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ITU-T M.3060/Y.2401

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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Telecommunications management network

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Network management

Principles for the Management of Next Generation Networks

ITU-T Recommendation M.3060/Y.2401

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ITU-T Recommendation M.3060/Y.2401

Principles for the Management of Next Generation Networks

Summary

This Recommendation presents the management requirements, general principles and architectural requirements for managing Next Generation Networks (NGN) to support business processes to plan, provision, install, maintain, operate and administer NGN resources and services.

This Recommendation defines concepts of the Next Generation Networks Management (NGNM) architecture, i.e., its business process view, functional view, information view, and physical views; and their fundamental elements.

This Recommendation also describes the relationships among the architectural views and provides a framework to derive the requirements for the specification of management physical views from the management functional and information views. A logical reference model for partitioning of management functionality, the Logical Layered Architecture (LLA), is also provided.

Source

ITU-T Recommendation M.3060/Y.2401 was approved on 22 March 2006 by ITU-T Study Group 4 (2005-2008) under the ITU-T Recommendation A.8 procedure.

Keywords

Architecture, business process, conformance and compliance, function block, interface, management function set (MFS), management functionality, management service, next generation networks management (NGNM), NGNM logical layered architecture (LLA), operations system (OS), operations systems component (OSC), reference point.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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This Recommendation also defines concepts of the Next Generation Networks Management (NGNM) architecture, i.e., its business process view, functional view, information view, and physical view; and their fundamental elements.

This Recommendation also describes the relationships among the architectural views and provides a framework to derive the requirements for the specification of management physical view from the management functional and information views. A logical reference model for partitioning of management functionality, the Logical Layered Architecture (LLA), is also provided.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks.*

– ITU-T Recommendations G.85x series, *Management of the transport network.*

– ITU-T Recommendation M.3010 (2000), *Principles for a telecommunications management network.*

– ITU-T Recommendation M.3016.0 (2005), *Security for the management plane: Overview*.

– ITU-T Recommendation M.3016.1 (2005), *Security for the management plane: Security requirements*.

– ITU-T Recommendation M.3016.2 (2005), *Security for the management plane: Security services.*

– ITU-T Recommendation M.3016.3 (2005), *Security for the management plane: Security mechanism.*

– ITU-T Recommendation M.3016.4 (2005), *Security for the management plane: Profile proforma.*

– ITU-T Recommendation M.3020 (2000), *TMN interface specification methodology.*

– ITU-T Recommendation M.3050.0 (2004), *Enhanced Telecom Operations Map (eTOM) – Introduction.*

– ITU-T Recommendation M.3050.1 (2004), *Enhanced Telecom Operations Map (eTOM) – The business process framework.*

– ITU-T Recommendation M.3050.2 (2004), *Enhanced Telecom Operations Map (eTOM) – Process decompositions and descriptions.*

– ITU-T Recommendation M.3050.3 (2004), *Enhanced Telecom Operations Map (eTOM) – Representative process flows.*

– ITU-T Recommendation M.3050.4 (2004), *Enhanced Telecom Operations Map (eTOM) – B2B integration: Using B2B inter-enterprise integration with the eTOM.*

– ITU-T Recommendations M.310x series, *Generic network information model.*

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– ITU-T Recommendation M.3400 (2000), *TMN management functions.*

– ITU-T Recommendation Q.811 (2004), *Lower layer protocol profiles for the Q and X interfaces.*

– ITU-T Recommendation Q.812 (2004), *Upper layer protocol profiles for the Q and X interfaces.*

– ITU-T Recommendations Q.82x series, *Stage 2 and Stage 3 description for the Q3 interface.*

– ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic reference model: The basic model.*

– ITU-T Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT applications.*

– ITU-T Recommendation X.703 (1997) | ISO/IEC 13244:1998, *Information technology – Open distributed management architecture.*

– ITU-T Recommendations X.73x series, *Management functions and ODMA functions.*

– ITU-T Recommendation X.805 (2003), *Security architecture for systems providing end-to-end communications.*

– ITU-T Recommendation X.903 (1995), *Information technology – Open distributed processing – Reference Model: Architecture.*

– ITU-T Recommendation Y.110 (1998), *Global information infrastructure principles and framework architecture*.

– ITU-T Recommendation Y.2001 (2004), *General overview of NGN*.

– ITU-T Recommendation Y.2011 (2004), *General principles and general reference model for Next Generation Networks.*

– ITU-T Recommendations Z.31x-series, *Man-machine language – Basic syntax and dialogue procedures.*

3 Definitions

This Recommendation uses the following term from ITU-T Rec. G.805:

– Administrative Domain

This Recommendation uses the following terms from ITU-T Rec. M.3010:

– Business Management Layer

– Business Process

– Data Communication Network

– Element Management Layer
– Function Block
– Interface
– Logical Layered Architecture (LLA)
– Managed Resource
– Management Domain
– Management Function
– Management Function Set (MFS)
– Management Layer
– Management Service
– Network Element Function *[Note: SEF and TEF are specialization of NEF]*
– Network Management Layer
– Operations System (OS)
– Operations Systems Component (OSC)
– Operations Systems Function (OSF)
– Physical Block
– Q Interface
– q Reference Point
– Reference Point
– Service Management Layer
– Transformation Function
– X Interface
– x Reference Points

This Recommendation uses the following terms from ITU-T Rec. Y.2001:

– Generalized Mobility
– Next Generation Network (NGN)

This Recommendation uses the following terms from ITU-T Rec. Y.2011:

– Control Plane
– Management Plane
– User Plane
– NGN Service Stratum
– NGN Transport Stratum

This Recommendation uses the following terms from ITU-T Rec. M.3050.1:

– Customer
– End-user
– Enterprise
– Partner
– Product
– Supplier

This Recommendation defines the following terms:

3.1 B2B/C2B interface: Synonymous to X interface.

3.2 b2b/c2b reference point: Synonymous to x reference point.

3.3 consumer reference point (CRP): A reference point which delineates a function block and consumes the management functionality provided by another function block through one of its provider reference points.

3.4 distributed multi-element structure: An architectural concept that represents a grouping of network elements that must be managed as a single entity for operational efficiency sake. Examples include Optical Bidirectional Line Switched Ring (BLSR) or an entire MPLS network when viewed from the perspective of an edge router.

3.5 element management function (EMF): A function block that processes information related to the telecommunications management for the purpose of monitoring/coordinating and/or controlling network elements on an individual or collective basis.

3.6 HMI Interface: An interface applied at hmi reference points.

3.7 hmi reference point: A reference point provided for consumption by human users.

3.8 market, product and customer management function (MPCMF): A function block that includes dealing with sales and channel management, marketing management, and product and offer management, as well as operational processes such as managing the customer interface, ordering, problem handling, SLA management and billing.

3.9 network management function (NMF): A function block that processes information related to the management of the network, including coordination of activity in a network view.

3.10 next generation networks management (NGNM): Planning, provisioning, installation, maintenance, operation and administration of next generation telecommunications equipment for transmission or control of resources and services within NGN transport and service strata.

3.11 NGN network element (NNE): An architectural concept that represents telecommunication equipment (or groups/parts of telecom equipment) and support equipment or any item or groups of items considered belonging to the telecommunications environment that performs at least one of transport element functions (TEFs) or service element functions (SEFs).

NOTE – In this Recommendation, the term NGN Network Element (NNE) is used interchangeably with Network Element (NE).

3.12 operation: A behaviour which is published as a member of a Provider Reference Point or a Consumer Reference Point.

3.13 provider reference point (PRP): A reference point which delineates and exposes an external view of management functionality of a function block, where all exposed management functions are provided for consumption by other function blocks.

3.14 provider reference point group (PRPG): A pre-defined collection of provider reference points that belong together according to a chosen context.

3.15 resource management function (RMF): A function block with the properties of both a service resource management function block and a transport resource management function block. It includes dealing with development and delivery of resource (network and IT) infrastructure, and its operational management including aspects such as provisioning, trouble management and performance management. Resource infrastructure supports products and services, as well as supporting the enterprise itself.

3.16 service element function (SEF): A function block that is a specialization of NEF representing the telecommunication service functions.

3.17 service element management function (SEMF): An EMF in the NGN service stratum.

3.18 service management function (SMF): A function block that processes information related to service instance management, including the contractual aspects, service order handling, complaint handling and invoicing, of services that are being provided to customers or available to potential new customers.

3.19 service network management function (SNMF): An NMF in the NGN service stratum.

3.20 service resource: Resource in the NGN service stratum.

3.21 service resource management function (SRMF): A function block that processes information related to the management of service resources, including inventory and availability.

3.22 supplier/partner relationship management function (SPRMF): A function block that communicates with suppliers and partners for the purpose of importing external transport or service resources for use by the enterprise. It includes dealing with the enterprise's interaction with its suppliers and partners. This involves both processes that develop and manage the Supply Chain that underpins product and infrastructure, as well as those that support the operational interface with its suppliers and partners.

3.23 transport element function (TEF): A function block that is a specialization of NEF representing the telecommunication transport functions.

3.24 transport element management function (TEMF): An EMF in the NGN transport stratum.

3.25 transport network management function (TNMF): An NMF in the NGN transport stratum.

3.26 transport resource: A resource in the NGN transport stratum.

3.27 transport resource management function (TRMF): A function block that processes information related to the management of network transport resources, including inventory and availability.

4 Abbreviations

This Recommendation uses the following abbreviations:

3GPP	3rd Generation wireless technologies Partnership Project
AD	Adaptation Device
ANI	Access Network Interface
API	Application Programming Interface
B2B	Business-to-Business
BLSR	Bidirectional Line Switched Ring
BML	Business Management Layer
C2B	Customer-to-Business
CORBA	Common Object Request Broker Architecture
CPE	Customer Premises Equipment
CRP	Consumer Reference Point
DCF	Data Communication Function
DCN	Data Communication Network

EMF	Element Management Function
EML	Element Management Layer
EpM	Enterprise Management
EpMF	Enterprise Management Function
eTOM	enhanced Telecom Operations Map
ETSI	European Telecommunications Standards Institute
FCAPS	Fault, Configuration, Accounting, Performance, and Security
HCPN	Hybrid Circuit/Packet Networks
HMI	Human Machine Interface
ICT	Information and Communications Technology
IDL	Interface Definition Language
IEC	International Electrotechnical Commission
IMS	IP Multimedia Subsystem
IOC	Information Object Class
IP	Internet Protocol
IRP	Integration Reference Point
IS	Information Service
ISO	International Organization for Standardization
ITU	International Telecommunication Union
J2EE	Java 2 Platform, Enterprise Edition
LLA	Logical Layered Architecture
MAF	Management Application Function
MD	Mediation Device
MFS	Management Function Set
MPCMF	Market, Product and Customer Management Function
MPCMS	Market, Product and Customer Management System
MPLS	Multi-Protocol Label Switching
NAT	Network Address Translation
NE	Network Element
NEL	Network Element Layer
NEF	Network Element Function
NGN	Next Generation Networks
NGNM	NGN Management
NGOSS	New Generation Operations Systems and Software
NMF	Network Management Function
NML	Network Management Layer
NNE	NGN Network Element

NNI	Network-to-Network Interface
OASIS	Organization for the Advancement of Structured Information Standards
ODMA	Open Distributed Management Architecture
ODP	Open Distributed Processing
OMG	Object Management Group
OOA	Object-Oriented Approach
OOAD	Object-Oriented Analysis and Design
OS	Operations System
OSC	Operations Systems Component
OSF	Operations Systems Function
OSI	Open Systems Interconnection
OSS	Operations Support System
PRP	Provider Reference Point
PRPG	Provider Reference Point Group
PSTN	Public Switched Telephone Network
QA	Q-Adapter
QMD	Q-Mediation Device
QoS	Quality of Service
RMF	Resource Management Function
RML	Resource Management Layer
RM-ODP	Reference Model of ODP
SEF	Service Element Function
SEMF	Service Element Management Function
SIP	Strategy, Infrastructure & Product
SLA	Service Level Agreement
SMF	Service Management Function
SML	Service Management Layer
SMS	Security Management System
SNMF	Service Network Management Function
SOA	Service-Oriented Architecture
SP	Service Provider
SPRMF	Supplier/Partner Relationship Management Function
SRM	Service Resource Management
SRMF	Service Resource Management Function
SRML	Service Resource Management Layer
TEF	Transport Element Function
TEMF	Transport Element Management Function

TF	Transformation Function
TISPAN	Telecoms & Internet converged Services & Protocols for Advanced Networks
TMF	TeleManagement Forum
TMN	Telecommunications Management Network
TNMF	Transport Network Management Function
TRM	Transport Resource Management
TRMF	Transport Resource Management Function
TRML	Transport Resource Management Layer
UML	Unified Modelling Language
UNI	User-to-Network Interface
W3C	World Wide Web Consortium
WSDL	Web Services Description Language
WSF	WorkStation Function

5 Introduction

This Recommendation presents the management requirements, general principles and architectural requirements for managing Next Generation Networks to support business processes and the management requirements of network operators and service providers to plan, provision, install, maintain, operate and administer NGN resources and services. Customer operations processes may also include customer activity.

Within the context of NGN, management functionality refers to a set of management functions to allow for the exchange and processing of management information to assist network operators and service providers in conducting their business efficiently.

NGN management (NGNM) provides management functions for NGN resources and services, and offers communications between the management plane and the NGN resources or services and other management planes.

The aim of NGNM is to facilitate the effective interconnection between various types of Operations Systems (OSs) and/or NGN resources for the exchange of management information using an agreed architecture with standardized interfaces including protocols and messages. In defining the concept, it is recognized that many network operators and service providers have a large infrastructure of OSs, telecommunications networks and equipment already in place, and which must be accommodated within the architecture.

NGNM also provides end-users with access to, and display of, management information, and end-user-initiated business processes.

Next Generation Networks are essentially about delivering new services that are available any place, any time, and on any device, through any customer-chosen access mechanism.

A Management Framework is required that increases customer satisfaction and at the same time underpins a significant reduction in operating costs through new technologies, new business models, and new operational methods.

The use of the term "Services" in this context is the traditional telecommunication industry use of the word encompassing applications such as: voice, multimedia, messaging, etc., which in most other industry sectors are referred to as "Products".

Much of the NGN challenge arises from new business models and the effective operational delivery of those services, which in turn is highly dependent on flexible and efficient management systems and processes.

6 Basic objectives for managing a next generation network

The objective for this Recommendation is to provide a set of principles and a framework for managing next generation networks. This requires agreement amongst suppliers and operators on the organization of processes amongst them that may be operated by people, Operation Systems (OSs) or other Information and Communications Technology (ICT) systems. The management architecture needs to address:

– Administrative boundaries amongst operator domains;
– Processes amongst operators across these domain boundaries;
– Processes between Operators and their suppliers' equipments;
– Provider and Consumer Reference points between the logical functions used to realize those processes;
– Provider and Consumer Interfaces between the physical entities used to realize the provider and consumer reference points;
– Information model concepts used to support logical functions.

For example, by using the concepts of generic network models for management, it is possible to perform general management of diverse equipment, networks and services using generic information models and standard interfaces.

Management of telecommunications networks is intended to support a wide variety of management areas, which cover the planning, installation, operations, administration, maintenance and provisioning of telecommunications networks and services.

The ITU-T has categorized management into five broad management functional areas (ITU-T Rec. M.3400). The five FCAPS management functional areas identified to date are as follows:

– Fault management;
– Configuration management;
– Accounting management;
– Performance management;
– Security management.

This classification of the information exchange within the management framework is independent of the use that will be made of the information.

The management of the telecommunications network needs to be aware of networks and services as collections of cooperating systems. The business processes in the M.3050.x series and the FCAPS Management Functional Areas in ITU-T Rec. M.3400 should be considered for abstracting constructs required for NGN networks and services. The architecture is concerned with orchestrating the management of individual systems so as to have a coordinated effect upon the network. Management objectives for Next Generation Networks include:

– minimize mediation work between different network technologies through management convergence and intelligent reporting;
– minimize management reaction times to network events;
– minimize load caused by management traffic;
– allow for geographic dispersion of control over aspects of the network operation;

– provide isolation mechanisms to minimize security risks;
– provide isolation mechanisms to locate and contain network faults;
– improve service assistance and interaction with customers;
– layering of services to enable a provider to provide the building blocks for services and others to bundle the services and its implications on the management architecture;
– business processes as defined in the M.3050.x series and how they would be used in NGN;
– support of applications, both on the same distributed computing platform and those distributed throughout the network.

The following areas are for further study:

– implications of the need to manage end-to-end services;
– implications of home networks and customer premises equipment.

7 General NGNM requirements

NGN management supports the monitoring and control of the NGN services and the service and transport resources via the communication of management information across interfaces between NGN resources and management systems, between NGN-supportive management systems, and between NGN components and personnel of service providers and network operators.

NGN management supports the aims of the NGN by:

a) Providing the ability to manage, throughout their complete life cycle, NGN system resources, both physical and logical. This includes resources in the core network (including IMS), access networks, interconnect components, and customer networks and their terminals.

b) Providing the ability to manage NGN Service Stratum resources independently from the underlying NGN Transport Stratum resources and enabling organizations offering NGN end-user services (potentially from different service providers) to build distinctive service offerings to customers.

c) Providing the management capabilities that will enable organizations offering NGN end-user services to offer customers the ability to personalize end-user services and to create new services from service capabilities (potentially from different service providers).

d) Providing the management capabilities that will enable organizations offering NGN services to provide end-user service improvements including customer self-service (e.g., provision of service, reporting faults, online billing reports).

e) Ensuring secure access to management information by authorized management information users, including customer and end-user information.

f) Supporting the availability of management services any place any time to any authorized organization or individual (e.g., access to billing records shall be available 24/7).

g) Supporting eBusiness Value Networks based upon concepts of business roles (Customer, Service Provider, Complementor, Intermediary, Supplier (e.g., Equipment Vendor)) (ITU-T Recs Y.110 and M.3050.x/eTOM).

h) Allowing an enterprise and/or an individual to adopt multiple roles in different value networks and also multiple roles within a specific value network (e.g., one role as a retail Service Provider and another role as a wholesale Service Provider) (ITU-T Rec. M.3050.x/eTOM).

i) Supporting B2B processes between organizations providing NGN services and capabilities.

j) Integrating an abstracted view on Resources (network, computing and application), which is hiding complexity and multiplicity of technologies and domains in the resource layer.

k) Supporting the collection of charging data for the network operator regarding the utilization of resources in the network either for later use by billing processes (offline charging) or for near-real time interactions with rating applications (online charging).

l) The ability to provide survivable networks in the event of impairment.

m) The ability to have proactive trend monitoring.

n) The ability to manage customer networks.

o) The ability to have integrated end-to-end services provisioning.

p) The ability to have automatic and dynamic allocation of network resources.

q) The ability to have service quality-based network operations.

r) The ability to have management that is independent of company organizations, which are subject to change, while maintaining the concept of organizational boundaries.

s) The ability to exchange management information across the boundary between network environments; the three types of boundaries to be considered are: the boundary between the transport and service strata, the boundary between control and management planes and the boundary between administrative domains.

t) Have consistent cross-technology management interfaces on network elements (service and transport elements) allowing an integrated view of resources and include available management technology implementations, as appropriate.

u) A management architecture and set of business processes and management services that will enable service providers to reduce the time-frame for the design, creation, delivery, and operation of new services.

v) The ability to manipulate, analyse and react to management information in a consistent and appropriate manner.

w) The ability to deliver management information to the management information user and to present it in a consistent and appropriate manner.

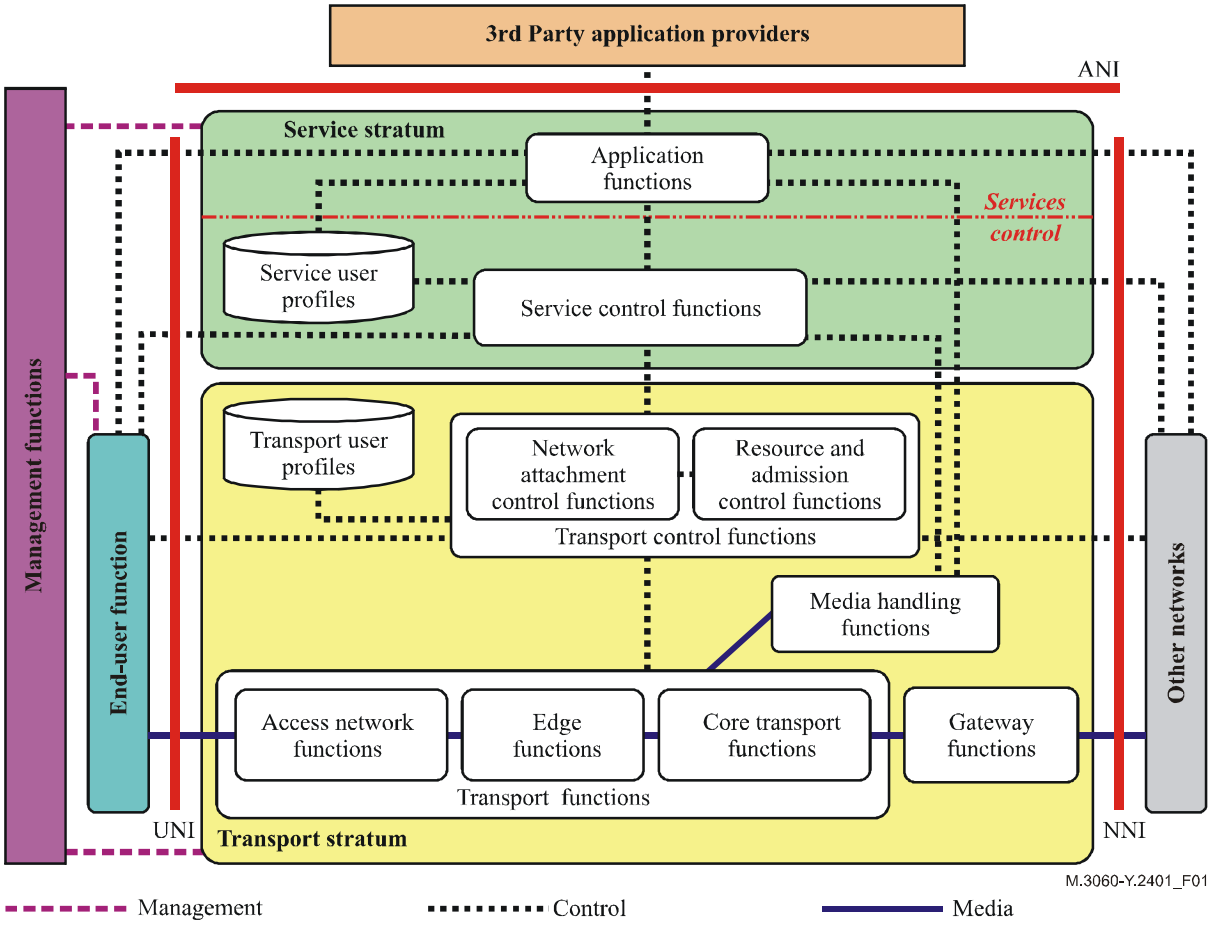
x) NGN management specifications should be defined to not preclude implementations which support regulatory and legal requirements.

Management of hybrid networks comprising NGN and non-NGN (e.g., PSTN, cable network) resources is out of the scope of this Recommendation. ITU-T Rec. M.3017 provides the specification for the management of hybrid circuit/packet networks (HCPN) composed of both circuit-switched and packet-based layer networks.

8 NGN architecture

8.1 Functional architecture for NGN

The goal of NGN is to provide the capabilities to make the creation, deployment, and management of all kinds of services possible. In order to achieve this goal, it is necessary to decouple and make independent, the service creation/deployment infrastructure from the transport infrastructure. Such decoupling is reflected in the NGN architecture as the separation of the Transport and Service strata and shown as two independent stratums. Figure 1 below shows the scope of this management architecture in the context of NGN.



NOTE – Charging and billing functions and management functions are applied to both Service and Transport strata.

Figure 1/M.3060/Y.2401 – NGN architecture overview

8.1.1 Service stratum

The NGN Service Stratum provides the functions that control and manage network services to enable the end-users services and applications. End-user services may be implemented by a recursion of multiple service strata within the network. Services may be related to voice, data or video applications, arranged separately or in some combination in the case of multimedia applications. Refer to ITU-T Rec. Y.2011 for further details.

8.1.2 Transport stratum

The NGN Transport Stratum is concerned with transfer of information between peer entities. For the purposes of such transfers dynamic or static associations may be established to control the information transfer between such entities. Associations may be of durations that are extremely short, medium term (minutes), or long term (hours, days, or longer). Refer to ITU-T Rec. Y.2011 for further details.

8.2 NGN management plane

The NGN management plane is the union of the NGN service stratum management plane and the NGN transport stratum management plane and may include joint management functions, i.e., functions used to manage entities in both strata plus functions required to support this management. Refer to ITU-T Rec. Y.2011 for details.

9 NGN management architecture overview

The NGN Management architecture will be divided into four different architecture views as shown in Figure 2 below:

– Business Process View;

– Management Functional View;

– Management Information View;

– Management Physical View.

Each view shows a different perspective into the architecture. These four architecture views also take security into consideration.

Figure 2 describes the workflow in the creation of management specifications, where first the functional view is defined, followed by the information view and finally the physical view. The Business Process is an influence throughout the lifecycle. Note that, in practice, this process is iterative to enable all aspects of the architecture to evolve over time as required.

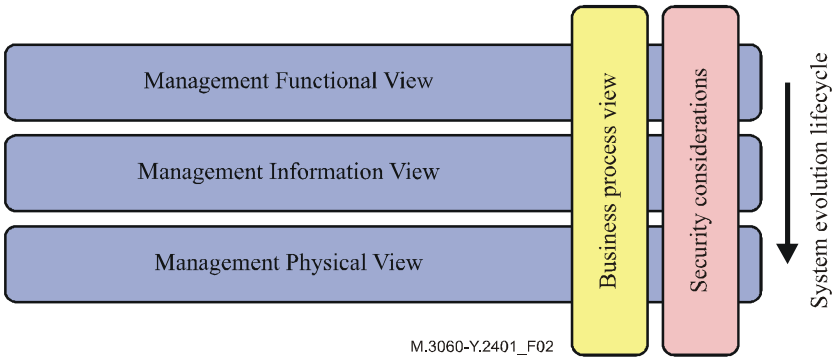


Figure 2/M.3060/Y.2401 – NGN management architecture

9.1 Business process view

The business process view, based on the eTOM model (ITU-T Rec. M.3050.x-series), provides a reference framework for categorizing the business activities of a service provider.

9.2 Management functional view

The functional view permits the specification of what functions have to be achieved in the management implementation.

9.3 Management information view

The information view characterizes the management information required for communication between the entities in the functional view to enable the performance of the functions to be achieved in the management implementation.

9.4 Management physical view

The physical view describes the varied ways that management functions can be implemented. They may be deployed in a variety of physical configurations using a variety of management protocols.

9.5 Security considerations

Security is an extensive domain with a mission to protect important business assets against different types of threats. Assets can be of different types such as buildings, employees, machines, information, etc. NGN Management is specifically concerned with the management of security

aspects of the NGN and with the security of the NGN Management infrastructure. ITU-T Recs X.805 and M.3016.x series should be considered for securing the NGN management infrastructure. The management of security aspects of the NGN is for further study.

ITU-T Rec. X.805 defines the security architecture to achieve end-to-end security of a telecommunications infrastructure. ITU-T Rec. X.805 defines concepts and components intended to provide reusable countermeasures across multiple layers of the infrastructure, including transport and service strata, and is the basis for more specific security specifications.

ITU-T M.3016.x series of Recommendations addresses the requirements, services and mechanisms in support of securing the management plane of the NGN infrastructure. In this context, the M.3016.x series focuses on end-to-end security, both in the case where management traffic is separate from user traffic and when they are mixed together. The reference model for deriving the requirements in the M.3016.x series shows the interfaces where management traffic is to be secured.

To deal with the complexity of securing all of the NGN, including its management plane, there is a need to mechanize the application of various security services, mechanisms, and tools by employing operation systems to automate the process. Requirements and architecture for such operations systems, also known as Security Management Systems (SMS), is for further study.

9.6 Relationship to service-oriented architecture (SOA)

One of the architectural principles behind the management architecture for Next Generation Networks is that of being a Service-Oriented Architecture (SOA).

A Service-Oriented Architecture (SOA) is a software architecture of services, policies, practices and frameworks in which components can be reused and repurposed rapidly in order to achieve shared and new functionality. This enables rapid and economical implementation in response to new requirements thus ensuring that services respond to perceived user needs.

SOA uses the object-oriented principle of encapsulation in which entities are accessible only through interfaces and where those entities are connected by well-defined interface agreements or contracts.

Major goals of an SOA in comparison with other architectures used in the past are to enable:

– faster adaptation to changing business needs;
– cost reduction in the integration of new services, as well as in the maintenance of existing services.

SOAs provide open and agile business solutions that can be rapidly extended or changed on demand. This will enable NGN Management to support the rapid creation of new NGN services and changes in NGN technology.

The main features of SOA are:

– loosely coupled, location independent, reusable services;
– any given service may assume a client or a server role with respect to another service, depending on situation;
– the "find-bind-execute" paradigm for the communication between services;
– published contract-based, platform and technology-neutral service interfaces. This means that the interface of a service is independent of its implementation;
– encapsulating the lifecycle of the entities involved in a business transaction; and exposing a coarser granularity of interfaces than OOA.

The TMF NGOSS Technology-Neutral Architecture TMF053 is an extensive example of the use of an SOA for telecommunications management.

9.6.1 SOA design patterns

The SOA follows the "find, bind and execute" paradigm as Figure 3 depicts. The service consumer queries a registry for service that matches its criteria. Once such a service is discovered, the consumer will bind to the provided SOA service.

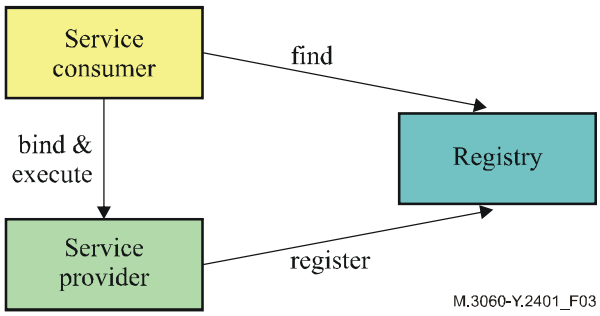


Figure 3/M.3060/Y.2401 – Find, bind and execute paradigm

The binding occurs in two aspects:

– the consumer binds to provider's arguments and data formats;

– the consumer binds to the transport mechanism specified by the provider.

After binding is done, the consumer invokes the service and receives the response of the service. This binding can be established at runtime.

9.6.2 SOA terminology

It should be noted that, within ITU-T Recommendations, a reference point is a functional or logical architectural concept, while an ITU-T interface is a physical artefact that realizes or implements one or more reference points. By contrast, the ICT industry only uses the term "interface" and it depends on the specification language used such as UML, CORBA IDL, Java, or C++ whether the interface is considered to be logical (i.e., technology-neutral/agnostic) or physical (i.e., enabling technology-specific).

The concept of ICT interface arose from the concepts of an abstract operation which has no implementation and an abstract class which cannot be instantiated. An interface is a class that has no implementation, i.e., all its features are abstract (e.g., it has only constant data and abstract operations).

Within this Recommendation the term "provider reference point" is used for the SOA "Interface" and "function block" is used for the "SOA Service".

9.7 Other considerations

Other areas with overarching architectural influence are for further study.

10 Business process view

The ITU-T M.3050.x series of Recommendations specifies comprehensive examples of business processes and organizes them in the form of a multi-level matrix, the enhanced Telecom Operations Map (eTOM), into process areas, horizontal (functional) process groupings, and vertical (flow-through) process groupings. It also provides basic mappings between business processes and management function sets.

The model described by eTOM, as shown in Figure 4, is used in this NGNM architecture. eTOM is a business process framework that suggests enterprise processes required for a service provider. However, it is not a service provider business model.

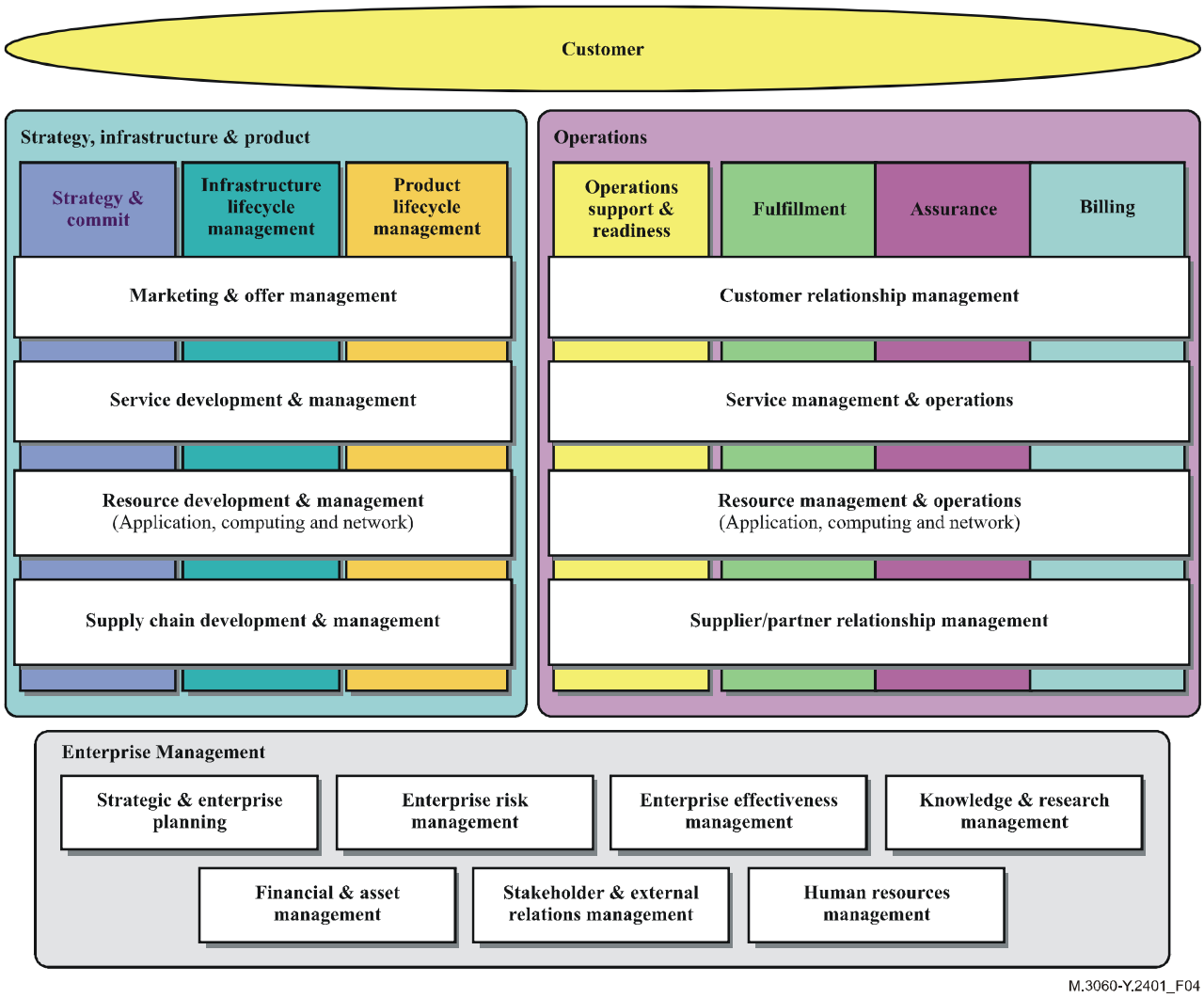


Figure 4/M.3060/Y.2401 – eTOM business process framework – level-1 processes

Business requirements need to take regulator requirements into account. In the business requirements view, the interaction between actors, information objects and business services has to be described. These information objects and business services derive from the multi-level process descriptions in eTOM and business services have to be organized according to eTOM terminology. Refer to ITU-T M.3050.x series Recommendations for further details.

11 Management functional view

The NGN management (NGNM) functional view is a structural and generic framework of management functionality that is subject to standardization.

The management functional view is structured from the following fundamental elements:

– management function blocks;

– support function blocks;

– management functionality;

– provider reference points and consumer reference points;

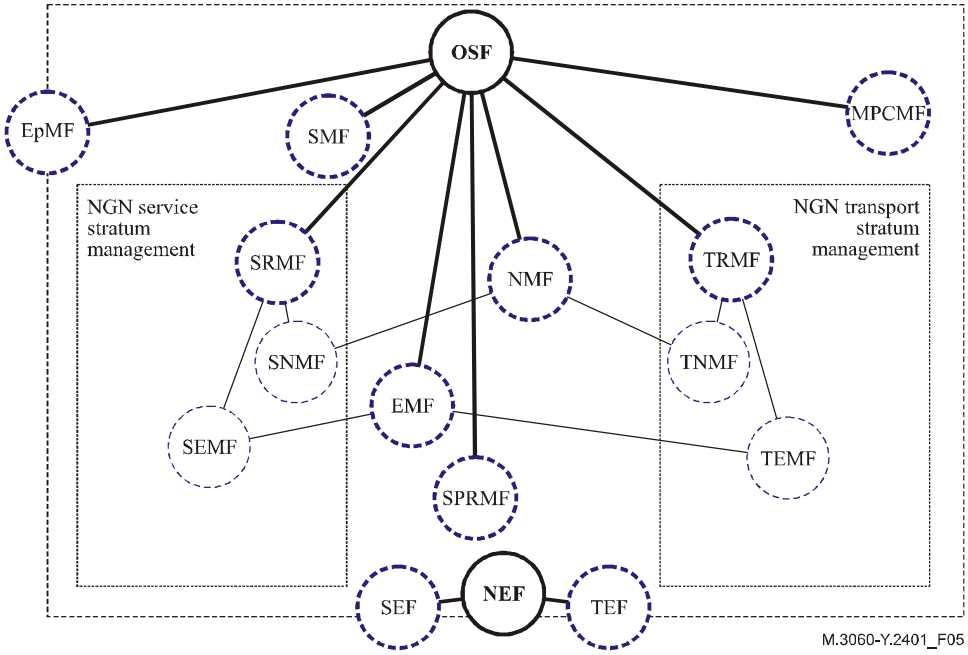
– logical management function layers.

Management functionality to be implemented can then be described in terms of these fundamental elements.

11.1 Management function blocks

A management function is the smallest part of a business process (or management service), as perceived by the user of the process (or service). A management function block is the smallest deployable unit of management functionality (see 11.3). Figure 5 illustrates the different types of management function blocks and indicates that only the functions that are directly involved in management are part of the scope of NGNM standardization. Some of the function blocks are partly in and partly out of the scope of this Recommendation; these management function blocks also perform functions outside of the management functional boundaries as discussed and defined in the subclauses below. A function block includes management functions from one or more Management Function Sets.

Note that while management functions may be considered to have behaviour, this behaviour is only exposed via operations on the reference point.



*EMF	Element Management Function	*SMF	Service Management Function
*EpMF	Enterprise Management Function	*SNMF	Service Network Management Function
*MPCMF	Market, Product & Customer Management Function	*SPRMF	Supplier/Partner Relationship Management Function
NEF	Network Element Function	*SRMF	Service Resource Management Function
NGN	Next Generation Network	*TEF	Transport Element Function
*NMF	Network Management Function	*TEMF	Transport Element Management Function
OSF	Operations Systems Function	*TNMF	Transport Network Management Function
*SEF	Service Element Function	*TRMF	Transport Resource Management Function
*SEMF	Service Element Management Function		

NOTE – The lines drawn between function blocks represent specializations or decompositions. For example, a TRMF is a specialized OSF, an SEMF is a specialized SRMF, and a TEF is a specialized NEF. Black coloured objects (solid circles) are base objects and light-blue coloured objects (dotted-line circles, indicated by an asterisk in the list) are derived objects.

Figure 5/M.3060/Y.2401 – Management function blocks

NOTE – The OSF specializations/decompositions reflect the high level processes identified in M.3050.x series and introduced in clause 10.

11.1.1 Operations Systems Function block (OSF)

The OSF processes information related to the next generation networks management for the purpose of monitoring/coordinating and/or controlling next generation networks telecommunications functions including management functions (i.e., the NGNM itself).

The *NGN Basic Reference Model,* according to ITU-T Rec. Y.2011, requires the separation of services from transport and defines the *NGN Service Stratum* and the *NGN Transport Stratum*. To cope with this model, from the management point of view, the OSF is decomposed into functions of a service stratum, functions of a transport stratum, and common functions. ITU-T Rec. Y.2011 also defines a *general functional model*, based on ITU-T Rec. Y.110, which consists of services, service resources with management and control functions, and transport network resources with management and control functions.

Compliance with these two NGN models can be achieved by decomposing the OSF into a service management function (SMF), a service resource management function (SRMF) and a transport resource management function (TRMF). The SRMF may be further decomposed into Service Network Management Function (SNMF) and Service Element Management Function (SEMF). Similarly, the TRMF may be further decomposed into Transport Network Management Function (TNMF) and Transport Element Management Function (TEMF).

11.1.1.1 Service Management Function block (SMF)

The SMF is an OSF that is dedicated to service instance management. Its functionality comprises, but is not limited to, the following management tasks:

– management of service life cycles;
– B2B and C2B roles (i.e., stakeholder-facing and customer-facing roles) involving:
  • management of contractual aspects of services (SLAs) that are being provided to customers or available to potential new customers such as ordering/delivery (service order handling), assurance of service instances (complaint handling) and associated consequences for billing/invoicing, including operational monitoring and maintenance of statistical data (e.g., QoS);
  • management of association between customers and their subscribed service profiles;
– management of service profiles (requirements on network and service resources);
– management of service and network resources necessary for service-enabling activation including connectivity, bandwidth, QoS requirements (i.e., *resource-facing role*);
– on creation of service instances:
  • allocation of user-specific service instantiation identifiers;
  • request to SRMF to create user-specific service-related data;
  • in case of fixed access, request to TRMF to configure the user's access line;
  • in case of cross-domain connectivity, a request to TRMF to secure E2E configuration of required network resources.

NOTE – The SMF is concerned, amongst other tasks, with resource-facing service management and also partly with dedicated customer-facing service management. In this latter role it is supplemented by the MPCMF, which is also concerned with customer-facing service management (see below).

11.1.1.2 Service Resource Management Function block (SRMF)

The SRMF is an OSF whose functionality comprises, but is not limited to, the following management tasks:

– logical service infrastructure management including network resources and mechanisms required to:
  - manage service applications (software life cycle) and data, application technologies, open APIs and associated security mechanisms;
  - support subscription and controlled access to services;
  - allow routing and billing services to end-users taking into account network and terminal capabilities;
– mapping of SMF requirements into data interpretable by the underlying NMF/EMF;
– management of:
  - the actions of end-users on their profiles;
  - aspects related to service capabilities (e.g., presence, location, nomadism) from a user's perspective;
  - subscriber data and user profile database and its content.

The SRMF is described in terms of FCAPS management function sets.

11.1.1.3 Transport Resource Management Function block (TRMF)

The TRMF is an OSF whose functionality comprises, but is not limited to, the following management tasks:

– realization of the requested connectivity, including selection of network technologies, routing, network inventory (e.g., network topology, geographical information, logical addresses);
– mapping of SMF requirements into network service profiles interpretable by the underlying NMF/EMF;
– management of connectivity across multiple networks, taking into account the multiple vendor contexts;
– management of network resources (e.g., admission control configuration, QoS mechanisms, mappings at inter-network borders);
– provision of network to service correlation.

The TRMF is described in terms of FCAPS management function sets.

11.1.1.4 Network Management Function block (NMF)

The NMF is an OSF that has the responsibility for the management of a network as supported by the EMF.

The NMF addresses the management of a wide geographical area. Complete visibility of the whole network is typical and, as an objective, a technology-independent view will be provided to the resource management function.

The NMF has the following five principal roles:

– control and coordination of the network view of all network elements within its scope or domain;
– provision, cessation or modification of network capabilities for the support of service to customers;
– maintenance of network capabilities;

– maintaining statistical, log and other data about the network and interact with the resource management function on performance, usage, availability, etc.;
– NMFs may manage the relationships (e.g., connectivity) amongst NEFs.

Thus, the NMF provides the functionality to manage a network by coordinating activity across the network and supports the "network" demands made by the resource management function. It knows what resources are available in the network, how these are interrelated and geographically allocated and how the resources can be controlled. It has an overview of the network. Furthermore, this OSF is responsible for the technical performance of the actual network and will control the available network capabilities and capacity to give the appropriate accessibility and quality of service.

If the NMF is located in the NGN service stratum, it is called Service Network Management Function (SNMF), and if it is located in the NGN transport stratum, it is called Transport Network Management Function (TNMF).

11.1.1.5 Element Management Function block (EMF)

The EMF is an OSF that is responsible for the management of network elements on an individual or group basis and supports an abstraction of the functions provided by the network element function.

The EMF has one or more element OSFs, which are individually responsible, on a devolved basis from the network management function, for some subset of network element functions. As an objective, a vendor-independent view will be provided to the network management function.

The EMF has the following three principal roles:

– Control and coordination of a subset of network elements on an individual NEF basis. In this role, the EMFs support interaction between the NMF and the NEF by processing the management information being exchanged between NMFs and individual NEFs. Element OSFs should provide full access to NE functionality.
– The EMF may also control and coordinate a subset of network elements on a collective basis.
– Maintaining statistical, log and other data about elements within its scope of control.

If the EMF is located in the NGN service stratum, it is called Service Element Management Function (SEMF), and if it is located in the NGN transport stratum, it is called Transport Element Management Function (TEMF).

11.1.1.6 Supplier/Partner Relationship Management Function block (SPRMF)

The SPRMF is an OSF that communicates with Suppliers and Partners for the purpose of importing external transport or service resources for use by the enterprise; it is not concerned with the management of the NGN strata directly. The SPRMF provides the service and support functions that are required to support the supplier's supply chain processes/services being managed. The SPRMF includes the service functions described in the Supplier/Partner Relationship Management and Supply Chain Development & Management process groupings of ITU-T Rec. M.3050.2.

It includes dealing with the enterprise's interaction with its suppliers and partners. This involves both processes that develop and manage the Supply Chain that underpins product and infrastructure, as well as those that support the operational interface with its suppliers and partners.

11.1.1.7 Market, Product and Customer Management Function block (MPCMF)

The MPCMF is an OSF that is responsible for creating, managing, and maintaining service provider products. It is not concerned with the management of the NGN strata directly. Refer to 11.6.1.2 for details.

The MPCMF is concerned, amongst other tasks, with customer-facing service management. In this role it is supplemented by the SMF, which is also concerned with customer-facing service management and additionally with resource-facing and stakeholder-facing service management.

It includes dealing with sales and channel management, marketing management, and product and offer management, as well as operational processes such as managing the customer interface, ordering, problem handling, SLA management and billing.

11.1.1.8 Enterprise Management Function block (EpMF)

The EpMF is an OSF that is responsible for those basic business processes that are required to run and manage any large business. These processes include disaster recovery, security and fraud management, quality management and IT planning and architecture. These generic processes focus on the setting and achieving of strategic corporate goals and objectives, as well as providing those support services that are required throughout an Enterprise.

11.1.2 Service Element Function block (SEF)

The SEF is a function block that communicates management information for the purpose of being monitored and/or controlled. The SEF provides telecommunication and support functions which are required by the NGN service stratum of the NGN being managed.

The SEF includes the telecommunication functions of the NGN service stratum that are the subject of management. These functions are not part of the scope of standardization but are represented to the management system by the SEF. The part of the SEF that provides this representation in support of the management is part of the scope of this framework, whilst the telecommunication functions themselves are outside.

11.1.3 Transport Element Function block (TEF)

The TEF is a function block which communicates management information for the purpose of being monitored and/or controlled. The TEF provides telecommunication and support functions which are required by the NGN transport stratum of the NGN being managed.

The TEF includes telecommunication functions of the NGN transport stratum which are the subject of management. These functions are not part of the scope of standardization but are represented to the management system by the TEF. The part of the TEF that provides this representation in support of the management is part of the scope of this framework, whilst the telecommunication functions themselves are outside.

11.1.4 Network Element Function block (NEF)

The NEF is a function block with the properties of both an SEF and a TEF.

11.2 Support function blocks

Management functions may be supported by support functions that may form a support function block or optionally be part of a management function block. Support functionality may be shared by management function blocks within an implementation. Some support functionality assists a management function block in its interactions with other function blocks.

11.2.1 Transformation Function block (TF)

The applicability and evolution of the Transformation Function block (TF) functionality for NGNM is for further study. The TF is not concerned with the management of the NGN strata.

The Transformation Function block (TF) provides functionality to connect two functional entities with incompatible communication mechanisms. Such mechanisms may be protocols or information models (see 12.3) or both.

The TF may be used anywhere within an administrative domain or anywhere at the boundary of an administrative domain. When used within an administrative domain, the TF connects two function blocks, each of which supports a standardized, but different, communication mechanism.

When used at the boundary of an administrative domain, the TF may be used either as communication between two compliant administrative domains or between a compliant and a non-compliant environment.

When used at the boundary of two administrative domains, the TF connects two function blocks, one in each administrative domain, each of which supports a standardized, but different, communication mechanism.

When the TF is used between a compliant and a non-compliant environment, the TF connects a function block with a standardized communication mechanism in the compliant environment to a functional entity with a non-standardized communication mechanism in the non-compliant environment.

11.2.2 Other support function blocks

Other support function blocks are for further study (see 11.3.2).

11.3 Management functionality

ITU-T Rec. M.3050.0 describes two complementary ways of defining management functionality:

– the Management Service/Function approach of M.3200 and M.3400 that has been built on the requirements to manage network equipment and networks (bottom up);

– the Business Process approach of M.3050.x (eTOM) that has been built on the need to support processes of the entire Service Provider enterprise (top down).

Both approaches can be used to identify generic and specialized management function sets to support management activities as defined in ITU-T Rec. M.3400. The Management Service/Function approach captures a technology- and resource-oriented view of the management domain, and this is often valuable and relevant when considering the structure and organisation of a management solution. The Business Process approach provides an additional business-oriented viewpoint that is important in considering the business requirements of the Service Provider, as the user of a management solution, and in ensuring that the arrangement of management functions is meaningful and useful for the way that the Service Provider does business.

It is expected that both approaches will eventually converge into an implementable Business Process approach where Management Services are seen as parts of Business Processes. A first step in this direction is the initial mapping of M.3400 to M.3050.x and vice versa given in M.3050/Suppl.3 that turned the Business Process approach into a Business Process/Management Function approach. The evolution of the relationship of the Business Process approach to the management service concept, and whether one approach will dominate in the future, is for future study.

Management Functions, that collectively define a single management capability, are grouped together and referred to as a Management Function Set. The Management Function Sets used to specify the Management Services and Business Processes and, thereby, the required management functionality are either taken from a Management Function Set (MFS) library such as M.3400 or are newly developed and then added to an MFS library.

Management functionality is defined to be recursively composed for flexibility during the evolution of a complex NGNM and backwards compatibility with TMN.

A Management Function is defined to be a smallest part of a Business Process or Management Service as perceived by the user of the process or service. An MFS is a grouping of management functions that contextually belong together, i.e., they are related to a specific well-defined management capability set (e.g., NE(s) configuration, alarm reporting, or traffic control as defined in ITU-T Rec. M.3400). Management Functionality is a well-defined grouping of related management function sets and possibly further management functionalities of a smaller scope that contextually belong together. See Figure 6 for an illustration of this recursive definition. The definition allows for the introduction of as many levels of functional granularity as appropriate between the user of a particular management functionality and the managed resources used to specify or realize that management functionality. Management functionality is defined to be recursively composed for flexibility during the evolution of a complex NGNM solution.

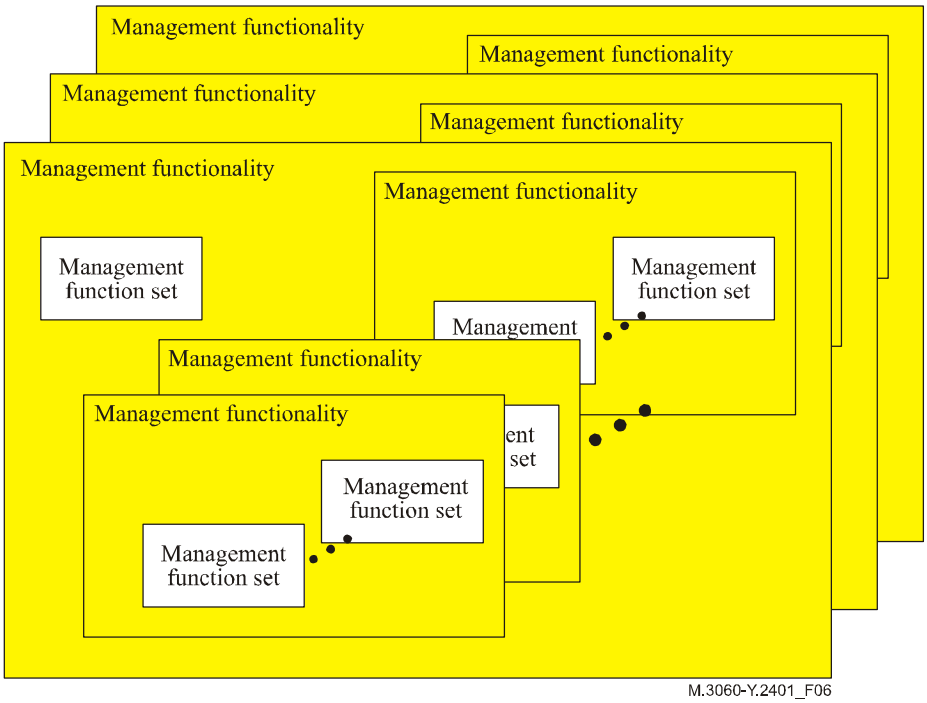


Figure 6/M.3060/Y.2401 – Recursive nature of management functionality

Figure 7 depicts that:

– management functionality for some management solutions is defined by Management Services and/or Business Processes, which are comprised of Management Function Sets;

– any management functionality is structured (from its specification) into Operations System Function (OSF) blocks.

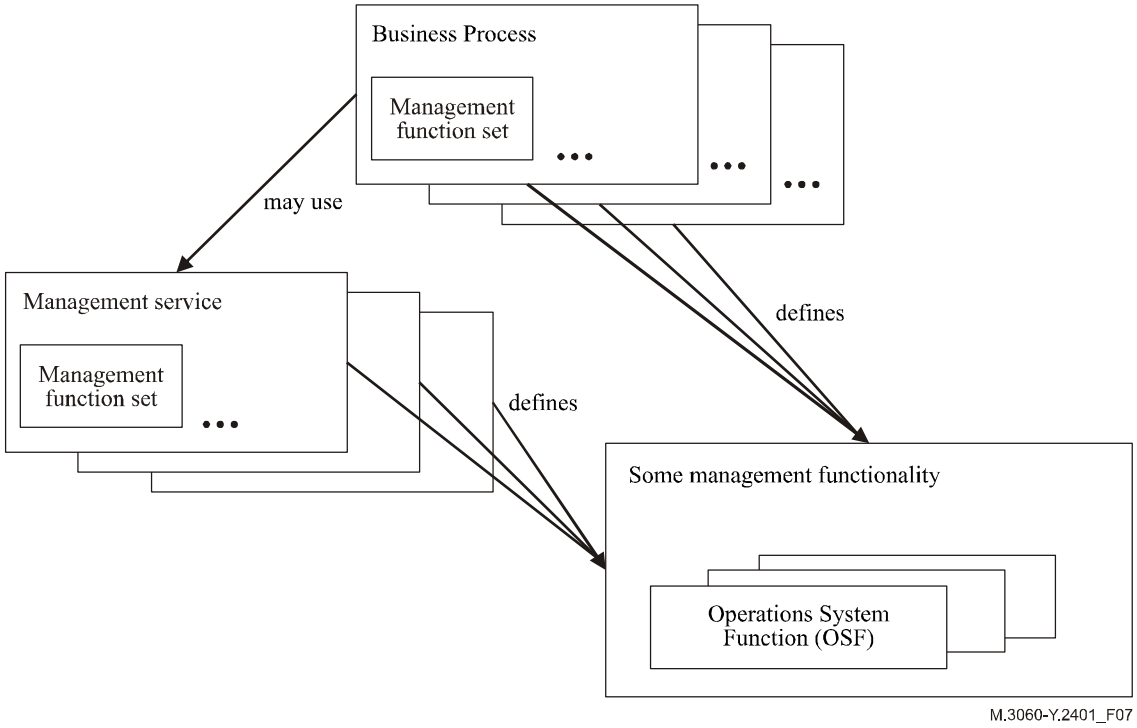


Figure 7/M.3060/Y.2401 – Definition of management functionality

11.3.1 Management functions

Besides the user-centric definition of management function, there is an equivalent system-centric definition which is based on the interaction of function blocks. To perform business processes and management services, function blocks expose their functionality and interactions take place between two or more function blocks, with the help of support functions. These exposed functions are referred to as Management Functions. Management functions that contextually belong together and, therefore, collectively define a specific and recognized management capability set, are grouped together and referred to as a Management Function Set (MFS). For example, the management functions that collectively are all of the potential interactions that a single part of the functionality of one or more business processes or management services will support, may form an MFS.

A major advantage of this definition of Management Function is that it leads directly to the core concept of Reference Point that is introduced in the next subclause. To initiate and perform interactions with other function blocks, any function block provides management functions for use by other function blocks and requires management functions from other function blocks for its own use. A reference point represents a set of such management functions. If it encompasses only provided functions, it is called a provider reference point, and if it encompasses only required functions, it is called a consumer reference point.

11.3.2 Support functionality

Support functions may form a support function block or optionally be found in a management function block. The support functionality is potentially common to more than one management function block within an implementation. Some support functionality assists a management function block in its interactions with other function blocks.

Examples of such functionality include the following:

– transformation functionality;
– data communication functionality (DCF);
– workstation support functionality;
– user interface functionality;
– directory system functionality;
– database functionality;
– security functionality;
– message communication functionality.

11.4 Reference points

A Reference Point delineates and exposes/consumes an external view of management functionality of a function block; it defines all or a part of that function block's service boundary. Reference points expose behaviour offered by, or used by, a function block. The interactions between function blocks are usually established dynamically at run time and not defined statically at design time. An external view of management functionality of a function block is captured in a set of management functions that will have visibility from the function block. For example, a Management Function Set may form an external view of management functionality of a function block. A reference point may be used to delimit Management Function Sets and to define a service boundary of an MFS.

Reference points have meaning in functional specifications leading to an implementation. A reference point represents the interactions between function blocks. Table 1 shows the relationships between the function blocks in terms of common reference points between them. The reference point concept is very important because a reference point represents one or both of two aggregate types. The first type is an aggregate of all, or some, of the abilities that a particular function block requires from another particular function block, or equivalent function blocks for consumption. The second type is an aggregate of all, or some, of the operations and/or notifications (as defined, for example, in ITU-T Recs X.903 and X.703 for RM-ODP and ODMA) that a function block provides to a requesting function block. Correspondingly, a reference point may be qualified as a consumer reference point, or a provider reference point, or may remain unqualified, meaning that it can be either one, for the sake of discussion within this Recommendation. A reference point, specified in the functional view, corresponds to an interface, in the physical view, if its defining function block and corresponding peer function blocks are implemented in different physical blocks. Several reference points may correspond to the same interface.

The following subclauses classify and describe the reference points that are subject to standardization in this Recommendation. Other reference points are not precluded by this management functional view and they are for further study.

11.4.1 Provider reference points

A provider reference point is a reference point which delineates and exposes an external view of management functionality of a function block, where all exposed management functions are provided for consumption by other function blocks. It is depicted with a filled lollipop.

11.4.2 Consumer reference points

A consumer reference point is a reference point which delineates a function block and consumes the management functionality provided by another function block through one of its provider reference points. It is depicted with a black crescent.

11.4.3 Provider reference point groups

A provider reference point group is a pre-defined collection of provider reference points that belong together according to a chosen context.

11.4.4 Classes of reference points

Three classes of management reference points are defined, these are:

q A reference point provided/consumed from an OSF consumed/provided by another OSF or an NEF.

b2b/c2b A reference point provided by an OSF of one administrative domain to be consumed by an OSF in another administrative domain. It could also be provided by the OSF of an administrative domain and consumed by the equivalent OSF-like functionality of another administrative domain.

hmi A reference point provided for consumption by human users.

Example relationships of functional blocks and reference points are listed in Table 1. The interfaces corresponding to implementations of reference points are designated with the same but capitalized letters and described in 13.6. See also Figure 16.

Table 1/M.3060/Y.2401 – Example relationships between logical functional blocks expressed as classes of provider and consumer reference points

	SEF	**TEF**	**OSF (Note 2)**	**non-compliant**
SEF			q	
TEF			q	
OSF (Note 2)	q	q	q, b2b/c2b (Note 1)	
non-compliant				
NOTE 1 – b2b/c2b reference point only applies when each OSF is in a different administrative domain. NOTE 2 – OSF can be EpMF, MPCMF, SPRMF, SMF, SRMF, or TRMF. SRMF and TRMF in turn can be NMF or EMF. NOTE 3 – Any function may communicate at a non-compliant reference point. These non-compliant reference points may be standardized by other groups/organizations for particular purposes.				

11.4.5 Reference point descriptions and usage

The management functional view, and the reference points it contains, gives a framework to the task of deriving the requirements for the specification of management interfaces. Each reference point requires different interface characteristics for the information exchange. However, a reference point does not itself determine the protocol suite. Protocol specification occurs as a latter task in the management interface specification methodology.

The protocol definition should seek to minimize the differences between the management interfaces and thus the requirements leading to protocol differences need to be clearly defined.

11.4.5.1 q reference points

The q reference points are often located between the function blocks NEF and OSF, and between OSF and OSF, either directly or via the DCF.

The q reference points may be distinguished by the knowledge required to communicate between the function blocks they connect, in particular, in case of different OSF specializations. The distinction is for further study.

11.4.5.2 b2b/c2b reference points

The b2b/c2b reference points are located between the OSFs in different administrative domains. Entities located beyond the b2b/c2b reference point may be part of an actual compliant environment (OSF) or part of a non-compliant environment (OSF-like). This classification is not visible at the b2b/c2b reference point.

11.4.5.3 hmi reference points

A human machine interface (hmi) reference point is exposed for consumption by human users. Note, that an hmi need not be graphical in nature. It could be text-based. The detailed definition of the hmi reference point can be found in the Z.31x-series Recommendations.

11.4.6 Relationship of reference points to function blocks

Figure 8 illustrates the relationship of reference points to function blocks.

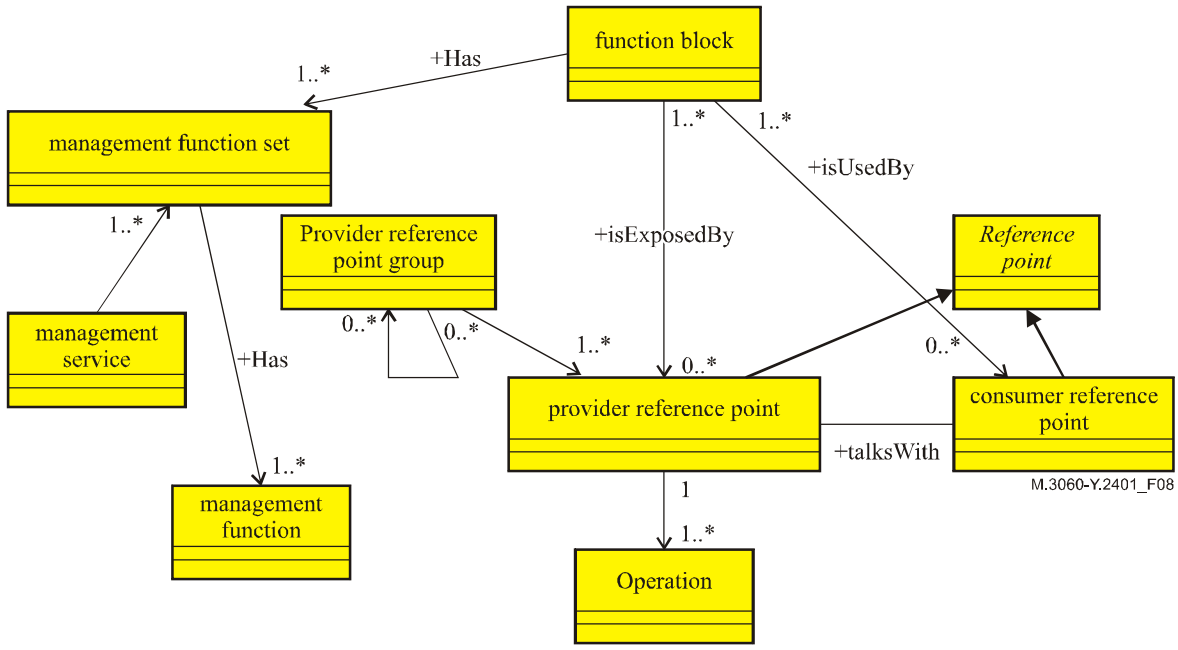


Figure 8/M.3060/Y.2401 – Reference point and function block relationship

NOTE – The cardinality of the relationships within Figure 8 may evolve as a result of further study.

Figure 9 illustrates an example of possible reference points between function blocks. In particular, it demonstrates communication between different administrative domains as illustrated by the network clouds. The dashed line contains the function blocks and reference points within the scope of standardization (NGNM functional boundary). Those function blocks only partially contained within the dashed line are not fully within the scope of standardization.

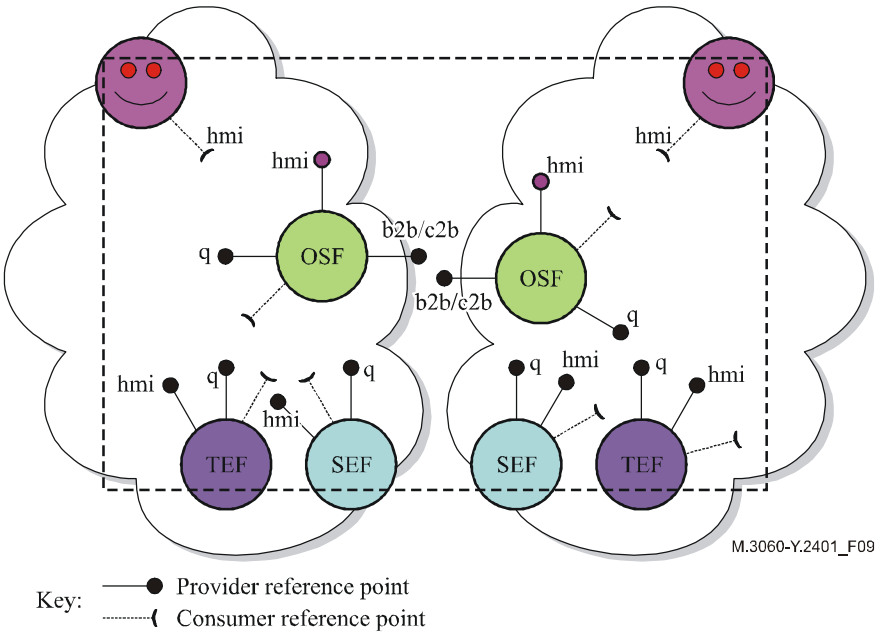


Figure 9/M.3060/Y.2401 – Illustration of reference points between function blocks

11.5 Operations

An Operation is a behaviour which is published as a member of a Provider Reference Point or a Consumer Reference Point. An Operation:

– is bound to a specific Provider or Consumer Reference Point;

– represents a published behaviour of the Function Block exposing this Reference Point;

– may be defined using Operations that are published as part of reference points of other Function Blocks;

– is a single logical unit of behaviour. This behaviour is defined in terms of pre-conditions, post-conditions, and exceptions, and further policy artefacts, in which case the Operation is called contract-defined. An example operation would be to retrieve an alarm list, which is defined, for example, in the 3GPP Alarm IRP Information Service document (TS 132 111-2);

– is defined using "Message Exchange Patterns" (such as synchronous or asynchronous Request/Response/Notification) as defined, for example, by TMF NGOSS Contracts, the design pattern TMF MTOSI communication styles and patterns, and W3C WSDL.

NOTE 1 – The role of notifications with respect to operations is for further study.

NOTE 2 – Management functions may be considered to have behaviour, but this behaviour is only exposed via operations on the reference point.

11.6 Management layers within the management functional view

To deal with the complexity of NGN management, management functionality may be partitioned into logical layers, or functional Management Layers. The Logical Layered Architecture (LLA) is a concept for the structuring of management functions, which organizes the functions into groupings called "logical layers" and describes the relationships between layers. A logical layer reflects particular aspects of management arranged by different levels of abstraction.

The NGN Management Logical Layered Architecture is illustrated in Figure 10. Note that in this figure, related functions are depicted grouped together to aid understanding, but this does not imply prescriptive grouping of reference points in implementation.

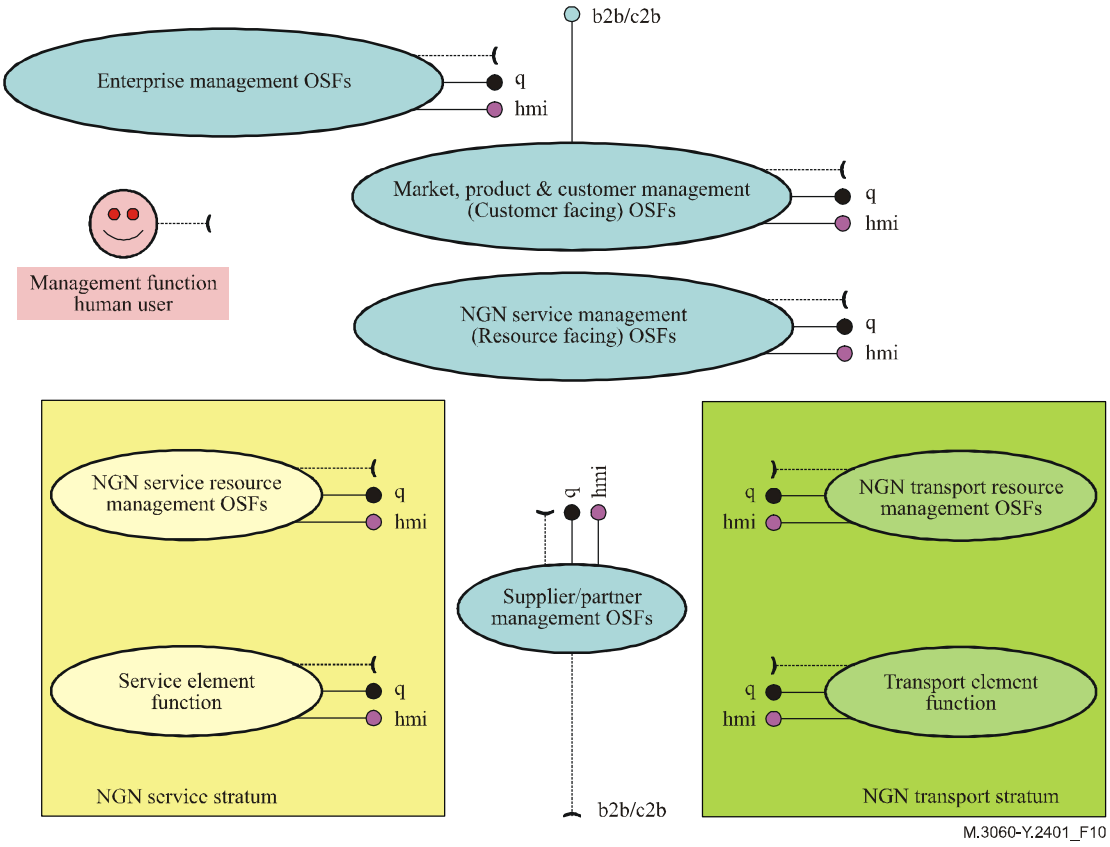


Figure 10/M.3060/Y.2401 – NGN management logical architecture

11.6.1 Management function layers of abstraction

The grouping of management functionality implies grouping of management function blocks into logical layers. A specialization of OSFs based upon different layers of abstraction is the following:

– Enterprise Management;

– Market, Product and Customer Management (Customer-Facing Service Management);

– NGN Service Management (Resource-Facing Service Management);

– Resource Management;

– Service and Transport Element Management;

– Supplier and Partner Relationship Management.

These layers of abstraction are depicted in Figure 10.

Management implementations may include Enterprise Management Function blocks that are concerned with a total enterprise and carry out an overall business coordination. Market Product and Customer Management Function blocks and Service Management OSFs are concerned with services offered by one or more networks and will normally perform a customer interfacing role. NGN Resource Management OSFs are concerned with the management of networks, and Element Management OSFs with the management of individual elements. Supplier and Partner Relationship Management Function blocks are concerned with the management of the enterprise's interaction with its suppliers and partners.

The layering of OSFs shown in Figure 10, although widely accepted, should not be regarded as the only possible solution. Additional or alternative layers may be used to specialize functionality.

The following subclauses describe a typical allocation of functionality amongst the management layers based on the reference model.

11.6.1.1 Enterprise management

Enterprise Management is responsible for those basic business processes that are required to run and manage any large business.

11.6.1.2 Market, product and customer management

The Market, Product and Customer Management Layer consist of Market Product and Customer Management Functions. It is the top layer in the NGN management logical layered architecture. It is mainly responsible for supporting the development, management and improvement of the relationship with the Customer and for the development, management and lifecycle of Products.

The management functions exposed as part of the market, product and customer management Provider Reference Point is for further study. It is recommended that the eTOM framework (ITU-T M.3050.x series of Recommendations) be referred to as a starting point.

The main purposes of the Market, Product and Customer Management Layer are:

– Management of instances of Product Objects during their whole lifecycle;

– To provide common functionality for order management of SP's products;

– To provide functionality to handle the dialog with customers through a well-defined business interface;

– To administer and manage functionality that uses information from the Service Management Layer. For example, trouble ticket handling, collection and processing of accounting data on a product and/or customer level.

For example, the functions that would need to be covered in the Market, Product and Customer Management Layer include the following:

– Definition of the product itself from a marketing and commercial perspective, how to bill, to whom the service is addressed, are there specific geographical areas where the service cannot be offered, bundle of services, etc.

In terms of comparison with the M.3050.x (eTOM) framework, similarities can be expressed as in Figure 11 below.

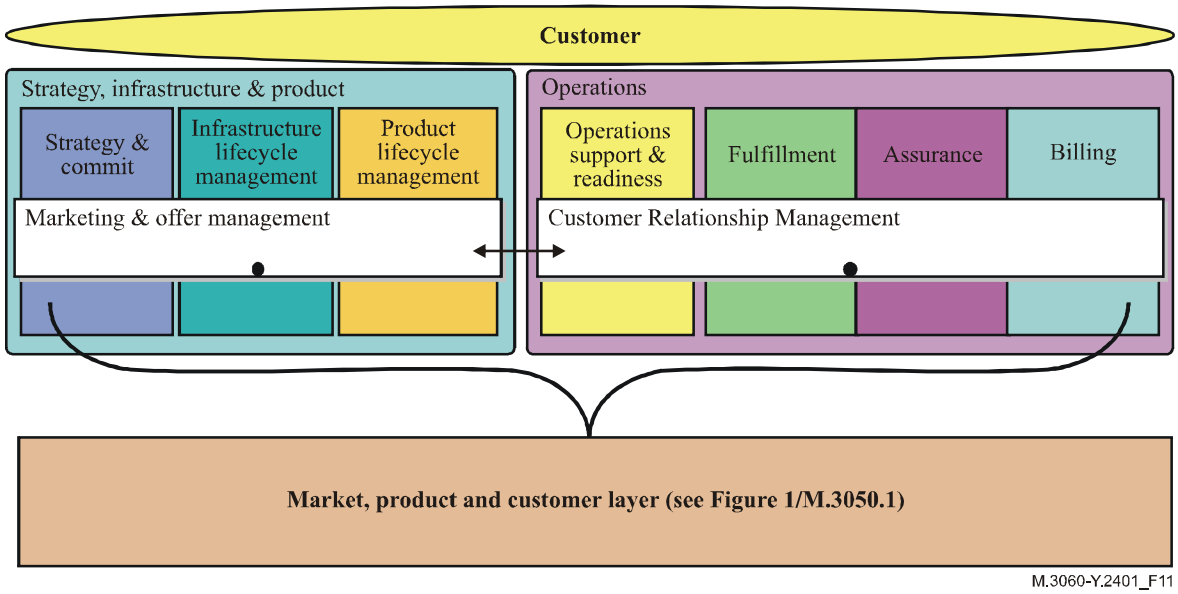


Figure 11/M.3060/Y.2401 – Market, product and customer management

11.6.1.3 Service management

The Service Management Layer (SML) supports the functions for managing the delivery and assurance of services to end-users according to customer expectations. It includes the functions for:

– The management of service profiles: each service profile expresses the transport and service resources requirements needed to activate the service; the underlying SRML and TRML map these requirements into network parameters of the underlying network elements;

– The management of the association of actual subscribers to the set of profiles corresponding to this subscribers service contract;

– The management of the service and transport resources required for enabling the activation of services according to the end-user contract, including the required connectivity and its associated characteristics: bandwidth, QoS, level of SLA;

– The supervision of active services to guarantee meeting the contractual SLA and the impact of non-respect on the billing functions (delivery of information to the operator, rebate indications to billing system in case of too low QoS, etc).

All management functions exposed by service management-related Provider Reference Points towards the Market, Product and Customer Management Layer are resource/technology independent and will not provide any technical knowledge on the underlying resources involved in the provisioning of services to the customers: no information about transport or service platforms are available through service management functions.

The service management function relies on the Resource Management function to map its service-oriented view and information to the required entities in the appropriate NGN resources.

The exhaustive set of management functions, which compose the service management-related Provider Reference Point, is for further study. It is recommended that the eTOM framework (ITU-T M.3050.x series of Recommendations) be referred to as a starting point.

In terms of comparison with the M.3050.x (eTOM) framework, similarities can be expressed as in Figure 12 below:

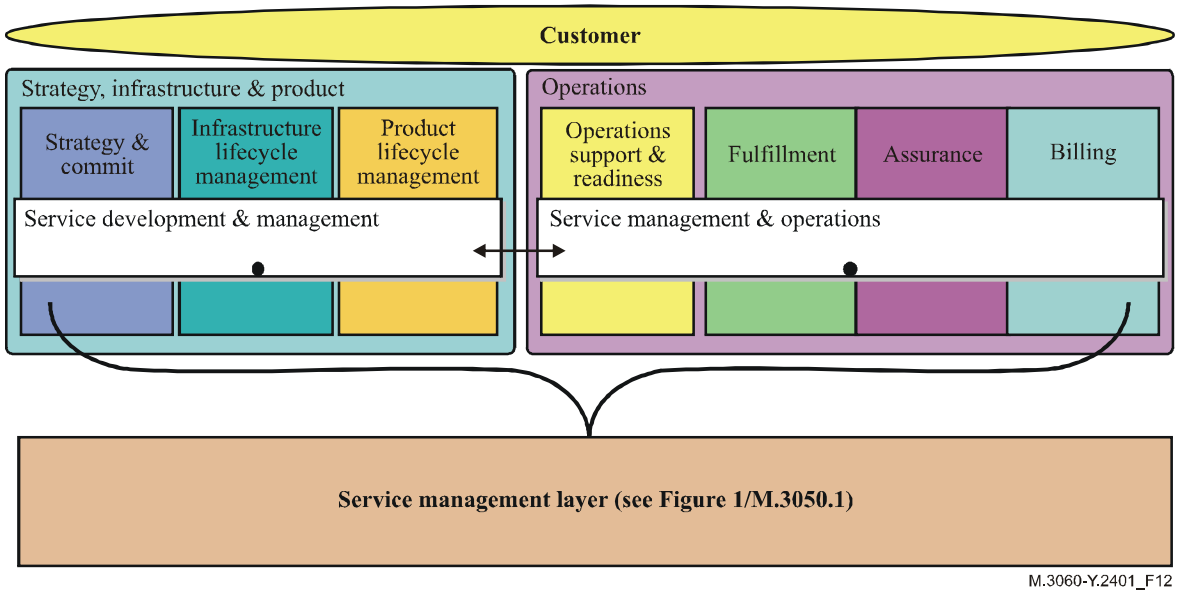


Figure 12/M.3060/Y.2401 – Service management

The contracting of a given service by an end-user may result, for example, in the following:

– the creation in the Service Management Layer of a unique identifier for the new service instance that will associate the results of allocating the required service and transport resources to this service instance;

– a request to the Transport Resource Management Function for checking availability of required network resources;

– in case of services, a request to the Service Resource Management Layer for creating all service-related data for this user in the relevant network databases;

– if appropriate, a request to the Service Resource Management Function for triggering/checking the configuration of the CPE equipment;

– in case of fixed access, a request to the Transport Resource Management Layer for configuring this end-users' access line according to the technical requirements corresponding to the service contract;

– if required, a request to the Transport Resource Management Layer for the end-to-end/cross-application configuration of required network resources.

11.6.1.4 Resource management

While the Service Management Layer (SML) has the responsibility for managing the service lifecycle and the delivery and assurance of service instances, the Resource Management Layer (RML) is responsible for the management of the logical service and transport infrastructures.

The functions that are part of the Resource Management Functions enable the mapping of service-oriented information used in the Service Management Functions into resource/technology dependent information used in the NGN Resources.

In terms of comparison with the M.3050.x (eTOM) framework, similarities can be expressed as in Figure 13 below:

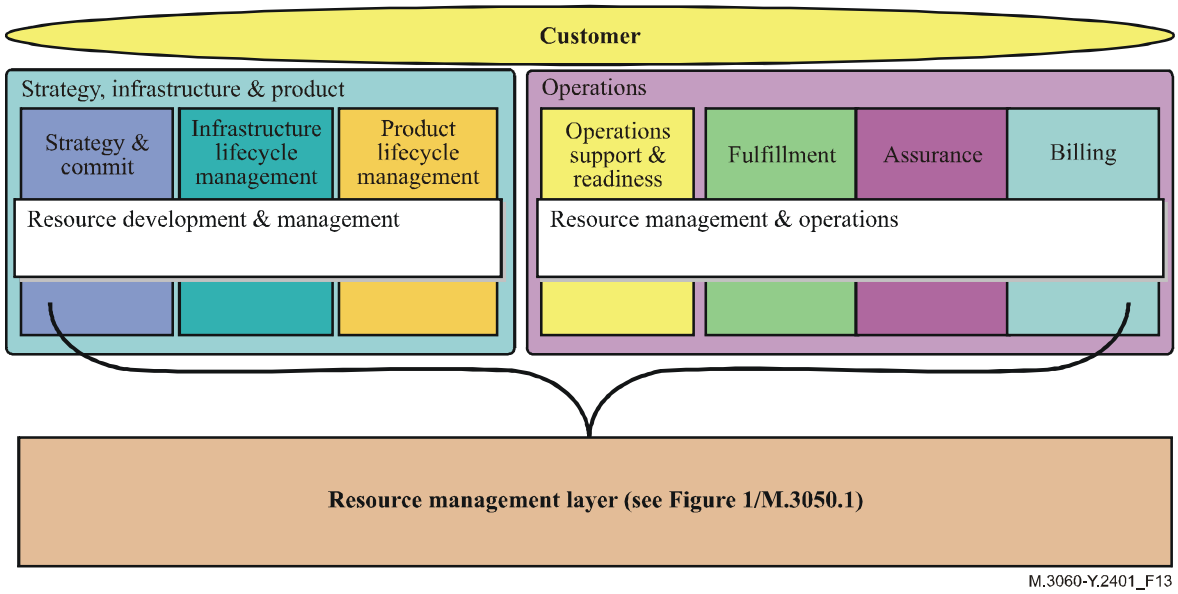


Figure 13/M.3060/Y.2401 – Resource Management

The Resource Management Function is composed of two main sub-functions linked to the split of the NGN architecture into the NGN Service Stratum and the NGN Transport Stratum:

– the Service Resource Management Function;

– the Transport Resource Management Function.

The Service Resource Management Function provides the management functionality for a new set of resource management features related to support the service stratum of the NGN, such as the management of applications, application data, users, user data, terminal equipment, etc.

The Transport Resource Management Function provides the management functionality for the traditional transport management functions, with enhancements to support the transport stratum of the NGN, such as end-to-end IP connectivity and QoS management, etc.

In the following, an example of the respective responsibilities of the Service Management Function and Resource Management Function is given. The provisioning of a given service to an end-user will result in the following actions:

– the creation in the Service Management Function of a new service instance that will associate the results of the allocation of the required service and transport resources to this service instance by the Resource Management Function;

– interactions with the Transport Resource Management Function:
  - for checking availability of required transport network resources;
  - for the end-to-end/cross-application configuration of required transport network resources;
  - for configuring this end-users' access line according to the technical requirements corresponding to the service contract;

– interactions with the Service Resource Management Function:
  - for creating all user-related data in the relevant network databases, in case of a new user;
  - for creating all service-related data for this user in the relevant network databases;
  - for allocating the required service network resources;
  - for triggering/checking the configuration of the CPE equipment.

11.6.1.4.1 Service resource management

The Service Resource Management Function is responsible for the management of the resources in NGN service stratum. The Service Resource Management Function is decomposed into service network management functions and service element management functions.

This NGN service stratum infrastructure includes the data/information required to enable the functioning of the NGN services with:

– associated mechanisms used by the services to access the data;

– the management of the contained data.

The Service Resource Management Function includes, but is not limited to, the following functions:

– the mapping of the Service Management Function requirements into service profiles and data interpretable by the underlying resources;

– the management of the application software and application data in the network, including introduction, upgrade, inventory, distribution, application technologies, open application interfaces and associated security mechanisms;

- the management of the end-user actions on his/her service profile: access by the end-user to his/her profile, the management of the impact on management systems, following profile changes made by the end-user;
- the management of the aspects related to Service Capabilities, such as Presence, Location, Nomadism, and their impact on active services from the user perspective;
- the management of the aspects related to Network Capabilities, such as Billing, Routing, etc.;
- the management and mechanisms to support subscription to services and the management of the subscription by the end-user (self management);
- the management of the subscriber data and user profile database and its content;
- the collection of service delivery SLA data (data to calculate the time to deliver a service to a user after subscription) in order to guarantee that services are delivered with the requested characteristics;
- the collection of service performance data and its analysis to enable input to service resource planning functions;
- the management of the service required software and configuration on customer premises equipment;
- the management of the system allowing for customer premises equipment management;
- the management of the pre-testing of the service;
- the management of the application redundancy policy;
- the management of the re-dimensioning of the infrastructure in case the service needs to be extended;
- the management of the collection of application performance data.

11.6.1.4.2 Transport resource management

The Transport Resource Management function is responsible for the realization of the connectivity and for the configuration of other service-related aspects in the network. This includes functions such as selection of network technologies, routing, network resource management, inventories, etc.

The Transport Resource Management Function is decomposed into transport network management functions and transport element management functions. It also defines additional NGN management functions for handling the end-to-end aspects of implementing transport services on the network, such as:

- The mapping of the Service Management Function requirements into service profiles interpretable by the underlying TEMF/TNMF;
- The management of the connectivity aspects related to inter-operator connectivity or connectivity over multiple networks taking into account the multi-vendors contexts in which NGN networks will operate;
- The management of the connectivity aspects related to the provisioning of resources related to access lines;
- The management of the network resources in the network, such as QoS mechanisms and mappings at inter-network borders, NAT/firewall configuration, signalling network configuration.

The Network Inventory stores information about network resources, their relations and locations. The Network Inventory provides Management Functions with necessary information about how the real network is built and configured. The Network Inventory has to consist of a network technology independent and a network technology-dependent part. The independent part manages:

– Information that describes the management view of the network topology;
– Connectivity Paths describing installed connections;
– Logical addresses;
– Geographical information (where network resources and entities are located);
– Naming.

The network technology-dependent part manages:

– Information about physical equipment;
– Information about logical equipment;
– The topology of how these equipments (physical and logical) are connected to each other.

11.6.1.5 Supplier/partner relationship management

The Supplier/Partner Relationship Management Layer is responsible for the communication of the suppliers and partners for the purpose of importing external transport or service resources for use by the enterprise. The Supplier/Partner Relationship Management Layer provides the service and support functions which are required to support the supplier supply chain processes/services being managed. It includes the service functions described in the Supplier/Partner Relationship Management, Supply Chain Development management process grouping of M.3050.x.

11.6.2 Functional interaction between management layers

While a management function block will typically interact with management function blocks in logical adjacent management layers, operational and management considerations may support the need for interactions between non-adjacent layers. For example, due to management traffic considerations, the service management layer may wish to interact directly with the element management layer for the exchange of accounting data.

11.6.3 Relationship between multiple NGN management layered architectures

In the case where enterprises buy resources or sell products to other enterprises, the NGNM Logical Layered Architectures of the enterprises need to be linked together.

Products, sold both to the end customer and to other enterprises, are exported through the Product, Market and Customer Management Layer. Purchased Transport and Service Resources are imported through the Supplier/Partner Relationship Management Layer.

Figure 14 illustrates an example of interconnected NGN Management Logical Layered Architectures where an NGN Service Provider imports Transport Resources and Location Service Resources in order to supply NGN service customers.

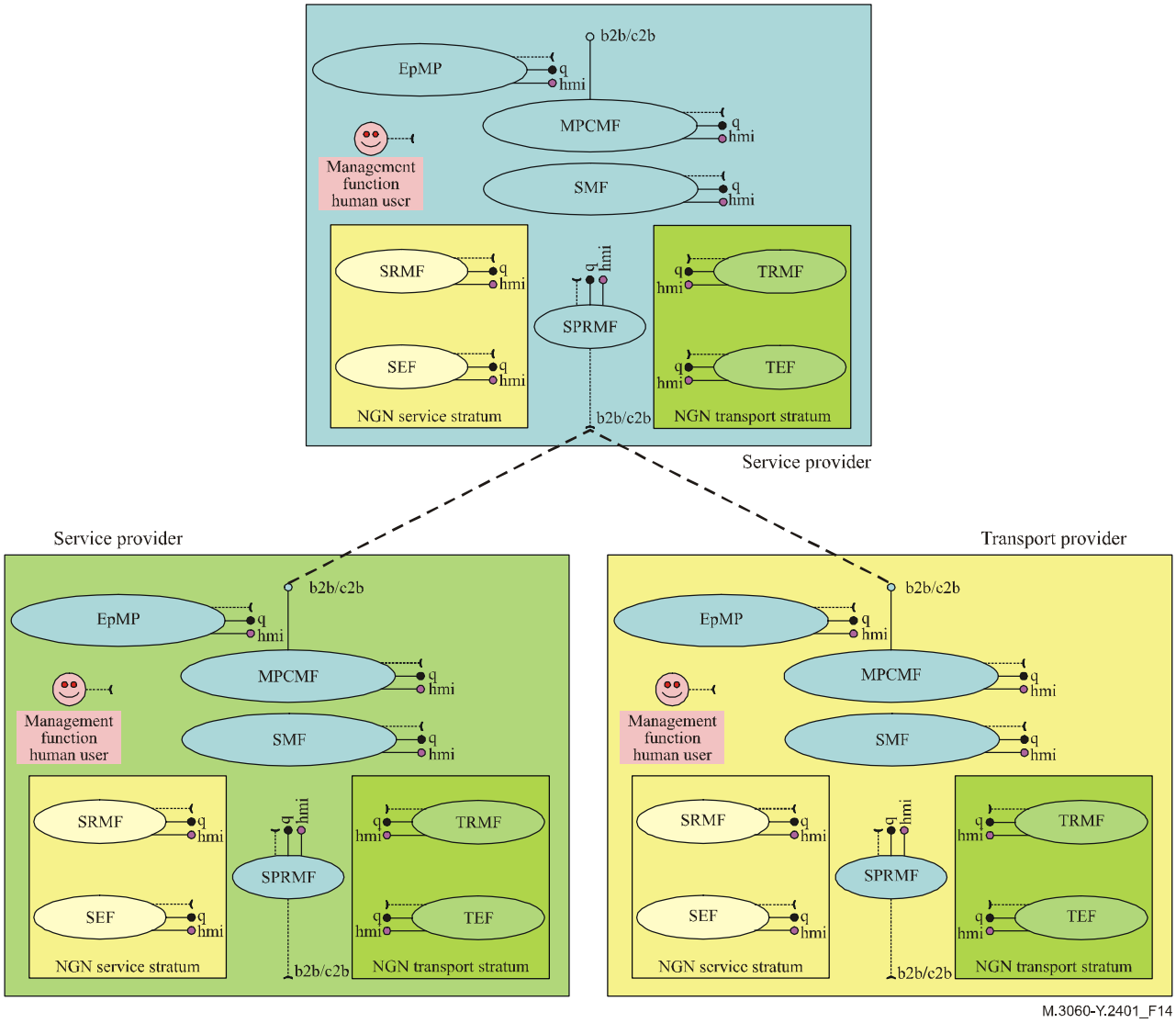


Figure 14/M.3060/Y.2401 – Example of interconnected NGNM logical layered architectures

11.7 Relationship of the management functional view to service-oriented architecture

One of the architectural principles behind the management architecture for Next Generation Networks is that of its being Service-Oriented. A Service-Oriented Architecture (SOA) is an architectural style whose goal is to maximize service sharing, reuse, and interoperability in distributed environments through loose coupling among interacting functional blocks that offer their management functionality through reference points. Loose coupling is achieved by function block behaviours which are defined completely by dynamic reference points where interactions are established and broken dynamically at run time and not yet defined statically at design time (see 11.5).

SOAs for NGN management are based on the following principles:

– An NGN management service is an entity that represents an application function for NGN management to be used in business processes and exposes its behaviour through one or more dynamic reference points (i.e., logical service interfaces).

– An NGN management service may be packaged as one or more (reusable) function blocks. Particularly a function block may be considered a NGN manager.

– The management functions of a service are organized into one or more service reference points, and so a service is represented as a reference-point-oriented grouping of management functions.

In an SOA, all invocation relationships between function blocks are established dynamically at run time using the "find-bind-execute" paradigm. This means:

– there is no static reference point architecture;

– a registry/repository is a typical mechanism used to support a "find-bind-execute" model;

– when a registry/repository is used, providers must register/publish their services and consumers must use a "find-bind-execute" model;

– the registry/repository needs to be structured so that function blocks can search for, and find, the services that they wish to use.

12 Management information view

This clause gives a high-level overview of information view principles and information architectural elements. The management information view of the NGN management architecture specifies the exposed information exchanged between function blocks defined in the functional view. The specification of information models is outside the scope of this Recommendation.

12.1 Information view principles

Management of a telecommunications environment is an information processing application. To effectively manage complex networks and support network operator/service provider business processes, it is necessary to exchange management information between management applications implemented in multiple managing and managed systems. Thus telecommunication management is a distributed application.

The management information view, in order to promote interoperability, is based on standardized, open management paradigms that support the standardized modelling of the information to be communicated. Management standardization activities will not develop a specific management paradigm but build upon industry-recognized solutions, focusing primarily on object-oriented and service-oriented techniques. Specific management paradigms and information architectural principles may be used in management standards when judged to be adequate. For a general discussion of this type of methodology and related techniques, see the M.3020 series, or see the related work in the Integration Reference Point (IRP) specifications (3GPP TS 32.150 series or ETSI TS 132 150 series).

Management standardization favours the reusability of standardized information definitions to reduce the overall standardization effort. Where information is expected to be utilized in conjunction with more than one management paradigm, the information should first be defined in a paradigm-neutral manner utilizing industry-recognized techniques after which it would then be mapped onto paradigm-specific formats.

It must be noted that the techniques applied to define information to be exchanged should not constrain the internal implementation of the telecommunications managing or managed systems.

As management information and actions play crucial roles for administrations, security techniques have to be applied in the management environment in order to assure the safety of the information exchanged over the interfaces and residing in the management application. Security principles and mechanisms are also related to the control of access rights of the management systems users to information associated with management applications. See 9.5 for the security consideration of NGN management. Internal system implementations are outside the scope of management standardization.

The management information view is structured from the following fundamental elements: interaction models, information models, information elements, information model of a reference point (information-specified reference point). Management information exchange to be implemented can then be described in terms of these fundamental elements.

As indicated in clause 9, the business process is an influence throughout the lifecycle of management specifications. Note that the details of the relationship between the business process and information views are for further study.

NOTE – Implication of SOA on the management information view is for further study.

12.2 Interaction model

A management interaction model provides the rules and patterns that govern the flow of information between management function blocks at a reference point.

For the exchange of management information, management processes will take on one of two possible roles:

– managed role: a process that manages the management information elements associated with managed resources. The process acting in this role responds to directives issued by the process acting in the managing role. It will also reflect to the process acting in the managing role a view of these information elements and provide information reflecting resource behaviour (e.g., information source);

– managing role: a process that issues management operation directives and receives information from the process acting in the managed role (e.g., information user).

It is the responsibility of the information user to be able to address the information source in a manner that the information source will respond properly. In addition, the information user is responsible for parsing what the information source provides.

Possible interaction models include peer-to-peer and consumer/provider. Each interaction model is associated with a specific management paradigm.

Parties involved in a management communication will exchange messages according to a Communication Pattern, which identifies the actors and their role in the communication, as well as the sequence and cardinality of messages sent and/or received. A simple request/response, multiple batch response, or notification, are examples of Communication Patterns. The design of a business activity will reference one of these patterns. For example, an activity to retrieve the inventory of a managed system will probably carry out partitioning of the result set in several segments to be forwarded to the service consumer according to a multiple batch response.

Four distinct Communication Patterns are:

– Simple response (a simple invoke/response pattern);

– Multiple batch response (to be used to handle significant large result data set);

– Bulk response (file transfer in off-band communication channel);

– Notification (to disseminate information to subscribers).

These Communication Patterns address different communication needs: while the first three are oriented towards an exchange of information between two parties in an activity (P2P), the notification communication pattern is designed to disseminate information to a set of recipients (publish and subscribe), possibly greater than one.

Additional communication patterns are for further study.

12.3 Management information models

The management information view contains a single construct called an information model, which can be considered to consist of multiple information model fragments that are supported by function blocks and exposed via a provider reference point. All or a subset of this information is known by both entities acting in managed roles (provider) and by those acting in managing roles (consumer). As examples, information model fragments can be found in ITU-T series Recommendations: M.310x series, X.73x series, G.85x series, and Q.82x series.

A management information model presents an abstraction of the management aspects of service and network resources and the related support management activities. The model determines the scope of the information that can be exposed and exchanged in a standardized manner. This activity to support the information model fragments takes place at the application level and involves a variety of management applications such as storing, retrieving and processing information.

Multiple information model fragments are necessary to describe the full range of information to be exchanged for telecommunication management. The relationship between these different information model fragments needs to be documented and understood.

The contents of this clause are for further study.

12.4 Management information elements

Management information models consist of management information elements, which model information exchanged by management systems. Management information elements may be conceptual views of the resource types that are being managed or may exist to support certain management functions (e.g., event forwarding or event logging). Thus, an information element is the abstraction of such a resource that represents its properties as seen by and for the purposes of management.

12.5 Information model of a reference point

A subset of this exposed information, which can be considered the information model of a reference point, is mapped to each reference point, based on the functional interactions defined for the reference point. This information model of a reference point is the minimum cluster of exposed management information that may be specified on a management function block.

12.6 Information-specified reference points

The management information-specified reference point further defines the concept of reference point (beyond the management functional view definition); the reference point concept unifies the management functional and information views. Management function blocks interact via management functions over a reference point. Over the same reference point, the management function blocks communicate the appropriate management information in order to perform the specified management functionality. Reference points have meaning in functional and information-exchange specifications leading to an implementation. A reference point represents the functional interactions and information exchange between function blocks. The reference point concept is very important because a reference point represents one or both of two aggregate types. The first type is an aggregate of all, or some, of the abilities with associated information exchange that a particular function block requires from another particular function block, or equivalent function blocks for consumption. The second type is an aggregate of all, or some, of the operations and/or notifications (as defined, for example, in ITU-T Recs X.903 and X.703 for RM-ODP and ODMA) that a function block provides to a requesting function block.

A management functionally-specified and information-specified reference point corresponds to an interface, in the management physical view, if its defining function block and corresponding peer function blocks are implemented in different physical blocks.

12.7 Management logical layered architecture within the management information view

As introduced in clause 11, the Logical Layered Architecture (LLA) is a concept for the structuring of management functionality which organizes the functions into groupings called "logical layers" and describes the relationship between layers. A logical layer reflects particular aspects of management arranged by different levels of abstraction. Interactions between OSF function blocks within different logical layers are described by reference points. Over the same reference point, the management function blocks communicate the appropriate management information in order to perform the specified management functionality.

The relationship of the Logical Layered Architecture and the management information view can be described by projecting the management information view through a series of views. Each view represents the information elements from the information models that may be exposed or exchanged at reference points between function blocks in layers of the LLA. The view encompasses the necessary level of abstraction necessary for the exchange of management information at the level of abstraction captured in the layer.

The exchange of management information between logical layers employs the managing roles and managed roles of the management 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). 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.

12.8 Designing information models for scalable and low cost management

When designing information models, it is easy to simply look at what data can be observed rather than what information network operators need to make decisions and take corrective action on the network. The result can be too much data or not enough information. Providing measurements at too fine a granularity results in complex and network traffic-intensive forms of network management. Providing information at a coarse granularity greatly simplifies the task of operating a network, but this information must be related to the more detailed network measurements in order to enable trouble shooting and debugging. It is, therefore, recommended that care be taken when designing information models to ensure both scalable management and the availability of more detailed information in a predicable manner.

13 Management physical view

The management physical view is structured from the following fundamental elements: physical blocks and interfaces. A physical block is an architectural concept representing a realization of one or more function blocks. An interface is an architectural concept that enables interoperable interconnection at reference points between physical blocks by realizing the reference points.

Figure 15 shows an example of a simplified physical view for a management implementation. This example is provided to assist in understanding the management physical blocks described below.

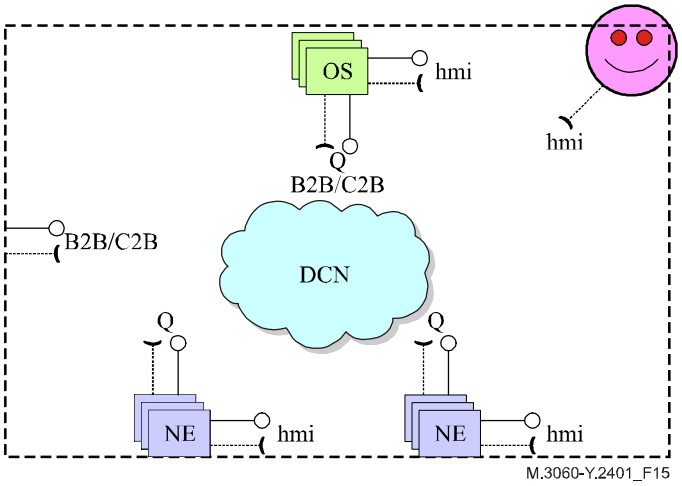


Figure 15/M.3060/Y.2401 – An example of a physical view

As indicated in clause 9, the business process is an influence throughout the lifecycle of management specifications. Note that the details of the relationship between the business process and physical views are for further study.

13.1 Management physical blocks

Management functions can be implemented in a variety of physical configurations. The relationship of the functional blocks to physical equipment is shown in Table 2 which names the management 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 which is mandatory for it to contain. There also exist other functions which are optional for the physical blocks to contain. Table 2 does not imply any restriction of possible implementations, but defines those identified within this Recommendation.

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

Table 2/M.3060/Y.2401 – Relationship of management physical block names to management function blocks (Notes 1 and 2)

	TEF	SEF	OSF
NE	M (Note 3)	M (Note 3)	O
OS			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 – Management physical blocks may contain additional functionality, which allows them to be managed.

NOTE 3 – The NE needs to support at least one of the TEF or SEF.

Figure 16 below illustrates example implementations of physical views. The OS physical block realizes OSFs, of which a great variety is available. Some of these are a consequence of the impact of the eTOM, ITU-T Rec. M.3050, and others are a reflection of the NGN architecture defined in ITU-T Rec. Y.2011. There is great flexibility in the design of NGN Operations Systems. This flexibility can enable the co-management of multiple functional layers.

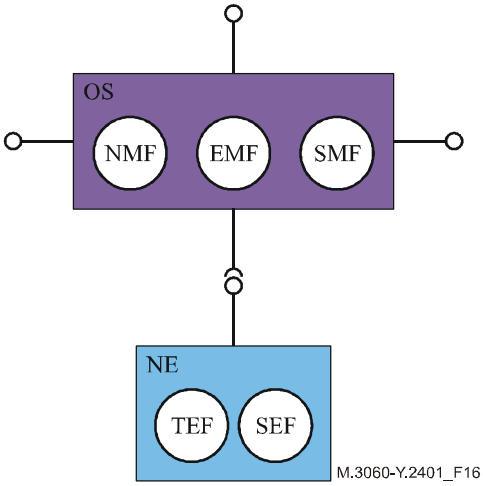


Figure 16/M.3060/Y.2401 – An example implementation of a physical view

Figure 17 below illustrates an example physical implementation of co-management of multiple functional management layers.

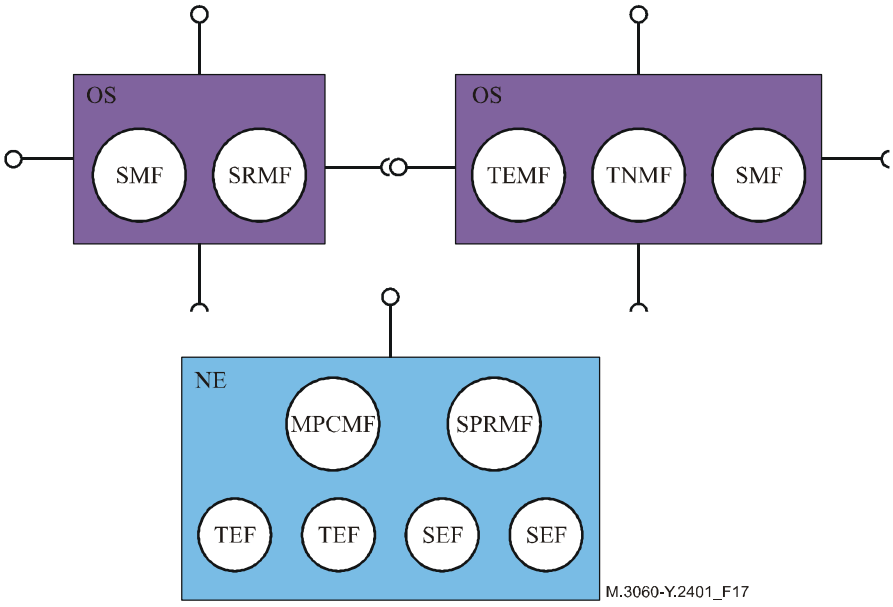


Figure 17/M.3060Y.2401 – Co-management of multiple functional management layers

13.1.1 Operations System (OS)

The OS is a system that performs OSFs. An OS may conceptually be considered as part of the NGN transport stratum, the NGN service stratum, both, or neither, depending on the OSFs that it realizes.

13.1.2 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 management function blocks according to its implementation requirements. The NE has one or more standard Q-type interfaces and may optionally have B2B/C2B interfaces. An NE performs at least one of transport element functions (TEFs) or service element functions (SEFs), and so can be deployed in an NGN transport stratum or in an NGN service stratum or in both.

Existing NE-like equipment that does not possess a standard management interface will gain access to the management infrastructure via a Q adapter (see 13.3.1.1), which will provide the necessary functionality to convert between a non-standard and standard management interface.

A Transport Network Element is an NE that performs only TEFs. A Service Network Element is an NE that performs only SEFs.

13.2 Data Communication Network (DCN)

The DCN is a support service that provides the capability to establish paths for information flow between physical blocks in a management environment. 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.

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

Physical blocks communicate using a common communication mechanism which provides a set of Application Programming Interfaces (APIs) that include the services of the upper three protocol layers of the OSI Reference Model. Some of these API services expose the communications capabilities of the DCN and others expose common platform functions (e.g., Directory Services, Time Services, Security, etc.). Refer to ITU-T Recs Q.811 and Q.812 for specific interface protocols for information transfer through a DCN.

13.3 Support physical blocks

13.3.1 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 b2b/c2b reference points.

13.3.1.1 Adaptation device

An adaptation device (AD), or adapter, provides transformation between a non-compliant physical entity to a NE to OS within an administrative domain. A Q-adapter (QA) is a physical block used to connect NE-like or OS-like physical blocks with non-compatible interfaces to Q interfaces. A B2B/C2B-adapter is a physical block used to connect non-compatible physical entities having a non-compatible communication mechanism in a non-compatible environment to an OS at the edge of an administrative domain.

13.3.1.2 Mediation device

A mediation device (MD) provides transformation between management physical blocks that incorporate incompatible communication mechanisms. A Q-mediation device (QMD) is a physical block that supports connections within one administrative domain. A B2B/C2B-mediation device is a physical block that supports connections of OSs in different administrative domains

13.3.2 Distributed multi-element structure

A distributed multi-element structure is an architectural concept that represents a grouping of network elements that must be managed as a single entity for operational efficiency sake. An example is an Optical Bidirectional Line Switched Ring (BLSR). Due to the distributed nature of their blocks and the complexity of their internal make up, it is sometimes difficult to distinguish between Distributed multi-element structures and a sub-network.

13.4 Management logical layered architecture within the management physical view

Several specializations of the OS physical block can be defined to support a physical realization of function blocks in logical layers (see Figures 5 and 10).

The variety of types of management functionality is reflected in a corresponding flexibility for the mapping of OSFs to Operations Systems so that, in principle, any combination of specialized OSFs can map to an Operations System. As a result, the interfaces offered by an Operations System may include functionality from various OSF specializations (e.g., service management, service resource management and transport resource management functions).

Such a flexible transition from the functional view to a physical view (subject to constraints from the information architecture as outlined in clause 14) allows for different types of OS interactions and corresponding Operations Systems Interface design patterns:

– Provider/consumer;

– Peer-to-peer.

As a result, a physical architecture may flatten the functional Management Layers described in 11.6 into a single, unified management layer for the co-management of several functional Management Layers. Examples of this layer co-management paradigm are shown in Figures 16 and 17.

The unified management layer is opaque, i.e., the interworking of the functional Management Layers is invisible to the user of the Interface.

13.5 Interface concept

Management interface is an architectural concept that provides interconnection between physical blocks at reference points. Management interfaces provide, via specific communication protocols, for the interconnection of NEs and OSs through the DCN. Interactions between physical blocks, to exchange management information, are established dynamically at run time and are usually not defined statically at design time. In order for such dynamic interactions to occur, physical blocks must be connected by a communications path and each element must support compatible interfaces. It is useful to use the concept of an interface to simplify the communications problems arising from a multi-vendor, multi-capability network. The interface defines the specific protocols, commands, procedures, message formats and semantics used for the management communications between physical blocks. The goal of an interface specification is to ensure compatibility of devices interconnected to accomplish a given management function independent of the type of device or of the supplier.

Figure 15 shows the interconnection of the various management physical blocks by a set of standard interoperable interfaces.

Management standard interfaces are defined corresponding to the reference points and are classified in two types:

– Provider interfaces: physical realizations of one or more provider reference points; each provider interface is depicted with a white lollipop or ball icon.

– Consumer interfaces: physical realizations of one or more consumer reference points; each consumer interface is depicted with a white crescent or socket icon.

An interface contains the mapping from the protocol-neutral reference point specifications to a protocol-specific specification. An interface consists of one or more reference points together with a single communication protocol binding, which is a protocol suite used to realize a communications path at these reference points.

13.6 Standard interfaces

Management standard interfaces are realizations of specific reference points. The classes of references points correspond to the classes of interfaces.

13.6.1 Classes of interfaces

This Recommendation defines three classes of interfaces: Q interfaces, B2B/C2B interface, and HMI interface. The definition of further interface classes or subclasses is for further study.

13.6.1.1 Q interface

The Q interface is applied at q reference points. The Q interface is characterized by that portion of the information model shared between the OS and those management elements to which it directly interfaces.

13.6.1.2 B2B/C2B interface

The B2B/C2B interface is applied at the b2b/c2b reference point. It will be used to interconnect two administrative domains or to interconnect a compliant environment with other networks or systems which accommodate a compliant-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 B2B/C2B interface will set the limits on the access available from outside the administrative domain. The set of capabilities made available at the B2B/C2B interface for access to the administrative domain will be referred to as administrative domain Access.

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

13.6.1.3 HMI interface

A physical realization of a hmi reference point.

13.6.1.4 Other standard interfaces

It is recognized that NEs, OSs, and MDs may have other interfaces in addition to the Q, and B2B/C2B interfaces defined in this Recommendation. It is also recognized that this equipment may have other functionality in addition to that associated with information sent or received via Q, and B2B/C2B interfaces. These additional interfaces and related functionality are outside of the scope of this Recommendation.

13.6.2 Relationship of management interfaces to management physical blocks

Table 2 defines the possible interfaces which each named management physical block can support. It is based upon the function blocks which Table 2 associates with each physical block and the reference points between function blocks, defined in Table 2.

14 Relationships between management views

A business process provides a set of requirements that defines management functionality in the functional view. This management functionality is composed of management function sets that are composed of management functions. Operations systems realize a number of functional blocks, deployable units of management functionality, in the physical view. The functional view defines reference points that involve interaction between functional blocks. The information view constrains the data and interaction patterns of the interface between operations systems components that are physical realizations of functional blocks. Figure 18 shows this relationship between management views and their components.

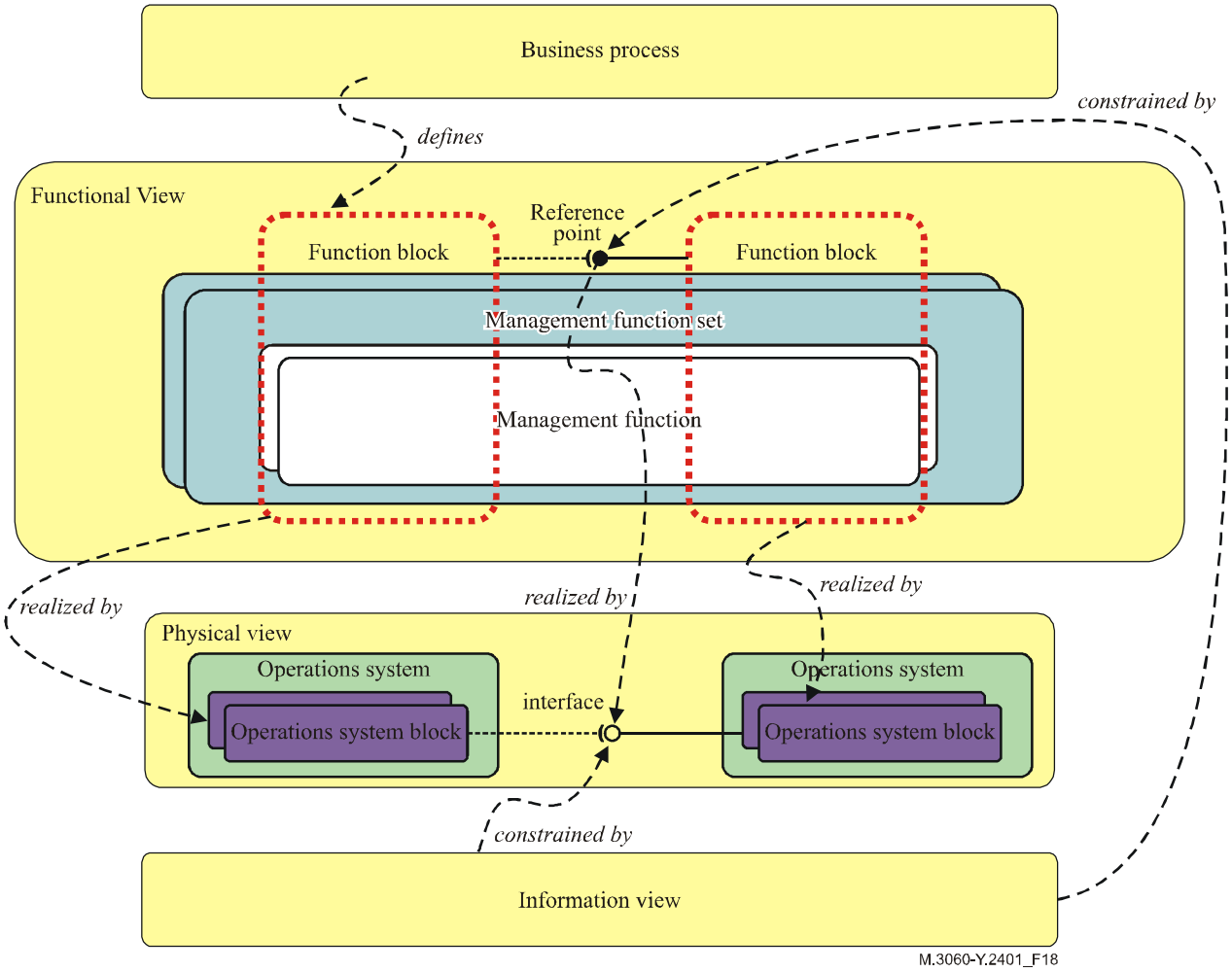


Figure 18/M.3060/Y.2401 – Relationship of management views and their constructs

The management implementation is realized from four different, but interrelated views. These are the business process, functional, information and physical views.

Three of these views (business process, functional and information) provide a framework that allows requirements to be documented about *what* a management implementation should do.

The business process view, based on the eTOM model, provides a reference framework for categorizing the business activities of a service provider.

The functional view framework permits the specification of what functions have to be achieved in the management implementation. The information view permits the specification of what information (i.e., data) has to be stored so that the functions defined in the functional view can be achieved in the management implementation. The management implementation, that meets the requirements of the management functional and information specifications, may vary greatly from one management solution to another. Management implementations are not currently a subject for standardization.

Management implementations have to blend and balance a number of divergent constraints such as cost, performance, and legacy deployments, as well as new functionality being delivered. Since every management implementation will have different sets of these constraints to cope with, reality dictates that there will be many physical view implementations. These implementation views are the result of different distributions of the fundamental elements.

15 Relationship to ITU-T Rec. M.3010

ITU-T Rec. M.3010 defined *Principles for a Telecommunications management network*. It defined the Telecommunications Management Network (TMN) used to manage traditional telecommunications networks.

TMN provided a mainly technology-agnostic architecture for managing networks. So, in theory, it could be used, with minor changes, to manage NGNs. However, requirements to provide better support for network services, business processes and to reduce operational costs, made it clear that major changes were going to be required.

These changes are reflected in this Recommendation which defines a separate and independent architecture from that defined in ITU-T Rec. M.3010. This clause provides an overview of these changes for those familiar with ITU-T Rec. M.3010.

– Peer to the traditional functional, information and physical views, there is a new business process view, based on eTOM as well as a high-priority set of security considerations.
– A move towards a Service-Oriented Architecture (SOA), which requires more run-time flexibility to be built into the architecture. This has particular impact on the M.3010-defined reference points and interfaces, as they are not enough defined dynamically.
– Division of resources to be managed into transport resources and service resources.
– The introduction of new function blocks into the functional view – service resource management function block, transport resource management function block, service element function block, transport element function block.
– The introduction of new function blocks. This includes enterprise, supplier, market, product and customer management. The second class is for supporting function blocks such as the transformation function block.
– The human-machine interface is formally within the scope of NGNM standardization. This is an evolution of the g reference point and interface.
– The workstation function (WSF) is now absorbed into OSF and NEF.
– The QA and M interfaces are not described in NGNM.
– The introduction of communication patterns into the information view.
– To increase flexibility in NGNM, the TMN concepts of management application function (MAF), management function set group are no longer used, and a support function is considered a special case of a management function.
– While ITU-T Recommendations deliver abounding information on the management of the SML, NML, EML and NEL, they were, until recently, rather insufficient with regard to BML management. In fact, ITU-T Rec. M.3010 defines the BML as "A management layer responsible for the total enterprise and not subject to standardization". By contrast, ITU-T Rec. M.3050's eTOM development considerably enhanced the specification of the BML by introducing the new Strategy, Interface & Product (SIP) process area, the Enterprise management (EpM) process area, and the new Supplier/Partner Relationship Management (SPRM) grouping in the Operations (OPS) process area. Therefore, the M.3010 statement on the BML is obsolete since the approval of the eTOM as the M.3050.x series.

To deal with the complexity of telecommunications management, TMN management functionality is partitioned into logical layers, or functional Management Layers. The Logical Layered Architecture (LLA) is a concept for the structuring of management functionality, which organizes the functions into groupings called "logical layers" and describes the relationships between layers. A logical layer reflects particular aspects of management arranged by different levels of abstraction (i.e., Business Management Layer, Service Management Layer, Network Management Layer,

Element Management Layer and Network Element Layer). This concept of layering is described in ITU-T Rec. M.3010 and has been further developed in the M.3050.x series (eTOM).

The NGN Management Logical Layered Architecture is described in 11.6 and illustrated in Figure 10. Figure 19 provides a mapping of the NGN Management Logical Layered Architecture to the M.3010 logical layers. Note that the NGNM resource management layer encompasses the NML and EML.

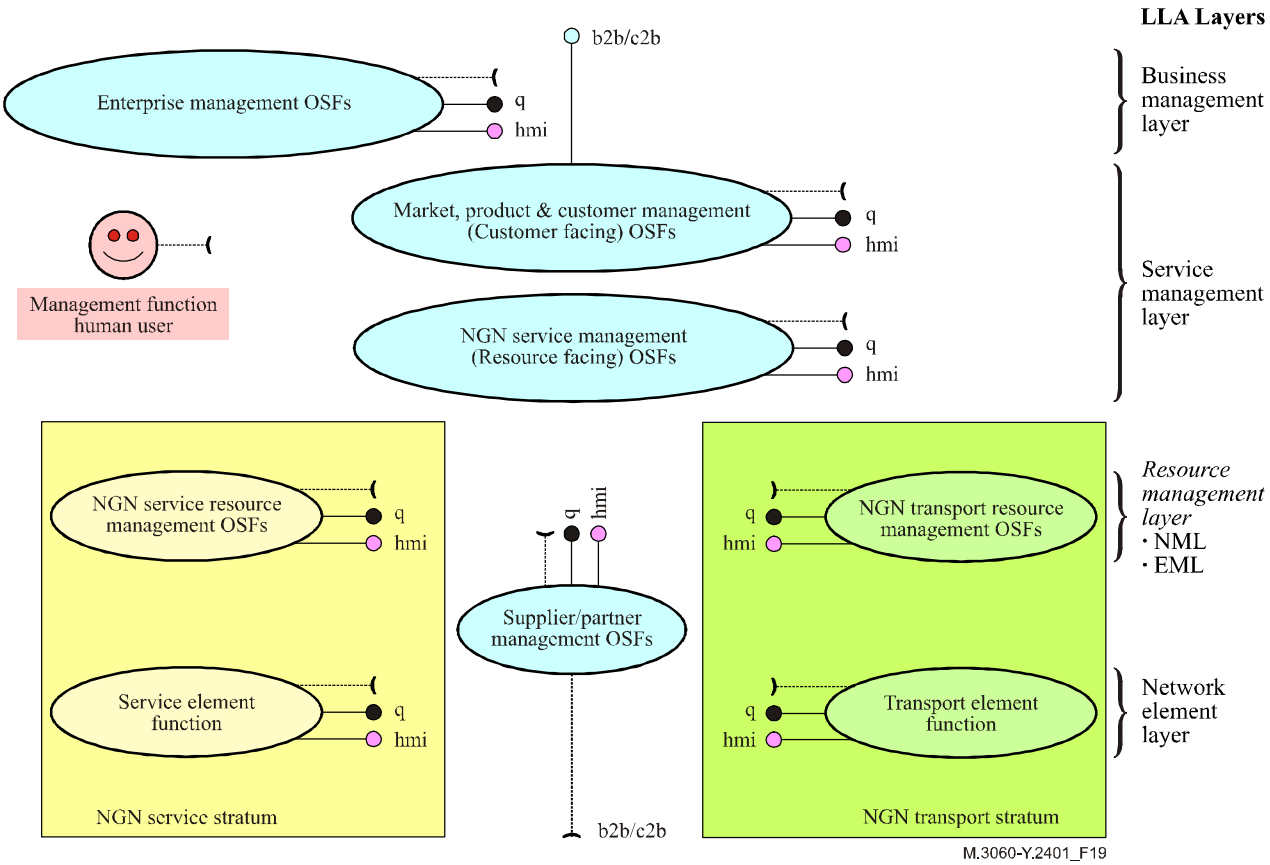


Figure 19/M.3060/Y.2401 – Relationship of NGN management architecture with TMN logical layered architecture

16 Management conformance and compliance

For further study

Appendix I

Component-oriented functional and physical architecture

Within the NGN management physical view, a physical block is an architectural concept representing a realization of one or more function blocks. A related concept is a component.

A physical component is an instance of one or more functional components, i.e., function blocks. If the functional view is supplemented by an information view, and so reference points are information-specified, a physical component is an instance of an information component, i.e., a UML 2.0 component or class.

NOTE 1 – The 3GPP SA5 IRP methodology specifies at its level 2, i.e., within the Information Service (IS) specifications, certain Information Object Classes (IOCs) which are termed "<Itf-N_aspect>IRP" (e.g., "AlarmIRP" of 32.111-2). Such IRP IOCs may be considered information components, i.e., information-specified functional components. Therefore, from an M.3060 point of view, the 3GPP IRP IS-specified IRP IOCs correspond to function blocks. The interfaces specified in a 3GPP IRP IS form part of the definition of the respective IRP IOC (according to TS 32.152, "The IRP IOC has a unidirectional mandatory realization relationship with the <<Interface>>."), and so the IRP IS interfaces correspond to M.3060 reference points (i.e., logical interfaces which may be static or dynamic).

The operations systems component (OSC) is an architectural concept representing a physical realization of one or more OSFs (i.e., being able to perform the management functionality defined by these OSFs) and exposing interfaces to other OSCs or to managed resources. OSCs are, when deployed, the constituents of OSs. The smallest OSC is the realization, i.e., deployment, of a single OSF. Clause 13.1 provides a rationale for the introduction of physical components.

NOTE 2 – The assembly of Operations Systems from OS Components is optional, since an OS may consist of a single OSC (which may even realize only a single OSF), for example a legacy OS. The ability to build componentized OSs is fundamental, however, to ensure the sufficient flexibility and agility of OS engineering and development needed to meet emerging telecommunications management requirements.

Management functionality may be realized by componentized Operations Systems, where OSFs are mapped to operations systems components (see Figure 16). The flexibility of the structure of management functionality is reflected in a corresponding flexibility for this mapping so that any combination of specialized OSFs can map to an OSC and an Operations System can be composed of any combination of such OSCs. As a result, the interfaces offered by an Operations System may include functionality from various OSF specializations (e.g., service management, service resource management and transport resource management functions).

There is a strong industry trend towards component-oriented implementation environments where components (in the sense of, for example, UML 2.0 or J2EE or WSDL) are realized by an object-oriented approach or, preferably, by a service-oriented approach (SOA) wherever reasonable. Component-oriented approaches provide greater flexibility and agility for software engineering and development & deployment and resolve several issues associated with purely object-oriented analysis and design (OOAD) best practices (e.g., interface granularity and separation of object state and behaviour). It is, therefore, expected that the trend towards component and service orientation will stand the test of time and that component and service-oriented analysis and design (SOAD) are very suitable to meet the challenges of next-generation management software requirements.

With regard to the management physical view, in this scenario, an up-to-date Operations System would be assembled from one or more OS components which expose (provider or consumer, contract-defined) interfaces, as set forth, e.g., in TM Forum's NGOSS (New Generation Operations Systems and Software) program (see http://www.tmforum.org/browse.asp?catID=1911) or in the telecom APIs of the OSS/J (OSS through Java) initiative (see http://www.ossj.org/). The basic concept of "physical block" (which stems from the TMN-oriented ITU-T Recs M.3010 and

M.3013) is not flexible enough to also cover (e.g., by recursion) components. Therefore, clause 13.4 introduced the concept of "OS Component (OSC)" to allow for more flexible and agile OSs.

Appendix II

Relationship of NGNM architectural elements

To assist the effort of alignment of NGNM architectures, the following table provides a mapping of the ITU-T terms and concepts for NGNM to the current terms used by related working groups of other standards development organizations (SDOs). Currently this SDO comparison table includes ETSI, 3GPP, TM Forum, OMG, and OASIS.

The first line of each frame provides shorthand for each architectural element according to the icon used to depict it, or a cue word if no icon is used.

Legend:

"--" indicates either not applicable or definitely not within scope;

"" (empty cell) indicates no decision made by the SDO (could be for further study, or not applicable, or out of scope, etc.).

Table II.1/M.3060/Y.2401 – Comparison of architectural elements between ITU-T SG 4, ETSI TISPAN WG 8, 3GPP SA5, TMF NGOSS TNA, OMG UML and OASIS SOA TC

Graphical Representation: Unit of deployment	
ITU-T SG 4 (M.3060, M.3010)	For further study
ETSI TISPAN WG 8 (TS 188 001)	For further study
3GPP SA5 (IRP, TS 32-series)	--
TM Forum NGOSS (TNA, TMF 053-series)	NGOSS Component
OMG UML 2.0	Component
OASIS SOA TC	

Table II.1/M.3060/Y.2401 – Comparison of architectural elements between ITU-T SG 4, ETSI TISPAN WG 8, 3GPP SA5, TMF NGOSS TNA, OMG UML and OASIS SOA TC

Graphical Representation: Ellipse	
ITU-T SG 4 (M.3060, M.3010)	Function block The smallest deployable unit of management functionality.
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service A profileable aggregation of NGN OSS Service Interfaces and NGN OSS Service Interface Consumers, whose aggregate behaviour fulfils a specific business need which can be controlled through customizable business policies.
3GPP SA5 (IRP, TS 32-series)	Operations Systems Function An OSF is implemented by one or more interface IRP IOCs which expose only lollipops.
TM Forum NGOSS (TNA, TMF 053-series)	--
OMG UML 2.0	Classifier
OASIS SOA TC	Service A behaviour or set of behaviours offered by one entity for use by another according to a policy and in line with a service description.

Graphical Representation: Lollipop	
ITU-T SG 4 (M.3060, M.3010)	Provider reference point An architectural concept which delineates and exposes an external view of management functionality of a function block, where all exposed management functions are provided for consumption by other function blocks.
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service Interface (NGN OSS SI) A well-defined grouping of related NGN OSS Operations and constant data which are necessary to deliver coherent business or system functionality.
3GPP SA5 (IRP, TS 32-series)	One or more interface IRP IS <<Interface>>s NOTE – As currently defined, the 3GPP IRP is limited to the network management level and element management layer. (Interface N)
TM Forum NGOSS (TNA, TMF 053-series)	NGOSS Contract
OMG UML 2.0	Provided Interface An interface, i.e., a classifier that has declarations of properties and methods but no implementations, that is implemented by another classifier (class, component).
OASIS SOA TC	Interface A named set of operations that characterize the behaviour of an entity.

Table II.1/M.3060/Y.2401 – Comparison of architectural elements between ITU-T SG 4, ETSI TISPAN WG 8, 3GPP SA5, TMF NGOSS TNA, OMG UML and OASIS SOA TC

Graphical Representation: Operation	
ITU-T SG 4 (M.3060, M.3010)	Operation
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Operation A behaviour which is published as a member of an NGN OSS Service Interface or an NGN OSS Service Interface Consumer.
3GPP SA5 (IRP, TS 32-series)	Operation
TM Forum NGOSS (TNA, TMF 053-series)	NGOSS Contract Operation
OMG UML 2.0	Operation
OASIS SOA TC	

Graphical Representation: Notification	
ITU-T SG 4 (M.3060, M.3010)	NOTE – Notifications are one of many aspects of management functions. Precise equivalence is for further study. See also operation.
ETSI TISPAN WG 8 (TS 188 001)	NOTE – Mapping of notifications to TISPAN NGN OSS Operations is for further study.
3GPP SA5 (IRP, TS 32-series)	Notification
TM Forum NGOSS (TNA, TMF 053-series)	
OMG UML 2.0	
OASIS SOA TC	

Graphical Representation: Ellipse with only crescents (consumer role)	
ITU-T SG 4 (M.3060, M.3010)	Function block with only consumer reference points
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service with only NGN OSS SICs
3GPP SA5 (IRP, TS 32-series)	IRPManager
TM Forum NGOSS (TNA, TMF 053-series)	Client entity
OMG UML 2.0	Classifier with only Required Interfaces
OASIS SOA TC	

Table II.1/M.3060/Y.2401 – Comparison of architectural elements between ITU-T SG 4, ETSI TISPAN WG 8, 3GPP SA5, TMF NGOSS TNA, OMG UML and OASIS SOA TC

Graphical Representation: Crescent	
ITU-T SG 4 (M.3060, M.3010)	Consumer reference point An architectural concept which delineates a function block and consumes the management functionality provided by another function block through one of its provider reference points.
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service Interface Consumer (NGN OSS SIC) A well-defined grouping of related NGN OSS Operations and constant data which represent the user/consumer of an NGN OSS Service Interface.
3GPP SA5 (IRP, TS 32-series)	--
TM Forum NGOSS (TNA, TMF 053-series)	Client entity Contract NOTE – Possibly to be added to the NGOSS meta-model.
OMG UML 2.0	Required Interface An interface, i.e., a classifier that has declarations of properties and methods but no implementations, that is required by another classifier (class, component) in order to function.
OASIS SOA TC	Interface A named set of operations that characterize the behaviour of an entity.

Graphical Representation: Ellipse with only lollipops (provider role)	
ITU-T SG 4 (M.3060, M.3010)	Function block with only provider reference points
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service with only NGN OSS SIs
3GPP SA5 (IRP, TS 32-series)	IRPAgent
TM Forum NGOSS (TNA, TMF 053-series)	Server entity
OMG UML 2.0	Classifier with only Provided Interfaces
OASIS SOA TC	

Graphical Representation: Dotted line oval	
ITU-T SG 4 (M.3060, M.3010)	Provider Reference Point Group A pre-defined collection of provider reference points that belong together according to a chosen context.
ETSI TISPAN WG 8 (TS 188 001)	NGN OSS Service Interface Groups (primarily based on the M.3050.x series) A grouping of NGN OSS Service Interfaces that belong together according to a chosen context.
3GPP SA5 (IRP, TS 32-series)	--
TM Forum NGOSS (TNA, TMF 053-series)	--
OMG UML 2.0	--
OASIS SOA TC	

Table II.1/M.3060/Y.2401 – Comparison of architectural elements between ITU-T SG 4, ETSI TISPAN WG 8, 3GPP SA5, TMF NGOSS TNA, OMG UML and OASIS SOA TC

Graphical Representation	
ITU-T SG 4 (M.3060, M.3010)	Management function set
ETSI TISPAN WG 8 (TS 188 001)	
3GPP SA5 (IRP, TS 32-series)	
TM Forum NGOSS (TNA, TMF 053-series)	
OMG UML 2.0	
OASIS SOA TC	

Graphical Representation	
ITU-T SG 4 (M.3060, M.3010)	Management service
ETSI TISPAN WG 8 (TS 188 001)	
3GPP SA5 (IRP, TS 32-series)	
TM Forum NGOSS (TNA, TMF 053-series)	
OMG UML 2.0	
OASIS SOA TC	

Graphical Representation	
ITU-T SG 4 (M.3060, M.3010)	Management logical layer
ETSI TISPAN WG 8 (TS 188 001)	
3GPP SA5 (IRP, TS 32-series)	NML, EML, NEL according to ITU-T Rec. M.3010
TM Forum NGOSS (TNA, TMF 053-series)	
OMG UML 2.0	
OASIS SOA TC	

NOTE – The concepts of lifecycle and methodology and their impact on architecture artefacts are for further study.

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