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*Technical Specification*

## **Universal Mobile Telecommunications System (UMTS); Telecommunication management; Architecture (3GPP TS 32.102 version 6.3.0 Release 6)**



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# 1 Scope

The present document identifies and standardises the most important and strategic contexts in the physical architecture for the management of PLMNs. It serves as a framework to help define a telecom management physical architecture for a planned PLMN and to adopt standards and provide products that are easy to integrate.

The requirements identified in the present document are applicable to all further development of 3GPP Telecom Management specifications as well as the development of PLMN Management products. The present document can be seen as guidance for the development of all other Technical Specification addressing the management of PLMNs, except TS 32.101 [2].

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# 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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] ITU-T Recommendation M.3010 (2000): "Principles for a Telecommunications management network".
- [2] 3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".
- [3] Void.
- [4] ITU-T Recommendation X.200 (1994): "Information technology - Open Systems Interconnection - Basic Reference Model: The basic model".
- [5] 3GPP TS 32.150: "Telecommunication management; Integration Reference Point (IRP) Concept and definitions".
- [6] Void.
- [7] Void.
- [8] Void.
- [9] TMF GB910: "Smart TMN Telecom Operations Map (Release 2.1)". <http://www.tmforum.org>
- [10] TMF GB909: "Smart TMN Technology Integration Map (Issue 1.1)". <http://www.tmforum.org>
- [11] ITU-T Recommendation M.3013 (2000): "Considerations for a telecommunications management network".
- [12] 3GPP TS 23.002: "Network architecture".
- [13] 3GPP TS 23.101: "General UMTS Architecture".
- [14] 3GPP TS 32.111 parts 1 to 4: "Telecommunication management; Fault Management;".
- [15] OMG: "Unified Modelling Language Specification, Version 1.4, September 2001". <http://www.omg.org/technology/documents/formal/uml.htm>

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## 3 Definitions and abbreviations

### 3.1 Definitions

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

**architecture:** organisational structure of a system or component, their relationships, and the principles and guidelines governing their design and evolution over time

**closed interfaces:** privately controlled system/subsystem boundary descriptions that are not disclosed to the public or are unique to a single supplier

**de facto standard:** standard that is widely accepted and used but that lacks formal approval by a recognised standards organisation

**information object:** defined in TS 32.101 [2].

**information service:** see IRP information service.

**interface standard:** standard that specifies the physical or functional interface characteristics of systems, subsystems, equipment, assemblies, components, items or parts to permit interchangeability, interconnection, interoperability, compatibility, or communications

**interoperability:** ability of two or more systems or components to exchange data and use information

**intra-operability:** ability to interchange and use information, functions and services among components within a system

**IRP:** defined in TS 32.101 [2].

**IRPAgent:** encapsulates a well-defined subset of network (element) functions. It interacts with IRPManagers using an IRP. From the IRPManager's perspective, the IRPAgent behaviour is only visible via the IRP.

**IRP information model:** defined in TS 32.101 [2].

**IRP information service:** defined in TS 32.101 [2].

**IRP solution set:** defined in TS 32.101 [2].

**IRPManager:** models a user of IRPAgent(s) and it interacts directly with the IRPAgent(s) using IRP(s). Since the IRPManager represents an IRPAgent user, it gives a clear picture of what the IRPAgent is supposed to do. From the IRPAgent perspective, the IRPManager behaviour is only visible via the IRP.

**managed object:** defined in TS 32.101 [2].

**management infrastructure:** Defined in TS 32.101 [2]. **market acceptance:** means that an item has been accepted in the market as evidenced by annual sales, length of time available for sale, and after-sale support capability.

**modular:** pertaining to the design concept in which interchangeable units are employed to create a functional end product.

**module:** interchangeable item that contains components. In computer programming, a program unit that is discrete and identifiable with respect to compiling, combining with other modules, and loading is called a module.

**Network Resource Model (NRM):** defined in TS 32.101 [2].

**open specifications:** public specifications that are maintained by an open, public consensus process to accommodate new technologies over time and that are consistent with international standards

**open standards:** widely accepted and supported standards set by recognised standards organisation or the commercial market place. These standards support interoperability, portability, and scalability and are equally available to the general public at no cost or with a moderate license fee.

**open systems strategy:** focuses on fielding superior telecom capability more quickly and more affordably by using multiple suppliers and commercially supported practices, products, specifications, and standards, which are selected based on performance, cost, industry acceptance, long term availability and supportability, and upgrade potential.

**physical architecture:** minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements whose purpose is to ensure that a conformant system satisfies a specified set of requirements. The physical architecture identifies the services, interfaces, standards, and their relationships. It provides the technical guidelines for implementation of systems upon which engineering specifications are based and common building blocks are built.

**PLMN Organisation:** see 3GPP TS 32.101 [2].

**plug&play:** term for easy integration of HW/SW

**portability:** the ease with which a system, component, data, or user can be transferred from one hardware or software environment to another

**proprietary specifications:** specifications, which are exclusively owned by a private individual or corporation under a trademark or patent, the use of which would require a license

**reference model:** a generally accepted abstract representation that allows users to focus on establishing definitions, building common understandings and identifying issues for resolution. For TMN Systems acquisitions, a reference model is necessary to establish a context for understanding how the disparate technologies and standards required to implement TMN relate to each other. A reference model provides a mechanism for identifying the key issues associated with applications portability, modularity, scalability and interoperability. Most importantly, Reference Models will aid in the evaluation and analysis of domain-specific architectures.

**scalability:** capability to adapt hardware or software to accommodate changing workloads

**service specific entities:** entities dedicated to the provisioning of a given (set of) service(s). The fact that they are implemented or not in a given PLMN should have limited impact on all the other entities of the PLMN.

**solution set:** see IRP solution set.

**specification:** document that prescribes, in a complete, precise, verifiable manner, the requirements, design, behaviour, or characteristics of a system or system component

**standard:** document that establishes uniform engineering and technical requirements for processes, procedures, practices, and methods. Standards may also establish requirements for selection, application, and design criteria of material.

**standards based architecture:** architecture based on an acceptable set of open standards governing the arrangement, interaction, and interdependence of the parts or elements that together may be used to form a TMN System, and whose purpose is to insure that a conformant system satisfies a specified set of requirements.

**support object:** defined in TS 32.101 [2].

**system :** any organised assembly of resources and procedures united and regulated by interaction or interdependence to accomplish a set of specific functions

**System Architecture (SA):** description, including graphics, of systems and interconnections providing for or supporting management functions. The SA defines the physical connection, location, and identification of the key nodes, circuits, networks, platforms, etc., and specifies system and component performance parameters. It is constructed to satisfy Operational Architecture requirements per standards defined in the Physical Architecture. The SA shows how multiple systems within a subject area link and inter-operate, and may describe the internal construction or operations of particular systems within the architecture.

## 3.2 Abbreviations

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

3G	3 <sup>rd</sup> Generation
AAA	Authentication, Authorisation and Accounting
AN	Access Network
AS	Application Server

ATM	Asynchronous Transfer Mode
AUC	Authentication Centre
BG	Border Gateway
BGCF	Breakout Gateway Control Function
BSC	Base Station Controller
BSS	Base Station Subsystem
BTS	Base Transceiver Station
CAMEL	Customised Applications for Mobile network Enhanced Logic
CBC	Cell Broadcast Center
CBS	Cell Broadcast Service
CIM	Common Information Model Specification (from DMTF)
CMIP	Common Management Information Protocol
CMIS	Common Management Information Service
CMISE	Common Management Information Service Element
CN	Core Network
CORBA	Common Object Request Broker Architecture
CS	Circuit Switched
CSCF	Call Session Control Function
DCN	Data Communication Network
DECT	Digital Enhanced Cordless Telecommunications
DSS1	Digital Subscriber System 1
EIR	Equipment Identity Register
EM	Element Manager
E-OS	Element Management Layer-Operations System
F/W	Firewall
FM	Fault Management
FTAM	File Transfer, Access and Management
GCR	Group Call Register
GDMO	Guidelines for the Definition of Managed Objects
GGSN	Gateway GPRS Support Node
GMLC	Gateway Mobile Location Center
GMSC	Gateway MSC
GPRS	General Packet Radio Service
GTT	Global Text Telephony
HLR	Home Location Register
HSS	Home Subscriber Server
HTTP	HyperText Transfer Protocol
HW	Hardware
I-CSCF	Interrogating CSCF
IDL	Interface Definition Language
IOP	Internet Inter-ORB Protocol
IM	Information Model
IM-MGW	IP Multimedia Media Gateway
IMS	IP Multimedia Subsystem
INAP	Intelligent Network Application Part
IP	Internet Protocol
IRP	Integration Reference Point
IS	Information Service
ISDN	Integrated Services Digital Network
IWU	Inter Working Unit
LCS	Location Services
LMU	Location Measurement Unit
MD	Mediation Device
ME	Mobile Equipment
MGCF	Media Gateway Control Function
MIB	Management Information Base
MMI	Man-Machine Interface
MML	Man-Machine Language
MMS	Multimedia Messaging Service
MNP	Mobile Number Portability
MNP-SRF	Mobile Number Portability/Signalling Relay Function
MRF	Multimedia Resource Function

MRFC	Multimedia Resource Function Controller
MRFP	Multimedia Resource Function Processor
MSC	Mobile service Switching Centre
MT	Mobile Termination
NE	Network Element
NM	Network Manager
N-OS	Network Management Layer-Operations System
NPDB	Number Portability Database
NR	Network Resource
NRM	Network Resource Model
NSS	Network Switching Subsystem
NW	Network
OMG	Object Management Group
OS	Operations System
OSA	Open Services Access
OSF	Operations System Functions
P-CSCF	Proxy CSCF
PDH	Plesiochronous Digital Hierarchy
PS	Packet Switched
PSA	Product Specific Applications
PSS	Packet Switched Service
PSTN	Public Switched Telephone Network
QA	Q-Adapter
QoS	Quality of Service
RNC	Radio Network Controller
RNS	Radio Network System
RSVP	Resource ReserVation Protocol
S-CSCF	Serving CSCF
SDH	Synchronous Digital Hierarchy
SGSN	Serving GPRS Support Node
SGW	Signalling Gateway
SIM	Subscriber Identity Module
SLA	Service Level Agreement
SLF	Subscription Locator Function
SMI	Structure of Management Information
SMLC	Serving Mobile Location Center
SMS	Short Message Service
SNM	Sub-Network Manager
SNMP	Simple Network Management Protocol
SS	Solution Set
SS7	Signalling System No. 7
SW	Software
TA	Terminal Adapter
TE	Terminal Equipment
TM	Telecom Management
TMN	Telecommunications Management Network as defined in ITU-T Recommendation M.3010 [1]
UE	User Equipment
UML	Unified Modelling Language
USAT	USIM/SIM Application Toolkit
USIM	UMTS Subscriber Identity Module
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
VHE	Virtual Home Environment
VLR	Visitor Location Register
WAG	WLAN Access Gateway
WBEM	Web Based Enterprise Management
WS	WorkStation

---

## 4 General

### 4.1 PLMN Telecom Management

#### 4.1.1 3GPP Reference Model

A 3GPP System 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, point-to-multipoint etc) and physical means (radio, fibre, copper, etc.).

The 3GPP system components have signalling mechanisms among them (DSS1, INAP, MAP, SS7, RSVP, etc.).

From the service perspective, the 3GPP system 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.

#### 4.1.2 3GPP Provisioning Entities

Two major entities, which cover the set of 3GPP functionalities involved in the provision of the 3GPP services to the user, are identified as follows:

- **Home Environment:** This entity holds the functionalities that enable a user to obtain 3GPP 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.

#### 4.1.3 Management Infrastructure of the PLMN

Every PLMN Organisation has its own Management Infrastructure. Each Management Infrastructure will contain different functionality depending on the role-played and the equipment used by that Entity.

However, the core management architecture of the PLMN Organisation is very similar. Every PLMN 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 PLMN Organisation will implement the complete Management Architecture and related Processes. Some processes may be missing dependent on the role a particular Organisation is embodying. Processes not implemented by a particular Organisation are accessed via interconnections to other organisations, which have implemented these processes (called X-interfaces in the TMN architecture).

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

## 4.2 TMN

TMN (Telecommunications Management Network), as defined in [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 TMN interfaces.

The PLMN Management Architecture is largely based on TMN, and will reuse those functions, methods and interfaces already defined (or being defined) that are suitable for the management needs of a PLMN. However, the new challenges of 3G Telecom Management may require the exploration and incorporation of other concepts (other management paradigms widely accepted and deployed).

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## 5 General view of PLMN Management Physical architectures

Telecom Management Architectures can vary greatly in scope and detail. The architecture for a large service provider, with a lot of existing legacy systems and applications, upon which many services are based, will be of high complexity. In contrast, the architectural needs of a start-up mobile operator providing its services to a small group of value-added Service Providers will be much less and will probably focus on more short-term needs.

A mobile network operator has to manage many different types of networks as radio networks, exchanges, transmission networks, area networks, intelligent nodes and substantial amounts of computer hardware/software. This wide variety of network equipment will most probably be obtained from a variety of equipment vendors. The nature of a mobile radio network will be heterogeneous and will present a number of operational difficulties for the service provider on enabling effective and efficient network management.

The standardisation work for the management of a PLMN has adopted the top-down approach and will from business needs identify functional and informational architectures. The physical architecture will have to meet these requirements and as there are many ways to build a PLMN it will vary greatly from one TMN solution to another. There will be many physical implementations, as different entities will take different roles in a PLMN.

It is obvious that it will not be meaningful or even possible to fully standardise a common Telecom Management physical architecture for PLMNs. The present document will identify and standardise the most important and strategic contexts and serve as a framework to help define a physical architecture for a planned PLMN.

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## 6 Basic objectives for PLMN Management Physical Architecture

The management of a 3G system will put a lot of new requirements to the management systems compared to the second generation of Mobile telephony. Some of the challenging requirements affecting the physical architecture are:

- To be capable of managing equipment supplied by different vendors.
- To enable TM automation in a more cost efficient way - TM optimised for maximum efficiency and effectiveness.
- To provide PLMN configuration capabilities that are flexible enough to allow rapid deployment of services.
- To report events and reactions in a common way in order to allow remote control.

- To allow interoperability between Network Operators/Service Providers for the exchange of management/charging information.
- To be scalable and applicable to both larger and small deployments.
- Accessibility to information.
- To profit from advances and standards in IT and datacom industry.

The second generation of mobile networks can - from a management point of view - be characterised as the era of vendor-dependent NE managers. The different OSs had very low interoperability with other systems and functional blocks could rarely be re-used. The Mobile Telecom Management Networks were far away from the TMN vision where one vendor's OS should be able to manage other vendors' network elements.

PLMN Organisations need cost-effective management solutions and better time to market focus. Interoperability, scalability and re-use are keywords for the new generation of management systems.

Many of the new requirements on the management of PLMNs can only be solved by defining and establish a suitable physical architecture. Thou it is not possible to standardise the one single TM physical architecture, it is evidently so that the success of a Telecom Management Network of a PLMN Organisation will heavily depend on critical physical architectural issues. The present document will identify those architectural critical issues.

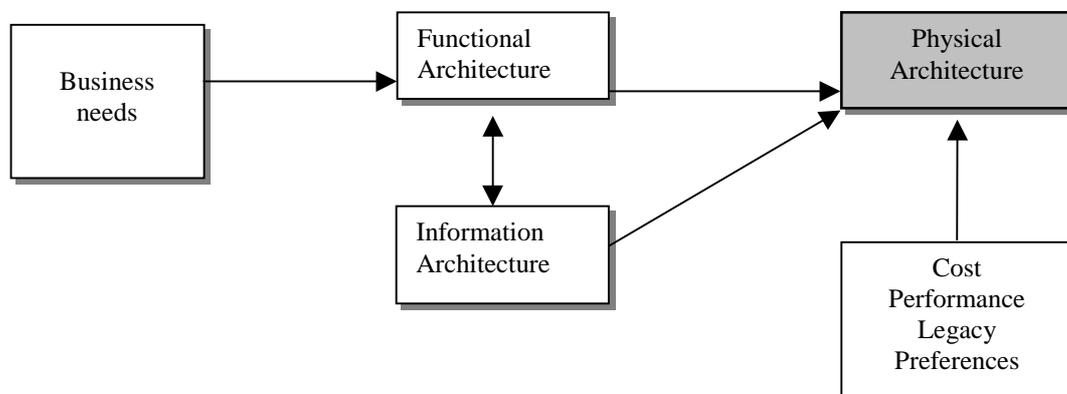
## 7 TM Architectural aspects

### 7.1 Architectural relationship

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

- The functional architecture.
- The information architecture.
- The physical architecture.

The management requirements - from the business needs - will be the base for the functional architecture, which will 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. Other constraints from realty will also have impact to the physical architecture as cost, performance, legacy systems and all preferences any operator will have on a big capital investment as a TM network.



**Figure 7.1: Architectural relationship**

## 7.2 Architectural constraints

Large software systems, such as a network management system, are a capital investment that operators cannot afford to scrap every time its requirements change. Network operators are seeking cost-effective solutions to their short-term needs. All these reality-related issues are vital constraints that should be addressed in the definition of the architecture.

The standardisation of 3G systems will bring new and different services that will add new demands on network management. Every PLMN organisation will include different functionality depending on the role-played and the equipment used by that entity. Regulation may force some of the roles that shall be taken. The need to link systems across corporate boundaries will be a consequence of this.

The rapid evolution of new services and technologies will also put requirements on the PLMN physical management architecture to accommodate market and technology trends. To future-proof investments and continuously be able to take advantage of new technologies are important constraints to the physical architecture.

A PLMN TMN should also adopt an architecture that will achieve scalability and extensibility of systems and networks so the TMN can grow as the services expand over time. To start with a small TMN and easily be able to expand the TMN after new requirements will be important issues for most PLMN operators.

The Telecom Management Network will be just one part of the overall business of a company. System management, general security issues and development strategies can be the target for company policies. System architectures and technology choices, as well as the availability of off-the-shelf commercial systems and software components that fulfil the requirements established in the present document, may be critical to an operator's implementation of the specified management architecture.

## 7.3 Interoperability

### 7.3.1 Introduction

The new requirement on a 3G system TMN will imply a focus change from network element management towards management of information "information management". Network providers make use of different information in several different ways which also may vary from network to network and from time to time. Basic information as alarms is of course essential information for localising faults but may also be the key information to be able to set up a service with a service level agreement.

Numerous of different interfaces can be identified in a PLMN network in the areas of network element management, network management and service management. The most important and complex of these interfaces will be standardised but many interfaces of less importance are unlikely to be fully standardised and will be up to the individual operator and vendor to develop. To adopt mainstream computing technologies, re-use widely used protocols, standards and an open system architecture will be essential to secure interworking between all physical entities in a PLMN.

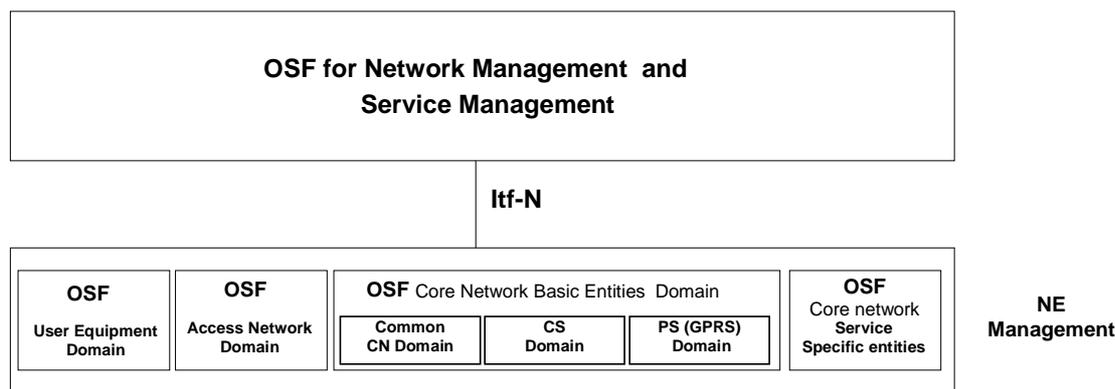
Low-cost and general access to management systems information will be needed. Obviously this is the critical issue and challenging task in the heterogeneous, distributed and complex network of a PLMN.

### 7.3.2 Interfaces

A PLMN will consist of many different types of components based on different types of technologies. There will be access-, core-, transmission- and service node networks and many of the components have already been the targets for Telecom Management standardisation at different levels. Many of these standards will be reused and the management domain of a PLMN will thereby consist of many TMNs. The architecture of PLMN TMNs should support distributed TMNs and TMN-interworking on peer-to-peer basis.

The Telecom Management Architecture can vary greatly in scope and detail, because of scale of operation and that different organisations may take different roles in a PLMN (see clause 5). The architecture of PLMN TMNs should provide a high degree of flexibility to meet the various topological conditions as the physical distribution and the number of NEs. Flexibility is also required to allow high degree of centralisation of personnel and the administrative practices as well as allowing dispersion to administrative domains (see further clause 10). The 3G Telecom Management architecture should be such that the NEs will operate in the same way, independently of the OS architecture.

Figure 7.2 illustrates the basic domains in a 3GPP system (identified in 3GPP Technical Standards [12], [13]), related management functional areas and introduces Interface-N (Itf-N).



**Figure 7.2: Overview of 3GPP Telecom Management Domains and Itf-N**

Itf-N between the NE OSFs and NM/SM OSFs could be used by the network- and service management systems to transfer management messages, notifications and service management requests via the NE OSF to the Network Elements (NEs).

This interface shall be open and the information models standardised.

Telecom management interfaces may be considered from two perspectives:

- 1) the management information model;
- 2) the management information exchange.

The management information models will be standardised in other 3GPP documents but the management information exchange will be further described in this architectural standard.

The management task will vary greatly between different network elements in a PLMN. Some NEs are of high complexity e.g. a RNC, while others e.g. a border gateway is of less complexity. Different application protocols can be chosen to best suite the management requirements of the different Network Elements and the technology used.

Application protocols can be categorised out of many capabilities as:

- Functionality;
- Implementation complexity;
- Processor requirements;
- Cost efficiency;
- Market acceptance, availability of "off the shelf commercial systems and software".

For each Telecom Management interface that will be standardised by 3GPP at least one of the accepted protocols will be recommended. Accepted application protocols (e.g. CMIP, SNMP, CORBA IIOP) are defined in TS 32.101 [2], annex A.

### 7.3.3 Entities of a 3GPP system

To provide the mobile service as defined in a 3GPP system, some specific functions are introduced [12]. These functional entities can be implemented in different physical equipments or gathered. In any case, exchanges of data occur between these entities and from the Telecom Management perspective they can all normally be treated as network elements. The basic telecom management functional areas such as fault management, configuration management, performance management and security management are all applicable to these entities. As such they are all the targets for 3GPP Telecom Management technical standards.

As discussed in clause 5, there will be many possible ways to build a 3GPP system and thereby many possible architectures of a mobile system. The entities presented in figure 7.3 should be treated as the fundamental building blocks of any possible implementation of a 3GPP system.

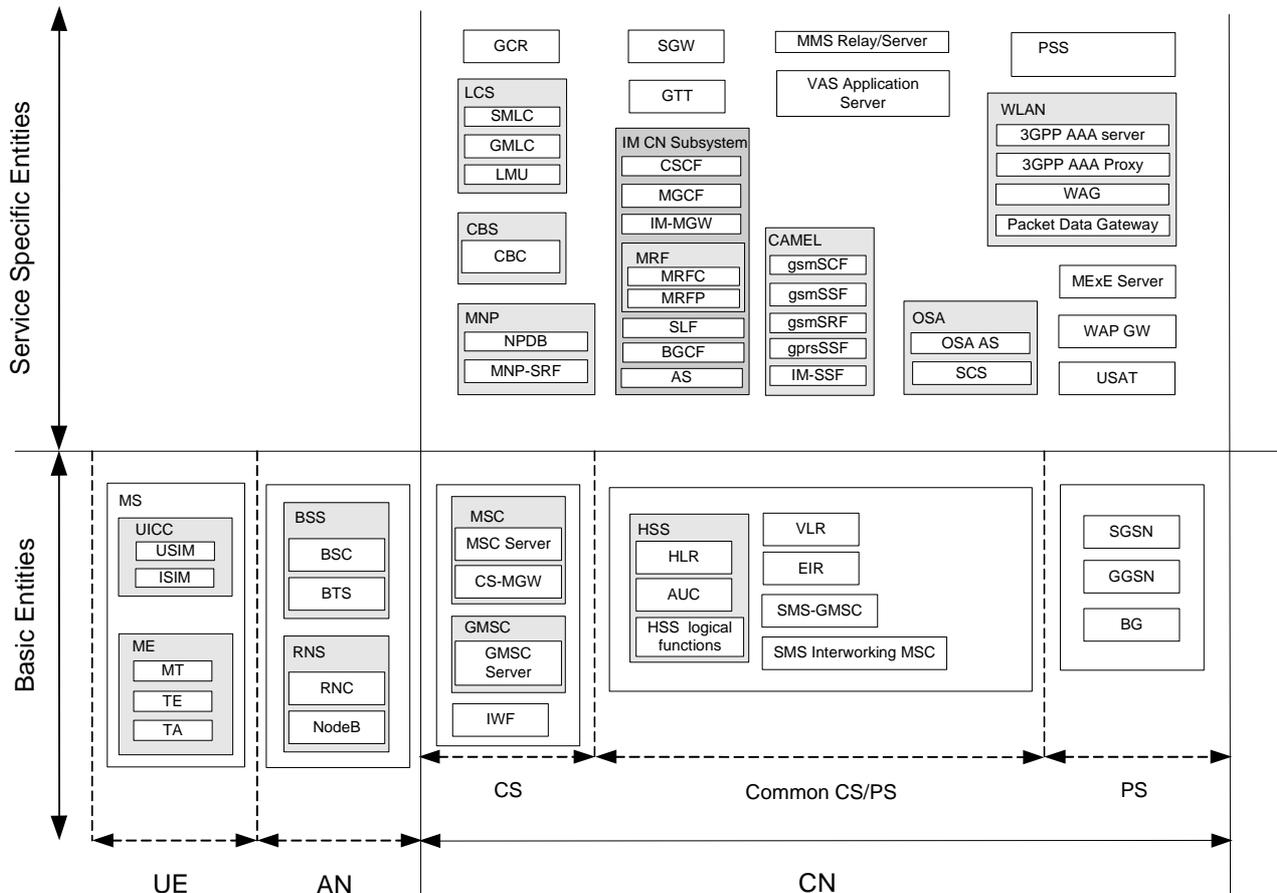
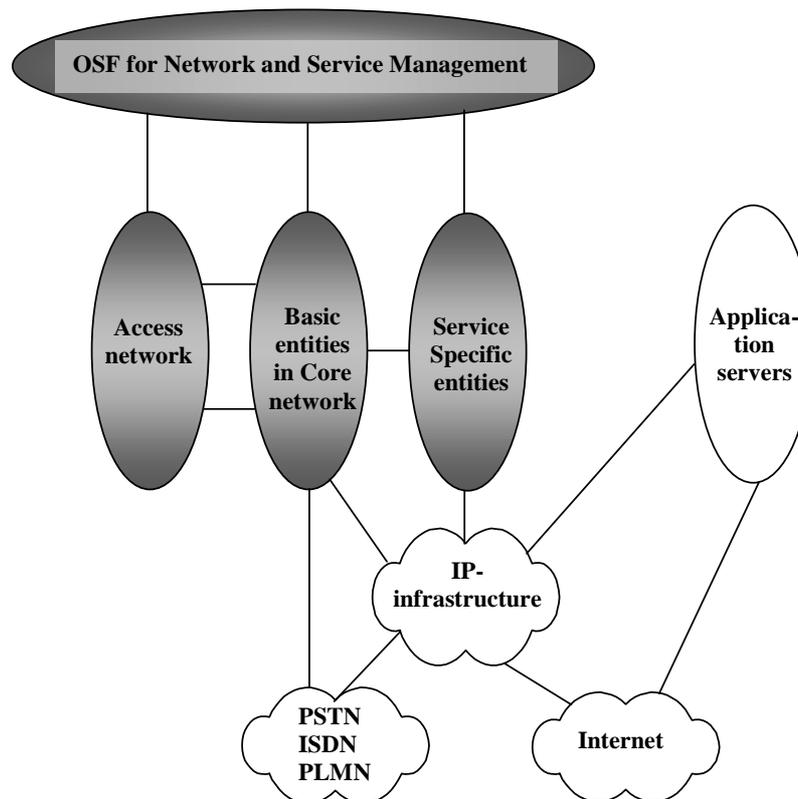


Figure 7.3: Examples of entities of the mobile system to be managed

In figure 7.4 the prime domains for the standardisation effort of 3GPP Telecom Management are shown as shaded.



**Figure 7.4: High level 3GPP system Network architecture**

### 7.3.4 Open systems approach

Even in the second generation of mobile radio networks the operators has to cope with heterogeneous environments in many different ways. No single vendor is likely to deliver all the management systems needed for a mobile operator.

The many different types of network elements, some with very high management complexity as an exchange and some less complex as a repeater system, are generally supported with unique vendor specific management systems with very low interoperability. Duplicated TMN applications is another obvious reality of this generation of management systems. This will be further discussed under clause 9 (TMN Applications).

The 3G requirements call for open systems that can be supported by the marketplace, rather than being supported by a single (or limited) set of suppliers, due to the unique aspects of the design chosen. Open systems architectures are achieved by having the design focus on commonly used and widely supported interface standards. This should ensure costs and quality that are controlled by the forces of competition in the marketplace.

The open systems approach is a technical and business strategy to:

- Choose commercially supported specifications and standards for selected system interfaces.
- Build systems based on modular hardware and software design.

Selection of commercial specifications and standards in the Open systems approach should be based on:

- Those adopted by industry consensus based standards bodies or de facto standards (those successful in the market place).
- Market research that evaluates the short and long term availability of products.

- Trade-offs of performance.
- Supportability and upgrade potential within defined cost constraint.
- Allowance for continued access to technological innovation supported by many customers and a broad industrial base.

### 7.3.5 Level of openness

The level the interfaces conform to open standards is critical for the overall behaviour. A low level of openness will severely impact on long-term supportability, interoperability, development lead-time, and lifecycle cost and overall performance.

Interfaces are expensive parts in a TMN and interfaces with low level of openness severely impact on development lead-time for the introduction of any system, application component or service. Easy implementation (plug & play) is a requirement for TMN physical entities and requires a high the level of openness.

### 7.3.6 Closed interfaces

Many second-generation mobile network physical management entities have vendor controlled system/subsystem boundary descriptions that are not disclosed to the public or are unique to this single supplier - closed interfaces.

Such interfaces will not fulfil the basic requirements of a 3G TMN. Closed interfaces can only be used as internal interfaces where no information what so ever has to be shared to other physical management entities.

## 7.4 Data communication networks

Within a TMN, the necessary physical connection (e.g. circuit-switched or packet-switched) may be offered by communication paths constructed with all kinds of network components, e.g. dedicated lines, packet-switched data network, ISDN, common channel signalling network, public-switched telephone network, local area networks, terminal controllers, etc. In the extreme case the communication path provides for full connectivity, i.e. each attached system can be physically connected to all others.

The TMN should be designed such that it has the capability to interface with several types of communications paths, to ensure that a framework is provided which is flexible enough to allow the most efficient communications:

- between NE and other elements within the TMN;
- between WS and other elements within the TMN;
- between elements within the TMN;
- between TMNs;
- between TMNs and enterprise.

In this case the term efficiency relates to the cost, reliability and maintainability of the data transported.

Two aspects impact costs. The first is the actual cost to transport data across the network between the TMN and the NE. The second aspect is the design of the interface including the selection of the appropriate communications protocol.

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 3GPP management interface, is a valid Networking Protocol for that interface.

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

- Capability to run over all supported bearers (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.

## 7.5 New technologies

Meeting application requirements in the most affordable manner together with development lead-time are important issues identified in early 3GPP management standardisation work. But the TMN functional, information and physical architectures should also keep pace with the introduction of new technologies, services and evolving network infrastructures. Technology is advancing so rapidly today that this should be a fundamental part of the physical architecture - to be able to easily adopt new important technologies.

A 3GPP system will need to incorporate new successful technologies from the IT-world. Today distributed computing implementations have matured to a point where the goals of TMN can be realised using commonly available technologies for a reasonable cost.

Widely accepted open standards and new IT-technologies will be indispensable to fulfil the challenging managing requirements of a 3GPP system.

New technologies in the IT business such as generic application components together with distributed processing technology are new important drivers upon application design of management systems. The possibility to purchase functional components from the open market are of great importance from many aspects such as cost-efficiency and time-to-market.

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# 8 3GPP Management Physical architectures

A 3GPP Telecom Management Network will consist of many different management layers and many different building blocks. The complexity will vary greatly in detail because every organisation has different needs. The following clause will identify the most critical architectural issues and compliance conditions for a given 3GPP Management Interface. It should serve as fundamental requirements for any 3GPP entity (network element or management system) being a part of a 3GPP TMN.

## 8.1 Compliance Conditions

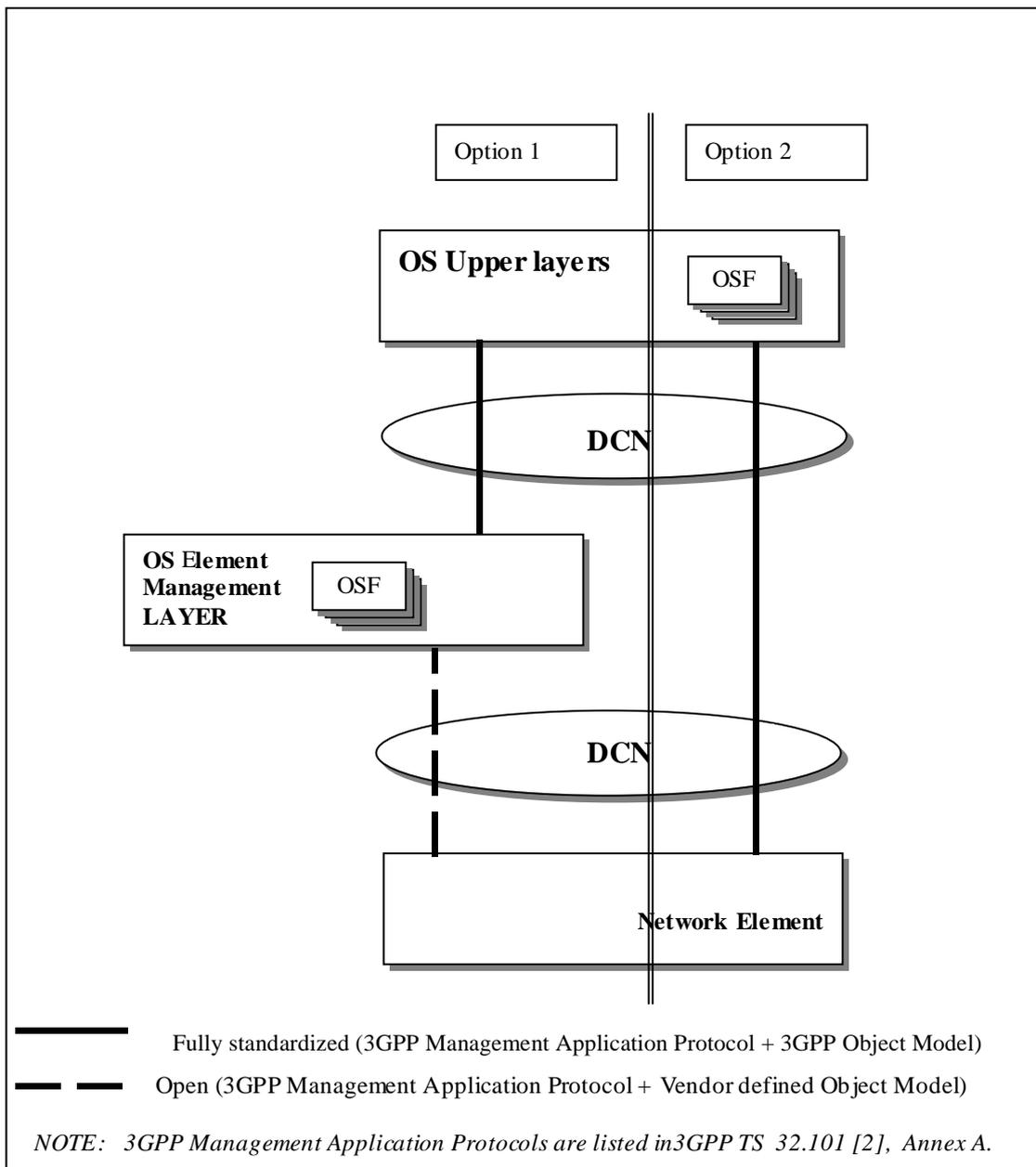
For a 3GPP entity (Management System or NE) to be compliant to a given Management Interface, all the following conditions shall be satisfied:

- 1) It implements the management functionality following the Information Model and flows specified by the relevant 3GPP Management Interface Specifications applicable to that interface.
- 2) It provides at least one of the IRP Solution Sets (were available) related to the valid Application Protocols specified by 3GPP Application Protocols for that interface, [2] annex C.
- 3) It provides at least one standard networking protocol.
- 4) 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 NE and/or Management System.
- 5) Support for Bulk Transfer Application Protocols specified by the relevant 3GPP Management Interface Specifications applicable to that interface.

## 8.2 Network Element (NE) management architecture

Figure 8.1 shows two possible options for management interface from the OS upper layers to NE. Option 1, provides access to the NE via element manager, and Option 2, provides a direct access. It is sufficient to provide one or the other.

Figure 8.1 does not imply and limit the realisation of any OS physical block (e.g. E-OS, N-OS) to just one logical layer. OS physical blocks may span more than one logical layer (ITU-T Recommendation M.3010 [1]). Different types of network elements, different functional areas, operator and vendor preferences etc will put different constraints on the physical realisation of the OSFs. See further clause 9.



**Figure 8.1: Network Element Management Architecture**

For a 3GPP entity (Network Element or management system) to be compliant to a given Management Interface the following conditions shall all be satisfied:

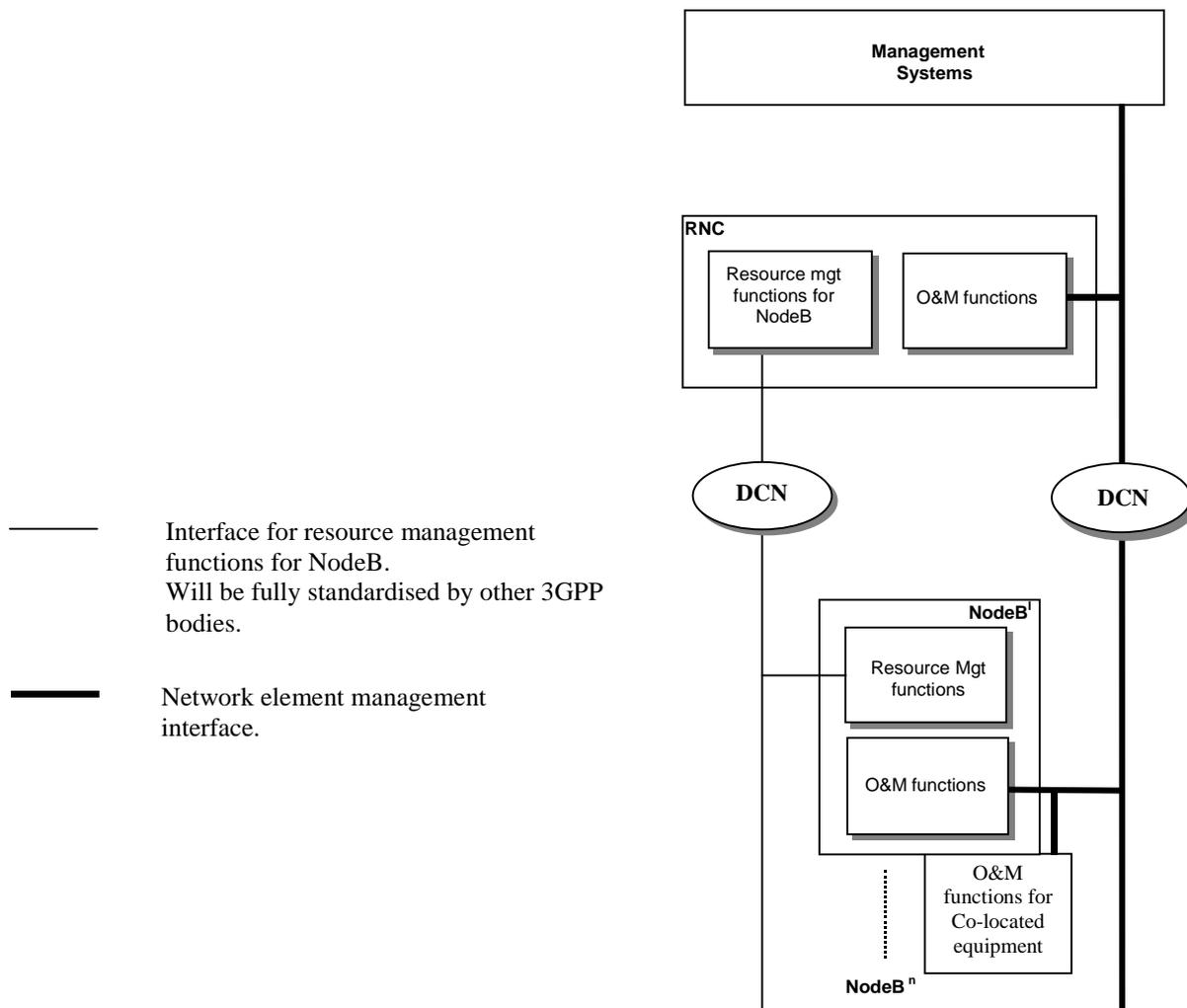
Item	Compliance conditions
1	Implements relevant 3GPP IRP Information Services and Network Resource Models For an interface illustrated by the dashed line in figure 4 the object model is not standardised but it shall be open
2	Application protocol (e.g. CMIP,SNMP,CORBA IIOP) (Defined in TS 32.101 [2], annex A) If 3GPP has specified one or more IRP Solution Sets corresponding to the IRP Information Models in item 1 then at least one of those IRP Solution Sets shall be supported.  (Defined in TS 32.101 [2], annex C)
3	Valid Network Layer Protocol (see annex B of TS 32.101 [2])
4	Lower protocol levels required by Item 1, 2 and 3

## 8.3 Subnetwork Management Architecture

(Example 3GPP RNC / NodeB)

An important special case of the network element management architecture is where one type of network element such as the RNC will need management information for co-ordination of a subnetwork of other types of network elements such as NodeB.

This management information shared between the RNC and NodeB will not reach the operators and is not considered to be a part of the 3GPP TMN. All other management information related to NodeB will transparently be transferred by the RNC towards the 3GPP TMN.



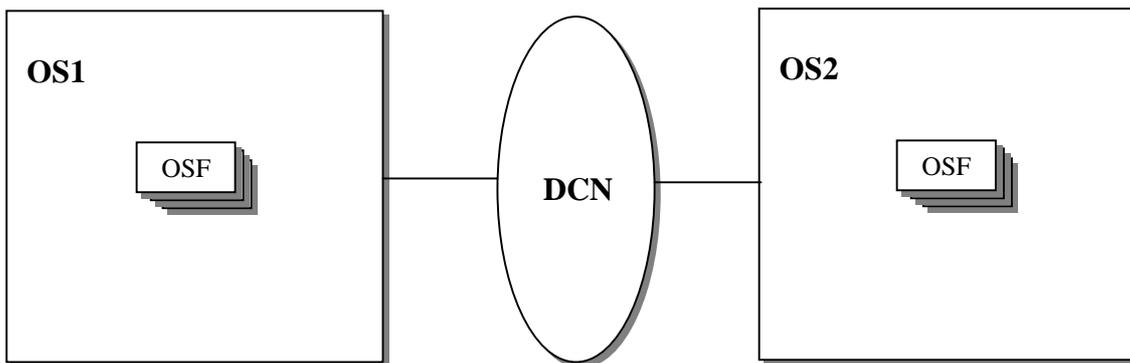
**Figure 8.2: Subnetwork Management Architecture**

The same compliance conditions apply for the subnetwork management architecture as for the network element management architecture (see clause 8.2).

## 8.4 Operations Systems interoperability architecture

Interoperability between operations systems is an important issue in a 3GPP system. Different organisations may take different roles in a 3GPP system. The need to share information across corporate boundaries will be a consequence of this.

The heterogeneous, distributed and complex network of a 3GPP system will be a market for many different vendors. All operations systems have to interoperate and shall be able to share information. This is a critical issue in the management of third generation systems.

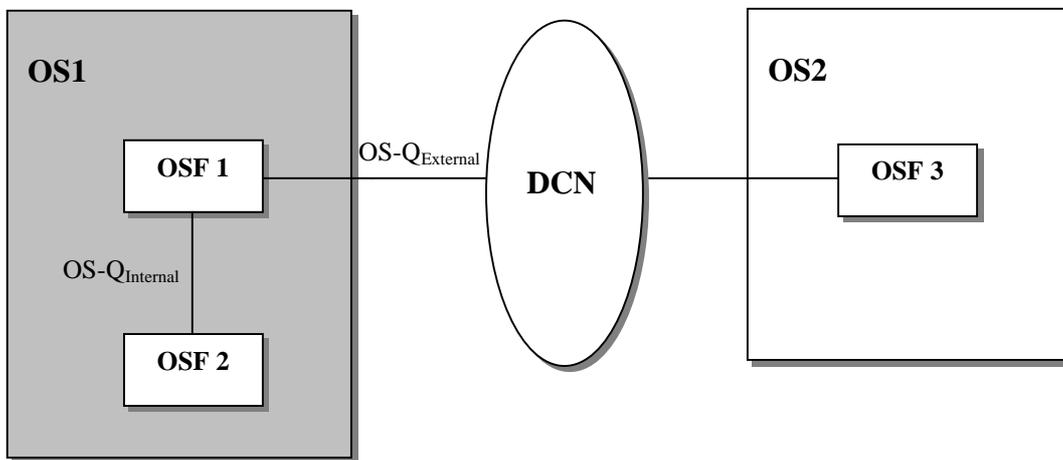


**Figure 8.3: Operations Systems interoperability Architecture**

For a Operations System to be 3GPP TMN compliant the following conditions shall all be satisfied:

Item	Compliance conditions
1	Implements relevant 3GPP IRP Information Services and Network Resource Models
2	Application protocol (e.g. CMIP,SNMP,CORBA IIOP) (Defined in TS 32.101 [2], annex A) If 3GPP has specified one or more IRP Solution Sets corresponding to the IRP Information Models in item 1 then at least one of those IRP Solution Sets shall be supported. (Defined in [2], annex C)
3	Valid Network Layer Protocol (see annex B of TS 32.101 [2])
4	Lower protocol levels required by Item 1,2 and 3

### 8.5 Operations Systems intra-operability architecture



**Figure 8.4: Operations Systems intra-operability Architecture**

OS-Q<sub>Internal</sub> indicates an internal flow and is not standardised.

OS-Q<sub>External</sub> indicates an external flow and shall to be compliant to a given 3GPP Management Interface satisfy the following conditions:

Item	Compliance conditions
1	Implements relevant 3GPP IRP Information Services and Network Resource Models
2	Application protocol (e.g. CMIP,SNMP,CORBA IIOP) (Defined in TS 32.101 [2], annex A) If 3GPP has specified one or more IRP Solution Sets corresponding to the IRP Information Models in item 1 then at least one of those IRP Solution Sets shall be supported. (Defined in TS 32.101 [2], annex C)
3	Valid Network Layer Protocol (see annex B of TS 32.101 [2])
4	Lower protocol levels required by Item 1,2 and 3

## 8.6 Business System interconnection architecture

The business management layer has in the second-generation systems a very low degree of standardisation. Operators have legacy systems or more IT influenced systems often adopted to every organisations different needs. Business systems are not a part of a 3GPP TMN.

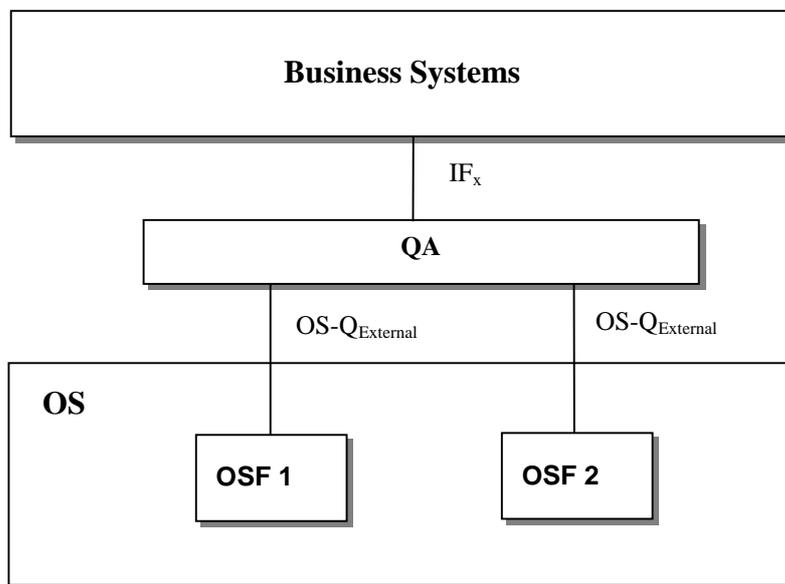


Figure 8.5: Business Systems interconnection architecture

OS-Q<sub>External</sub> indicates an external flow and shall to be compliant to a given 3GPP Management Interface satisfy the following conditions:

Item	Compliance conditions
1	Implements relevant 3GPP IRP Information Services and Network Resource Models
2	Application protocol (e.g. CMIP,SNMP,CORBA IIOP) (Defined in TS 32.101[2], annex A) If 3GPP has specified one or more IRP Solution Sets corresponding to the IRP Information Models in item 1 then at least one of those IRP Solution Sets shall be supported. (Defined in TS 32.101 [2], annex C)
3	Valid Network Layer Protocol (see annex B of TS 32.101 [2])
4	Lower protocol levels required by Item 1,2 and 3

IF<sub>x</sub> indicates an external flow and shall to be compliant to a given 3GPP Management Interface satisfy the following condition:

Item	Compliance conditions
1	Not standardised but open

## 9 TMN applications

Telecom management applications can be implemented in many different ways depending on constraints presented in previous clauses of the present document. Consistent operational processes are required for the management of the network irrespective of vendor equipment. A mobile operator can because of the very heterogeneous nature of their networks easily end up with dozens of duplicated applications for e.g. alarm surveillance. Most vendors of network equipment offer dedicated net-element managers and the ones not built with an open system approach will severely limit the possibility to report and manage the network in a consistent way.

Network element vendors with closed and unique network element managers or operations systems with closed interfaces or interfaces with low level of openness will not fulfil the basic requirements as a part of a 3G system. It will not be possible to design and build the Telecom Management Network to support the operational processes as required. Such physical entities are not under consideration in the present document.

Many TM application functions can be identified as generic functions used by all major types of telecom equipment. Alarm surveillance applications and performance analysing applications are generic necessities to manage most network elements. Security and system management applications are also common to many TM components and may be the scope for overall business policies.

To identify and specify the design criteria that will allow re-usable application components to be developed across multiple telecom business scenarios are important issues to fulfil the basic 3G Management requirement. "To minimise the costs of managing a PLMN such that it is a small component of the overall operating cost".

The implication of the top down approach in the standardising work of 3G is that consistent operational management processes are required irrespective of vendor equipment.

Generic management applications are required to facilitate:

- Reduced management application development costs.
- Simplification of operational processes and associated reduction in costs.
- Reduced time to deploy new services as management systems already exist.
- Consistent representation of basic information.

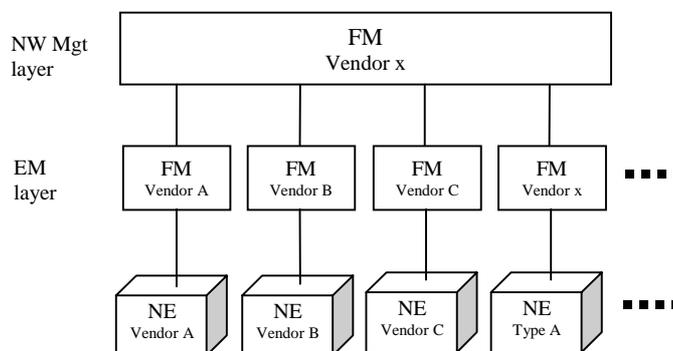
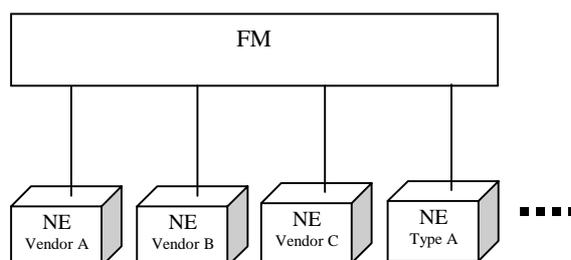


Figure 9.1: Unique NE Fault Management

Figure 9.1 represents a very common situation in the management of second generation of mobile networks. Different vendors supplied their network elements with unique net-element managers. The interfaces were mostly proprietary or unique. The information models for generic information such as alarms were rarely standardised. All together the consequence for the operators became very complex. Similar information at many levels, repeated acknowledge of alarms, inconsistent representation of similar information are a few of all the difficulties the operators had to cope with.

Some of the more severe implication of this situation is the difficulty to add more intelligence into the applications to better support the processes of the network providers. The operators who tried to brake up this situation had to put in a lot of effort into software development and proprietary interfaces. The marketplace did not support the needs of the operators.



**Figure 9.2: Generic Fault Management**

Figure 9.2 indicates the situation where the Telecom Management process alarm surveillance is supported by a generic application for Fault Management. A common information model and accessibility to all related information will make it possible to add more intelligence to the management systems and to better support the management task.

TMN application functions such as billing information collection or configuration management of a specialised network element are examples of application that can be identified as unique applications. Even these applications will need to interoperate with other applications and will also need the open system approach to be a part of a 3G TMN. With a network with many different types of network elements a common graphical user interface such as a web browser for configuration management applications could be an important issue to create consistent operational processes.

The complexity and heterogeneous nature of a 3G system calls for easy integration (plug&play) of HW/SW.

## 10 Integration Reference Points (IRPs)

### 10.1 General

Relating to the OSI functional areas "FCAPS", IRPs are here introduced addressing parts of "FCPS" – Fault, Configuration, Performance, and Security management. Comparing with TMF TOM (Telecom Operations Map) [9], the introduced IRPs address process interfaces at the EML-NML (Element Management Layer – Network Management Layer) boundary. In the 3GPP context, this is applied to the Itf-N between EM-NM and NE-NM.

The three cornerstones of the IRP concept are:

- **Top-down, process-driven modelling approach**  
The purpose of each IRP is automation of one specific task, related to TMF TOM. This allows taking a "one step at a time" approach with a focus on the most important tasks.
- **Technology-independent modelling**  
To create from the requirements an interface technology independent model. This is specified in the IRP Information Service.
- **Standards-based technology-dependent modelling**  
To create one or more interface technology dependent models from the technology independent model. This is specified in the IRP Solution Set(s).

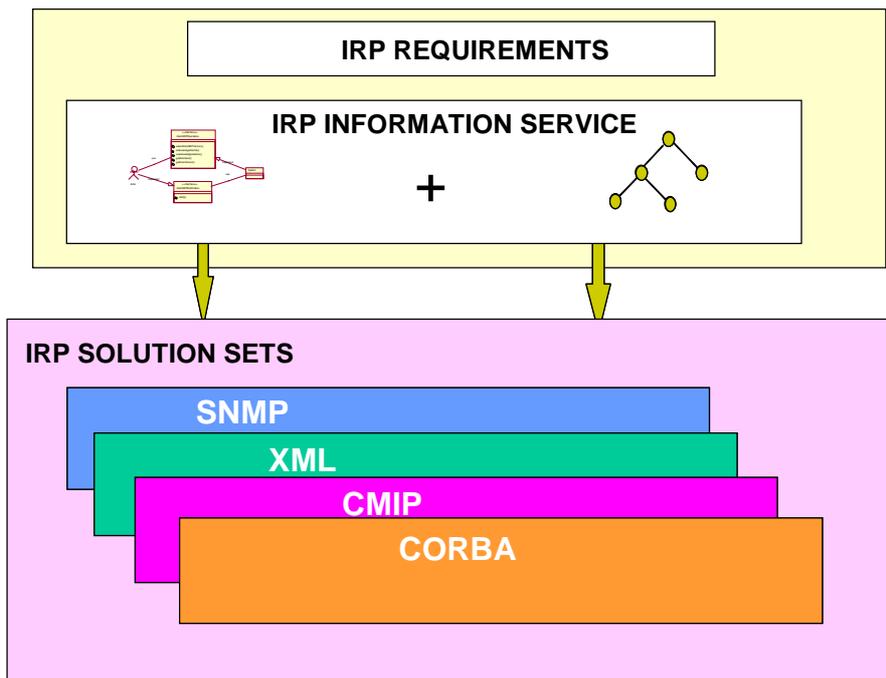


Figure 10.1: IRP components (with example solution sets)

### 10.1.1 IRP Specifications Approach

As highlighted in the previous subclause, IRP interfaces are specified using a 3-level approach: Requirements, IS-level specifications and SS-level.

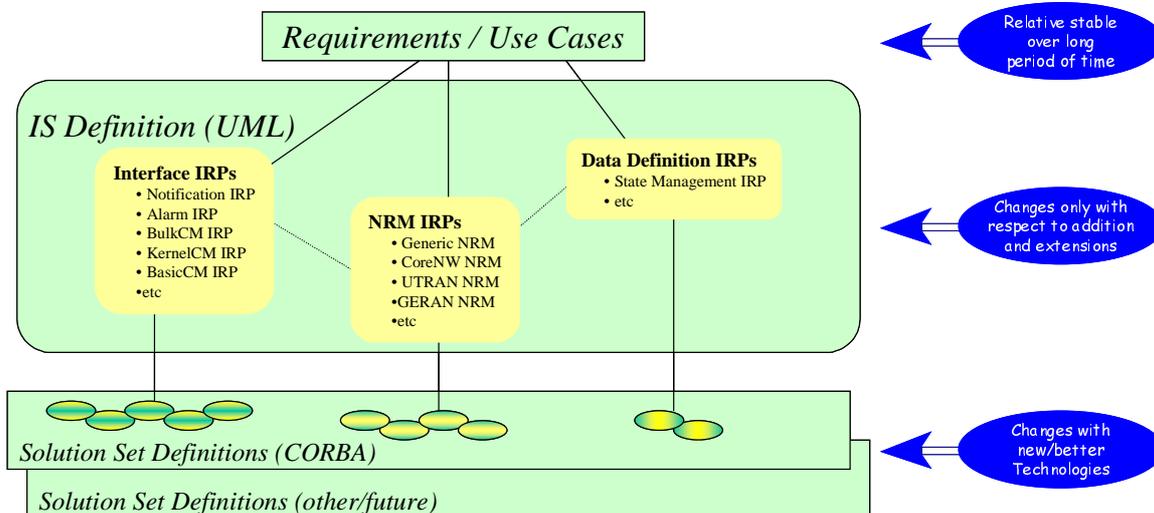


Figure 10.2: IRP Specifications Approach

The "Requirements-level" intends to provide conceptual and use cases definitions for a specific management interface aspect as well as defining subsequent requirements for this IRP.

The "IS-level" provides the technology independent specification of an IRP. From an IS-level perspective there are three types of IRP IS specifications:

- Interface IRPs - providing the definitions for IRP operations and notifications in a network agnostic manner.
- NRM IRPs - providing the definitions for the Network Resources to be managed through the Itf-N (commonly named "Network Resources IRPs").

- Data Definition IRPs - providing data definitions applicable to specific management aspects to be managed via reusing available Interface IRPs and being applied to NRM IRPs as applicable.

The "SS-level" finally provides the mapping of IS definitions into one or more technology-specific Solution Sets. This concept provides support for multiple interface technologies as applicable on a vendor and/or network type basis and also enables accommodation of future interface technologies – without the need to redefine requirements and IS-level definitions.

## 10.2 Integration levels

Virtually all types of telecom/datacom networks comprise many different technologies purchased from several different vendors. This implies that the corresponding management solution need to be built by integrating product-specific applications from different vendors with a number of generic applications that each provide some aspect of multi-vendor and/or multi-technology support. A complete management solution is thus composed of several independent applications.

The following levels of integration are defined:

- **Screen Integration:** Each application provides its own specific Graphical User Interface (GUI) that need to be accessible from a single, unified screen (a common desktop). A seamless integration between the various GUIs is then required. Screen Integration is not specified in the present document.
- **Application Integration:** Applications need to interwork, on a machine-machine basis, in order to automate various end-to-end processes of a communication provider.

### 10.2.1 Application integration

Interfaces related to application integration can be divided in the following three categories:

- **High-level generic interfaces** between generic applications on the network and service management layers. The same approach and concepts apply for these as the next category:
- **High-level (technology-independent to the extent possible) interfaces** between product-specific and generic applications are needed in order to automate and streamline frequently occurring tasks applicable to several types of network elements. A top-down approach shall be taken when defining these interfaces, where the main input is (1) business processes of a communication provider, and (2) the types of generic applications that are used to implement the process support. The interfaces need to be stable, open and (preferably) standardised. These IRPs are discussed below under the heading Network Infrastructure IRPs.
- **Detailed (product-specific) interfaces** between product-specific applications and the corresponding network elements are of course also needed. These interfaces are defined using the traditional bottom-up approach, where the actual network infrastructure is modelled. This is the traditional TMN approach to element management. The management information in these interfaces is not further discussed in the present document, as it is internal to a specific development organisation and does not need to be open. In fact, by publishing the management information in these interfaces, too much of the internal design may be revealed and it may become impossible to later enhance the systems that are using the interfaces. The management services (operations and notifications) and protocol shall however be open and standardised as long as they are independent of the NRM describing the managed NEs/NRs.

## 10.3 Network infrastructure IRPs

When providing integrated management solutions for multi-vendor networks, there is a strong requirement that the NEs and the management solutions that go together with them are systems integratable.

It should be noted that these IRPs could be provided by either the NE, or the Element Manager (EM) or Sub-Network Manager (SNM) that goes together with the type of NE. There is actually not a clear distinction any more between NE and element management applications, mainly due to the increased processing capacity of the equipment platforms. Embedded Element Managers providing a web user interface is a common example of that.

These IRPs are introduced to ensure interoperability between Product-Specific Applications (PSA) and the Network & System Management Processes of the Network Manager (ref [2] & [9]) shown in the figure 10.3. These IRPs are considered to cover the most basic needs of task automation.

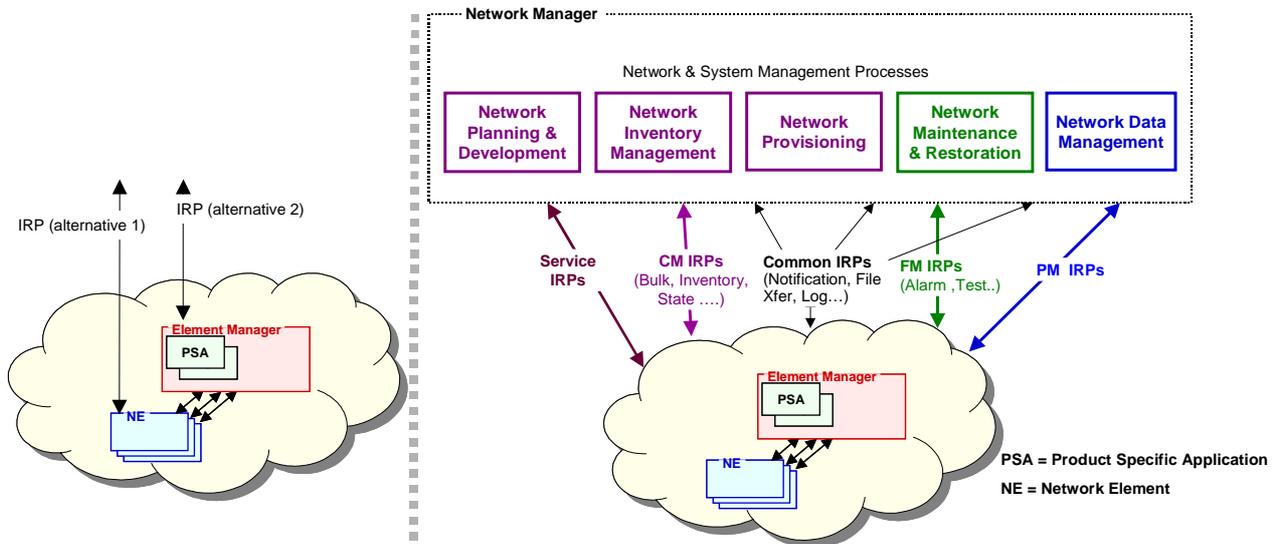


Figure 10.3: IRPs for application integration

The IRPs presented in figure 10.3 are just an example and do not reflect the exact set of IRPs defined by the 3GPP.

Taking one of the Common IRPs as an example, the Network & System Management Processes have similar need to receive notifications from various PSAs. The corresponding service is formalised as a *Notification IRP*. It specifies: firstly, an interface through which subscriptions to different types of notifications can be set up (or cancelled), and secondly, common attributes for all notifications.

Further, applying a common *Name Convention for Managed Objects* is useful for co-operating applications that require identical interpretation of names assigned to network resources under management.

Further detail on the definition of IRPs can be found in 3GPP TS 32.150 [5].

## 11 Implementation aspects

PLMN operators might categories and organise its operation systems in many different ways as:

- A national fault and performance OS.
- A national charging, billing and accounting OS.
- Regional configuration OS.
- Regional fault, performance and configuration OS.
- etc.

This geographical dependent categorisation may change after time and the growth of the network. A physical architecture based on an open system design and re-usable application components would ease the work to adopt such structural changes. A management system build for a PLMN shall provide the possibility of layering the applications.

## 12 3GPP TMN Conformance

The goal of TMN conformance (see ITU-T Recommendation M.3010 [1]) is to increase the probability that different implementations within a TMN will be able to interwork, that TMNs in different service/network provider's administrations and customer's system will be able to interwork as much as agreed on.

TMN conformance are testable conditions.

It is only the requirements on the external behaviour that have to be met by the conformance statements.

To finally guarantee interoperability the purchaser/user shall be able to test and verify that any two systems, claiming any type of TMN conformance, interoperate. Interoperability testing shall include:

- Testing of the interface protocols;
- The shared/exposed information over those interfaces;
- The interface functionality of the system.

A 3GPP TMN conformant entity shall support necessary information to support such interoperability testing namely:

- Statements made by the supplier of an implementation or system claimed to conform to a given specification, stating which capabilities and options have been implemented.
- Detailed information to help determine which capabilities are testable and which are un-testable.
- Information needed in order to be able to run the appropriate test.
- The system interface documentation shall list the documents that define the specified information models with the inclusion of the version number and date.
- Necessary information about vendor supplied extensions of a standardised interface

The interface specification shall be documented, publicly available and licensable at reasonable price on a non-discriminatory basis.

Specific conformance guidelines shall be included in the different IRP solution sets. A 3GPP TMN conformant entity **must** support information stated in those conformance guidelines.

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## 13 TMN planning and design considerations

A TMN should be designed such that it has the capability to interface with several types of communications paths to ensure that a framework is provided which is flexible enough to allow for the most efficient communications:

- Between one NE and other elements within the TMN;
- Between a WS and other elements within the TMN;
- Between elements within the TMN;
- Between TMNs.

The basis for choosing the appropriate interfaces, however, should be the functions performed by the elements between which appropriate communications are performed. The interface requirements are specified in terms of function attributes needed to provide the most efficient interface.

### 13.1 Function attributes

- a) *Reliability* - The capability of the interface to ensure that data and control are transferred such that integrity and security are maintained.
- b) *Frequency* - How often data is transferred across the interface boundary (Normal behaviour).
- c) *Quantity* - The amount of data that is transferred across the interface during any transaction.
- d) *Priority* - Indicates precedence to be given to data in case of competition for network resources with other functions.
- e) *Availability* - Determines the use of redundancy in the design of the communications channels between interfacing elements.

- f) *Delay* - Identifies the amount of buffering that may be tolerable between interfacing elements. This also impacts communications channel designs.

Table 13.1 suggests a possible ranges for these function attributes.

**Table 13.1: Possible ranges for TMN function attributes [1]**

Attributes		Requirements	Nature of attributes
Performance or grade of service (P)	Delay (speed)	Short Medium Long	Objective of design and control (acceptable/unacceptable but available/unavailable)
	Reliability (accuracy)	High Medium Low	
	Availability	High Medium Low	
Characteristics of TMN traffic (C)	Quantity	Large Medium Small	Condition or parameter of design
	Frequency	Often continuous Periodic Sparse	
	Priority	High Medium Low	

## 13.2 Functional characteristics

Each major type of telecommunications equipment has functional characteristic needs that can be used to describe the complexity of the interface.

There are, however, a basic group of TMN application functions that cross all major types of telecommunications equipment. There are also unique TMN application functions that are performed by specific categories of major telecommunications equipment. Alarm surveillance is an example of the former, whereas billing information collection is an example of the latter.

Functional characteristics of the elements within a TMN, e.g. OS, DCN and MD also describe the complexity of interfaces between these elements.

## 13.3 Critical attributes

Attribute values for a given function are generally consistent across the network elements.

When considering a single interface, it is important to identify the controlling attribute ranges for the design of the interface.

If there are conflicting attribute values for different functions in a given network element, more than one instance of an interface may be needed.

Overall TMN attribute values for the interfacing of elements within the TMN depend on the type and number of functions performed within these elements. In this case the functions are not consistent across TMN elements, but are controlled by the individual TMN design of an Administration.

## 13.4 Protocol selection

In many cases, more than one protocol suite will meet the requirements for the network element or TMN element under consideration. It is the approach for the 3GPP Telecom management standardisation to concentrate on protocol independent information models, allowing the mapping to several protocol suites.

The rationale behind this is:

- The blurring of Information and Telecommunication technologies in a 3G system, it is required to work on a more open approach (acknowledging the market status and foreseen evolutions).
- The lifecycle of information flows is 10 to 20 years, while the protocols is 5 to 10 years.
- The developments on automatic conversion allows for a more pragmatic and open approach.

The choice of the individual protocol from the recommended family will be left open to the vendors and operators.

To provide the most efficient interface care should be taken to select the protocol suite that optimises the relationship between the total cost to implement that protocol suite, the functional attributes and the data communications channels that carry the information across the interface.

## 13.5 Communications considerations

DCN architectures should be planned and designed to ensure that their implementation provides appropriate degrees of availability and network delay while minimising cost.

One should consider the selection of communications architectures, e.g. star, multipoint, loop, tree, etc.

The communications channels, e.g. dedicated lines, circuit-switched networks and packet networks used in providing the communications paths, also play an important role.

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# 14 Mediation/Integration

The increase in the need to incorporate a hybrid set of technologies, multiple protocols and heterogeneous resources requires the availability of open management interfaces between the management systems and the different network resources. These interfaces require an underlying mechanism to mediate - interpret, translate, and handle data - between the various data representations and protocols. A set of Technology Integration Points [10] can be identified and will need to be supported.

Software components on the open market as automatic conversion applications, gateways, mediation applications will be valuable products to fulfil the challenging task to incorporate multiple protocols and heterogeneous resources.

Figure 14.1 summarises Technology Integration Points for some technologies:

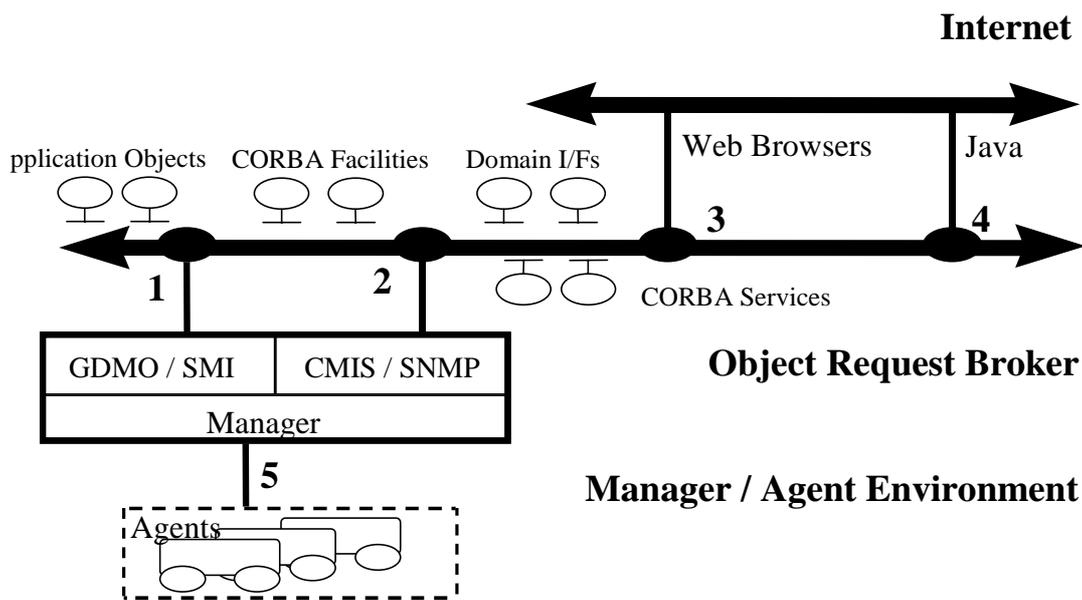


Figure 14.1: Technology Integration Points [10]

Essentially, figure 14.1 indicates that from the technologies selected, three technology areas will need to be integrated. These are:

- Internet/Web based services;
- Object Request Broker (CORBA) based services;
- Telecom based Manager/Agent services (i.e. CMIP/GDMO and SNMP/SMI).

In order to provide adequate points of integration between these areas of technology, five Integration Points (IPs) have been identified - as outlined in table 14.1:

Table 14.1 : Technology Integration Points [10]

	Managed Objects (GDMO/SMI)	Management Services (CMISE/SNMP)	Java Objects	Web Browser (HTTP/HTML)	TMN Agent
<b>CORBA Objects</b>	IP1		IP4	IP3	
<b>CORBA Services</b>		IP2			
<b>TMN Manager</b>					IP5
IP1	Provides mapping of objects defined in CORBA/IDL to managed objects defined in GDMO or SMI.				
IP2	Provides mapping of appropriate CORBA Services to CMIS and SNMP services.				
IP3	Provides a mapping of Web Browser technology access to CORBA objects (for situations where this may be needed as an addition to/replacement of Browser access to a database).				
IP4	Provides a mapping between Java based objects and CORBA objects.				
IP5	Provides a high level convenient programming interface for the rapid development of TMN based manager/agent interactions. It also provides a convenient point of integration if it is necessary to separate out the two sides of the manager/agent interface from the point of view of technology selection. For example, allowing the manager role to perhaps be supported in a Web-based environment, but giving a good point of integration with a TMN based agent.				

## Annex A (informative): Technology considerations

### A.1 TMN physical blocks

TMN functions can be implemented in a variety of physical configurations (ITU-T Recommendation M.3010 [1]). The relationship of the functional blocks to physical equipment is shown in table A.1 which names the TMN physical blocks according to the set of function blocks which each is allowed to contain. For each physical block there is a function block which is characteristic of it and is mandatory for it to contain. There also exist other functions, which are optional for the physical blocks to contain. Table A.1 does not imply any restriction of possible implementations, but defines those identified within this annex.

The subclauses below give the definitions for consideration in implementation schemes.

**Table A.1: Relationship of TMN physical block names to TMN function blocks**

(note 2 & note 3)	NEF	TF	OSF	WSF
NE	M	O	O	O (see note 3)
QA, XA, QM, XM		M		
OS		O	M	O
WS				M
M	Mandatory			
O	Optional			
NOTE 1:	Within this table, where more than one name is possible, the choice of the physical block name is determined by the predominant usage of the block.			
NOTE 2:	TMN physical blocks may contain additional functionality, which allows them to be managed.			
NOTE 3:	For the WSF to be present the OSF shall also be present. This means that the WSF shall address an OSF. The local man-machine access is not considered part of the TMN.			

#### A.1.1 Operations System (OS)

The OS is the system, which performs OSFs. The OS may optionally provide QAFs and WSFs.

#### A.1.2 Transformation

Transformation provides conversion between different protocols and data formats for information interchange between physical blocks. There are two types of transformation: adaptation and mediation that can apply at q or x reference points.

##### A.1.2.1 Adaptation device

An Adaptation Device (AD), or adapter, provides transformation between a non-TMN physical entity to a NE to OS within a TMN. A Q-adapter (QA) is a physical block used to connect NE-like or OS-like physical blocks with non-TMN compatible interfaces (at m reference points) to Q interfaces. An X-adapter (XA) is a physical block used to connect non-TMN physical entities having a non-TMN communication mechanism in a non-TMN environment to an OS at the edge of a TMN.

##### A.1.2.2 Mediation Device (MD)

A Mediation Device (MD) provides transformation between TMN physical blocks that incorporate incompatible communication mechanisms. A Q-Mediation Device (QMD) is a physical block that supports connections within one TMN. An X-Mediation Device (XMD) is a physical block that supports connections of OSs in different TMNs.

### A.1.3 Network Element (NE)

The NE is comprised of telecommunication equipment (or groups/parts of telecommunication equipment) and support equipment or any item or groups of items considered belonging to the telecommunications environment that performs NEFs. The NE may optionally contain any of the other TMN function blocks according to its implementation requirements. The NE has one or more standard Q-type interfaces and may optionally have F and X interfaces.

Existing NE-like equipment that does not possess a TMN standard interface will gain access to the TMN via a Q Adapter Function, which will provide the necessary functionality to convert between a non-standard and standard management interface.

NEs may be distributed or centralised. Various parts of a NE are not geographically constrained to one physical location. For example, the parts may be distributed along a transmission system. An example of a distributed NE is illustrated in figure A.1 (ITU-T Recommendation M.3010 [1]).

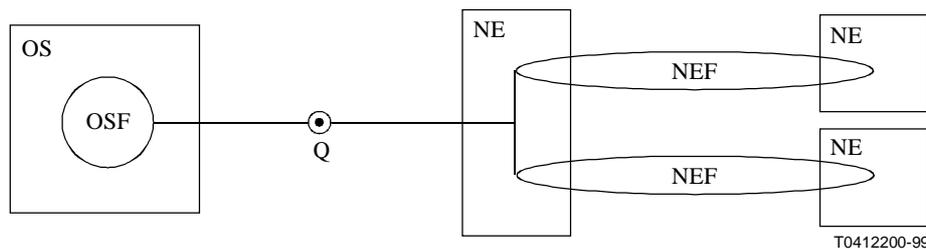


Figure A.1: Distributed network element

### A.1.4 Workstation (WS)

The WS is the system, which performs WSFs. The workstation functions translate information at the f reference point to a displayable format at the g reference point, and vice versa.

If equipment incorporates other TMN functionality as well as the WSF, then it is named by one of the other names in table A.1

### A.1.5 Data Communication Network (DCN)

A DCN supporting a TMN has traditionally conformed to the network service of the OSI reference model for ITU-T applications as specified in ITU-T Recommendation X.200 [4]. ITU-T Recommendation X.25 has been a commonly used packet protocol. However, the evolution of telecommunication services is merging circuit-switched and packet-switched modes with advancing technologies of ISDN, ATM, SDH, and the Internet. A variety of telecommunications services can be employed as long as integrity of information transfer can be preserved.

Within a TMN, the necessary physical connection, such as circuit-switched or packet-switched, may be offered by communication paths constructed with various network components, including dedicated lines, X.25 packet-switched data network, ISDN, common channel signalling network, public-switched telephone network, local area networks, terminal controllers, etc. The facilities can be either dedicated to a DCN or shared resources (for example, using SS No. 7 or an existing X.25 or IP-based packet-switched network).

Equipment supporting an OSF shall provide for two modes of data communication. These are spontaneous transmission of messages (e.g. for the NEF to the OSF) and a two-way dialogue (e.g. as the OSF obtains supporting information from the NEF and sends commands to the NEF or transfer messages to or from another OSF). In addition, an OSF is responsible for assuring the integrity of the data channels through a DCN. Physical connectivity in a local environment may be provided by a variety of subnetwork configurations including point-to-point, star, bus or ring.

The DCN may consist of a number of individual subnetworks of different types, interconnected together. The DCN may be a local path or a wide-area connection among distributed physical blocks. The DCN is technology independent and may employ any single or combination of transmission technologies.

## A.1.6 TMN logical layered architecture within the TMN physical architecture

Four specialisations of the OS physical block are defined to support a physical realisation of function blocks in logical layers. The four specialised OS physical blocks are the Business (B-OS), the Service (S-OS), the Network (N-OS) and the Element (E-OS) Operations Systems. These physical blocks are named according to the predominant function block they contain. Specifically, B-OS, S-OS, N-OS and E-OS predominantly contain B-OSF, S-OSF, N-OSF and E-OSF respectively. When physical blocks contain more than one kind of specialised OS function block that provide substantial functionality to the physical block, thus spanning more than one logical layer, the physical block is named according to the highest hierarchically layered function block. For example, a physical block containing both N-OSF and E-OSF, providing substantial network functionality is called an N-OS.

The exchange of management information between logical layers employs the managing roles and managed roles of the TMN interaction model. This allows management activities to be clustered into layers and to be decoupled. The managed roles will be associated with a set of information elements from information model(s) exposing a view at the layer's level of abstraction (e.g. equipment, element, network, service, etc.). Generally, managing and managed roles may be placed in logical layers without restriction. A managed role may be associated with a set of information elements from any layer. Managed roles may be placed in any layer and invoke operations associated with any other managed roles.

## A.1.7 Interoperable interface concept

In order for two or more TMN physical blocks to exchange management information they shall be connected by a communications path and each element shall support the same interface onto that communications path.

It is useful to use the concept of an interoperable interface to simplify the communications problems arising from a multi-vendor, multi-capability network.

The interoperable interface defines the protocol suite and the messages carried by the protocol. Transaction-oriented interoperable interfaces are based upon an object-oriented view of the communication and therefore, all the messages carried deal with object manipulations. It is the formally defined set of protocols, procedures, message formats and semantics used for the management communications.

The message component of the interoperable interface provides a generalised mechanism for managing the objects defined for the information model. As part of the definition of each object there is a list of management operations types which are valid for the object. In addition, there are generic messages that are used identically for many classes of managed objects.

In the architecture, what predominantly distinguishes one interface from another is the scope of the management activity that the communication at the interface shall support. This common understanding of the scope of operation is termed Shared Management Knowledge. Shared Management Knowledge includes an understanding of the information model of the managed network (object classes supported, functions supported, etc.), management support objects, options, application context supported, etc. The Shared Management Knowledge ensures that each end of the interface understands the exact meaning of a message sent by the other end.



## A.2.2 F interface

The F interface is applied at f reference points. The F interfaces connecting workstations to the TMN building blocks containing OSFs or MFs through a data communication network are included in the present document. Connections of implementation specific, WS-like entities to OSs or NEs, are not subject of the present document.

## A.2.3 X interface

The X interface is applied at the x reference point. It will be used to interconnect two TMNs or to interconnect a TMN with other network or systems which accommodates a TMN-like interface. As such, this interface may require increased security over the level, which is required by a Q-type interface. It will therefore be necessary that aspects of security are addressed at the time of agreement between associations, e.g. passwords and access capabilities.

The information model at the X interface will set the limits on the access available from outside the TMN. The set of capabilities made available at the X interface for access to the TMN will be referred to as TMN Access.

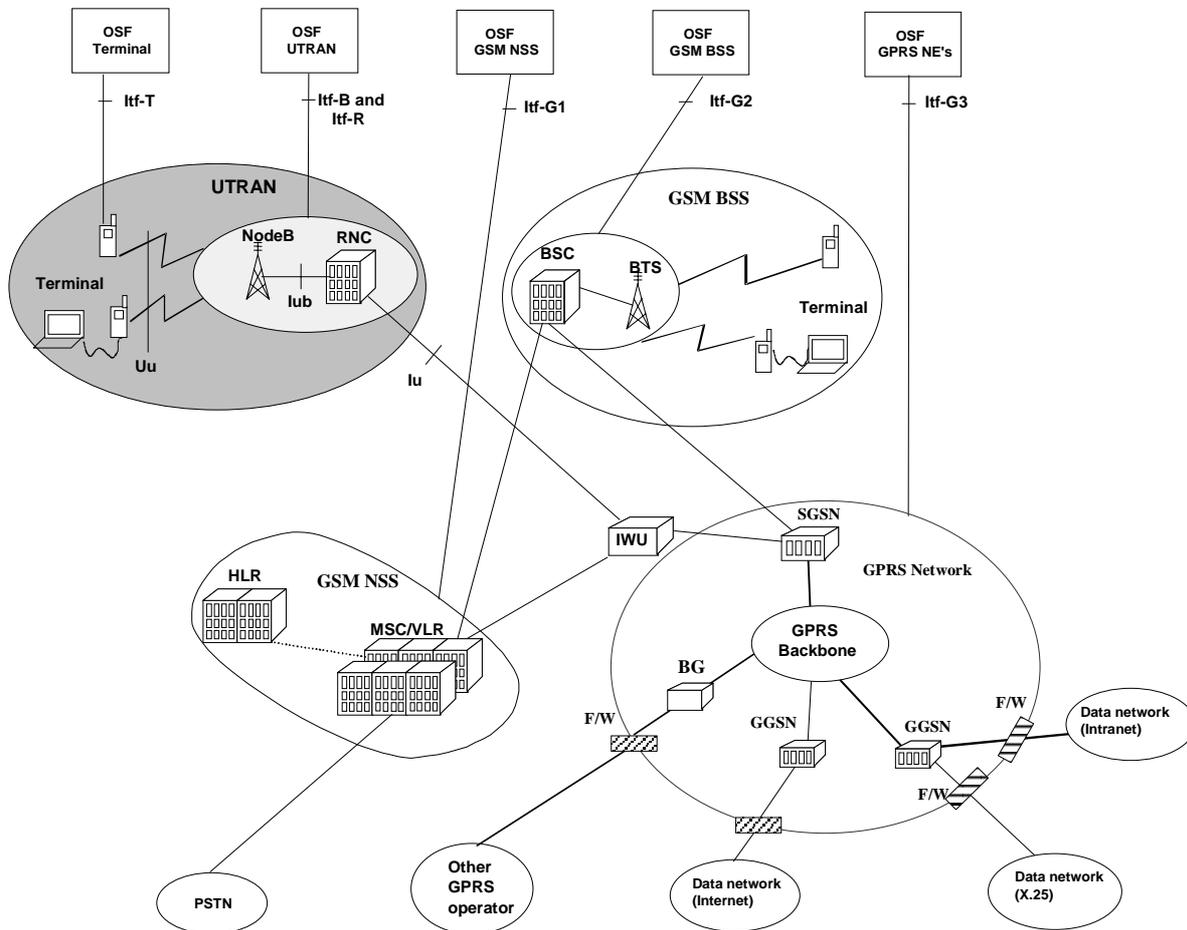
Additional protocol requirements may be required to introduce the level of security, non-repudiation, etc. which is required.

## A.2.4 Relationship of TMN interfaces to TMN physical blocks

Table A.1 defines the possible interfaces, which each named TMN physical block can support. It is based upon the function blocks which table A.1 associates with each physical block and the reference points between function blocks.

## Annex B (informative): Overview of a 3GPP System

Figure B.1 presents an example of a 3GPP System, related management areas and introduces some management interfaces. 3GPP Service specific entities are not shown.



**Figure B.1: Overview of a 3GPP System, showing management interfaces and management areas**

All the following interfaces are illustrated in figure B.1:

- Itf-T between a terminal and a NE Manager. This interface will in some extent manage the 3G terminal and the USIM of the subscriber. Requirements of this interface are for further study.
- Itf-B and Itf-R between UTRAN and a NE Manager.
- Itf-G1 between GSM NSS and NE Manager.
- Itf-G2 between GSM BSS and NE Manager. This interface is standardised in GSM 12-series specifications.
- Itf-G3 between GPRS NEs and a NE Manager.

## Annex C (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
Dec 1999	S_06	SP-99578	--	--	Approved at TSG SA #6 and placed under Change Control	-	3.0.0
Mar 2000	S_07	SP-000015	001	--	resolving remaining R99 inconsistency between 32.101 & 32.102	3.0.0	3.1.0
Mar 2000	S_07	SP-000015	002	--	Correction of IRP-related terminology	3.0.0	3.1.0
Mar 2000	--	--	--	--	Cosmetic	3.1.0	3.1.1
Jun 2000	S_08	SP-000227	003	--	Clarification of compliance conditions	3.1.1	3.2.0
Jun 2000	S_08	SP-000228	004	--	Update ITU-T TMN related reference material	3.1.1	3.2.0
Jun 2000	S_08	SP-000229	005	--	Definition of the Mandatory/Optional/Conditional qualifiers used in the IRPs	3.1.1	3.2.0
Jun 2000	S_08	SP-000230	006	--	Correction of erroneous editing and usage of undefined term	3.1.1	3.2.0
Mar 2001	S_11	SP-010026	007	--	Add UMTS TMN conformance	3.2.0	4.0.0
Jun 2001	S_12	SP-010232	008	--	Correction of ITU-T TMN concerns	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	009	--	Alignment with 3GPP drafting rules regarding headings	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	010	--	Update of TM architectural aspects	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	011	--	General clarifications and enhancements	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	012	--	Alignment with 3GPP drafting rules regarding verbal forms for the expression of provisions	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	013	--	Update and clarify compliance condition for a UMTS entity	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	014	--	Delete OSA definition	4.0.0	4.1.0
Jun 2001	S_12	SP-010232	015	--	Enhancements of the IRP Concept	4.0.0	4.1.0
Sep 2001	S_13	SP-010466	016	--	Update and alignment of compliance conditions for UMTS Management Physical architectures	4.1.0	4.2.0
Sep 2001	S_13	SP-010522	017	--	Specify the Rule for IDL file names	4.1.0	4.2.0
Mar 2002	S_15	SP-020037	018	--	Add the rule on how all SA5 Solution Set specifications indicate a reference to a particular SA5 Information Service specification.	4.2.0	5.0.0
Mar 2002	S_15	SP-020037	019	--	Inclusion of the IMS in the 3G Telecom Management Architecture (32.102)	4.2.0	5.0.0
Sep 2002	S_17	SP-020450	020	--	Correction of diagrams describing entities of the mobile system to be managed	5.0.0	5.1.0
Sep 2002	S_17	SP-020450	021	--	IS Template Changes to support new UML Repertoire/Methodology	5.0.0	5.1.0
Sep 2002	S_17	SP-020450	022	--	Addition of 3GPP UML Repertoire for IRP: IS	5.0.0	5.1.0
Sep 2002	S_17	SP-020479	023	--	Add optional parameters in CORBA Solution Set IDLs	5.0.0	5.1.0
Dec 2002	S_18	SP-020726	024	--	Aligning IRP related terminology with SA5's SWGC IRP specifications (32.6xy)	5.1.0	5.2.0
Dec 2002	S_18	SP-020727	025	--	Updates and corrections to Integration Reference Points (IRPs) Introduction	5.1.0	5.2.0
Mar 2003	S_19	SP-030061	027	--	Add New Subclause to IS Template for Notification Related IOCs	5.2.0	5.3.0
Sep 2003	S_21	SP-030402	029	--	Correction of subclause X.2.1 in Annex C	5.3.0	5.4.0
Sep 2003	S_21	SP-030403	030	--	Expansion to UML repertoire to support more concise modelling of stage 2 specifications	5.4.0	6.0.0
Dec 2003	S_22	SP-030756	032	1	Replace the term UMTS in line with SA1/2 with 3G / 3GPP	6.0.0	6.1.0
Mar 2004	S_23	SP-040112	035	--	Deletion of clauses in 32.102 that have been moved to new Rel-6 TSs 32.150/1/2	6.1.0	6.2.0
Jun 2004	S_24	SP-040240	036	--	Update of new entities for 3GPP system and WLAN interworking - Align with SA2's 24.244	6.2.0	6.3.0

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# History

<b>Document history</b>		
V6.3.0	June 2004	Publication