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SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Telecommunications management network

Cloud-based network management functional architecture

Recommendation ITU-T M.3071

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Recommendation ITU-T M.3071

Cloud-based network management functional architecture

Summary

Recommendation ITU-T M.3071 introduces a new network management functional architecture with cloud-computing technology. In this Recommendation, the background and basic concept of cloud-based network management are provided. This Recommendation also provides details of a cloud-based network management functional architecture, including its basic components, functionalities and the relationship between its components.

History

Edition	Recommendation	Approval	Study Group	Unique ID[*]
1.0	ITU-T M.3071	2018-01-13	2	11.1002/1000/13479

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[*] To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Cloud-based network management functional architecture

1   Scope

This Recommendation provides details on the concept of cloud-based network management functional architecture and its fundamental components. It describes the composition of a cloud-based network management functional architecture, explains the functions of each component in the architecture, and also introduces the relationship between these components.

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

[ITU-T Y.3521]   Recommendation ITU-T Y.3521/M.3070 (2016), *Overview of end-to–end cloud computing management*.

3   Definitions

3.1   Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1   management service [ITU-T M.3010]: A management service is an offering fulfilling specific telecommunications management needs.

3.1.2   network element [ITU-T M.3010]: An architectural concept that represents telecommunication equipment (or groups/parts of telecommunication equipment) and supports equipment or any item or groups of items considered belonging to the telecommunications environment that performs network element functions (NEFs).

3.2   Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1   cloud-based network management: Cloud-based network management is to perform network management functions using cloud-computing technology, and it can also be used to manage both traditional telecommunication networks and/or cloud computing infrastructures.

3.2.2   management service analysis function: The management service analysis function provides the ability to analyse each management service in the network management. Each management service is registered in this analyser function, and all related information about this service is analysed and stored for future use.

3.2.3   management service composing function: The management service composing function provides the ability of composing several small management functions into a new complex management service, so that a new type of management functionality can be easily provided without having to change the implementation of the component management functions.

3.2.4   management service deployment function: The management service deployment function provides the ability of deploying required services for a management task. Each management task may need the support of multiple management services, and for those services which are not ready for use, they will appropriately be deployed into some virtualized resources on the cloud infrastructure.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FS   Function Set

IT   Internet Technology

NE   Network Element

NEF   Network Element Function

P&C   Perception and Control

VM   Virtual Machine

5   Conventions

None.

6   Introduction

Current network management and technologies have the weak point that when new management requirements are proposed, it is difficult to provide a new management service based on the existing services using traditional management technology. It is also hard to compose a small system with simplified management functions on demand.

Cloud computing has become one of the mainstream technologies used in telecommunication networks, as well as Internet services. Cloud-computing technology has the following benefits: high usage rate of physical resources, reliable service provision, high extensibility, cost efficient and service on demand, etc. When introducing cloud computing technology into the network management domain, it is easy to solve the above problems, and it will be very flexible to provide new management services.

When introducing the cloud into network management, it means that different management function blocks can be placed into virtual resources, and the virtualized resources can be grouped together to form a composed management service that is more powerful to provide complex management functions. It is also capable of dealing with a large amount of management data, as distributed computing can be carried out on cheap servers.

The term management services used in this Recommendation is not the cloud service provided by a network operator or a cloud operator. Management services are provided by a management system, regardless of whether it is based on the cloud or not. A cloud service is provided by a cloud-service provider to end users for resource virtualization, which provides end users with the cloud-computing and/or cloud-storing capabilities.

A cloud-aware management system described in [ITU-T Y.3521] is a management system which can be used to manage both traditional telecommunication networks and cloud-computing infrastructures. A cloud-based management system in this Recommendation is a management system which is built using cloud-computing technology, and it can also be used to manage both traditional telecommunication networks and/or cloud-computing infrastructures. A cloud-based management system can be a cloud-aware management system, but it is not necessary to manage cloud infrastructures using a cloud-based management system.
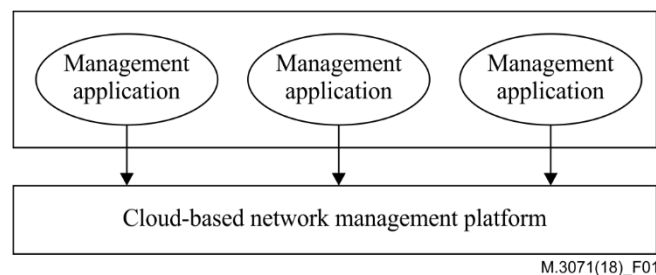
7 Cloud-based network management functional architecture

7.1 Basic concept

Cloud computing is a technology from the IT domain, with the aim for a supplier to share computing and storage capabilities in the cloud to multiple customers. A system can be built using the traditional means, or using cloud-computing technology to provide services to customer and using the cloud as its infrastructure, as far as the services can be provided. A network management system is a software system which provides network management services to operators or telecommunication service providers. Thus using cloud technology in network management systems will also bring the benefits of the cloud into the network management field.

Cloud-based network management systems may include two main parts, one is the cloud-based network management platform, and the other is management applications for various network technologies which are built over the management platform.

Figure 1 shows the basic concept of the cloud-based network management platform and the management applications.


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Figure 1 – Cloud-based network management platform and applications

The cloud-based network management platform is described in detail in clause 7.2. Management application functions can be the applications that provide functions dedicated to the management of a specific network technology (e.g., mobile core network, transport network), and they provide their own functionality for its dedicated network, and share the lower layer functions of the cloud-based network management platform, e.g., cloud infrastructure management, or common management services.

7.2 Detailed structure of cloud-based network management functional architecture

7.2.1 High-level layering of cloud-based network management functional architecture
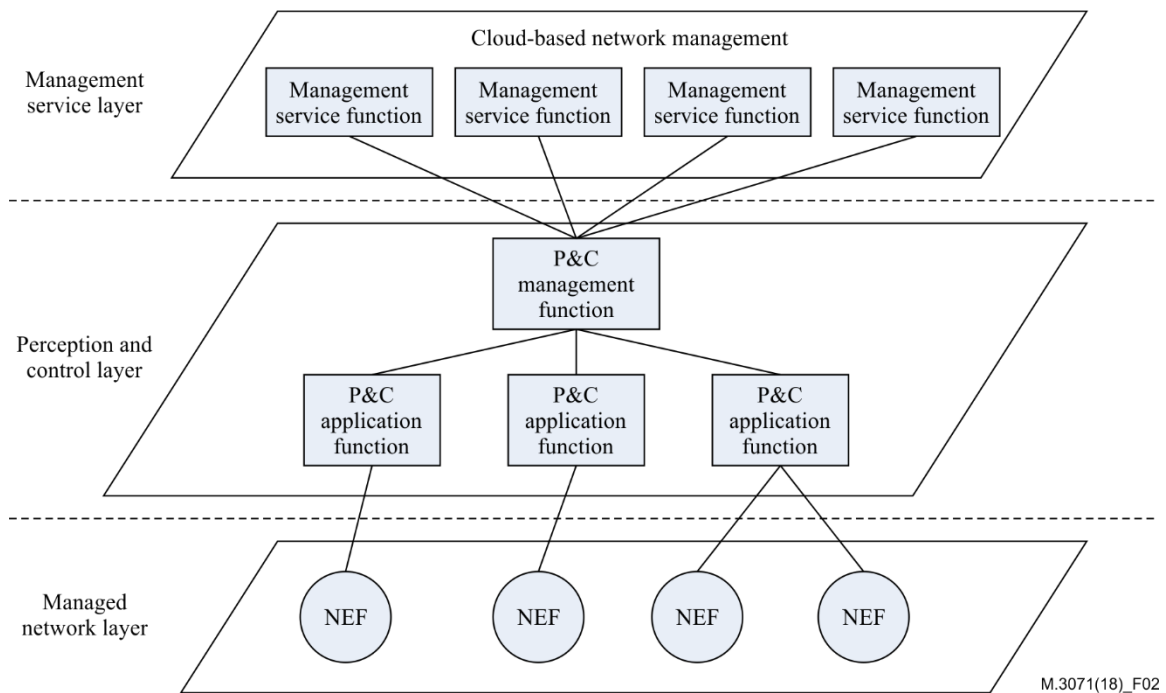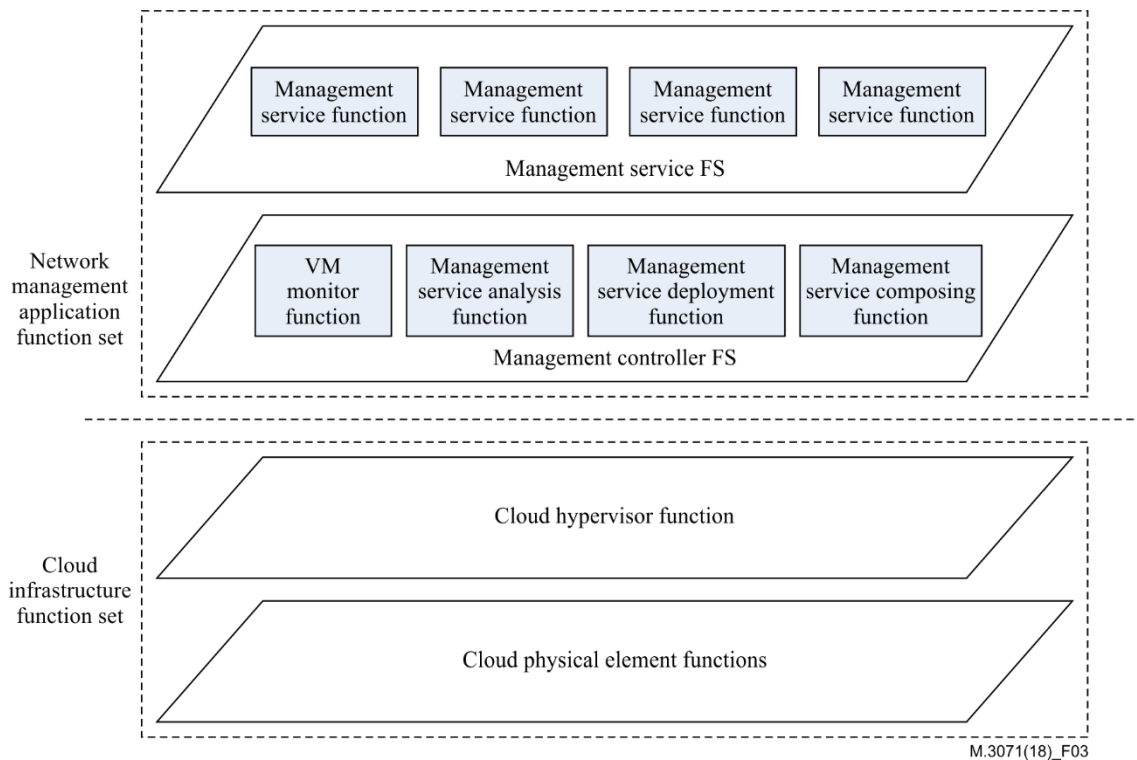

Figure 2 – High-level layering of cloud-based network management functional architecture

Figure 2 shows the high-level layering of cloud-based network management functional architecture, which includes the following three layers:

– Managed network layer: This layer indicates the layer containing all the network element functions (NEFs) that are to be managed. The NEs providing the NEFs can be the traditional telecommunication network elements, or elements in a cloud infrastructure.

– Perception and control layer (P&C layer): This layer indicates the perception function blocks and the NE controlling function blocks. Perception function blocks have the capability to collect the configuration information, running status, or the performance data from the NEFs, and the NE controlling function blocks are able to make necessary reconfigurations or modifications to NE parameters, through interactions with the specified NEFs.

– Management service layer: This layer mainly contains the network management function blocks, which provide management services to network operators.

7.2.2 Detailed composition of cloud-based network management functional architecture

Figure 3 – Detailed composition of the management service layer

Figure 3 shows the detailed composition of cloud-based network management functional architecture, which is a "refinery" of the components in the management service layer as shown in Figure 2.

The cloud-based network management functional architecture is composed of the following two main parts: cloud infrastructure function set and network management application function set.

The cloud infrastructure function set includes cloud physical element functions and a cloud hypervisor function above them. Cloud physical element functions provide the basic functions of computing and storage. The cloud hypervisor function provides the functionality to manage cloud physical elements, and provide virtualization functions above them.

The network management application function set may be further divided into two parts: management controller function set and management service function set. The management controller function set includes the basic supporting functions of the management platform, and also provides common functions to support management applications. The management service function set provides management functions, which are divided into several aspects of network management, and usually they are application specific.

7.3 The functions of each part in the architecture

In Figure 3, the functions of each component are further explained in this clause.

1) Cloud physical element function: This is the lowest level of cloud infrastructure and is usually composed of the functions provided by physical servers, computers, disks, network connectors, and all other elements that form a physical cloud computing environment. It provides the basic computing and storage resources from the physical layer.

2) Cloud hypervisor function: This is a management layer over cloud physical element functions. The cloud hypervisor function provides the management ability of virtualized resources, for example, creating/deleting a new virtual machine (VM), start/suspend a VM,

and query/change a configuration of a VM, etc. It also provides users with virtualized resources using a unified interface. From the users' perspective the cloud hypervisor function can provide computing and storage capabilities dynamically, based on users' requirements.

3) Management controller function set: This contains multiple controlling functions that support the running of the cloud-based network management platform, and each function can be implemented by a small function block. Some basic function blocks in the controllers are listed below.

    –   VM monitoring function: This function provides the ability to monitor the performance of VMs. It monitors the dynamic information of the running status of VMs. When performance degradation is detected, the monitor informs the controller to handle the resource reassignment or service transportation.

    –   Management service analysis function: This function provides the ability of analysing each management service in the network management. Each management service is registered in this analyser, and all the related information about this service is analysed and storage for future use.

    –   Management service deployment function: This function provides the ability of deploying required services for a management task. Each management task may need the support of multiple management services, and for those services which are not ready for use they will appropriately be deployed into some virtualized resources on the cloud infrastructure.

    –   Management service composing function: This function provides the ability of composing several small management functions into a new complex management service, so that they can easily provide a new type of management functionality without having to change the implementation of the component management functions.

    –   More function blocks can be extended to support the running of the cloud-based network management architecture.

4) Management service function set: This provides management functions to network operators, and is composed of all kinds of small management functions. Each network management function is performed by a service application, and those management functions can form composed services that provide more complex network management functions. Most management service applications are application-specific to a network technology, but there are still some applications which are more general to be used across different network technologies. In such cases, the common service application will be reused.

7.4   The relationship between the components in the architecture

This clause will introduce the relationship between the components in the architecture.
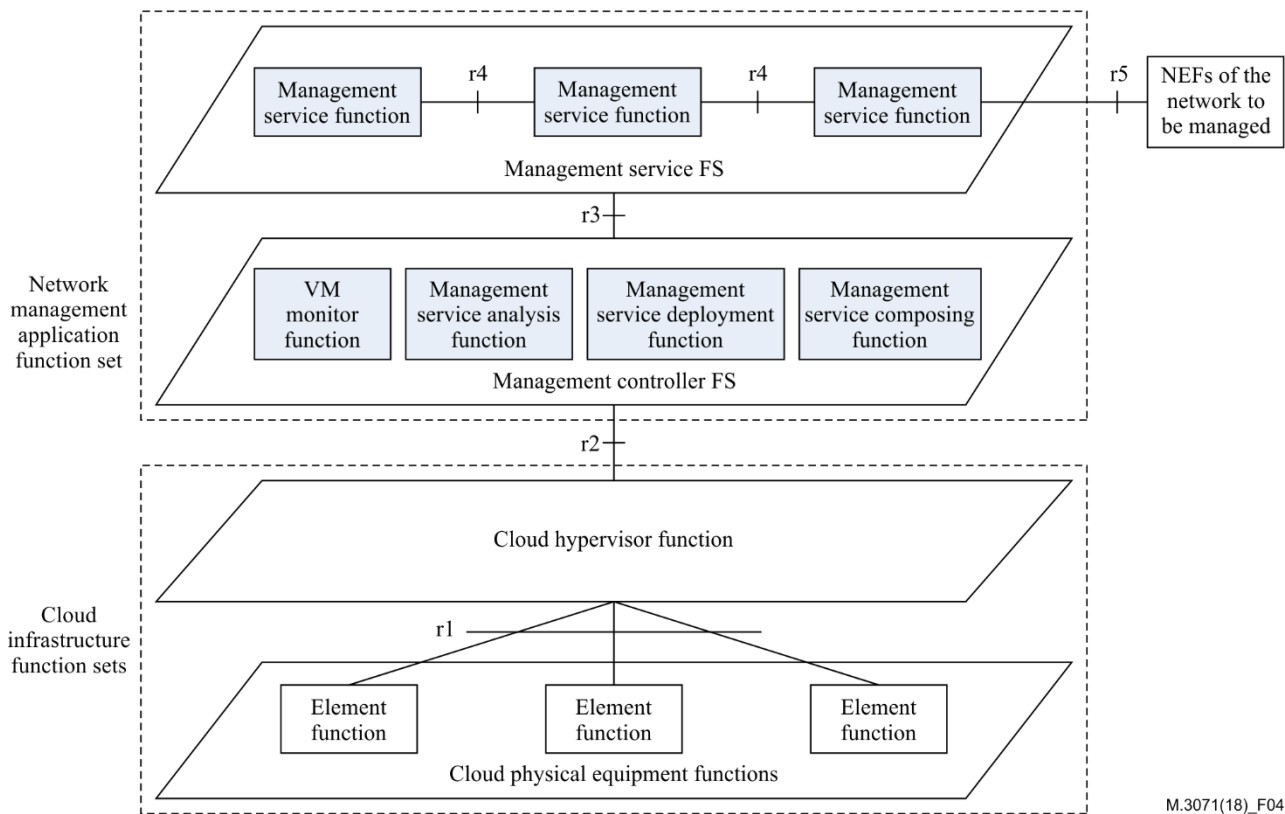
Figure 4 – Reference point between the components in the cloud-based network management functional architecture

Figure 4 shows the reference point between the components in the cloud-based network management functional architecture. All the reference points in Figure 4 are defined in [ITU-T M.3010]. In order to distinguish these references points in this Recommendation, which can show the relationship among functional components, they are numbered as r1, r2, r3 r4 and r5 respectively, as explained in Table 1.

Table 1 – Reference points in cloud-based network management functional architecture

Name	Position	Definition
r1	Between cloud hypervisor function and cloud physical element function.	Through reference point r1 a hypervisor function can connect to cloud physical element functions to perform the virtualized resource management functions (for example, VM management, including but not limited to, creation, deletion, query and modification of virtualized resources.) In this Recommendation the virtualized resource will be assigned to building the management system itself.
r2	Between management controller function set and cloud hypervisor function.	Through reference point r2 the management controller function set can interact with the cloud hypervisor function. The management controller function set sometimes may ask the cloud infrastructure function set to assign new virtual resources in order to meet new management requirements. Through this reference point there is no need for management controller FS to know any details about the physical layer resources, and it only sends the command including the requirement for the virtualized resources, and then the cloud hypervisor function will handle the rest.
r3	Between management service function set and management controller function set.	Reference point r3 is provided from the management controller function set to the management service function set. Through this reference point applications can use the common functions provided by the management controller FS. For example, one service application can search for another service application which may be able to meet its requirements. Management controller FS can also use this reference point to perform the management service analysis and composition, etc.
r4	Between management service applications.	Reference point r4 is between the management service functions at the application level. Usually, there are cases when one management service function needs the support of another management service function, then it just invokes the function provided by that management service function. Reference point r4 is used in this situation.
r5	Between management service function set and the NEFs of the network to be managed.	The network to be managed is the target for network management. Through reference point r5 management service functions can interact with the NEFs in the network to be managed, and perform the actual network management functions.

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