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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.

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Principles for the Management of Next Generation Networks

1 Scope

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 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*.
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- 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;

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- 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.

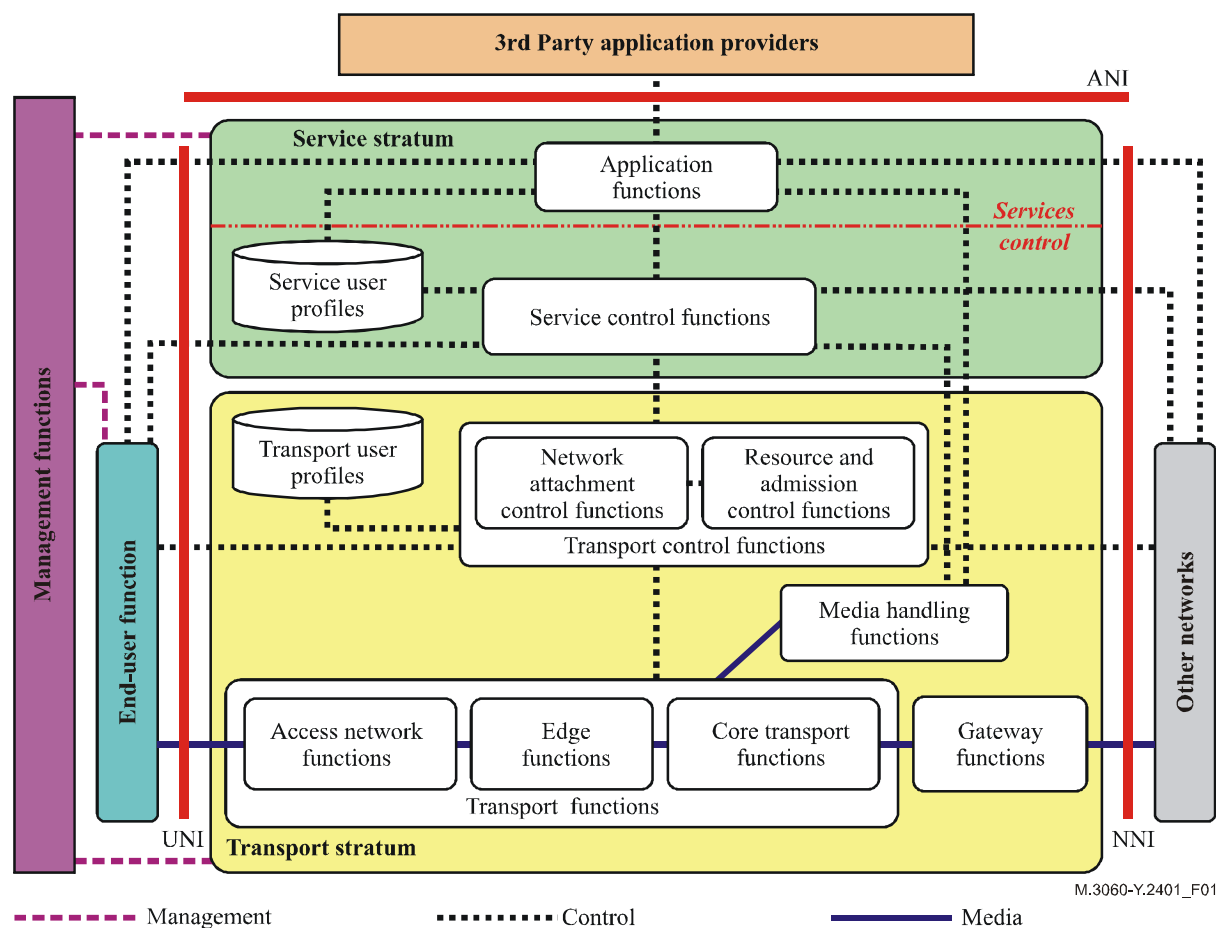
- k) Supporting the collection of charging data for the network operator regarding the utilization of resources in the network either for later use by billing processes (offline charging) or for near-real time interactions with rating applications (online charging).
- l) The ability to provide survivable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

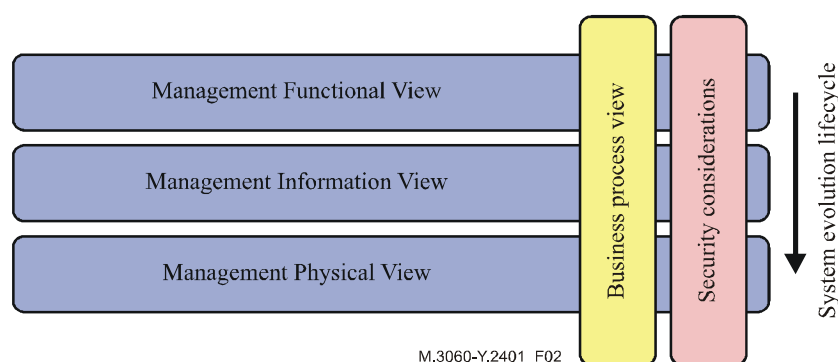


Figure 2/M.3060/Y.2401 – NGN management architecture

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.