commands:

- switch on/off units;
- activate stand-by units;
- control of time co-ordination;

b) configuration modifications:

- update BS addresses;
- update HW and Software (SW) configurations;
- set and update alarm and traffic data report rules;
- set and update alarm thresholds, test attributes and interworking parameters;

c) status request:

- PAC internal status;
- PAC external interfaces status;
- alarm status;

d) SW loading:

- telecommunication SW;
- control and supervision SW;
- diagnostic temporary SW.

6.2.2.2 PAC-OS to OMC messages

The PAC-OS to OMC messages are as follows:

a) traffic information:

- traffic parameters;
- performance and QOS parameters;

b) autonomous alarms:

- failure of HW units;
- failures in the operation processes.

6.2.3 OMC to BS interface

6.2.3.1 OMC to BS messages

The OMC to BS messages are as follows:

a) control commands:

- switch on/off units;
- activate stand-by units;
- adjust Transmitter (TX) parameters;

b) configuration modifications:

- update addresses and system information;
- update HW and SW configuration;
- set and update alarm thresholds and test attributes;
- set and update internal working parameters;

c) status request:

- BS internal status;
- alarm status;

d) SW loading:

- telecommunication SW.

In the relationship between the OMC and the BS a mediation function exists which may send to the BS poll, status and report requests according to a schedule defined by the OMC.

6.2.3.2 OMC to MD messages

The OMC to MD messages are as follows:

a) status request;

b) configuration modifications;

c) BS(s) alarm report:

- rules for the poll, status and report request to the BS(s);
- MD internal working parameters.

6.2.3.3 MD to OMC messages

The MC to OMC messages are as follows:

a) programmed alarm and status report of BS;

b) autonomous alarm generation (if implemented).

6.2.3.4 MD to BS messages

Status request:

- BS internal status;
- alarm status.

The messages between OMC and BS previously defined may pass transparently through the mediation device.

6.3 IOMC (OMC to OMC) interface

This subclause specifies the minimum requirements for all OMCs and is normative.

Connection to the Packet Switched Public Data Network (PSPDN) can either be via a separate link and address or via the same physical link and network address as the I4 interface (see ETS 300 133-3 [1], clause 9).

The same protocol stack (level 1 to 6) shall be used for the Interface OMC-OMC (IOMC) interface as specified for the I4 interface.

Association Control Service Element (ACSE) and Remote Operation Service Element (ROSE) (ITU-T Recommendations X.217 [8] and X.219 [7]) shall be used for the application layer. Within this part of the ERMES specification no subset is defined for ROSE and the following requirements are fulfilled:

- classes 1 and 5 for the operations are not foreseen;
- operations defined in this ETS are class 2 (result and error always expected);
- only the association class 1 is taken into account;
- no linked operation.

6.3.1 OMC operations

This subclause describes the operations used by applications within OMCs in order to exchange information. Annex A contains a more detailed specification of these operations (in terms of parameters) and gives the Abstract Syntax Notation One (ASN.1) form. This description is the reference for the implementation.

Each IOMC operation is an independent event and there is no requirement for the responding OMC to relate together the operations processed.

Table 1

Operation	Description	Essential/Optional
Network Status Request	Request for information on the current status of another operator network	Essential
Network Status Report	Information on the current status of an operator network. This could be transmitted periodically or when a status change occurs.	Essential
Change of Network Name	Notification of a change to the name used when accessing an OMC or PNC	Optional
Change of Password	Notification of a change to the password used when accessing an OMC or PMC	Essential
Define New GA Configuration	Request to define a new GA configuration within the invoked network, according to previous bilateral agreements.	Optional
Traffic Data Request	Request for information on the traffic exchanged during a certain period of time.	Optional

6.3.2 Use of ACSE

ACSE is used to establish an association between peer entities. This association shall be established before an operation can be invoked (association class 1). Only the entity which establishes the association can invoke operations. An association can be released only by the entity which has established the association. The peer entity can only invoke abort of the association but in this case it is possible to lose data. The abort of an association is considered as an abnormal situation.

The association can also be abnormally released by the lower layers. In this case ACSE will report an "abort by the provider" to the upper entity.

It is not the purpose of this IOMC interface specification to indicate when an association must be released. The applications within OMCs have the liberty to decide when an association has to be established and/or released.

6.3.3 Use of ROSE

The ROSE entity is defined, at a service level, by ITU-T Recommendation X.219 [7]. The service provided by the ROSE entity to the application entity is described below.

During the ROSE Bind Operation, OMCs exchange authorization information in order to ensure that no malicious calls can be handled either by authorized or non-authorized OMCs. This information is a password stored in each OMC according to the network address of the OMC.

When an OMC wants to establish an association with a peer entity, it sends as a parameter the password of the OMC to be accessed. The receiving entity checks this password with the one stored in its database. If the password is correct, the called OMC confirms the association establishment and gives back its password to the calling OMC in order that the calling OMC can be sure of the identification of the called OMC. Receiving the password, the first OMC checks it (according to the address provided by the lower layers) and the association can then be used for message delivery.

If the password is incorrect, the called OMC shall refuse the association establishment. It may also provide information to the OMC that a malicious entity has tried to enter the ERMES system. When the password checking fails at the calling entity after receiving the association confirmation, the association shall be released by an abort request and the OMC advised.

The service description below is given only as a guide. There is no constraint on the way to realize the ROSE and application entities.

RO-Invoke

The RO-Invoke Service is used by the invoker (one application entity within an OMC) to cause the invocation of an operation to be performed by the performer (the peer entity within the called OMC). Two primitives are used:

- RO-Invoke-Request from an application to the ROSE entity;
- RO-Invoke-Indication from the ROSE entity to an application.

The operation exchanged by these primitives is contained in the parameter "argument" of the primitive. An "Invoke ID" parameter issued by the caller allows the link with the results (positive or negative).

RO-Result

The RO-Result Service is used by a ROSE user (an application of OMC) to reply to a previous RO-INVOKE-INDICATION in the case of a successfully performed operation. Two primitives are used:

- RO-Result-Request from an application to the ROSE entity;
- RO-Result-Indication from the ROSE entity to an application.

The "result" parameter is used to report the success of the operation by the set of information required by the operation. The RO-Result uses the same Invoke-ID as the RO-Invoke primitive.

RO-Error

The RO-Error Service is used by a ROSE user (an application of OMC) to reply to a previous RO-INVOKE-INDICATION in the case of an unsuccessfully performed operation. Two primitives are used:

- RO-Error-Request from an application to the ROSE entity;
- RO-Error-Indication from the ROSE entity to an application.

The "Error-parameter" field may be used in order to provide additional information about the error. The RO-Error uses the same Invoke-ID as the RO-Invoke primitive.

RO-Reject-U

The RO-Reject-U Service is used by an application to reject a request (within a RO-Invoke-Indication) if it has detected a problem. This service may also be used by an application to reject a response (positive or negative). For the IOMC only the first case is possible. Two primitives are used:

- RO-Reject-U-Request from an application to the ROSE entity;
- RO-Reject-U-Indication from the ROSE entity to an application.

RO-Reject-P

The RO-Reject-P Service is used to advise an application of a problem detected by the ROSE provider. There is only one primitive associated to this service:

- RO-Reject-P-Indication from the ROSE entity to an application.

RO-Bind

The RO-Bind Service is used to allow the service of ACSE to establish an association. The RO-Bind primitive is used to exchange passwords between OMCs.

RO-Unbind

The RO-Unbind Service is used to allow the service of ACSE to release an association.

6.3.4 OMC addressing

The address formats for the IOMC network layer shall be as described in ITU-T Recommendation X.213 [9].

The final form of addressing for IOMC layers above the network layer shall be determined by agreement among the network operators.

7 Operations and Maintenance Centre (OMC)

The operations and maintenance centre (OMC) is a network operations system associated with a particular operator. Its main functions are:

- network and subscriber configuration handling;
- alarm management (i.e. generation, processing, filtering and report);
- evaluation of traffic and QOS figures;
- traffic management and flow control.

The OMC is defined in terms of functions (see subclause 7.1) and databases (see subclause 7.2). The functions are divided into operations, maintenance, performance and QOS management categories.

The calculation of call acceptance defined in subclause 7.1.4 is normative.

The functions for management of the internal resources (e.g. database management) are not specifically described.

7.1 Functions

7.1.1 Operations

The operations functions performed by the OMC shall include:

a) management of subscriber databases in the PNC e.g. add, delete and change information (parameters and status) in the databases defined in ETS 300 133-3 [1], clause 12;

b) management and distribution of the control orders to the NEs and its associated OS, e.g. set and update operations state;

c) configuration management of the Network Element (NE) and its associated OS, e.g.:

- upgrade NEs and OSs:
  - update internal addresses and passwords;
  - update HW and SW revision information;
- reconfigure network, NEs:
  - modify configuration;
  - inform interworking entities about reconfiguration;

d) management of the network configuration (e.g. connected OMCs, internal Geographical Areas (GAs), time and frequency division);

e) management of traffic handling parameters in the NE and its associated OS, e.g.:

- FSIs, priority criterion, decision interval and system information for PAC;
- update service areas, GAs and Paging Areas (PA) for PNC;
- block/unblock traffic to PNC, PACs, and BSs;

f) per call traffic data collection, e.g.:

- traffic information in order to give requested charging and supplementary subscriber information;
- traffic statistic per call, per type of service, and per subscriber;

g) management of the ERMES network passwords and addresses, updating of the relevant data base in PNC, e.g.:

- relay passwords and addresses to be used by the PNC when accessing other PNCs;
- relay passwords to be used by other PNCs during access;

h) modification, update and exchange with the other operators, of data concerning the ERMES network operations, e.g:

- GA identifiers and its PA for other OMCs;
- GA references in other OMCs;
- service areas and passwords;
- GA availability and delay status;

In addition the following operations functions may be performed by the OMC:

j) sending the OS status requests (poll and report request) of the associated NE and collect the relevant results, e.g. request internal status (operation state, working state and access state) and configuration status;

k) management of the operations functions tied to all the access links and interfaces associated to any entity (including IOMC), e.g.:

- control line profile;
- set and update line parameters;
- block/unblock the lines;

l) remote loading of software to any network element, e.g.:

- telecommunication software;
- O&M software;
- temporary software for test purposes;

m) management of billing parameters, e.g. charging rates for fixed subscribers.

Other operations functions may be included.

7.1.2 Maintenance

The maintenance functions performed by the OMC shall include:

a) receive and process alarms and failure situations autonomously generated by PNC-OS, PAC-OS, MD (if implemented), and BSs, e.g.:

- alarm management actions: receive alarm indications from HW units and links and malfunctioning indications from SW units;
- alarm processing and logging;
- classify alarms for importance;
- visualize alarms (display or print).

In addition the following maintenance functions may be performed by the OMC:

b) request and schedule alarm and failure reports by PNC-OS, PAC-OS, MD and BSs, e.g. request alarm report status;

c) activate scheduled and unscheduled tests and fault localization programs in PNC-OS, PAC-OS, MD and BSs, e.g.:

- order the entity to run tests and failure localization programs;
- order the entity to run diagnostic programs;

d) redundancy control, e.g.:

- switch on/off HW and SW units;
- activate standby HW units and back-up SW;

e) set and adjust the poll, status and report request in MD (for BSs);

f) management of the alarm and test conditions in PNC-OS and PAC-OS, e.g. set and update alarm, thresholds, modes and test attributes;

g) store results and reports of the maintenance functions, e.g. store results for further processing and/or for output.

Other maintenance functions may be included.

7.1.3 Performance and QOS management

The performance and QOS functions present in the OMC shall include:

a) processing of traffic and QOS data and management of the QOS threshold in the OMC, e.g:

- traffic parameter handling according to the definitions in subclause 5.4.1;
- QOS and network performance parameters according to the definitions in subclause 5.4.2;
- set and update thresholds used in the flow control mechanism.

In addition the following performance and QOS functions may be present in the OMC:

b) request for traffic data report from PNC-OS and PAC-OS, e.g.:

- request for counter values;
- request for queue lengths;

c) schedule of traffic data and QOS data report, e.g. set and update report rules;

d) request for current report schedule for traffic data and QOS;

e) management of test calls for QOS;

f) storage of the traffic data, the QOS measurements and the test call results.

Other performance and QOS functions may be present in the OMC.

7.1.4 Calculation of call acceptance

The OMC shall evaluate availability and delay status for GAs. The PNC shall use these results to calculate the availability call by call. Measured data shall be exchanged between OMCs on the IOMC. The definitions are in accordance with those specified in ETS 300 133-3 [1], subclause 12.6.2. The exchanged parameters are independent of any particular call.

7.1.4.1 Availability evaluation for GAs

Let:

G_n the set of GAs defined within the n-th PNC.

$G_{n,k}$ the set of PACs belonging to the k-th GA within the n-th PNC.

$G^*_{n,k}$ the set of available PACs belonging to the k-th GA within the n-th PNC.

$C_{n,l}$ the area covered by the transmitters of PAC_l, which is, by turn, associated with PNC_n.

$C^*_{n,l}$ the available area covered by the transmitters of PAC_l, which is, by turn, associated with PNC_n.

$D_{n,l}$ the equivalent density of receivers inside the nominal $PAC_{n,l}$.

$D^*_{n,l}$ the equivalent available density of receivers inside the nominal $PAC_{n,l}$.

$D_{n,l}$ is a relative figure derived from the population density within $C_{n,l}$ and is estimated from demographic information. The network operator may also apply other weighting factors.

Sets G_n and $G_{n,k}$ can vary for the same PNC, according to different bilateral agreements between operators.

OMC_n , associated with PNC_n, shall calculate the "k-th GA user visibility" $\delta_{n,k}$ using the following formula:

$$\delta_{n,k} = \sum_{l \in G^*_{n,k}} \frac{C^*_{n,l} \cdot D^*_{n,l}}{\sum_{i \in G_{n,k}} C_{n,i} \cdot D_{n,i}}$$

The percentage availability obtained from $\delta_{n,k}$ shall be used by the OMC to determine the GA availability status $AS_{n,k}$ exchanged with other OMCs according to ETS 300 133-3 [1], table 58.

7.1.4.2 Delay evaluation for geographical areas

In a similar way, OMC_n shall evaluate the "mean 90 % delay time":

$$\mu_{n,k} = \frac{1}{\left| G^*_{n,k} \right|} \sum_{l \in G^*_{n,l}} F_{n,l}$$

where $F_{n,l}$ is the 90 % delay time associated with the n-th PNC towards the l-th PA.

The percentage delay obtained from $\mu_{n,k}$ shall be used by OMC_n to determine the delay status $DS_{n,k}$ exchanged with other OMCs according to ETS 300 133-3 [1], table 59.

7.2 OMC database

The OMC database shall hold the necessary information for the parameters used in the OMC. The OMC database may include:

- configuration data:
  - network configuration related to the whole network;
  - network configuration related to the structure of NEs;
  - information on possible reconfiguration alternatives;
  - information on stand-by units;
  - GA configuration (per access network);
  - addresses of PNCs and OMCs (with passwords);
  - status request reports;
  - tables of network availability and delay for call acceptance;
  - information on geographical areas;
  - information on paging areas;
- maintenance data:
  - information on received alarms (per class);
  - list of possible fault situations related to an alarm pattern;
  - list of actions to be taken in different failure or anomaly situations (including tests);
  - schedule and parameters of routine tests;
  - test call patterns and results;
- performance and QOS data:
  - traffic data per call;
  - traffic handling (including call acceptance) criteria;
  - GA delay and availability (per access network);
  - delay and availability from other OMCs;
  - thresholds and working parameters for telecommunication network;
  - billing parameters;
  - call acceptance information, e.g. thresholds.

  For configuration management, each network element should be characterized according to its working mode, parameters, dimensioning and interconnection capabilities. The relevant information is stored in the dedicated database.
- PNC:
  - addresses;
  - number of PACs controlled;
  - interconnections with other PNCs (topological and dimensioning data);
  - I4 interface: installed version;
  - I5 interface: installed version and user access capabilities;
  - data base structure when acting as PNC-H;
  - version of the algorithm for scheduling the message transmission;
  - software versions.
- PAC:
  - addresses;
  - number of BSs controlled;
  - assigned radio channels;
  - available subsequences and cycles;
  - message transmission rules (batch utilization for addressing and message transmission capability);
  - rules for controlling the internal queues;

  - synchronization reference;
  - transmission and coverage parameters for the controlled BSs;
  - software versions.

- BS:

  - addresses;
  - modulation parameters;
  - transmission parameters;
  - synchronization reference and alignment criterion;
  - active channels and associated FSIs;
  - software versions.

8 Paging Network Controller - Operations System (PNC - OS)

The PNC-OS is a basic operations system performing the following kinds of O&M functions:

- those related to commands given to the associated PNC and to the information collected from the PNC (e.g. functionality behaviour, degradation, failure, alarms, basic traffic or QOS measurements). These functions are described in subclause 8.1;

- those involved in the management of the telecommunication process in the PNC. These interworking functions are performed in association with the PNC. They assist in accomplishment of decisions taken by the OMC and, according to implementation, they can also be directly implemented in the PNC. Such functions are described in subclause 8.2.

A general description of the PNC-OS database is given in subclause 8.3.

All the network management functions are categorized as operations, maintenance or performance and QOS management.

The management functions of the internal resources (e.g. database management, transparent data transfer, etc.) are not specifically described.

8.1 Functions

8.1.1 Operations

The operations functions of the PNC-OS shall include:

a) register and notify to the OMC configuration changes due to maintenance, e.g.:

  - switching on/off of PNC units;
  - activation of standby units;

b) report to the OMC (on request) the internal status of the PNC;

c) management of per call traffic data to be stored in the OMC, e.g. for billing purposes (administrative function);

d) accomplish the internal configuration changes decided by the OMC, e.g. set and update:

  - the addresses of the PAs controlled by the PNC;
  - geographical areas, paging areas and service areas;
  - passwords for I4 interfaces with other network operators.

In addition the operations functions of the PNC-OS may include:

e) set and update internal working parameters tied to the traffic conditions;

f) management of the operations functions tied to the access links (I3, I4, I5 interfaces), e.g.:

- control the line profile due to previous OMC commands;
- block/unblock the line(s);

g) local or remote (from the OMC) software loading and updating.

Other operations functions may be performed by the PNC-OS.

8.1.2 Maintenance

The maintenance functions of the PNC-OS shall include:

a) supervision of units and failure detection. Logging the failure with its classification e.g.:

- urgent failure;
- anomaly indication;

b) capability of reporting the fault situation and the test and diagnostic results.

In addition the maintenance functions of the PNC-OS may include:

c) activation of tests, failure localization and diagnostic programs and storage of the results;

d) scheduling of alarm and failure reports set by the OMC;

e) management of alarm and test conditions e.g. arrange alarm and test attributes, modes and thresholds.

Other maintenance functions may be performed by the PNC-OS.

8.1.3 Performance and QOS management

The performance and QOS management functions carried out by PNC-OS shall include:

a) cumulative counting of:

- input requests, per access network;
- call not accepted ACK, per access network and per refusal reason;
- input messages, per access network, per kind of service and according to correctness;
- outgoing messages per destination network and per kind of service;
- requests for subscriber features and supplementary services;

b) message length counting and counter reset per kind of basic service and, in PNC-T, per destination PAC;

c) calculation of the average waiting time for transmission of messages in the PNC;

d) handling of per call traffic data reports by the PNC;

e) management of delay and availabilities reports by the PNC.

The performance and QOS management functions carried out by PNC-OS may also include:

f) cumulative counting of:

- waiting input requests in PNC-I;
- messages waiting (in PNC-I) before the page accepted ACK is sent to the calling party;
- messages waiting for forward transmission;
- messages not delivered to the PAC(s);

g) evaluation of cumulative roaming volume per geographical area (the roaming volume is the number of time units of roaming periods for each pager) for all pagers belonging to the PNC-H;

h) averaging over the chosen observation period for discrete and continuous measurements;

j) reporting of the measured parameters to the OMC according to a scheduled frequency depending on the parameter;

k) management of test calls for QOS.

Other performance and QOS management functions may be carried out by the PNC-OS.

8.2 Interworking with the telecommunication network

The dialogue between the telecommunication part of the PNC and the PNC-OS allows the two entities to exchange O&M data and working parameters concerning the telecommunication context. It involves measurement data sent from the PNC, and O&M actions and information coming from the OMC. The PNC-OS transfers the necessary data between the PNC and the OMC.

8.2.1 Data from PNC to PNC-OS

Basic fault management data, e.g.:

- failure events in PNC;
- reports of automatic isolation of faulty units and automatic activation of stand-by units;
- report of the test and diagnostic results.

Basic data needed for the traffic and performance parameters concerning e.g.:

- queue states (waiting messages and waiting input requests);
- messages length;
- per call traffic data;
- messages not delivered to the PACs.

8.2.2 Actions and data from PNC-OS to PNC

These O&M actions and information are primarily generated by the OMC:

- update and set PNC and network configuration;
- update user database;
- request per call data;
- request current report schedule for basic traffic data and QOS;
- modify the working parameters;
- relay PAC message delay information;
- relay availability and delay information from other OMCs;
- relay network addresses to be used by PNC when accessing other PNCs;
- relay passwords to be used by PNC when accessing other PNCs;
- relay password to be used by other PNCs during access;
- relay GAs information;
- relay PAs information;
- relay service areas information.

8.3 PNC-OS database

The PNC-OS database holds the necessary information for the parameters used in the PNC-OS in order to obtain the required functions for operations, maintenance, performance and QOS management.

The O&M data needed for the telecommunication process in the PNC is stored in the PNC-OS database and accessible by both of the entities, PNC and PNC-OS. The PNC-OS database may include:

- configuration data:

  - configuration of PNC (e.g. connected PACs);
  - results of PNC status reports;
  - information on stand-by units;
  - information on reconfiguration alternatives;
  - network addresses to be used by PNC for accessing other PNCs;
  - password to be used by other accessing PNCs;
  - GAs, PAs and service areas information.

- maintenance data:

  - parameters and thresholds for fault detection and alarm message production;
  - failure data;
  - routine test schedules and parameters;
  - test results.

- performance and QOS data:

  - status of traffic registers;
  - averaging periods for QOS and performance measurements;
  - sampling rates of the queue states (see subclause 5.4.2);
  - averaging rules when alternatives are available;
  - report rates to the OMC;
  - PAC message delays.

9 PAC-OS and mediation device functions

PAC-OS and MD functions are considered together since they operate at the same network hierarchical level. The MD functions can be implemented in the PAC-OS.

9.1 PAC-OS

PAC-OS is a basic operations system performing the following kinds of O&M functions:

- those related to the commands given to the associated PAC and to the information collected from the associated PAC (e.g. functionality behaviour, degradation, failure, alarms, basic traffic or QOS measurements). These functions are described in subclause 9.1.1;

- those involved in the management of the O&M data needed for the telecommunication process in the PAC. These interworking functions are performed in association with the PAC. They consist in execution of decisions taken by the OMC and, according to implementation, they can also be directly performed in the PAC. Such functions are described in subclause 9.1.2.

A general description of the PAC-OS database is given in subclause 9.1.3.

All the network management functions are categorized as operations, maintenance or performance and QOS management.

The management functions of the internal resources (e.g. database management, transparent data transfer, etc.) are not specifically described.

9.1.1 Functions

9.1.1.1 Operations

The operations functions of the PAC-OS shall include:

a) register and notify to the OMC configuration changes due to maintenance, e.g.:

   - switching on/off of PAC units;
   - activation of stand by units;

b) report to the OMC (on request) the internal status of the PAC relevant to input, output and control sections;

c) set and update internal working parameters tied to the traffic conditions e.g.:

- FSN to FSI conversion table;
- the decision and anticipation intervals, in the case of using the call processing given as an example in ETS 300 133-3 [1], subclause 13.5.5;
- the priority criterion;

d) accomplish the internal configuration changes decided by the OMC, e.g. set and update:

- the system information and the supplementary system information to be sent to the air interface;
- the addresses of the BSs controlled by the PAC;
- the channels, cycles and subsequences schemes.

In addition the operations functions of the PAC-OS may include:

e) management of the operations functions tied to the access links (I2,I3 interfaces), e.g.:

- control the line profile due to previous OMC commands;
- block/unblock the line(s);

f) local or remote (from the OMC) software loading and updating.

Other operations functions may be included in the PAC-OS.

9.1.1.2 Maintenance

The maintenance functions of the PAC-OS shall include:

a) supervision of units (e.g. memories, CPUs and lines) and failure detection. Logging of failures with their classification, e.g.:

- urgent failure;
- anomaly indication;

b) capability of reporting the fault situation and the test and diagnostic results.

In addition the PAC-OS may include the following maintenance functions:

c) activation of test, fault localization and diagnostic programs and storage of the results;

d) scheduling of alarm and failure reports;

e) management of alarm and test conditions, e.g. arrange alarm and test attributes, modes and thresholds.

Other maintenance functions may be included.

9.1.1.3 Performance and QOS management

The following performance and QOS management function shall be accomplished by the PAC-OS:

a) sampling of the message delays and calculation of the relevant 90 % delay time for call acceptance and flow control mechanism (see ETS 300 133-3 [1], subclause 12.6).

In addition the following performance and QOS management function may be accomplished by the PAC-OS:

b) cumulative counting and counters reset of messages waiting for transmission in PAC, per kind of basic service and per priority;

c) calculation of the average number of waiting messages and reporting to the OMC according to the scheduled frequency;

d) management of test call for QOS;

e) report to the OMC the statistics concerning paging messages not delivered to the BSs.

Other performance and QOS management function may be performed by the PAC-OS.

9.1.2 Interworking with the telecommunication network

The dialogue between the PAC and the PAC-OS allows the two entities to exchange O&M data and working parameters concerning the telecommunication context. It involves measurement data sent from the PAC and O&M actions and information directed to the PAC mainly coming from the OMC.

The PAC-OS shall transfer the necessary data between the PAC and the OMC.

9.1.2.1 Data from PAC to PAC-OS

Basic fault management data, e.g.:

- failure events in PAC;
- reports of automatic isolation of faulty units and automatic activation of stand-by units;
- report of the test and diagnostic results.

Basic data needed for the traffic and performance parameters concerning, e.g.:

- queue states per priority, batch and channel;
- number of waiting messages per kind of basic service and priority;
- message length;
- number of messages not delivered to the BSs;
- message delay.

9.1.2.2 Actions and data from PAC-OS to PAC

These come mainly from the OMC:

- update and set PAC configuration;
- request scheduled reports for basic traffic data and QOS evaluation;
- modify the working parameters (e.g. priority criterion);
- set FSIs and relevant channels;
- set FSNs and relevant FSIs.

9.1.3 PAC-OS database

The PAC-OS database holds the necessary information for the parameters used in the PAC-OS in order to obtain the required functions for operations, maintenance, performance and QOS management.

The O&M data needed for the telecommunication process in the PAC is stored in the PAC-OS database and accessible to both of the entities, PAC and PAC-OS.

The PAC-OS database may include:

- configuration data:

    - PAC configuration (e.g. connected BSs);
    - results of PAC status reports;
    - information on reconfiguration alternatives;
    - information on stand-by units;
    - PA subsequences and cycles;
    - active channels and associated FSIs;
    - conversion table from FSN to FSI;
    - BSs status.

- maintenance data:

    - parameters and threshold data for testing, fault detection and alarm message production;
    - failures data;
    - routine test schedules and parameters;
    - test results.

- performance and QOS data:

    - real time and statistical traffic data;
    - observation periods for measuring performance figures;
    - sampling rate;
    - thresholds for traffic measurements and flow control;
    - report rate to the OMC.

9.2 Mediation device

The MD performs concentration functions and routing actions to the BSs. For this reason it is inserted at the PAC level. The mediation functions could be performed directly by the OMC. The functions and actions are outlined below:

a) send to the BSs poll, status and report requests according to a given schedule. Store the relevant results and, possibly, perform some synthesis on them;

b) report the results and the synthesis to the OMC according to defined rules;

c) set and adjust the poll, status and report request rules and the reporting rates (this is done under the OMC commands);

d) transfers data transparently in the OMC-BS connection;

e) accomplish the internal configuration modification decided by the OMC, e.g. set and update the BS addresses belonging to the MD, the BS's active channels, etc.;

f) management of the operations functions tied to the access link (I2 interface), e.g. block/unblock the line.

10 The operations and maintenance part of the base station

The O&M part of the BS consists of functions (described in subclause 10.1) and database (described in subclause 10.2). The functions are examined according to operations, and maintenance categories.

The functions for management of the internal resources (e.g. database management) are not specifically described.

10.1 Functions

10.1.1 Operations

The operations functions of the BS shall include:

a) report to the OMC (on request) the parameter figures and the internal configuration related to the control commands and to the status and poll requests;

b) control of time reference;

c) accomplish the control commands sent by the OMC.

In addition the operations functions of the BS may include:

d) local or remote (from the OMC) software loading and updating;

e) updating of the BS hardware configuration;

f) management of the operations functions tied to the access link (I2 interface), e.g. block/unblock the line.

Other operations functions may be included.

10.1.2 Maintenance

The maintenance functions of the BS shall include:

a) supervision of units and failure detection, logging and reporting of the failures with their classifications:

- urgent failure;
- anomaly indication.

In addition the maintenance functions of the BS may include:

b) automatic isolation of failed units and activation of stand-by units;

c) activation of tests, fault localization and diagnostic programs and storage of the results;

d) management of alarm and test conditions, e.g. alarm and test attributes, modes and thresholds.

Other maintenance functions may be included.

10.2 BS database

The BS database holds the necessary information for the parameters used in the BS in order to obtain the required information for operations and maintenance.

The BS database may include:

- configuration data:
  - record of measured data;
  - configuration of BS;
  - information on stand-by units;
  - information on reconfiguration alternatives;
  - status data;

- maintenance data:

    - test programs and parameters;
    - parameters and thresholds data for testing, failure detection and alarms;
    - failure data;
    - test results.

Annex A (normative): Formal description of the IOMC

This annex contains the ROSE operations used in the IOMC (see clause A.1) and the Abstract Syntax Notation (ASN) of the IOMC Service Element (see clause A.2).

A.1 IOMC ROSE operations

The following IOMC ROSE operations are defined:

Table A.1

IOMC ROSE Operation	Operation Argument	Operation Result
Network Status Request	NE-Stat-Req-Par	NE-Stat-Req-Ack
Network Status Report	NE-Stat-Rep-Par	NE-Stat-Rep-Ack
Change Network Name	CH-Net-Name-Par	CH-Net-Name-Ack
Change Password	CH-Pass-Par	CH-Pass-Ack
Define New GA Configuration	DE-New-GA-Par	DE-New-GA-Ack
Traffic Data Request	TR-Dat-Req-Par	TR-Dat-Req-Ack

The operations and associated parameters are defined in the following tables. The data formats are specified in clause A.2.

Network status request operation

Table A.2

Parameter	Parameter Type	Presence in SDU	Description
GAs	Octet String	O (note)	List of GAs whose status is required
NOTE: When this operation is sent without parameters, this means that the status of all GAs is required.			

Network status request - positive result

Table A.3

Parameter	Parameter Type	Presence in SDU	Description
GA1	Octet String	M	Name of the first GA
AS1	Integer	M	Availability Status of the first GA
2DS1	Integer	M	Priority 2 Delay Status of the first GA
3DF1	Boolean	M	Presence of Priority 3 Delay Status of the first GA
3DS1	Integer	O (note 1)	Priority 3 Delay Status of the first GA[3]
GAn	Octet String	O	Name of the n-th GA
ASn	Integer	O	Availability Status of the n-th GA
2DSn	Integer	O	Priority 2 Delay Status of the n-th GA
3DFn	Boolean	O	Presence of Priority 3 Delay Status of the n-th GA
3DSn	Integer	0 (note 2)	Priority 3 Delay Status of the n-th GA
NOTE 1: Present only if priority 3 service is provided (3DF1=TRUE) NOTE 2: Present only if priority 3 service is provided (3DFn=TRUE)			

Network status request - negative result

The following error may be returned within a negative result to a network status request operation.

Undefined GAs: A subset of GAs whose status has been requested is not defined within the network. Table A.4 shows the relevant parameters.

Table A.4

Parameter	Parameter Type	Presence in SDU	Description
GA1	Octet String	M	Name of the first GA not defined
GAn	Octet String	O	Name of the n-th GA not defined

Network status report operation

Table A.5

Parameter	Parameter Type	Presence in SDU	Description
GA1	Octet String	M	Name of the first GA
AS1	Integer	M	Availability Status of the first GA
2DS1	Integer	M	Priority 2 Delay Status of the first GA
3DF1	Boolean	M	Presence of Priority 3 Delay Status of the first GA
3DS1	Integer	O (note 1)	Priority 3 Delay Status of the first GA
GAn	Octet String	O	Name of the n-th GA
ASn	Integer	O	Availability Status of the n-th GA
2DSn	Integer	O	Priority 2 Delay Status of the n-th GA [3]
3DFn	Boolean	0	Presence of Priority 3 Delay Status of the n-th GA
3DSn	Integer	0 (note 2)	Priority 3 Delay Status of the n-th GA [3]
NOTE 1: Present only if Priority 3 service is provided (3DF1 = TRUE) NOTE 2: Present only if Priority 3 service is provided (3DFn = TRUE)			

Network status report - positive result

Table A.6

Parameter	Parameter Type	Presence in SDU	Description
GN	Integer	M	Number of GAs whose status has been received

Network status report - negative result

The following error may be returned within a negative result to a network status report operation.

Inconsistent GAs Data: The status data are not consistent with the defined figures range and format. Table A.7 shows the relevant parameters.

Table A.7

Parameter	Parameter Type	Presence in SDU	Description
DE	Integer	M	Data error type Label (note 1)
UGN	Octet String	O (note 2)	List of undefined GA Names
UAF	Octet String	O (note 2)	List of GAs whose Availability Status is inconsistent
UDF	Octet String	O (note 2)	List of GAs whose Delay Status is inconsistent
NOTE 1: DE specifies the parameter(s) of the Network Status Report on which an error has been detected. NOTE 2: At least one among UGN, UAF, UDF is present, according to the Data error Type specified by DE.			

Change network name operation

Table A.8

Parameter	Parameter Type	Presence in SDU	Description
OPO	Printable String	O (note 1)	Actual Name of the PNC Operator
OPB	Printable String	O (note 1)	Actual Reference Name of the PNC Bilateral Agreement
OPA	Numeric String	O (note 1)	Actual X.121 Address of PNC
NPO	Printable String	O (note 1)	New Name of the PNC Operator
NPB	Printable String	O (note 1)	New Reference Name of the PNC Bilateral Agreement
NPA	Numeric String	O (note 1)	New X.121 Address of PNC
OOO	Printable String	O (note 2)	Actual Name of the OMC Operator
OOB	Printable String	O (note 2)	Actual Reference Name of the OMC Bilateral Agreement
OOA	Numeric String	O (note 2)	Actual X.121 Address of OMC
NOO	Printable String	O (note 2)	New Name of the OMC Operator
NOB	Printable String	O (note 2)	New Reference Name of the OMC Bilateral Agreement
NOA	Numeric String	O (note 2)	New X.121 Address of the OMC
NOTE 1: Not present if only OMC related parameters are changed. NOTE 2: Not present if only PNC related parameters are changed.			

Change network name - positive result

Table A.9

Parameter	Parameter Type	Presence in SDU	Description
NPO	Printable String	O (note 1)	New Name of the PNC Operator
NPB	Printable String	O (note 1)	New Reference Name of the PNC Bilateral Agreement
NPA	Numeric String	O (note 1)	New X.121 Address of PNC
NOO	Printable String	O (note 2)	New Name of the OMC Operator
NOB	Printable String	O (note 2)	New Reference Name of the OMC Bilateral Agreement
NOA	Numeric String	O (note 2)	New X.121 Address of the OMC
NOTE 1: Not present if only OMC related parameters are changed. NOTE 2: Not present if only PNC related parameters are changed.			

Change network name - negative result

The following errors may be returned within a negative result as a change network name operation. Both utilize the same set of parameters shown in table A.10.

Unknown network name: At least one of the parameters of the actual name, relevant to a Network Entity is not recognized.

New network name not applicable: At least one of the parameters of the new name, relevant to a network entity does not comply with a defined format.

Table A.10

Parameter	Parameter Type	Presence in SDU	Description
WPO	Printable String	O (note 1)	Wrong Name of the PNC Operator
WPB	Printable String	O (note 1)	Wrong Reference Name of the PNC Bilateral Agreement
WPA	Numeric String	O (note 1)	Wrong X.121 Address of the PNC
WOO	Printable String	O (note 2)	Wrong Name of the OMC Operator
WOB	Printable String	O (note 2)	Wrong Reference Name of the OMC Bilateral Agreement
WOA	Numeric String	O (note 2)	Wrong X.121 Address of the OMC
NOTE 1: Not present if only OMC related parameters are wrong. NOTE 2: Not present if only PNC related parameters are wrong.			

Change password operation

Table A.11

Parameter	Parameter Type	Presence in SDU	Description
OPP	Printable String	O (note 1)	Actual Password of the PNC
NPP	Printable String	O (note 1)	New Password of the PNC
OOP	Printable String	O (note 2)	Actual Password of the OMC
NOP	Printable String	O (note 2)	New Password of the OMC
NOTE 1: Not present if only OMC related parameters are changed. NOTE 2: Not present if only PNC related parameters are changed.			

Change password - positive result

Table A.12

Parameter	Parameter Type	Presence in SDU	Description
NPP	Printable String	O (note 1)	New Password of the PNC
NOP	Printable String	O (note 2)	New Password of the OMC
NOTE 1: Not present if only OMC related parameters are changed. NOTE 2: Not present if only PNC related parameters are changed.			

Change password - negative result

The following errors may be returned within a negative result to a change password operation. Both utilize the same set of parameters shown in the table A.13.

Unknown password: At least one of the actual passwords is not recognized.

New password not applicable: At least one of the new passwords does not conform to a defined format.

Table A.13

Parameter	Parameter Type	Presence in SDU	Description
WPP	Printable String	O (note 1)	Wrong password of the PNC
WOP	Printable String	O (note 2)	Wrong password of the OMC
NOTE 1: Not present if only OMC related parameters are wrong. NOTE 2: Not present if only PNC related parameters are wrong.			

Define new GA configuration operation

The set of GAs belonging to the new GA configuration shall cover the whole area provided to the external operator within the network pertaining to the home operator.

Table A.14

Parameter	Parameter Type	Presence in SDU	Description
GA1	Octet String	M	Name of the first GA of the new configuration
GAn	Octet String	O	Name of the n-th GA of the new configuration
MT	UTCTime (note)	M	Modification Time (note)
NOTE: Time when the new configuration shall be activated.			

Define new GA configuration - positive result

The same parameter table as for the "Define New GA Configuration Operation" applies.

Define new GA configuration - negative result

The following error may be returned within a Negative Result to a Define New GA Configuration Operation.

New GA configuration not applicable: The new GA configuration does not correspond to the agreement. Table A.15 shows the relevant parameters.

Table A.15

Parameter	Parameter Type	Presence in SDU	Description
MT	UTCTime	O	expected start time
GN	Integer	O (note 1)	expected number of GAs
GA1	Octet String	O (note 1)	wrong or missing GA1 name
GAn	Octet String	O	wrong or missing GAn name
NOTE 1: If any GA is present, then GN shall be present.			

Traffic data request operation

Table A.16

Parameter	Parameter Type	Presence in SDU	Description
BT	UTCTime	M	Start time for the observation period
ET	UTCTime	M	End time for the observation period
TT	Integer	M	Type of traffic: Incoming (PNC-I → PNC-H) Incoming (PNC-H → PNC-T) Outgoing (PNC-I → PNC-H) Outgoing (PNC-H → PNC-T)
LGA	Octet String	O	List of GAs

Traffic data request - positive result

Table A.17

Parameter	Parameter Type	Presence in SDU	Description
TT	Integer	M	Type of traffic
GA1	Octet String	M	Name of first GA
TO1	Integer	O	Number of tone-only calls
NU1	Integer	O	Number of numeric messages
NC1	Integer	O	Total number of numeric characters
AN1	Integer	O	Number of alpha messages
AC1	Integer	O	Total number of alphanumeric characters
TD1	Integer	O	Number of transparent data messages
TC1	Integer	O	Total number of transparent data bits
CD1	Integer	O (note 1)	Number of choice of destinations requested
REP1	Integer	O (note 1)	Number of repetitions requested
PR31	Integer	O (note 1)	Number of PR3 calls requested
MAD1	Integer	O (note 1)	Number of multi-address requested
URG1	Integer	O (note 1)	Number of urgent mess. indicators requested
DFDL1	Integer	O (note 1)	Number of deferred deliveries requested
STX1	Integer	O (note 1)	Number of standard texts requested
GAn	Octet String	O	Name of the n-th GA
FC	Boolean	O (note 2)	Indicates failed calls texts requested
PE	Integer	O (note 3)	No. of calls rejected due to parameter in error
PF	Integer	O (note 3)	No. of calls rejected due to PNC failure
PT	Integer	O (note 3)	No. of calls partially Transmitted
LC	Integer	O (note 3)	Total no. of lost calls

NOTE 1: Presence depends on the value of TT. Exists for PNC-I to PNC-H traffic types only.
NOTE 2: True if there is any call rejected.
NOTE 3: Present only if FC is true and if it is applicable.

Traffic data request - negative result

The following error may be returned within a negative result to a traffic data request operation.

Traffic Data Error: If the request is relevant (i.e. the associated parameters are correct) but no traffic data is available, no parameter will be associated with this result. Otherwise table A.18 shows the relevant parameters.

Table A.18

Parameter	Parameter Type	Presence in SDU	Description
GA1	Octet String	M	Name of the first GA
GAn	Octet String	O	Name of the n-th GA
TT	Integer	O	Undefined traffic type
Period	UTCTime	O	Requested observation period not applicable

A.2 IOMC ROSE ASN-1 transcription

This clause specifies the abstract syntax for the IOMC protocol using the Abstract Syntax Notation One (ASN.1), defined in ITU-T Recommendation X.208 [10].

The encoding rules which are applicable to the defined abstract syntax are the basic encoding Rules for ASN.1, defined in ITU-T Recommendation X.209 [11].

For each IOMC parameter which has to be transferred by an IOMC Protocol Data Unit (PDU) (IOMC message), there is a PDU field (an ASN.1 NamedType) whose ASN.1 identifier has the same name as the corresponding parameter, except for the differences required by the ASN.1 notation (blanks between words are replaced by a hyphen "-", the first letter of the first word is lower-case and the first letter of the following words are capitalized (e.g., "choice of destination" is mapped to choice-Of-Destination"). In addition some words may be abbreviated as follows:

info = information;
id = identity;
ms = mobile subscriber.

When a mandatory element is missing in any component or inner data structure, a reject component is returned (if the association still exists). The problem cause to be used is "Mistyped parameter". When an optional element is missing in an invoke component or in a inner data structure when it is required by the context, an error component is returned; the associated type error is "DataMissing".

Operations types ASN.1 specification

The ASN.1 specification of the operation types required for the IOMC is provided in the three ASN.1 module "IOMC-ROSE Operations" which follows:

```
--                  The Abstract Syntax Notation of
--                  the Inter OMC Service Element
--
--                  IOMCSE      Ver. 2.0


--                        1st module of 3:
--                  IOMC-UsefulDefinitions

IOMC-UsefulDefinitions   { iomc(0) id-mod(1) iOMC-UsefulDefinitions(0) }

DEFINITIONS

IMPLICIT TAGS

::=
```

```
BEGIN

        EXPORTS   id-ac-OMC, id-IOMCSE, id-as-IOMCSE;

        ID ::= OBJECT IDENTIFIER

-- root for all iomc allocations

pagingDomain            ID ::= (ccitt (0) identified organization (4) etsi (0) pagingDomainId (1))
iomc                ID ::= { pagingDomain ermesIomcId (0) }


-- categories

        id-mod                      ID ::= { iomc 1 }     -- modules
        id-ac                   ID ::= { iomc 2 }     -- appl. contexts
        id-ase                  ID ::= { iomc 3 }     -- ASEs
        id-as                   ID ::= { iomc 4 }     -- abstract syntaxes

-- modules

        iOMC-UsefulDefinitions  ID ::= { id-mod 0 }
        iOMC-Service                ID ::= { id-mod 1 }
        iOMC-Protocol               ID ::= { id-mod 2 }

-- application contexts

        id-ac-OMC               ID ::= { id-ac 0 }

-- application service elements

        id-IOMCSE               ID ::= { id-ase 0 }

-- abstract syntaxes

        id-as-IOMCSE                ID ::= { id-as 0 }

END
```

```
--                      2nd module of 3:
--                  IOMC-Service


IOMC-Service        { ermesIomcId(0) id-mod(1) iOMC-Service(1) }


DEFINITIONS

IMPLICIT TAGS

::=

BEGIN

--      EXPORTS everything

IMPORTS

        BIND, UNBIND, OPERATION, ERROR
                FROM Remote-Operations-Notation
                        { joint-iso-ccitt remote-operations(4) notation(0) };

-- upper bound settings

        ub-oper-name-length             INTEGER  ::=    20
        ub-agr-name-length              INTEGER  ::=    20
        ub-X121Addr-length              INTEGER  ::=    15
        ub-password-length              INTEGER  ::=    20
        ub-ga-name-length       INTEGER  ::=    20
        ub-ga-number                    INTEGER  ::=    64
        ub-stat-level           INTEGER  ::=    9
        ub-tomax-number         INTEGER  ::=    10^4
        ub-mesmax-number                INTEGER  ::=    10^4
        ub-lmax-number          INTEGER  ::=    10^6

-- Bind

        IOMC-Bind  ::=  BIND
                        ARGUMENT                IOMC-Bind-Par
                        RESULT              IOMC-Bind-Conf
                        BIND-ERROR              IOMC-Bind-Fail

-- Unbind

        IOMC-Unbind  ::= UNBIND
                        ARGUMENT                IOMC-Unbind-Par
                        RESULT              IOMC-Unbind-Conf
                        UNBIND-ERROR    IOMC-Unbind-Fail

-- Network Status Request Operation

        Network-Status-Request  ::=     OPERATION
                                ARGUMENT        NE-Stat-Req-Par
                                RESULT      NE-Stat-Req-Ack
                                ERRORS
                                        {
                                                Und-Gas
                                        }
```

```
-- Network Status Report Operation

    Network-Status-Report   ::=     OPERATION
                            ARGUMENT        NE-Stat-Rep-Par
                            RESULT      NE-Stat-Rep-Ack
                            ERRORS
                                {
                                    Unc-Gas-Data
                                }

-- Change Network Name Operation

    Change-Network-Name  ::=    OPERATION
                            ARGUMENT        CH-Net-Name-Par
                            RESULT      CH-Net-Name-Ack
                            ERRORS
                                {
                                    Unk-Net-Name,
                                    New-Net-Name-NA
                                }

-- Change Password Operation

    Change-Password ::=     OPERATION
                            ARGUMENT        CH-Pass-Par
                            RESULT      CH-Pass-Ack
                            ERRORS
                                {
                                    Unk-Pass,
                                    New-Pass-NA
                                }

-- Define New Geographical Area Configuration Operation

    Define-New-GA-Config    ::=     OPERATION
                            ARGUMENT        DE-New-GA-Par
                            RESULT      DE-New-GA-Ack
                            ERRORS
                                {
                                    New-GA-NA
                                }

-- Traffic Data Request Operation

    Traffic Data Request    ::=     OPERATION
                            ARGUMENT        TR-Dat-Req-Par
                            RESULT      TR-Dat-Req-Ack
                            ERRORS
                                {

                                    Traffic-Data-Err

                                }
```

```
-- Bind Parameters

        IOMC-Bind-Par           ::=     SEQUENCE
        {
                initiator-Id            [0]     Name,
                password                [1]     Password,
                operations              [2]     List-Of-Operations
        }

        IOMC-Bind-Conf  ::=     SEQUENCE
                {
                        resp-Id                 [0]     Name,
                        password        [1]     Password,
                        operations      [2]     List-Of-Operations,
                        connect-Time            [3]     Time-When-Connected
                }

        IOMC-Bind-Fail  ::=     SEQUENCE
                {
                        failure-Reason          [0]     Fail-Reason
                }

-- Unbind Parameters

        IOMC-Unbind-Par ::=     SEQUENCE
                {
                        connect-Time            [0]     Time-When-Connected
                }

        IOMC-Unbind-Conf        ::=     SEQUENCE
                {
                        disconnect-Time [0]     Time-When-Disconnected
                }

        IOMC-Unbind-Fail ::=    SEQUENCE
                {
                        failure-Reason          [0]     Fail-Reason
                }

-- Network Status Request Parameters

        NE-Stat-Req-Par  ::=    SEQUENCE
                {
                        gas             [0]     Geo-Areas               OPTIONAL
                }

        NE-Stat-Req-Ack  ::=    SEQUENCE
                {
                        gas-stat-1      [0]     Gas-Stat,
                        gas-stat-n      [1]     Gas-Stats               OPTIONAL
                }
```

```
-- Network Status Report Parameters

    NE-Stat-Rep-Par   ::=     SEQUENCE
        {
            gas-stat-1          [0]     Gas-Stat,
            gas-stat-n          [1]     Gas-Stats               OPTIONAL
        }

    NE-Stat-Rep-Ack   ::=     SEQUENCE
        {
            gas-num             [0]     INTEGER (1..ub-ga-number)
        }

-- Change Network Name Parameters

    CH-Net-Name-Par ::=     SEQUENCE
        {
            old-PNC-name            [0]     Name                    OPTIONAL,
            new-PNC-name            [1]     Name                    OPTIONAL,
            old-OMC-name            [2]     Name                    OPTIONAL,
            new-OMC-name    [3]     Name                    OPTIONAL
        }

    CH-Net-Name-Ack ::=     SEQUENCE
        {
            new-PNC-name            [0]     Name                    OPTIONAL,
            new-OMC-name    [1]     Name                    OPTIONAL
        }

-- Change Password Parameters

    CH-Pass-Par             ::=     SEQUENCE
        {
            old-PNC-pass            [0]     Password                OPTIONAL,
            new-PNC-pass            [1]     Password                OPTIONAL,
            old-OMC-pass            [2]     Password                OPTIONAL,
            new-OMC-pass            [3]     Password                OPTIONAL
        }

    CH-Pass-Ack             ::=     SEQUENCE
        {
            new-PNC-pass            [0]     Password                OPTIONAL,
            new-OMC-pass            [1]     Password                OPTIONAL
        }

-- Define New GA Configuration Parameters

    DE-New-GA-Par   ::=     SEQUENCE
        {
            new-gas             [0]     GA-list
            modif-time          [1]     UTCTime
        }

    DE-New-GA-Ack   ::=     SEQUENCE
        {
            new-gas             [0]     GA-list
            modif-time          [1]     UTCTime
        }
```

```
-- Traffic Data Request Parameters

        TR-Dat-Req-Par    ::=     SEQUENCE
                {
                        start-time              [0]     UTCTime,
                        end-time                [1]     UTCTime,
                        traffic-cat             [2]     TT,
                        gas-1                   [3]     Geo-Area,
                        gas-n                   [4]     Geo-Areas               OPTIONAL
                }

        TR-Dat-Req-Ack    ::=     SEQUENCE
                {
                        traffic-cat             [0]     TT,
                        gas-tra-1               [1]     Gas-Tra,
                        gas-tra-n               [2]     Gas-Tras                OPTIONAL,
                        fail-call                       [3]     Fail-Call               OPTIONAL
                }

-- Error Alternatives of Operations

        GA-Num-NA       ::=     ERROR

        Und-Gas         ::=     ERROR
                                PARAMETER               GA-list

        Unc-Gas-Data            ::=     ERROR
                                PARAMETER               Gas-Data

        Unk-Net-Name            ::=     ERROR
                                PARAMETER               Net-Name

        New-Net-Name-NA         ::=     ERROR
                                PARAMETER               Net-Name

        Unk-Pass        ::=     ERROR
                                PARAMETER               Net-Pass

        New-Pass-NA             ::=     ERROR
                                PARAMETER               Net-Pass

        New-GA-NA       ::=     ERROR
                                PARAMETER               GA-Expt

        Traffic-Data-Err        ::=     ERROR
                                PARAMETER               TRA-Err
```

```
-- Types used in :  Association Control Parameters
--                  Operation Parameters
--                  Error Alternatives Parameters

        List-Of-Operations ::=      BIT STRING
                {
                        network-status-request          (1),
                        network-status-report           (2),
                        change-network-name             (3),
                        change-password         (4),
                        define-new-ga-conf              (5),
                        traffic-data-request    (6),
                }

        Fail-Reason         ::=     INTEGER
                {
                        not-entitled                    (0),
                        temporary-overload              (1),
                        temporary-failure       (2),
                        incorrect-ID-or-password (3),
                        not-supported                   (4),
                        not-connected                   (5)
                }

        Time-When-Connected         ::=     UTCTime

        Time-When-Disconnected      ::=     UTCTime

        Gas-Stats               ::=     IMPLICIT SEQUENCE OF Gas-Stat

        Gas-Stat                ::=     SEQUENCE
                {
                        ga              [0]     Geo-Area,
                        avail-stat      [1]     INTEGER (0..ub-stat-lev),
                        delay-stat      [2]     Delay-Stat
                }

        GA-list                         ::=     SEQUENCE
                {
                        gas-1           [0]     Geo-Area,
                        gas-n           [1]     Geo-Areas               OPTIONAL
                }

        GA-Expt                 ::=     SEQUENCE
                {
                        time-expt       [0]     UTCTime                 OPTIONAL,
                        gas-num         [1]     INTEGER (0..ub-ga-number)   OPTIONAL,
                        gas             [2]     Geo-Areas               OPTIONAL
                }

        TRA-Err                 ::=     SEQUENCE
                {
                        gas-1           [0]     Geo-Area,
                        gas-n           [1]     Geo-Areas               OPTIONAL,
                        typ-tra         [2]     TT                      OPTIONAL,
                        obs-time        [3]     UTCTime                 OPTIONAL
                }
```

```
Gas-Data                ::=  SEQUENCE
        {
                data-error          [0]  INTEGER
                                         {
                                                 name-err          (1)
                                                 avail-err         (2)
                                                 delay-err         (3)
                                                 na-av-err         (4)
                                                 na-del-err        (5)
                                                 av-del-err        (6)
                                                 na-av-del-err           (7)
                                         }
                und-ga-name             [1]  Geo-Areas          OPTIONAL,
                unc-avail-fig           [2]  Geo-Areas          OPTIONAL,
                unc-del-fig             [3]  Geo-Areas          OPTIONAL
        }

Net-Name                ::=  SEQUENCE
        {
                pNC-Name            [0]  Name               OPTIONAL,
                oMC-Name            [1]  Name               OPTIONAL
        }

Net-Pass                ::=  SEQUENCE
        {
                pNC-Pass            [0]  Password           OPTIONAL,
                oMC-Pass            [1]  Password           OPTIONAL
        }

Name                    ::=  SEQUENCE
        {
                operator            [0]  Operator           OPTIONAL,
                bilateralAgreem     [1]  BilateralAgr       OPTIONAL,
                dataNetAddress      [2]  X121Addr           OPTIONAL
        }

Password                ::=  PrintableString (SIZE (0..ub-password-length))

Geo-Areas               ::=  IMPLICIT SEQUENCE OF Geo-Area

Geo-Area                ::=  OCTET STRING (SIZE (0..ub-ga-name-length))

Delay-Stat              ::=  SEQUENCE
        {
                prio2               [0]  INTEGER (0..ub-stat-level),
                p3flag              [1]  BOOLEAN,
                prio3               [2]  INTEGER (0..ub-stat-level)  OPTIONAL
        }

TT                      ::=  INTEGER
        {
                incomingI-H         (1),
                incomingH-T              (2),
                outgoingI-H         (3),
                outgoingH-T         (4)
        }
```

```
Fail-Call               ::=  SEQUENCE
        {
                fail            [0]  BOOLEAN            OPTIONAL,
                par-err              [1]  INTEGER            OPTIONAL,
                pnc-err              [2]  INTEGER            OPTIONAL,
                part-call            [3]  INTEGER            OPTIONAL,
                lost-call            [4]  INTEGER            OPTIONAL
        }

Gas-Tras                ::=  IMPLICIT SEQUENCE OF Gas-Tra

Gas-Tra                 ::=  SEQUENCE
        {
                ga              [0]  Geo-Area,
                tone            [1]  INTEGER (0..ub-tomax-number)   OPTIONAL,
                num             [2]  Num-Length             OPTIONAL,
                alpha           [3]  Num-Length             OPTIONAL,
                trans-dat       [4]  Num-Length             OPTIONAL,
                choice-dest     [5]  INTEGER                OPTIONAL,
                repetition      [6]  INTEGER                OPTIONAL,
                priority3            [7]  INTEGER            OPTIONAL,
                multiadr             [8]  INTEGER            OPTIONAL,
                urgent               [9]  INTEGER            OPTIONAL,
                deferred        [10] INTEGER                OPTIONAL,
                standartxt      [11] INTEGER                OPTIONAL
        }


Operator            ::=  PrintableString (SIZE (0..ub-oper-name-length))

BilateralAgr        ::=  PrintableString (SIZE (0..ub-agr-name-length))

X121Addr            ::=  NumericString (SIZE (0..ub-X121Addr-length))

Num-Length          ::=  SEQUENCE
        {
                nbmess               [0]  INTEGER (0..ub-mesmax-number),
                lmess           [1]  INTEGER (0..ub-lmax-number)
        }

END
```

```
--                              3rd module of 3 :
--                          IOMC-Protocol


IOMC-Protocol           { ermesIomcId(0) id-mod(1) iOMC-Protocol(2) }


DEFINITIONS

IMPLICIT TAGS

::=

BEGIN

--      EXPORTS everything

IMPORTS

--      application service elements and application contexts

        aCSE, APPLICATION-SERVICE-ELEMENT, APPLICATION-CONTEXT
                FROM        Remote-Operations-Notation-extension
                        { joint-iso-ccitt remote-operations(4)
                          notation-extension(2) }

        rOSE FROM       Remote-Operations-APDUs
                        { joint-iso-ccitt remote-operations(4) apdus(1)}

--      IOMC service parameters

        IOMC-Bind, IOMC-Unbind, Network-Status-Request,
        Network-Status-Report, Change-Network-Name, Change-Password,
        Define-New-GA-Config, Traffic-Data-Request,
        Und-Gas, Unc-Gas-Data, Unk-Net-Name,
        New-Net-Name-NA, Unk-Pass, New-Pass-NA, New-GA-NA,
        Traffic-Data-Err
                FROM        IOMC-Service
                        { ermesIomcId(0) id-mod(1) iOMC-Service(1) }

--      object identifiers

        id-ac-OMC, id-IOMCSE, id-as-IOMCSE
                FROM        IOMC-UsefulDefinitions
IOMC-Service            { ermesIomcId(0) id-mod(1) iOMC-UsefulDefinitions(0) } ;


        aS-ACSE     OBJECT IDENTIFIER     ::=
                    {       joint-iso-ccitt association-control(2)
                            abstractSyntax(1) apdus(0) version(1)
                    }
```

```
-- Application context

        oMC-BINDs-and-UNBINDs
                APPLICATION-CONTEXT
                APPLICATION SERVICE ELEMENTS{ aCSE }
                BIND        IOMC-Bind
                UNBIND      IOMC-Unbind
                REMOTE OPERATIONS       { rOSE}
                INITIATOR CONSUMER OF           { iOMCSE }
                ABSTRACT SYNTAXES       { id-as-IOMCSE, aS-ACSE}
                ::= id-ac-OMC

-- Application service element

        iOMCSE  APPLICATION-SERVICE-ELEMENT
                CONSUMER INVOKES
                        {
                                network-Status-Request,
                                network-Status-Report,
                                change-Network-Name,
                                change-Password,
                                define-New-GA-Config,
                                traffic-Data-Request
                        }
                ::= id-IOMCSE

-- Remote operations

        network-Status-Request
                Network-Status-Request
                ::= 1

        network-Status-Report
                Network-Status-Report
                ::= 2

        change-Network-Name
                Change-Network-Name
                ::= 3

        change-Password
                Change-Password
                ::= 4

        define-New-GA-Config
                Define-New-GA-Config
                ::= 5

        traffic-Data-Request
                Traffic-Data-Request
                ::= 6
```

```
-- Remote errors

        und-Gas     Und-Gas
                    ::= 1

        unc-Gas-Data
                    Unc-Gas-Data
                    ::= 2

        unk-Net-Name
                    Unk-Net-Name
                    ::= 3

        new-Net-Name-NA
                    New-Net-Name-NA
                    ::= 4

        unk-Pass    Unk-Pass
                    ::= 5

        new-Pass-NA
                    New-Pass-NA
                    ::= 6

        new-GA-NA
                    New-GA-NA
                    ::= 7

        traffic-Data-Err
                    Traffic-Data-Err
                    ::= 8
END
```

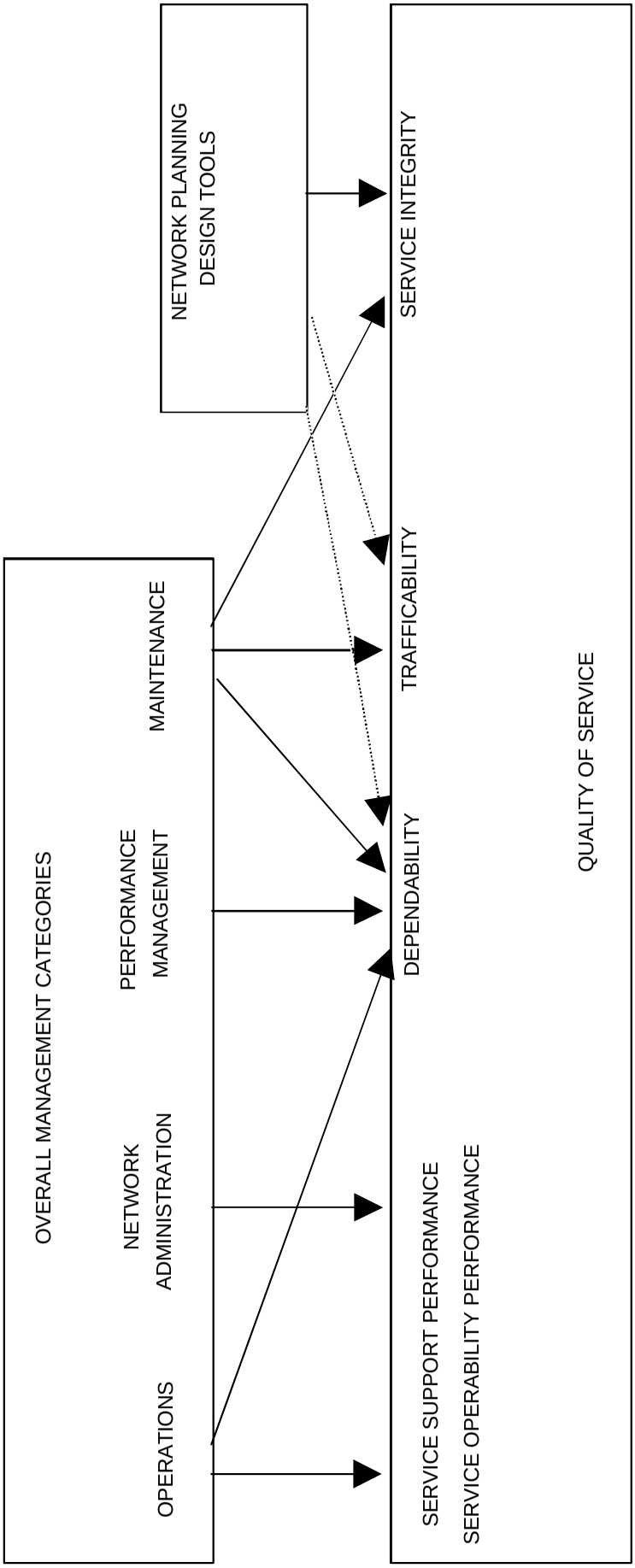


Figure A.1: Quality of service and management categories

Annex B (informative): General aspects of telecommunication management

This annex contains an informative description of the Network Management (NM) concepts (clause B.1) and of the network management functions (clause B.2).

B.1 Network management concepts

The correlation between the overall management categories for the ERMES system and the QOS parameters is depicted in annex A, figure A.1. The figure also shows the influence of the network planning and design tools on the QOS. These last functions make use of the same data collected and processed for network management purposes, but they are applied according to long-term strategies. For this reason, planning and design topics will not be considered as a part of the management environment.

Figure B.1 highlights the relationship between the network management functions and the operator networks. Two independent operator networks have been shown in order to illustrate the internetwork message exchange, for both service and management data.

The three functional areas of intervention on the network, i.e. operations, maintenance and performance management are individually drawn as one-way arrows. The network response to such commands (or structured procedures) is in the form of O&M data which are processed by the NM functions and converted into QOS (on the users side) and performance figures for appropriate NM actions.

B.1.1 Operations

Operations define the "combination of all technical and corresponding administrative actions that enable an item to perform a required function, recognizing necessary adaptation to changes in external conditions (for example changes in service demand and environmental conditions)".

It is useful to distinguish between operations strictly tied to the single operator network and those regarding the interworking between different operator networks.

An Operations and Maintenance Centre (OMC) is associated with each operator network and operates as a controller and centralized data collection entity of the network elements.

Interworking ensures the necessary cooperation between operators. The exchanged operations information should in particular refer to QOS and performance data of the networks. Traffic and availability performance parameters and data, together with transmission performance parameters (tied to the service integrity) should be transmitted between different OMCs in order to distribute useful information about the service quality and the network state of the ERMES system.

B.1.2 Maintenance

Maintenance is defined (see ITU-T Recommendations M.60 [3] and G.106 [4]) as "the technical and corresponding administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function".

A correct maintenance philosophy (see ITU-T Recommendation M.20 [5]) should be based on the characterization of the maintenance entity concept, the classification of the possible failures, the network supervision functions (alarm management, failure localization, testing) and the maintenance phases. The maintenance concept also involves the organization of personnel, equipment supply entities, repair actions and other functions which are completely under the operator or manufacturer control, and do not need any specification.

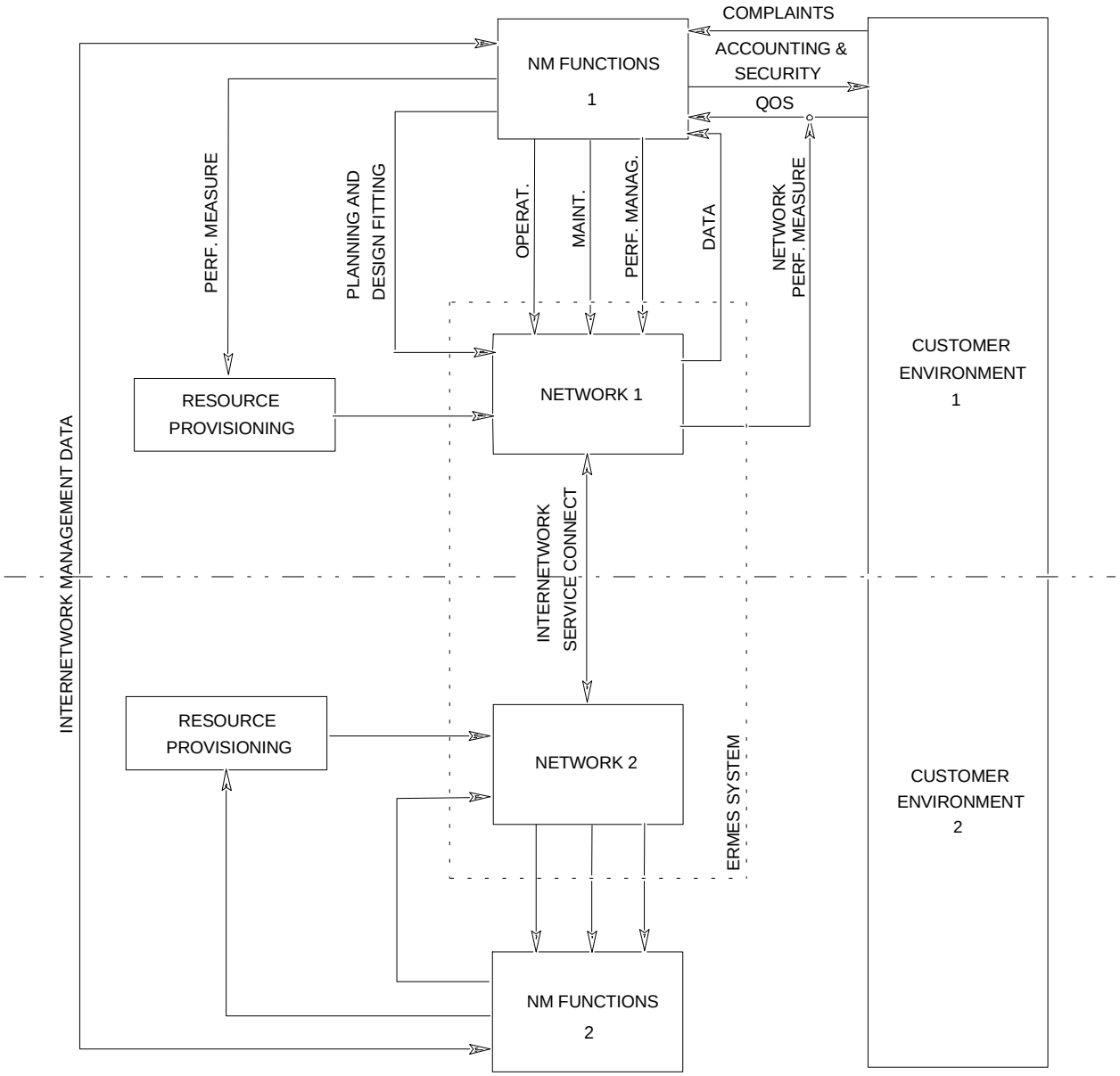


Figure B.1: Influence of network management on the ERMES network

Any equipment of a telecommunications network which is identified between two or more defined interfaces can be defined as a Maintenance Entity (ME), given that it is considered to be an object of the NM strategy.

The definition of failures (anomalies, defects and faults) is given in ITU-T Recommendations M.60 [3] and G.106 [4]. So far as the ERMES system is concerned, a failure classification can be chosen by ordering the failures according to their consequences on the QOS and network performance. In this sense, three failure groups are envisaged:

- failures causing a complete interruption of service for one or more customers, e.g., when a transmitter fails and an entire cell is left without coverage;

- failures causing a partial interruption or a degradation of service for one or more customers, e.g. when a failure causes a reduction of the transmitted power without interruption of the radio link;

- failures causing simply a degradation of the network availability without affecting the service availability, e.g., when a failure causes a channel capacity reduction with consequent delay increase in the message transfer time.

The supervision functions refer to the localization of a failure, its reporting to the maintenance staff, as well as to the other network entities which are interested in the failure itself. The detection of a failure should follow some defined supervision processes described in ITU-T Recommendation M.20 [5]. In particular, if an alarm signal is generated in a failed device and other non-defective devices are interested in the specific failure, subsequent "downstream" alarm generation should be inhibited by means of appropriate filtering functions.

The alarm message should not necessarily be produced in the network element where the failure occurred, even if it is assumed that the detection functions are located in the network element itself. In this case, the presence of a failure would be signalled to the OMC (e.g. as a state variation) and translated by the OMC itself into a real alarm including, among the others, information about the urgency of intervention.

The maintenance phases, following the failure detection, can be subdivided into:

a) system protection (service exclusion of the failed ME) by blocking or changeover;
b) failure indication;
c) (possibly) more detailed failure analysis;
d) personnel intervention and repair phases;
e) check of the repaired (or new) MEs;
f) restoring to network operation.

It is expected that phases a) and b) will be automatically achieved by the system, following failure detection. When automatic service exclusion is not possible, it should at least be possible to command it remotely from the OMC. Manual intervention in this phase should be avoided as much as possible for unmanned equipments.

Phases c) and e) require use of functions (failure localization and test facilities, respectively) that might be conveniently centralized. This is particularly true for on line failure analysis.

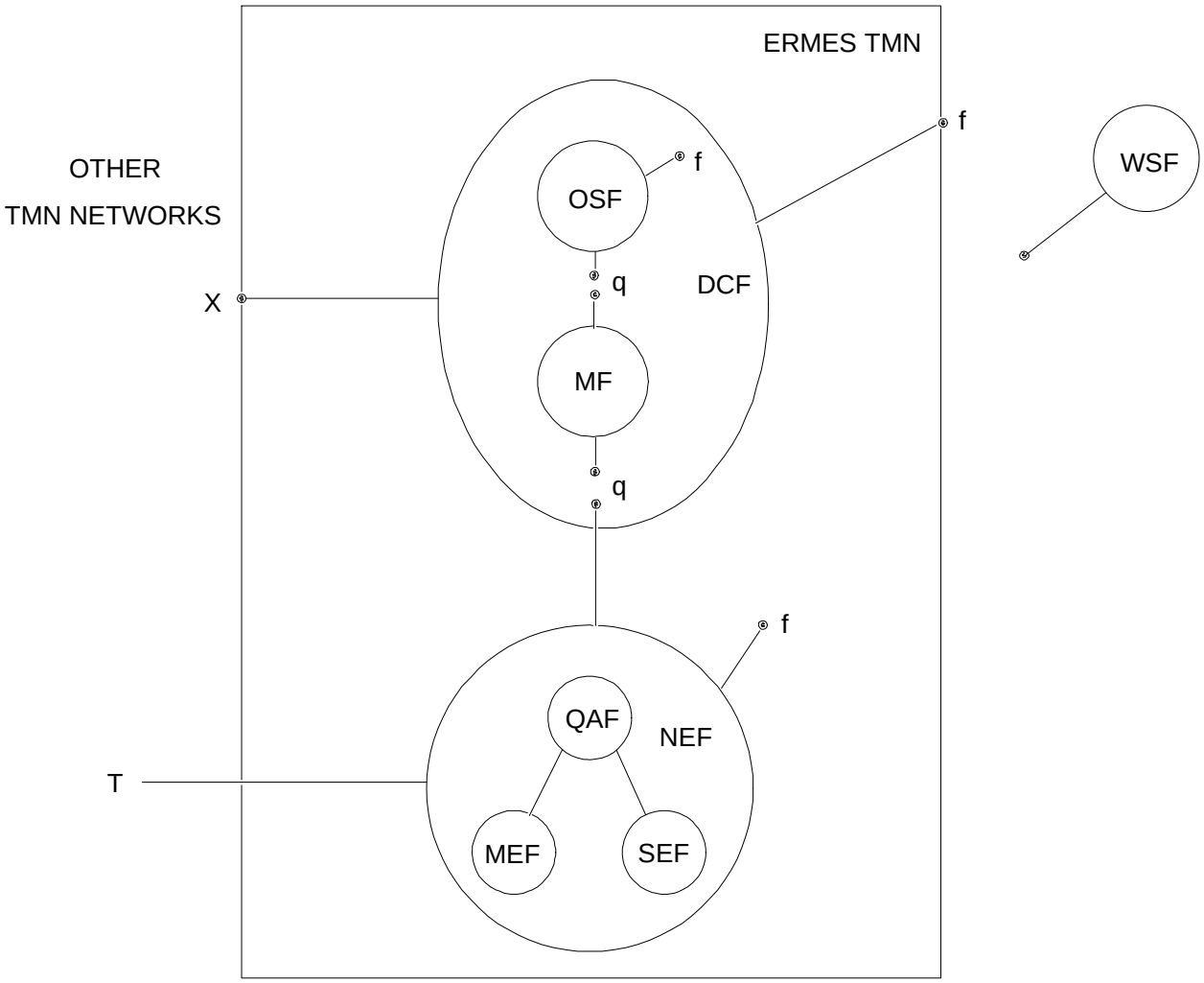
B.1.3 Performance and QOS management

A performance management policy is established in order to pursue the following objectives:

- measure and monitor the network performance and the QOS;

- collect traffic data and model the traffic behaviour of users;

- improve the network effectiveness under degraded conditions and/or abnormal traffic situations.



Reference Points (RP) and interface:

q: class of RPs between OS, M and NE functions;
f: class of workstation RPs;
x: class of RPs to other networks;
T: Telecommunication interface.

Function Blocks:

OSF: Operations System Function;
MF: Mediation Function;
DCF: Data Communication Function;
QAF: Q-interface Adaptor Function;
SEF: Support Entity Function;
MEF: Maintenance Entity Function;
NEF: Network Element Function;
WSF: Workstation Function.

Figure B.2: Functional architecture for ERMES TMN

The network effectiveness is the major component of the trafficability performance (see ITU-T Recommendation G.106 [4]).

The measure of both network performance and QOS is of great importance for the ERMES system. It is exchanged among the networks and can be utilized for verifying the operator agreements and quantifying the service performance.

Traffic data can be collected by making reference to the following categories:

- original user requests (call rate, call distribution among the service areas, message length, roaming service penetration);

- load of the network nodes (throughput, processing of transmission requests, service mixing at node level);

- telecommunications network load (transmission rates, data channel throughput).

The improvement of the network effectiveness can be reached by the following two (overlapping) phases:

- the knowledge (measurement) of the offered message traffic together with the status of the network;

- the activation of performance management actions modifying (in general) the criteria and rules according to which signalling or message traffic flow through the network.

The offered traffic is characterized by parameters such as the rate of transmission requests, the percentage of responses, the distribution of requests among the service areas, while the status of the network can be represented with the number of messages queueing for routing or transmission.

B.2 Network management functions

B.2.1 General

By applying the general telecommunication management network concepts (see ITU-T Recommendation M.60 [3]) to the specific application of ERMES network, the scheme of figure B.2 has been chosen. It represents a very flexible architecture which can be applied to all the NEs identified in the previous subclause.

As indicated, the proposed architecture consists of blocks where Operations System Functions (OSF) and Mediation Function (MF) are located. The Data Communication Functions (DCF) are implemented by one or more networks connecting the so called managed entities, which are:

- the Network Element Function (NEF) blocks;

- the Work-Station Function (WSF) blocks, where a reference point is available to TMN users;

- other networks.

The reference points indicated in the scheme define conceptual points of information exchange between blocks with non-overlapping functions. This concept allows for different allocations of the management capabilities according to three possible scenarios, for which, respectively:

- the NM functions implementation is embedded within the NEs, so that the same processing resources can be shared with a set of OSs and/or MDs, or is dedicated exclusively to NM functions;

- a combination of the two above configurations may be chosen.

The logical separation of NM functions from classical telecommunication functions is pointed out, even if some NEs can be shared between the two classes of functions.

B.2.2 Functional distribution

The physical configuration of the TMN should provide the alternatives of either centralizing or distributing the typical functions of OS, such as support application programs, access to databases, user terminal support, data formatting and display. To this purpose, three types of OSFs can be identified (see ITU-T Recommendation M.30 [6]), i.e.:

- basic OSFs which are distributed in specific NEs. These perform functions which should always be provided locally, because remote operations, even if existing, might be unreachable owing to node or line failures. In the ERMES TMN, basic OSFs should be implemented at NE;

- network OSFs which communicate with all the basic OSFs from a centralized position with the objective of ensuring network based TMN application functions. Such functions are typical of the OMC. The centralized character of the data stored in the OMC should allow easy and reliable TMN data exchange between network operators;

- service OSFs which perform TMN application functions related to a supplied service. They involve transactions between different operators. Such functions are also performed by the OMC.

In the OSs two types of data communications are involved:

- the spontaneous message transmission from the NE to the OS when a problem arises or according to a preassigned schedule. This is typically the case of a failure message, an automatic test result, the transmission of a measured value, etc;

- the two-way dialogue between OS and NE in which commands from the former and status information from the latter are exchanged in sequence. It is reasonable to assume that the OS is also responsible for integrity of the maintenance data channel through the Data Communication Network (DCN). This is an essential feature for the network OSFs.

The connection between an OS and a NE is accomplished by the so called MFs. It is not precluded that, in some implementations, MFs can be included in the NE, but they still belong conceptually to the TMN. The process of mediation routes and/or acts on the information exchange according to five general categories:

- communication control (e.g. checking the data flow integrity, addressing to the appropriate destination);

- protocol conversion and data handling (e.g. concentration, passage between Open System Interconnect (OSI) layers, data collection);

- communication of primitive functions (e.g. command/response statement, alarm forwarding);

- decision making (e.g. thresholding, data routing);

- storage (e.g. data storage, memory back up, network configuration).

All the above categories are recognized as essential and should reside in all NEs, where they can be carried out autonomously.

The Data Communications Functions (DCF) are in charge of a communication network, used to connect NEs with MDs and MDs with OSs. The two solutions of a Local Communication Network (LCN) and a (DCN) are both acceptable and the choice is usually dictated by economic considerations.

Every network element should contain:

- Maintenance Entity Functions (MEFs);

- Support Entity Functions (SEFs);

- Q-Adapter Functions (QAFs).

Annex C (informative): Conformance with the I3 and I2 interfaces

C.1 I3 Interface

The required O&M messages between the functional entities OMC ↔ PAC-OS and between the functional entities OMC ↔ MD are compared with the capability and conformance of the I3 interface described in ETS 300 133-3 [1]. The I3 interface also transparently carries the messages from OMC to BS described in subclause 6.2.3.1.

The I3 interface is described as a functional non-mandatory interface. All the message parameters included in this part of the specification are functional examples.

Only the originating messages from respective entities are described and compared. Acknowledgement messages such as ACK and NACK are neither described nor compared.

Table C.1

Functional interface OMC → PAC - OS	**Conformance with the I3 interface O&M - message**
transactions	
Control commands	
Switch on/off units.	Management exchange of commands and data.
Activate stand-by unit.	ditto.
Control time coordination.	ditto.
Configuration Modification	
Update BS addresses.	ditto.
Update hardware and software configurations.	ditto.
Set and update the alarm and the traffic data report rules.	ditto.
Set and update the internal working parameters.	Country code. Operator code Paging Area code Ermes Code Number Supplementary system information Transmission of timeslot information Management exchange of commands and data
Set and update the alarm thresholds.	Management exchange of commands and data
Status Request	
PAC internal status.	ditto.
PAC external interface status.	ditto.
Alarm status.	ditto.
Software Loading	
Telecommunication software.	ditto.
Control and supervision software.	ditto.
Diagnostic temporary software.	ditto.

Table C.2

Required O&M messages in the functional interface PAC - OS → OMC	Conformance with the I3 interface
	O&M - message transactions
Traffic Information	
Traffic parameters.	Traffic data (queue, delay, status) Universal time information Status and Paging Area Management exchange of commands and data
Performance and QOS parameters.	Flow control information Management exchange of commands and data
Autonomous Alarm	
Faults of the hardware units.	Alarms Management exchange of commands and data
Failures in the operation process.	Alarms Management exchange of commands and data

Table C.3

Required O&M messages in the functional interface OMC → MD	Conformance with the I3 Interface O&M - message transactions
Status Request	
Alarm status.	Management exchange of commands and data
Configuration Modification	
Configuration modification.	ditto.
BS(s) alarm report rules	
Rules for the poll, status and report requests to the BS(s)	ditto.
MD internal working parameters.	ditto.

Table C.4

Required O&M messages in the functional interface MD → OMC	Conformance with the I3 interface O&M - message transactions
Status Request	
Programmed alarm and status report of BS(s)	Management exchange of commands and data
Autonomously generate alarm (if implemented)	Alarm Management exchange of commands and data

C.2 I2 interface

The required O&M messages between the functional entities OMC <--> BS and between the functional entities MD <--> BS are compared with the capability and conformance of the I2 interface as defined in ETS 300 133-3 [1].

The I2 interface is an optional interface. All the message parameters included in this annex are functional examples.

Only the originating messages from respective entities are described and compared. Acknowledgement messages such as ACK and NACK are expected but will be neither described nor compared.

Table C.5

Required O&M messages in the functional interface OMC → BS	Conformance with the I2 Interface O&M - message transactions
Control Commands	
Switch on/off units.	Control command operation.
Activate stand by units.	ditto.
Adjust Tx parameters.	ditto.
Configuration Modification	
Update system information.	Paging request operation.
Update addresses.	Control command operation.
Update hardware and software configuration.	It is partly supported by the control command operations
Set and update alarm thresholds and test attributes	Control command operation.
Set and update internal working parameters	Control command operation BS time reference operation
Status Request	
BS Internal status.	Status request operation Report request operation
Alarm status.	Page request operation Poll request operation
Software Loading	
Telecommunication software.	Remote loading is not defined for the I2 interface

Table C.6

Required O&M messages in the functional interface MD → BS	Conformance with the I2 interface O&M - message transactions
Status Request	
BS internal status	Status request operation Report request operation
alarm status	Page request operation Poll request operation

History

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