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Technical Specification

Universal Mobile Telecommunications System (UMTS); 3G Telecom Management: Principles and high level requirements (3GPP TS 32.101 version 3.3.0 Release 1999)



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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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1 Scope

The present document establishes and defines the management principles and high-level requirements for the management of UMTS.

In particular, the present document identifies the requirements for:

- the upper level of a UMTS Management System;
- the reference model, showing the elements the UMTS Management System interacts with;
- the network operator processes needed to run, operate and maintain a UMTS network;
- the functional architecture of the UMTS Management System;
- the principles to be applied to UMTS Management Interfaces;
- the methodology to be followed in further steps of the UMTS Management Specifications.

The present document does not provide physical architectures of the UMTS Management System. These aspects are defined and discussed in more detail in 3GPP TS 32.102 [101].

This document is applicable to all further 3GPP specifications regarding the Network Management of UMTS.

2 References

The following documents contain provisions, which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

Operations System (OS): This abbreviation indicates a generic management system, independent of its location level within the management hierarchy.

Element Manager (EM): Provides a package of end-user functions for management of a set of closely related types of network elements. These functions can be divided into two main categories:

Element Management Functions: for management of network elements on an individual basis. These are basically the same functions as supported by the corresponding local terminals.

Sub-Network Management Functions: that are related to a network model for a set of network elements constituting a clearly defined sub-network, which may include relations between the network elements. This model enables additional functions on the sub-network level (typically in the areas of network topology presentation, alarm correlation, service impact analysis and circuit provisioning).

Enterprise Systems: those Information Systems that are used in the telecommunication organisation but are not directly or essentially related to the telecommunications aspects (Call Centre's, Fraud Detection and Prevention Systems, Invoicing etc).

IRP Information Model: An IRP Information Model consists of an IRP Information Service and a Network Resource Model (see below for definitions of IRP Information Service and Network Resource Model).

IRP Information Service: An IRP Information Service describes the information flow and support objects for a certain functional area, e.g. the alarm information service in the fault management area. As an example of support objects, for the Alarm IRP there is the alarm record and alarm list.

IRP Solution Set: An IRP Solution Set is a mapping of the IRP Information Service to one of several technologies (CORBA/IDL, SNMP/SMI, CMIP/GDMO, etc.). An IRP Information Service can be mapped to several different IRP Solution Sets. Different technology selections may be done for different IRPs.

Management Infrastructure: The collection of systems (computers and telecommunications) a UMTS Organisation has in order to manage UMTS.

Network Element (NE): a discrete telecommunications entity, which can be managed over a specific interface e.g. the RNC.

Network Manager (NM): Provides a package of end-user functions with the responsibility for the management of a network, mainly as supported by the EM(s) but it may also involve direct access to the network elements. All communication with the network is based on open and well-standardized interfaces supporting management of multi-vendor and multi-technology network elements.

Network Resource Model (NRM): A protocol independent model describing managed objects representing network resources, e.g. an RNC or NodeB.

UMTS Organisation: A legal entity that is involved in the provisioning of UMTS.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ASN.1	Abstract Syntax Notation One
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband ISDN
BOOTP	Boot protocol
CDR	Call Detail Record
CEIR	Common Equipment Identification Register
CMIP	Common Management Information Protocol
CMIP/GDMO	Common Management Information Protocol/Guidelines for the Definition of Managed Objects
CORBA IIOP	Common Object Request Broker Architecture Internet Inter-ORB Protocol
CORBA	Common Object Request Broker Architecture
CORBA/IDL	Common Object Request Broker Architecture/Interface Definition Language
CPE	Customer Premises Equipment
DCN	Data Communications Network
DECT	Digital Enhanced Cordless Telecommunications
DHCP	Dynamic Host Configuration Protocol
DNS	Directory Name Service
DSS1	Digital Subscriber System 1
EM	Element Manager
FFS	For Further Study
FTAM	File Transfer Access and Management
FTP	File Transfer Protocol
ftp	FTP
GDMO	Guidelines for the Definition of Managed Objects
GSM	Global System for Mobile communications
IDL	Interface Definition Language
IIOP	Internet Inter-ORB Protocol
IN	Intelligent Network
INAP	Intelligent Network Application Part
IRP	Integration Reference Point
ISDN	Integrated Services Digital Network
LLA	Logical Layered Architecture
MAP	Mobile Application Part
MIB	Management Information Base
MMI	Man-Machine Interface
NM	Network Manager
NRM	Network Resource Model
OS	Operations System
OSI	Open Systems Interconnection
PDH	Plesiochronous Digital Hierarchy
PKI	Public Key Infrastructure
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RNC	Radio Network Controller
RSVP	Resource ReserVation Protocol
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol (IETF)
SS7	Signalling System No. 7
TCP/IP	Transmission Control Protocol/ Internet Protocol
ftp	trivial ftp
TM	Telecom Management
TMF	TeleManagement Forum
TMN	Telecommunications Management Network (ITU-T)
TOM	Telecom Operations Map (TMF)
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunication System
UPT	Universal Personal Telecommunication

UTRA Universal Terrestrial Radio Access
VHE Virtual Home Environment

4 General

4.1 UMTS

4.1.1 Requirements

The requirements and decomposition of Telecom Management for UMTS do not differ radically from that of 2G systems. The following requirements have been identified:

- to be capable of managing equipment supplied by different vendors including the management systems themselves.
- to minimise the complexity of UMTS management.
- to provide the communication between UMTS Network Elements (NEs) and UMTS Operations Systems (OS) or between UMTS OSs themselves via standardised interfaces (e.g. CMIP, CORBA, SNMP, etc.) as appropriate and necessary.
- to minimise the costs of managing a UMTS network such that it is a small component of the overall operating cost.
- to provide UMTS configuration capabilities that are flexible enough to allow rapid deployment of services.
- to provide integrated Fault Management capabilities.
- to simplify maintenance interventions by supporting remote maintenance operations.
- to allow interoperability between Network Operators/Service Providers for the exchange of management/charging information. This includes interoperability with other networks and services (e.g. ISDN/B-ISDN, PSTN and UPT) as well as other UMTS networks.
- to enable the support and control of a growing number of resources. This would allow the system to start from a small and simple configuration and grow as needed, both in size and complexity.
- to re-use existing relevant standards (e.g. GSM, IN, ISDN/B-ISDN, ITU-T, TMF etc.) where applicable.
- to support the security management of UMTS (e.g. key management, access control management, operation and administration of security mechanisms) with particular emphasis on new features such as automatic roaming and packet switched services.
- to provide and support a flexible billing and accounting administration, to support charging across UMTS and non-UMTS systems.
- to address the management and assessment of system performance and operation through the use of common measurements, etc. This would enable a Network Operator/Service Provider to assess actual performance against planned targets.
- to expose any information only once.
(Example: In case an operator would like to change one parameter in a cell: Then all occurrences of this parameter, e.g. transceiver frequency, hand-over relationships, performance measurements, frequency hopping control, etc., should be changed by one action only.)
- to support the restoration of a UMTS Operations System (e.g. resynchronisation and atomic transactions).
- to have one (1) name convention for network resources under management in the 3GPP context. To perform network management tasks, co-operating applications require identical interpretation of names assigned to network resources under management. Such names are required to be unambiguous as well.

It is acknowledged that the introduction of new architecture to support new services or the introduction of new services themselves may impact the detailed requirements of some or all of the above.

4.1.2 UMTS reference model

A Universal Mobile Telecommunications System (UMTS) is made of the following components:

- one or more Access Networks, using different types of access techniques (GSM, UTRA, DECT, PSTN, ISDN ...) of which at least one is UTRA;
- one or more Core Networks;
- one or more Intelligent Node Networks service logic and mobility management, (IN, GSM ...);
- one or more transmission networks (PDH, SDH etc.) in various topologies (point-to-point, ring, and point-to-multi-point...) and physical means (radio, fibre and copper ...).

The UMTS components have signalling mechanisms among them (DSS1, INAP, MAP, SS7, RSVP,...).

From the service perspective, the UMTS is defined to offer:

- Service support transparent to the location, access technique and core network, within the bearer capabilities available in one particular case;
- User to terminal and user to network interface (MMI) irrespective of the entities supporting the services required (VHE);
- Multimedia capabilities.

4.1.3 UMTS provisioning entities

3GPP TS 22.101 "Services Principles" [2] identifies two major entities, which cover the set of UMTS functionalities involved in the provision of the UMTS services to the user. These are:

Home Environment: This entity holds the functionalities that enable a user to obtain UMTS services in a consistent manner regardless of the user's location or the terminal used;

Serving Network: This entity provides the user with access to the services of the Home Environment.

4.1.4 UMTS management infrastructure

Every UMTS Organisation has its own management infrastructure. Each management infrastructure contains different functionality depending on the role-played and the equipment used by that UMTS Entity.

However, the core management architecture of the UMTS Organisation is very similar. Every UMTS Organisation:

- provides services to its customers;
- needs an infrastructure to fulfil them (advertise, ordering, creation, provisioning ...);
- assures them (Operation, Quality of Service, Trouble Reporting and Fixing ...);
- bills them (Rating, Discounting ...).

Not every UMTS Organisation will implement the complete Management Architecture and related Processes. Some processes may be missing dependent on the role a particular UMTS Organisation is embodying. Processes not implemented by a particular UMTS Organisation are accessed via interconnections to other UMTS organisations, which have implemented these processes (called X-interfaces in the ITU-T TMN architecture).

The Management Architecture itself does not distinguish between external and internal interfaces.

4.2 ITU-T TMN

ITU-T TMN (Telecommunications Management Network standard from the ITU-T), as defined in ITU-T Recommendation M.3010 [1], provides:

- an architecture, made of OS (Operations Systems) and NEs (Network Elements), and the interfaces between them (Q, within one Operator Domain and X, between different Operators);
- the methodology to define those interfaces;
- other architectural tools such as LLA (Logical Layered Architecture) that help to further refine and define the Management Architecture of a given management area;
- a number of generic and/or common management functions to be specialised/applied to various and specific ITU-T TMN interfaces.

The UMTS Management Architecture is based on ITU-T TMN, and will reuse those functions, methods and interfaces already defined (or being defined) that are suitable to the management needs of UMTS. However, the UMTS Management needs to explore the incorporation of other concepts (other management paradigms widely accepted and deployed) since:

- UMTS incorporates other technologies to which ITU-T TMN is not applied fully;
- UMTS faces new challenges that ITU-T TMN does not address today;

The ITU-T standards are mainly concentrated in the element management and network management layers. They have been developed from the bottom up, making it difficult to apply the standards as part of a business case. It is also difficult to have a customer centric focus.

An example of another management paradigm that will be employed to try and address these difficulties is the Telecom Operations Map from TeleManagement Forum (TMF). The Telecom Operations Map, using the TMN model as a foundation, addresses operation support and management for any communications service from a top down customer oriented standpoint.

It shall be noted that these concerns are applicable to other telecommunication areas as well as to UMTS, it is expected that the eventual evolution of ITU-T TMN will cover this ground. Indeed, most of the above concepts are already being taken into account by ITU-T TMN evolution (protocols and methodologies).

5 Architectural framework

5.1 UMTS Management Reference Model and Interfaces

Figure 1 illustrates the UMTS Management Reference Model. It shows the UMTS Operation System interfacing with other systems.

The present document (and the rest of the 3GPP UMTS Management detailed specifications) addresses the UMTS Operations System (function and architecture wise) and the interfaces to the other systems (information and protocol wise).

The present document does not address the definition of any of the systems, which the UMTS Operations System may interface to. The rest of the 3GPP specifications regarding UMTS Management will not cover them either.

It is not the approach (nor it is possible) to re-define the complete management of all the technologies that might be used in the provision of UMTS. However, it is the intention to identify and define what will be needed from the perspective of UMTS management.

A number of management interfaces in a UMTS network are identified in figure 1, namely:

- 1) between the NEs and the Operations System of a single UMTS Organisation:
 - a) network element to element management level;
 - b) element management to network management level.
- 2) between the Operations System and the Enterprise Systems of a single UMTS Organisation;
- 3) between Operations Systems of different UMTS Organisations;
- 4) within the Operations System of a single UMTS Organisation.

The present document focuses on management interfaces of type 1 from the above list, while interfaces of types 2 & 3 will be identified in the present document. Detailed specification of these interfaces is For Further Study (FFS). Interfaces of type 4 are beyond the scope of standardisation.

NOTE: Both TeleManagement Forum and ITU-T are carrying out work with interfaces of type 3.

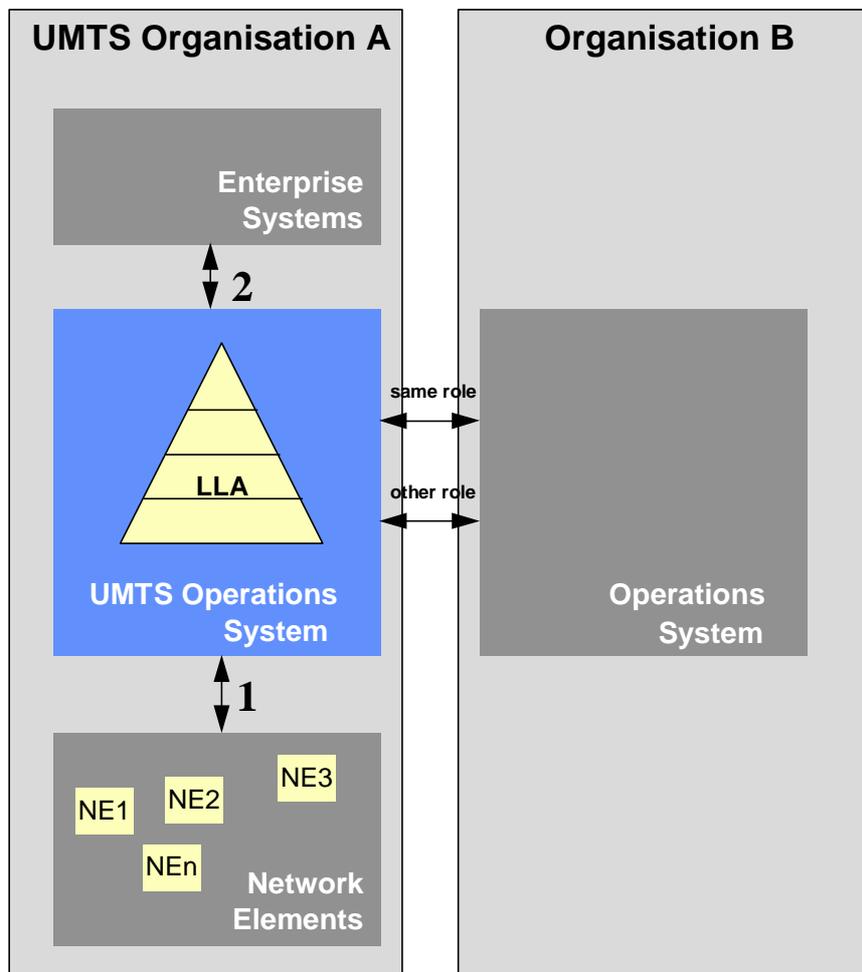


Figure 1: UMTS Management System Interactions

5.2 Interfaces to Enterprise Systems (Type 2)

It is the approach to define a UMTS Management that fully fits into the enterprise processes needs of the UMTS Organisations. One of the essential issues of today's way of running telecommunications businesses is integral operation (e.g.: customer care, from service subscription to billing, from order fulfilment to complaint management).

Enterprise Systems are those Information Systems that are used in the telecommunication organisation but are not directly or essentially related to the telecommunications aspects (Call Centres, Fraud Detection and Prevention Systems, Invoicing etc.).

Standardising Enterprise Systems is out of the scope of 3GPP work, since it involves many operator choices (organisational, etc.) and even regulatory. Also Enterprise Systems are often viewed as a competitive tool. However, it is essential that the requirements of such systems are taken into account and interfaces to the UMTS Operations Systems are defined, to allow for easy interconnection and functional support.

5.3 Interfaces to NEs (Type 1)

In some cases, the management interfaces to NEs have been defined bottom-up, trying to standardise the complete O&M functionality of the various NEs.

For UMTS management, a top-down approach will be followed to streamline the requirements from the perspective of UMTS Operators top priority management processes.

It is assumed that this will not fully cover the O&M functionality of all NE types in UMTS at once, therefore a part of the functionality will be phased for further work and consideration. Some proprietary solutions (local and/or remote) will be needed in the interim. The rationale of this approach is not only the best use of resources, but also to follow a pragmatic step-wise approach that takes into account the market forces (the manufacturers and operators capabilities). A further rationale is to define clear and easy to agree steps that allow Management functionality to be implemented in the same time frame as the telecom functionality in the network (i.e. to synchronise the management and network releases).

The approach for NE Management Interfaces will be to concentrate on protocol independent information models, allowing a mapping to several protocol suites. The rationale is:

- due to the convergence of Information and Telecommunication technologies in UMTS, it is required to work on a more open approach (acknowledging the market status and foreseen evolutions);
- the life cycle of information flows is 10 to 20 years, while that of protocols is 5 to 10 years;
- developments in automatic conversion from information models to various protocols/technologies will allow a more pragmatic and open approach (e.g. UML to GDMO, UML to IDL).

However, it is the intention to at least recommend one mapping for each interface.

5.4 Interfaces to other Operations Systems (Type 3)

UMTS Management considers integrally the interaction between the Operations Systems of other legal entities for the purpose of providing UMTS services.

There are two major types of interfaces to other management systems:

- 1) to other UMTS Operations Systems (i.e. other from other UMTS operators);
- 2) to other Operations Systems (i.e. to non-UMTS operators).

The first type deals with co-operation to provide UMTS services across a number of UMTS networks (e.g. roaming related interactions). The second type deals with client-server relationship to other operators (e.g. to leased lines providers, to added value service providers, etc.).

The approach that will be followed is to identify and define integral processes, not taking into account in the first step, how many operators or operations systems might be involved, but rather concentrating on the interactions between them (i.e. assuming a UMTS operator encompasses all functionalities). A further step will be to consider and define extra requirements (security, confidentiality etc.) when part of the process involves interactions with other operators Operations Systems (OSs).

5.5 Interface definition

The Management interfaces are studied here from four different perspectives or levels:

- 1) logical (information model and flows used in the relationship manager-agent, or equivalent);
- 2) application protocol (end-to-end, upper layers protocol running between manager-agent, or equivalent);
- 3) networking protocol (lower layer protocols carrying the information in/out the manager and agent, or equivalents);
- 4) physical (mapping of the manager and agent, or equivalents, roles into physical entities).

Figure 2 shows the management interfaces of one part of the UMTS (the Radio Network), by way of illustration of interfaces of types 1a and 1b).

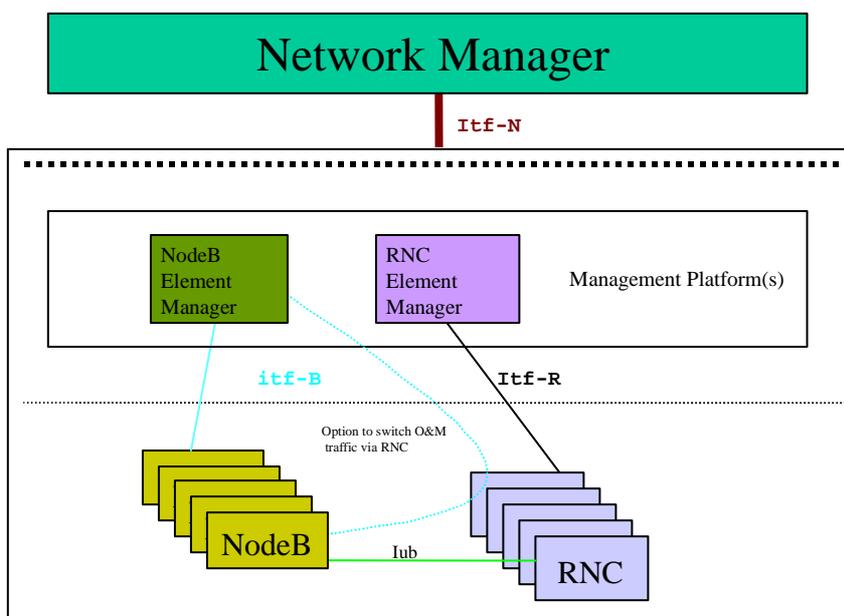


Figure 2: Radio Network Management Interfaces

Figure 2 identifies the following Management Interfaces:

- Itf-B - between Node B & its Manager (physically, this may be a direct connection or via the RNC) (type 1a).
- Itf-R - between RNC & its Manager (type 1a).
- Itf-N – between Network & Network Manager (type 1b).

5.6 Logical level

This level covers the mutual and conceptual knowledge of entities being connected by a given interface.

For type 1b interfaces (such as Itf-N in Figure 2 above) interactions at this level are fully standardised by 3GPP in terms of protocol independent Network Resource Models (static information definition) and IRP Information Services

(information flows) where available. These protocol-independent Network Resource Models and IRP Information Services are hereafter referred to as IRP Information Models (Integration Reference Point Information Models).

5.7 Solution Set (SS) level

For each IRP Information Model at the logical level there will be at least one IRP Solution Set defined. An IRP Solution Set is a mapping of the IRP Information Service to one of several technologies (for a full definition refer to subclause 3.1).

See Annex C for the valid UMTS Management IRP Solution Sets.

5.8 Application Protocol level

This level covers the set of primitives used to pass information across a given interface and the means to establish associations between the application entities (including the related addressing aspects) across a given interface.

Generally, the Application Protocol Suite used for the interaction between entities across a given interface is optional within the valid UMTS Management Application Protocol Suites (see Annex A for a list of UMTS Management Protocol Suites). However, in the case of interfaces of type 1b (such as Itf-N in figure 2 above) at least one of those protocol suites will be chosen as the standard protocol suite.

It is the intention to consider following attributes of each application protocol in making this decision:

CMIP:

- Very flexible;
- Powerful information modelling capability, therefore, in turn, complex to implement;
- Complex to integrate managers (specifically if CMIP stacks from different vendors are used in the agents and manager(s));
- Process hungry;
- Heavyweight stack (e.g. prevents it from being implemented on NodeB);
- Potential reuse of GSM and ITU-T standards and implementation;
- High on Cost Of Goods.

SNMP:

- is well used in other Telecom areas (e.g. ATM management);
- has inadequacies for Configuration Management (relatively simple/poor information modelling capability for management MIBs make implementation of complex information models difficult, although not impossible);
- supports auto-discovery of elements on the management network via MIB-II;
- has lower Cost Of Goods;
- more choice of "off the shelf commercial systems and software" (see subclause 7.2 and 3GPP TS 32.102 [101]).

CORBA-IIOP:

- very powerful and flexible;
- low Cost Of Goods;
- not proven in Telecom Management (but gaining acceptance).

5.9 Networking Protocol level

Whatever standardised protocol suite at the networking level that is capable of meeting the functional and operational requirements (including the network addressing aspects) of the Logical and Application Protocol levels of a given UMTS management interface, is a valid Networking Protocol for that interface.

A number of requirements shall be met by the Networking Protocol, as follows:

- capability to run over any bearer (leased lines, X.25, ATM, Frame Relay ...);
- support of existing transport protocols and their applications, such as OSI, TCP/IP family, etc.;
- widely available, cheap and reliable.

The Internet Protocol (IP) is a Networking Protocol that ideally supports these requirements. IP also adds flexibility to how management connectivity is achieved when networks are rolled out, by offering various implementation choices. For instance, these may take the form of:

- Dedicated management intranets.
- Separation from or integration into an operator's enterprise network.
- Utilisation, in one-way or another, of capacities of the public Internet and its applications or other resources.

5.10 Physical level

Though the interaction at the logical level takes place between the UMTS Management System and the UMTS NEs, it is left to the implementer's choice the possibility to use the Q-Adapter (see Note) concept of ITU-T TMN Architecture as physical implementation (as defined in ITU-T Recommendation M.3010 [1]).

NOTE: Q-Adapter needs to be interpreted here in a wider sense than in ITU-T Recommendation M.3010 [1], since UMTS will consider other application protocols different to CMIP.

The present document does not preclude the usage of Q-Adapters at other interfaces of the UMTS Management.

5.11 Compliance conditions

For a UMTS entity (Management System or NE) to be compliant to a given UMTS Management Interface, all the following conditions shall be satisfied:

- it implements the management functionality following the Information Model and flows specified by the relevant 3GPP UMTS Management Interface Specifications applicable to that interface;
- it provides at least one of the IRP Solution Sets (where available) related to the valid Application Protocols specified by 3GPP UMTS Application Protocols for that interface (see Annex A). For each interface at least one of the valid protocols will be recommended;
- it provides at least one standard networking protocol;
- in case the entity does not offer the management interface on its own, a Q-Adapter shall be provided. This Q adapter shall be provided independently of any other UMTS NE and/or UMTS Management System.

6 UMTS Management Processes

The present document details the general aspects of an UMTS Management system. It describes primarily the management processes that collectively support Customer Care Service Development & Operations, and Network & Systems Management Processes in an UMTS network.

These management processes are based on the widely accepted Telecom Operations Map from the TeleManagement Forum [100]. They map onto the Service and Network Management layers as defined in the ITU-T Recommendation M.3010 appendix II [1] as depicted in Figure 3 below.

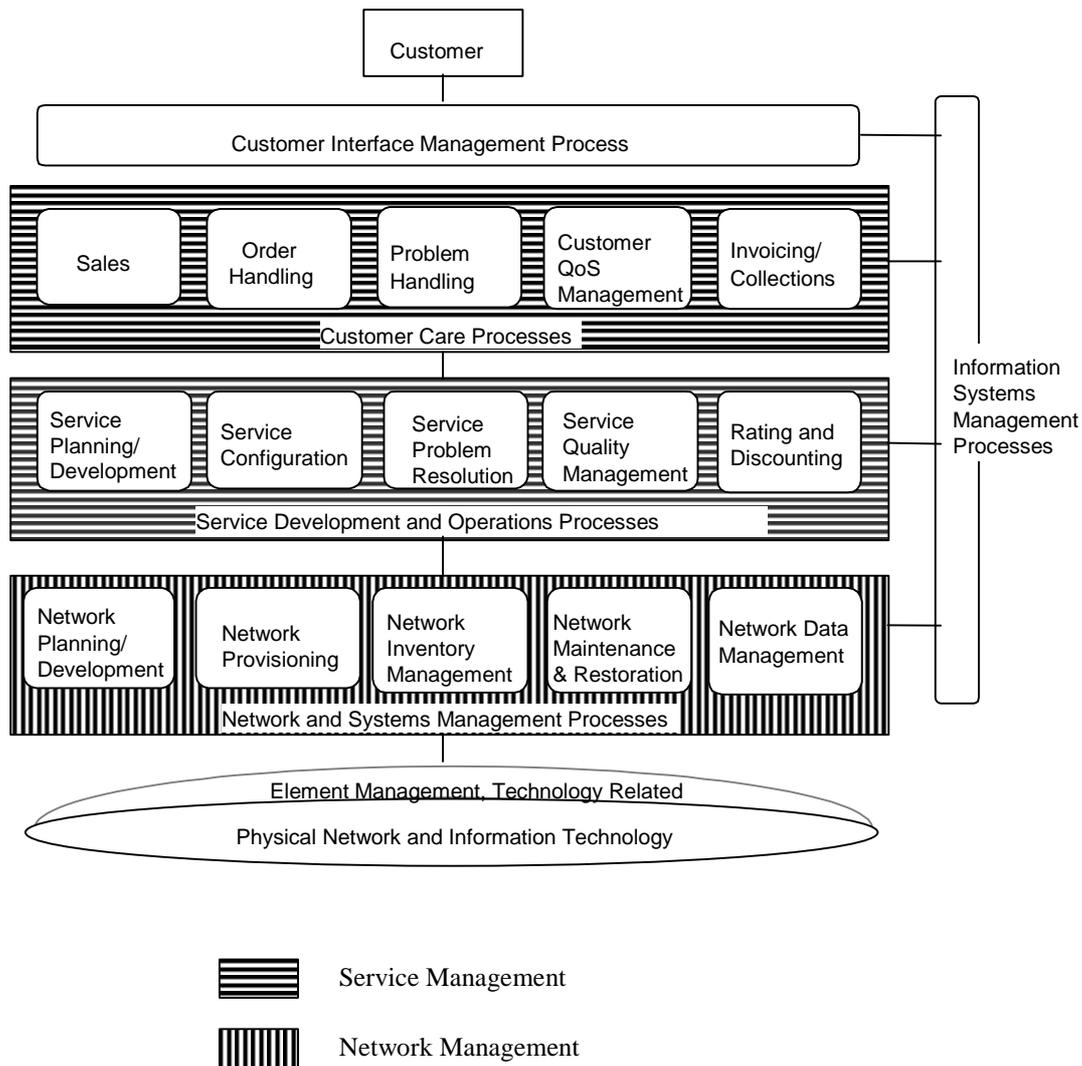


Figure 3: Telecom Operations Map Business Process Model (* imported from [100])
(Service & Network Management shading added in the present document)

The present document details the UMTS Management Functional Architecture. This is done by applying each of the management functions to the UMTS management processes.

The management functions are:

- fault management;
- configuration management (including equipment inventory);
- performance management (including quality of service management);
- roaming management;
- accounting;
- customer profile management;
- service deployment;
- fraud management;
- security management;
- software management.

All UMTS management processes have functions in several management areas. By identifying only those processes and interfaces relating to a certain management function, for example performance management, it is possible to take a slice through the Telecom Operations Map that details the functional architecture for performance management, this will be the approach taken by the present document.

7 Process decompositions

This clause gives a short description of each of the UMTS management processes introduced in "TMF Telecom Operations Map" [100]. To see a more detailed description and process spider diagram for each process, refer to "TMF Telecom Operations Map"[100].

7.1 Customer Interface Management

The Customer Interface Management Process directly interacts with customers and translates customer requests and inquiries into appropriate "events" such as, the creation of an order or trouble ticket or the adjustment of a bill.

7.2 Sales

The Sales Process encompasses learning about the needs of each customer, and educating the customer about the communications services that are available to meet those needs.

7.3 Ordering

The Ordering Process includes all the functions of accepting a customer's order for service, tracking the progress of the order, and notifying the customer when the order is complete.

7.4 Problem Handling

The Problem Handling Process is responsible to receive service complaints from customers, resolve them to the customer's satisfaction and provide meaningful status on repair or restoration activity.

7.5 Customer QoS Management

This process is concerned with UMTS Quality of Service (QoS) and its measurement, management and reporting.

7.6 Invoicing and Collection

This process encompasses sending invoices to customers, processing their payments and performing payment collections.

7.7 Service Planning and Development

This process encompasses:

- designing technical capability to meet specified market need at desired cost;
- ensuring that the service (product) can be properly installed, monitored, controlled, and billed;
- initiating appropriate process and methods modifications, as well as initiating changes to levels of operations personnel and training required;
- initiating any modifications to the underlying network or information systems to support the requirements;
- performing pre-service testing that the technical capability works and that the operational support process and systems function properly;
- ensuring that sufficient capacity is available to meet forecasted sales.

7.8 Service Configuration

This process encompasses the installation and/or configuration of service for specific customers, including the installation/configuration of customer premises equipment.

7.9 Service Problem Resolution

This process encompasses isolating the root cause of service affecting and non-service affecting failures and acting to resolve them. Typically, failures reported to this process affect multiple customers.

7.10 Service Quality Management

This process supports monitoring service or product quality on a service class basis in order to determine:

- whether service levels are being met consistently;
- whether there are any general problems with the service or product;
- whether the sale and use of the service is tracking to forecasts.

7.11 Rating and Discounting

This process encompasses:

- applying the correct rating rules to usage data on a customer-by-customer basis, as required;
- applying any discounts agreed to as part of the Ordering Process;
- applying promotional discounts and charges;
- applying outage credits;
- applying rebates due because service level agreements were not met;
- resolving unidentified usage.

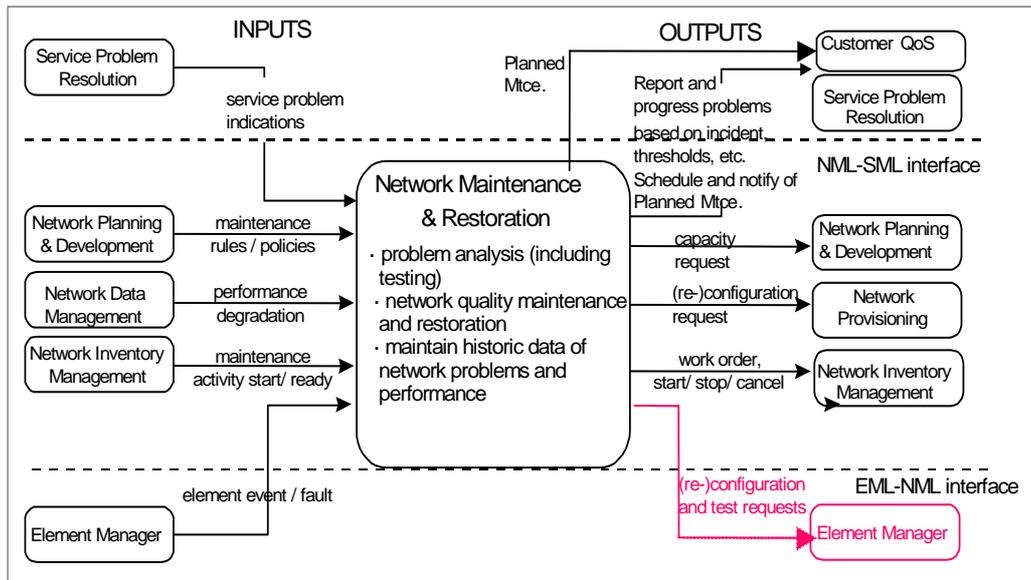
7.12 Network Data Management

In general, this process is responsible for the collection of performance/usage data and events for the purpose of network performance, usage and traffic analysis. This data is also an input to the Rating and Discounting process at the Service Management Layer.

7.13 Network Maintenance and Restoration

This process encompasses maintaining the operational quality of the network, in accordance with required network performance goals.

NOTE: 3GPP have added an additional process flow to this process. For this reason a modified spider diagram for this process is included in Figure 4 below (changes highlighted in red). This change has been submitted to TMF for inclusion in the Telecom Operations Map (TOM), when the changes is incorporated in the TOM the diagram can be removed from the present document.



NOTE: Red colours in this figure indicate changes to Telecom Operations Map not yet approved by the TMF.

Figure 4: Network Maintenance and Restoration Process

7.14 Network Inventory Management

This process encompasses anything to do with physical equipment and the administration of this equipment.

7.15 Network Provisioning

This process encompasses the configuration of the network, to ensure that network capacity is ready for provisioning of services.

7.16 Network Planning and Development

This process encompasses development and acceptance of strategy, description of standard network configurations for operational use, definition of rules for network planning, installation and maintenance.

8 UMTS Management Functional Architecture

8.1 TM Architectural aspects

The basic aspects of a TM architecture, which can be, considered when planning and designing a TM are:

- the functional architecture;
- the information architecture;
- the physical architecture.

The management requirements from the business needs are the base for the functional architecture, which describe the functions that have to be achieved. The information architecture defines what information that has to be provided so the functions defined in the functional architecture can be achieved. The physical architecture has to meet both the functional architecture and the information architectures. These relationships are shown in Figure 5 below.

The present document addresses the Functional Architecture, the Physical Architecture is addressed in 3GPP TS 32.102 [101].

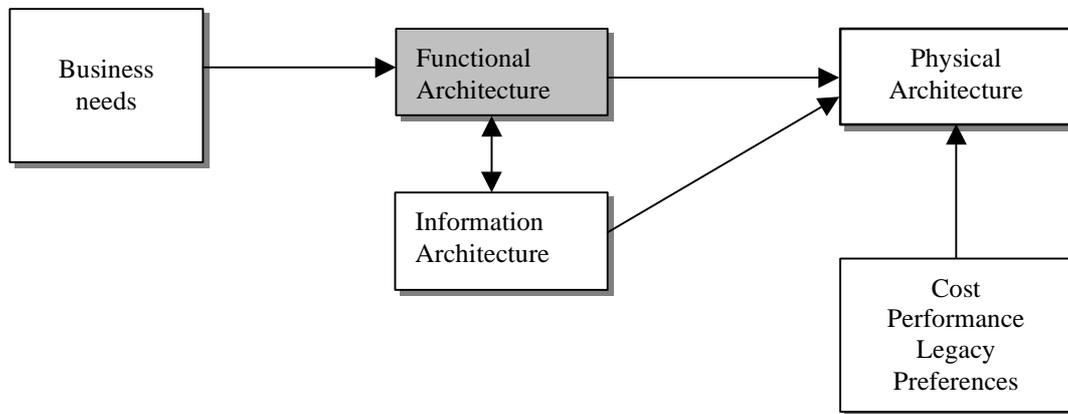


Figure 5: Architectural relationship

8.2 Performance Management

Figure 6 below makes a cut through the Telecom Operations Map from a Performance Management perspective. Although this "cut slice" is quite large it does not contain all and everything related to Performance Management. But it contains all processes and interfaces mainly involved in Performance Management. To make Figure 6 clearer different thickness of lines have been used to illustrate the different importance of the accordingly marked interfaces.

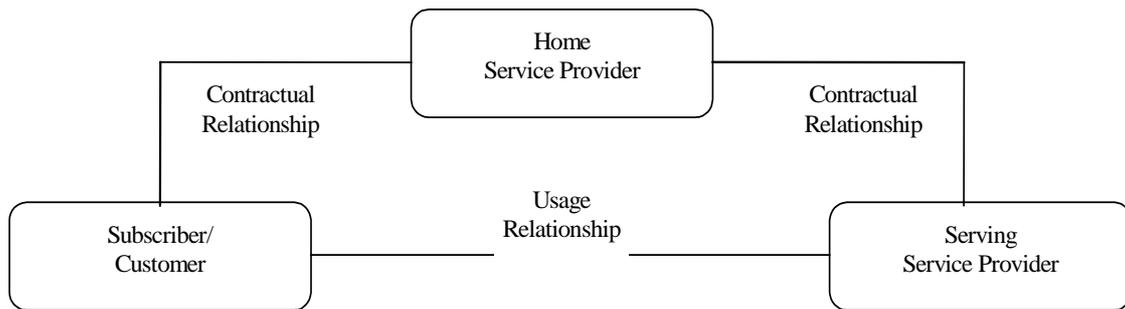


Figure 7: Relationships between Subscriber, Home and Serving Service Provider

In order to make this happen, the home service provider and serving service provider need a contractual relationship called a roaming agreement. The roaming agreement can be an ordinary direct agreement between both service providers or it can be established by the means of a clearinghouse.

In any case the roaming agreement regulates at least the following items:

- tariffing and pricing;
- signalling and traffic interconnection;
- CDR exchange format and exchange schedule;
- problem handling; and many others.

Today's mobile networks have roaming agreements with tens of other networks. With 3rd Generation mobile networks coming, this number is expected to increase to hundreds if not more. All these roaming agreements have an impact on many parts of the network.

The handling of this complex process requires an excellent understanding of roaming agreement management. To aid this understanding Figure 8 below is provided. All information flows, which are not effected or not changed by roaming agreement management, have been omitted to aim readability.

NOTE: The information flows shown in Figure 8 are intended to illustrate the flow of management information required to support roaming in 3rd Generation networks.

The information flow illustrated in Figure 8 is an overlay onto the main information flow of a serving mobile service provider to support it's own subscribers. This overlay information flow of the serving service provider is triggered by the request to establish or update a roaming agreement issued by the customer.

In this context the home service provider is classified as a customer of a serving service provider (customer in this context does not refer to an individual customer of the home service provider!).

The home service provider (customer) would like to offer roaming to the serving service provider to its subscribers.

The roaming agreement management information flow consists of one major and two optional supporting information flows:

- customer care information flow (solid line)
This is the major information flow supporting all contract related activities: negotiating tariffs, negotiating SLAs, trouble handling, roaming accounting file exchange,...
- new service facilities information flow (dash-dotted line)
This is an optional supporting flow which takes place if the support of an roaming agreement requires the introduction of new services or a configuration change of existing services.
- new network facilities information flow (dashed line)
This is an optional supporting flow which takes place if the support of an roaming agreement requires the introduction of new network facilities or a configuration change of existing network facilities.

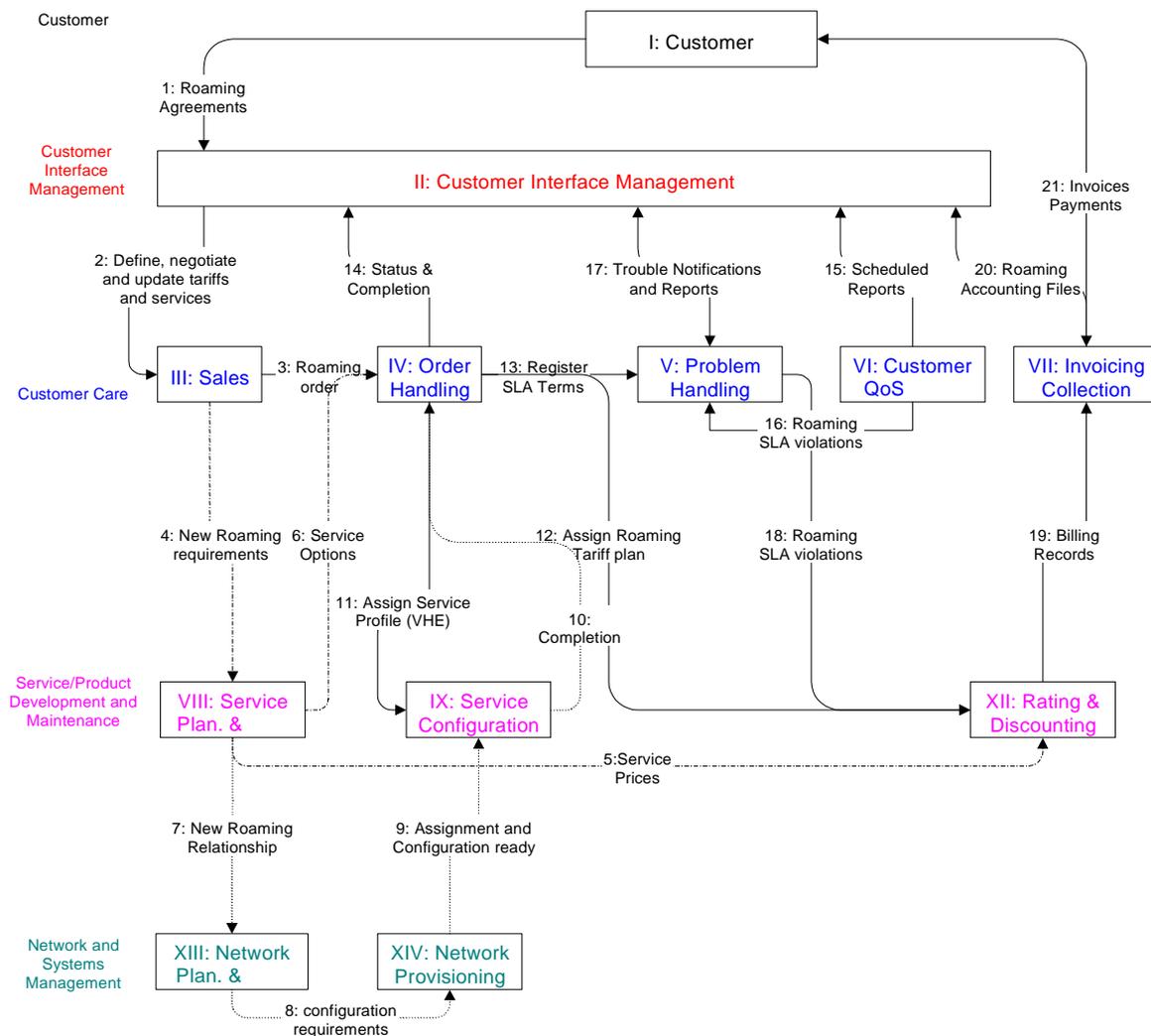


Figure 8: Information flow to support Roaming Management

8.4 Fraud Management

Fraud and all the activities to detect and prevent fraud are quite common for most of the networks. Nonetheless it should be mentioned that two mobile network specific services: mobility and roaming make fraud detection and fraud prevention even more complicated: The mobile service provider does not know where is the "end of the wire" leading to the home of a fraudulent customer. In case of roaming the situation is even worse. The fraudulent customer uses the network facilities of another – the serving - service provider, which means that it is to a large extent out of control of the home service provider.

Typically fraud management in mobile networks (i.e. fraud detection and prevention) covers at least the following functions:

- classification of customers according to levels of fraud risk (based on demographic and credit information);
- revision of the fraud risk level (based on usage information, payment behaviour,... near real time or off-line);
- detection of fraud patterns (in real time or near real time);
- taking the appropriate actions to suspend service provision, even if the customer is using a different network than its home (the customer is roaming);
- for visiting customers (i.e. those who are roaming) it may consult the home provider and/or international repositories (e.g. the Central Equipment Identity Register – CEIR for GSM mobile equipment).

Fraud management is present in several processes of the Telecom Operations Map. Figure 9 below shows the occurrence of fraud detection and fraud prevention functions listed above to the existing processes of the Telecom Operations Map.

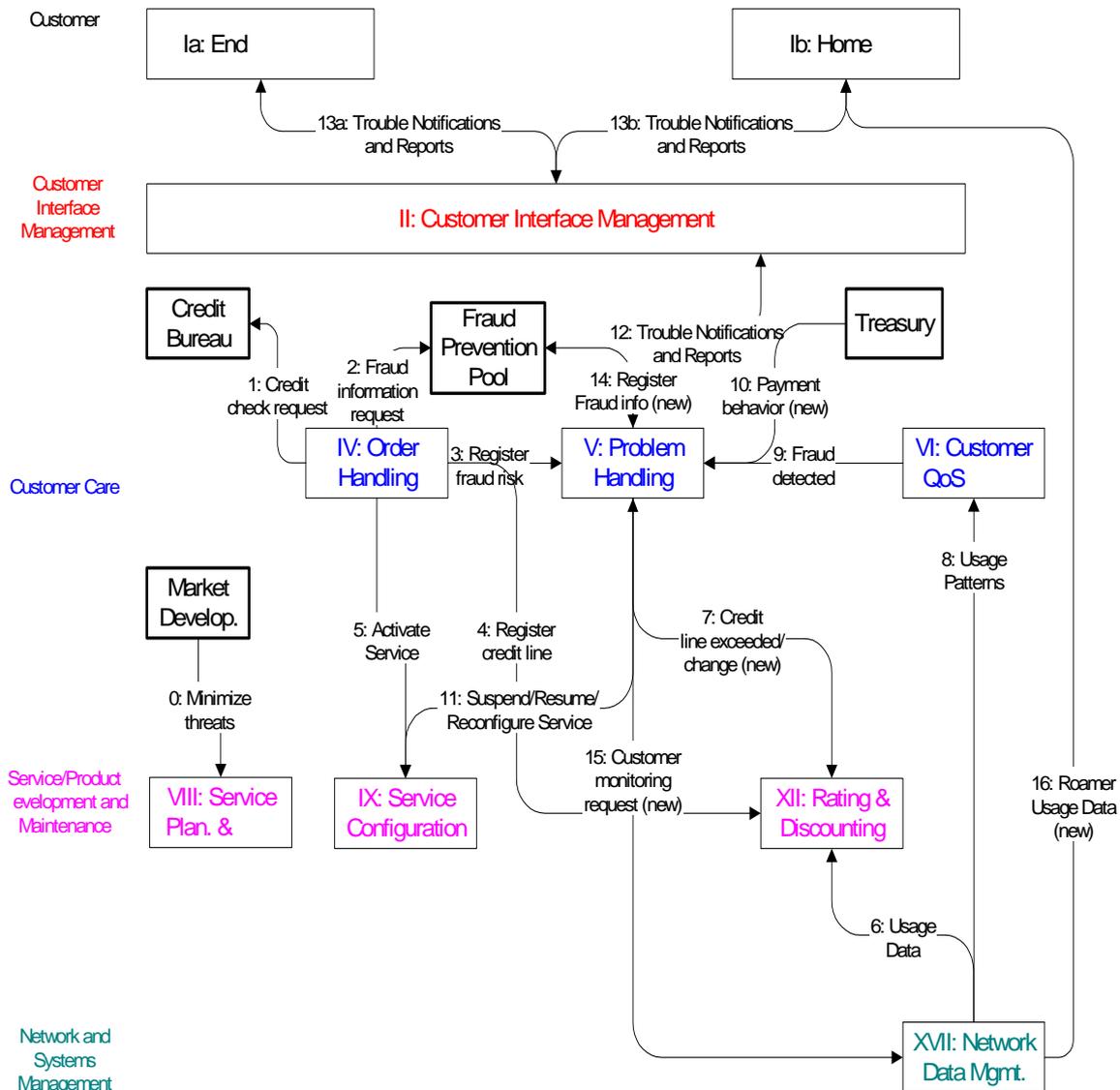


Figure 9: Information flow to support Fraud Management

Fraud management functions are present in many processes of the Telecom Operations Map. What makes fraud management so difficult is the fact that it consists of many process flows segments instead of one or two continuous process flows. This is also the reason making the presentation of fraud management in the Telecom Operations Map so difficult.

Although it seems that all required functions to support fraud management exist in the Telecom Operations Map, fraud management requires the introduction of some new interfaces (marked accordingly in Figure 9) to be efficient.

- Pre service: prevent fraud
 - Potential threats and leaks should be analysed during Service Planning and Design and the service should be optimised to be as resistant to threats as possible.
- Fulfilment: prevent fraud
 - Order Handling initiates the classification of customers according to levels of fraud risk. This includes a credit check request; and
 - A retrieval of fraud information from a fraud prevention pool (if available).

- The determined initial fraud risk level will be registered at Problem Handling.
- A credit line depending on the customer's fraud risk level will be registered at Rating & Discounting.
- Finally the ordered Service will be activated fully or partly depending on the fraud risk level.
- Assurance 1: detect fraud
 - Normal usage data (preferably hot billing usage data) is transferred to Rating and Discounting.
 - Rating & Discounting checks billing records for exceeding established credit lines and reports this Problem Handling (new).
- Assurance 2: detect fraud
 - Usage data/patterns are sent to the Customer QoS Management for analysis.
 - If Customer QoS Management detects a fraud then it sends an according notification to Problem handling which can decide on appropriate actions to take in order to prevent or stop fraud.
- Assurance 3: detect fraud
 - Treasury informs Problem handling about the payment behaviour of customers.
- Assurance 4: stop fraud
 - Problem Handling can decide on appropriate actions to take in order to prevent or stop fraud by reconfiguring the service; and/or
 - Contacting via Customer Interface Management
 - The Customer (either the end-customer or the home service provider in case of a visiting customer).
- Assurance 5: prevent fraud
 - Problem handling may register fraud information in the Fraud Prevention Pool.
- Assurance 6: stop roaming fraud
 - Problem handling requests the monitoring of a visiting customer on a trouble notification request of its home service provider according to the roaming agreement.
 - Network Data Management delivers the usage data to the requesting home service provider.

8.5 Fault Management

Fault Management is accomplished by means of several Processes/Sub-processes like fault detection, fault localisation, fault reporting, fault correction, fault repair, etc... These Processes/Sub-processes are located over different management layers, however, most of them (like fault detection, fault correction, fault localisation and fault correction) are mainly located over the Network Element and Network Element Management layers, since this underlying network infrastructure has the 'self healing' capabilities.

It is possible, however, that some faults/problems affecting the telecom services are detected within the "Network and Systems Management" layer, by correlating the alarm/events (originated by different Network Elements) and correlating network data, through network data management.

Network data management logically collects and processes both performance and traffic data as well as usage data.

While the Fault Management triggered within the Network Element and NE Management layers is primarily reactive, the Fault Management triggered within the Network and Systems Management layer is primarily proactive. Meaning triggered by automation rather than triggered by the customer; and this is important for improving service quality, customer perception of service and for lowering costs.

Focusing on the Network and Systems Management layer, when a fault/problem is detected, no matter where and how, several processes are implicated, as described in Figure 10 below.

8.5.1 Telecom Operations Map (TOM)

Figure 10 below taken from the Telecom Operations Map [100] shows an example of how Fault Management data can be used to drive an operator’s service assurance process. Service assurance then becomes primarily proactive, i.e. triggered by automation rather than triggered by the customer. It is argued that this approach is key to improving service quality, customer perception of service and for lowering costs.

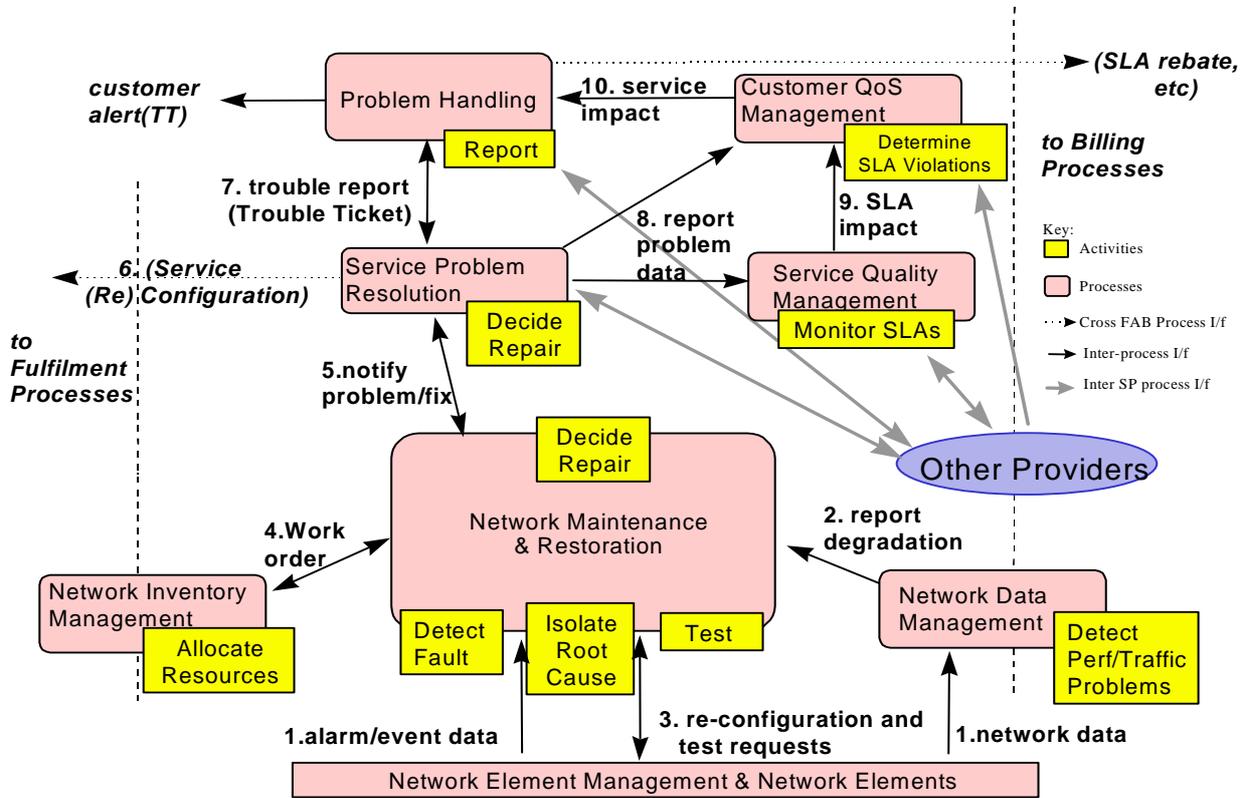


Figure 10: Service Assurance Process Flow (* imported from [100])

TOM assurance activities (and their associated interfaces) shown in Figure 10 above can be associated with ITU-T TMN service components from 3GPP TS 32.111-x "3G Fault Management" [3] according to Table 1 below:

Table 1:

ITU-T TMN Service Component 3GPP TS 32.111-x [3]	TOM Network Management Assurance Activities
Alarm Surveillance	Detect Fault
Fault Localisation	Isolate Root Cause
Fault Correction	Decide Repair / Allocate Resources
Testing	Test

The TOM assurance example shown in Figure 9 also recognises that Performance Management data can also be used to detect network problems.

The TOM assurance example also adds some detail to the Service Management Layer by showing how activities such as determining and monitoring Service Level Agreements (SLAs) and trouble ticket reporting are interfaced to the Network Management layer.

8.5.2 General Requirements, Service Components and Functions

Fault Management service components and functions are an area well documented by existing ITU-T, ETSI and other standards. The GSM Specification GSM 12.11 (Fault Management of the Base Station System) provides a

comprehensive explanation and specification of the relevant ITU-T TMN standards. This has been used as a basis for the 3GPP TS 32.111-x "3G Fault Management" [3].

3GPP TS 32.111-x [3] is based on the following service components:

- alarm surveillance;
- fault localisation;
- fault correction;
- testing.

Please refer to 3GPP TS 32.111-x [3] for complete details.

8.6 Security Management

This clause describes an architecture for security management of the TMN that is divided into two layers, as shown in Figure 11. No individual layer is dependent on any specific technology in the other one.

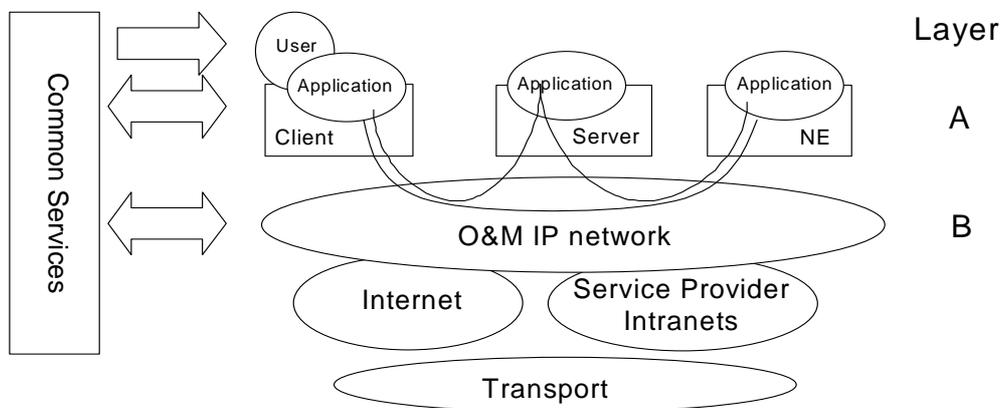


Figure 11: Security Management Architecture

8.6.1 Layer B - O&M IP Network

Some Service Providers might build their O&M IP network as a completely private, trusted network. In the normal case though, the O&M IP network should be regarded as partly insecure due to its size, complexity, limited physical security and possible remote access from dial-up connections or from the Internet. The only security service provided then is that the O&M IP network is logically separated from the Internet. IP infrastructure aspects on security are handled to the extent possible utilizing IP classic features (addressing schemes, DNS, DHCP, BOOTP, protection with firewalls etc.).

Additionally, a trusted IP-environment to the application level might be provided, e.g. an environment with no masquerading IP-hosts and where potential intruders cannot communicate. One way to accomplish such a secure DCN is to use IP security mechanisms (IPSec; see IETF RFC2401 [7]) to achieve authentication of IP hosts (servers, gateways, Network Elements) and optional encryption of O&M traffic. Note however that the secure DCN does not authenticate users.

8.6.2 Layer A - Application Layer

On this layer we find Telecom Management applications performing their tasks in the normal management functional areas. Managed objects residing in the network resources are often accessed or manipulated.

Layer A provides authentication of users ensuring that every party involved in O&M traffic is securely authenticated against every other party. The implementation of the authentication service supports "single log-on" (a user only has to

log-on once to get access to all O&M applications in the network) and "single point of administration" (an administrator only needs to maintain a user and his/her profile in one place).

Layer A also provides authorization (access control) - to verify if a user is authorized to perform a certain operation upon a specified target object at a given time. In addition, it addresses the use of signing and logging of events. Logging of events here means "logging of actions" (not necessarily logging of ALL actions) to be able to check "who did what". At least all "critical" actions (configurations etc.) shall be logged.

Interface definitions addressing authentication and authorization are needed. Also note that layer A requires confidentiality. Layer B may provide this service. If not, layer A instead has to provide it itself.

8.6.3 Common Services

In common services we find the security infrastructure components:

- Directory (for storage of user information, certificates, etc.);
- PKI (Certificate Authority, Registration Authority, Public Key Certificate, etc.).

Layer A relies on, and interacts with, the Common Services through distribution of certificates and keys, authentication of users, authorization, utilities for security administration (setting access rights), etc.

NOTE: Layer B does not necessarily interact with Common Services for security management purposes. The arrows in Figure 11 simply indicate the possible use of common services for Configuration Management.

8.7 Software Management

This subclause describes the software management process for 3rd Generation networks. Two main scenarios are considered:

- 1) Main Software Management Process: It covers requesting, acceptance, installation, monitoring, documenting, database updating and feedback to the vendor for managing software. The sub-processes are valid for complete software releases and software patches for fault correction of the network elements and even element managers.
- 2) Software Fault Management: Its emphasis is on network monitoring and handling faults, which are caused by software malfunctions.

8.7.1 Main Software Management Process

The main focus is the management of new software releases and correction patches. Importance is placed integrating new software into a network with out causing unnecessary service disruptions and maintaining high levels of quality for the network. The main steps in the software management process are:

- Delivery of software from the vendor.
- Delivery of the software to local storage in the network elements and/or element managers.
- Validation of the software to ensure that the Software is not corrupt.
- Activation of the software to an executable state.
- Validation of the software to ensure that it runs correctly.
- Acceptance or rejection of the software, depending on the outcome of the validation. (A rejection of the software implies a reversion to a previous software version).

Figure 12 shows an example of how these steps may be realized in terms of activities involving the processes defined in the Telecom Operations Map. However, alternative sequences may exist. For example, increased automation may cause step 3 to be omitted. Instead, a vendor certification activity could be run for a series of software releases or patches.

The following list is an explanation to the steps in Figure 12.

- 1) Based on inputs from customer care interactions and marketing research, a network operator will establish new feature requirements. These requirements are sent to the vendor in the form of a feature request.
- 2) The vendor delivers a new software release/correction with the corresponding documentation and installation procedure to the network operator. It should be noted that when a network operator utilises equipment from more than one vendor, this process runs as multiple parallel processes.
- 3) A service quality management department of the network operator receives and reviews the software. Upon approving the software for installation, the software is sent to the network-provisioning department.
- 4) Installation Task
 - a) The software is installed in the appropriate network elements and/or element managers by network provisioning.
 - b) Installation information is sent to the network maintenance and restoration department to inform them of pending changes in the network.
 - c) Installation information is sent to the customer care centre to inform them of pending changes in the network.
- 5) Installation Test and Validation
 - a) Once the software has been installed, network provisioning performs tests to check and ensure that the new software is working properly.
 - b) In addition to the checks that are performed by network provisioning, network maintenance and restoration could also detect malfunctions within and outside the updated Network Element (NE).
 - c) Should network maintenance and restoration detect a problem within the updated Network Element (NE), then network provisioning is informed to decide on further actions.
- 6) Successful Installation Result
 - a) Upon successful installation of the software, the service quality management department is informed.
 - b) A report is sent to network maintenance and restoration to inform them that the software will remain implemented in the network. At this point the documentation library and software database is updated.
 - c) The network data management department is informed over the changes in the network.
- 7) Negative Installation Result
 - a) If the installation fails, network provisioning performs a "fallback", i.e. remove the new software and insure that the Network Element (NE) is running properly on the old software.
 - b) A report containing the negative results and findings will be sent to service quality management and at the same time to network maintenance and restoration.
- 8) Once the installation procedure has been ended, the network maintenance and restoration department closely monitors the affected Network Element (NE) to ensure proper performance.
- 9) Service quality management will send feedback to the vendor as to the positive or negative results of the installation.

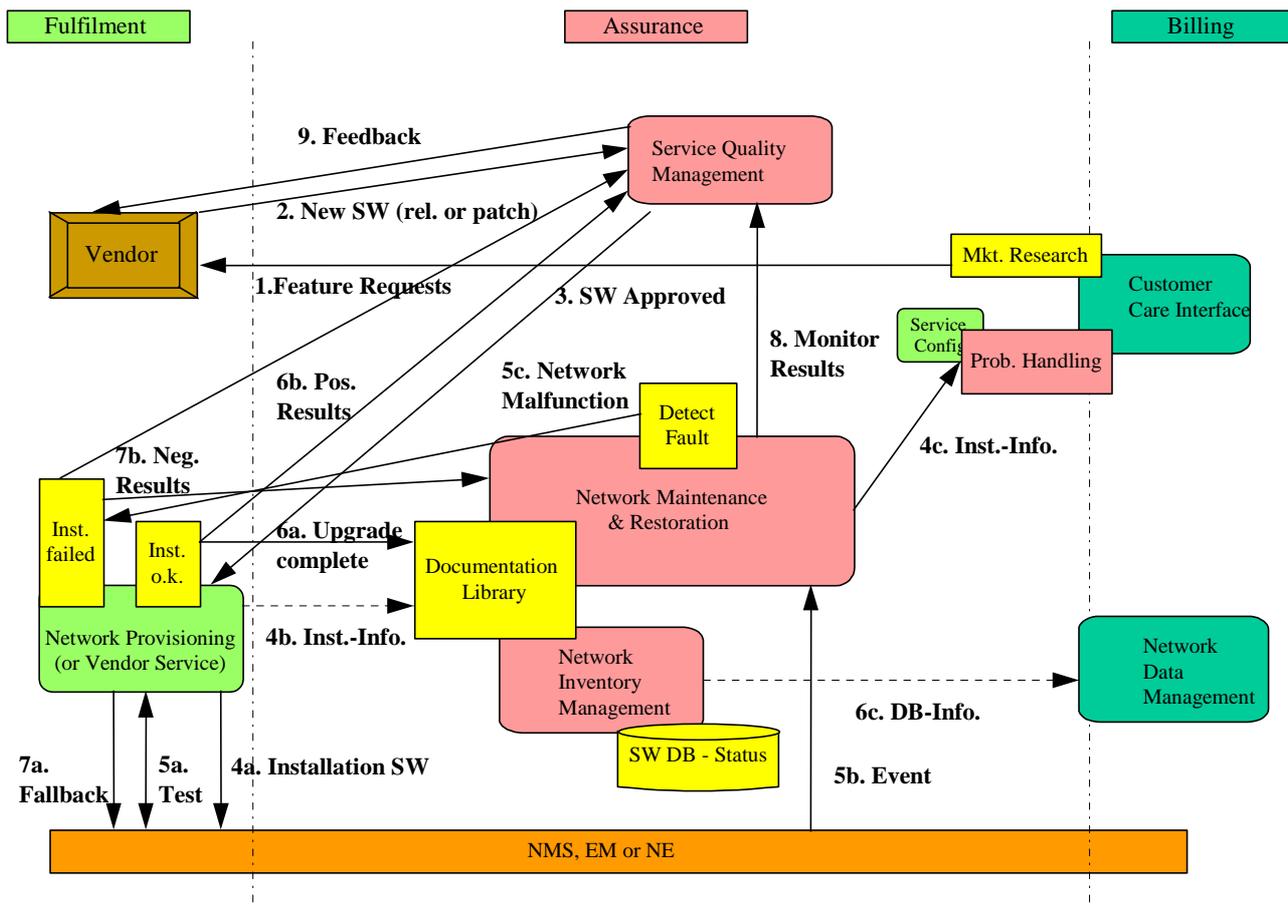


Figure 12: Main Software Management Process

8.7.2 Software Fault Management

Software Fault Management involves the following steps:

- Detection of Software malfunctions in the network.
- Problem resolution. The origin of the malfunction is determined and corrective action is decided. The corrective action can be one of the following:
 - Reversion to an earlier software version. This can imply both load and activation of the earlier software.
 - Load and activation of correction software, according to subclause 8.7.1.
 - Re-activation of current software.

Figure 13 shows an example of how these steps may be realized in terms of activities involving the processes defined in the Telecom Operations Map.

The following list is an explanation to the steps in Figure 13.

- 1) The network maintenance and restoration department detects an event or an alarm/fault from the Network Element (NE).
- 2) Problem solving and informing customer care
 - a) The alarm is forwarded to the service problem resolution department for corrective actions and it is determined that the problem is caused by a software defect.
 - b) In parallel the Customer Care Centre is informed, if the malfunction of the network may have impact on customers.

- 3) The service problem resolution department informs problem handling and subsequently the customer care centre over service impairments with in the network.
- 4) Problem handling reports to the service quality management department. The service disturbance is described within the report.
- 5) Service quality management checks the current software level of the affected network element with the network inventory management department.
- 6) If major network disturbances still appear the Service Quality management decides to fallback to a stable Software version (maybe some time after a new Software installation) and requests Network Provisioning.
- 7) a+b): Network Provisioning performs the fallback and informs Network Maintenance and Inventory.
- 8) Service quality management sends a request for a software correction to the vendor.
- 9) The vendor sends a new software release or correction to the network operator. The rest of the procedure can be followed in the main software management process.

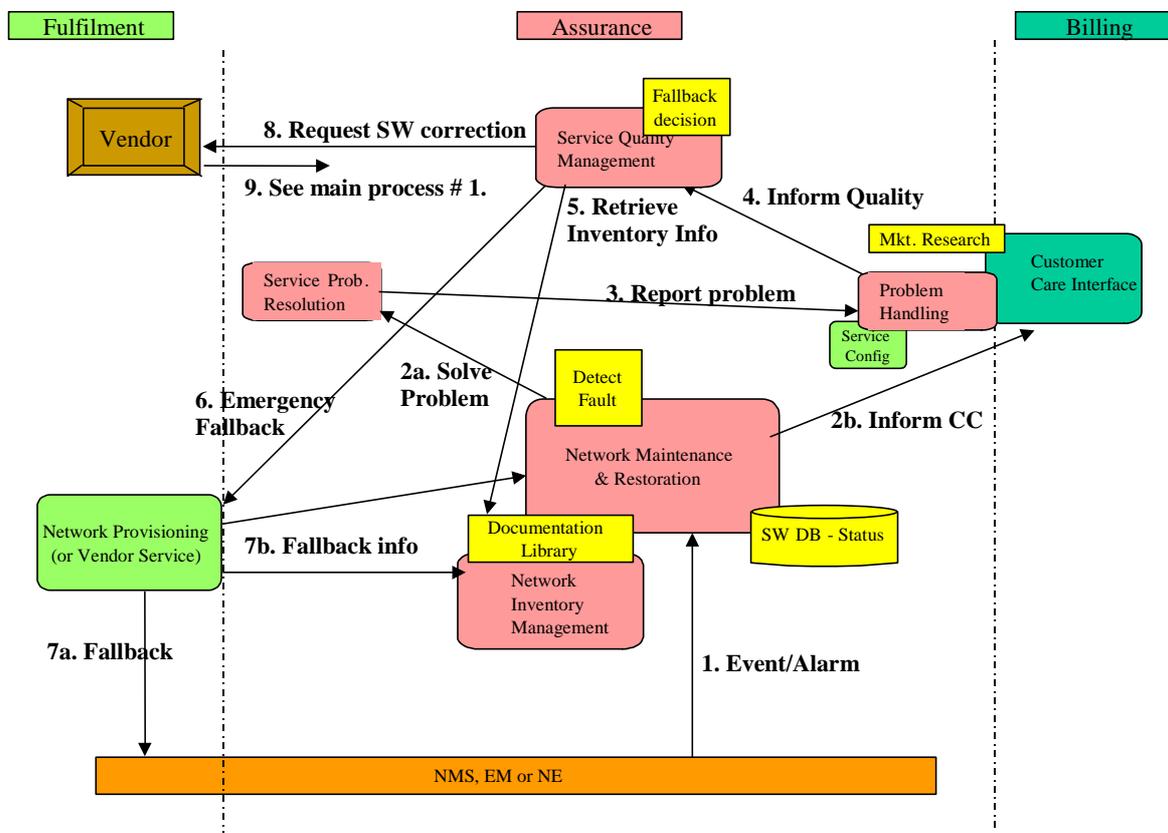


Figure 13: Software Fault Management

8.8 Configuration Management (including Equipment Inventory)

A variety of components will make up an operator’s actual implementation of a 3G network. Since it is an explicit goal of the standardisation effort within 3GPP to allow mix and match of equipment from different vendors, it is expected that many networks will indeed be composed of multiple vendors’ equipment. For an operator to be able to properly manage this diverse network, in order to provide the quality of service expected by his customers, it is essential to standardise the Configuration Management for 3G systems at least to an extent that the operation of the multi-vendor network will be possible effectively and efficiently. Therefore, a new work item is proposed for Configuration Management of 3G systems as described below. Within the scope of this work item, a distinction has to be made between those aspects of the Configuration Management targeting single Network Elements (NE management level) and those that are also, or exclusively, relevant for some part or the entire network (Network Management level).

8.9 Accounting Management

3GPP TS 32.105 "3G call event data" [50] is based on the requirements specified in 3GPP TS 22.115 " Service aspects; Charging and Billing" [51]. The main content of 3GPP TS 32.105 [50] is:

- Layout and formats of raw call and event data for the 3G switching nodes (circuit and packet switched);
- Data generation dependent on call states and 3GPP TS 22.115 [51] service requirements;
- Formal description of the call and event data records in ASN.1 and definition of a file transfer mechanism (FTP).

9 Methodology

9.1 Documentation

The methodology followed for the specification of UMTS Management is structured in the following levels and steps:

9.1.1 UMTS Management Overall Architecture, Functionality/Processes and Principles specification

The UMTS Management Overall Architecture, Functionality/Processes and Principles are specified in the present document.

9.2 Tools and Methods

The tool and method to be used for documenting Interface Specifications will be UML.

Annex A (normative): UMTS Management Application Layer Protocols

The valid Management Application Layer Protocols for UMTS are:

- CMIP (see references [20], [21]);

NOTE: Normative references relating to running CMIP over OSI application, presentation and session layers are [9] - [12] and [23] - [42].

- SNMP (see reference [6]);
- CORBA IIOP (see references [8] and [52]).

The valid Application Layer Protocols for Bulk Transfer are:

- FTAM (see references [13] – [19]);
- ftp (see reference [4]);
- tftp (see reference [5]).

Annex B (normative): UMTS Management Network Layer Protocols

The valid Network Layer Protocols for the Management of UMTS are:

- IP (see reference [48];
- X.25 (see reference [22]).

NOTE 1: IP is the recommended Networking Protocol.

NOTE 2: Normative references relating to ISO Transport over TCP-IP are [46] and [47] and ISO Transport over X.25 are [43] - [45].

Annex C (normative): UMTS Management IRP Solution Sets

The valid IRP Solution Sets for the Management of UMTS are:

- CMIP/GDMO;
- CORBA/IDL.

Annex D (informative): Change history

This annex lists all change requests approved for this document since the specification was first approved by 3GPP TSG-SA.

Change history					
TSG SA#	Version	CR	Tdoc SA	New Version	Subject/Comment
S_06	-	-	SP-99577	3.0.0	Approved at TSG SA #6 and placed under Change Control
S_07	3.0.0	001	SP-000014	3.1.0	Clarify use of X.25 as a Network Layer Protocol
S_07	3.0.0	002	SP-000014	3.1.0	Correction of IRP-related terminology
S_07	3.0.0	003	SP-000014	3.1.0	Clarification of Software Management
Mar 2000	3.1.0			3.1.1	Cosmetic
S_08	3.1.1	004	SP-000225	3.2.0	Add and Update Correct Normative Reference List
S_08	3.1.1	005	SP-000226	3.2.0	Terminology corrections
S_10	3.2.0	006	SP-000522	3.3.0	Update references to allow both CORBA Versions 2.1 and 2.3

History

Document history		
V3.0.0	January 2000	Publication
V3.1.1	March 2000	Publication
V3.2.0	July 2000	Publication
V3.3.0	December 2000	Publication