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SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Telecommunications management network

# Requirements for synergy management of cloud and SDN-based networks

Recommendation ITU-T M.3373

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# Recommendation ITU-T M.3373

## Requirements for synergy management of cloud and SDN-based networks


### Summary

Recommendation ITU-T M.3373 introduces the management function set and requirements for synergy management of cloud and SDN-based networks. It describes the synergy management structure and the composition of the function set, explains the functions of each component in the function set. The requirements for the synergy management of cloud and SDN-based networks are also described. In this Recommendation, the general background of the synergy service of cloud and SDN-based networks are also analysed. The benefit of introducing synergy management of cloud and SDN-based networks is explained.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
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### Keywords

Cloud and network synergy, management requirements.


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# Recommendation ITU-T M.3373

## Requirements for synergy management of cloud and SDN-based networks

### 1 Scope

This Recommendation provides the function set and functional requirements for synergy management of cloud and SDN-based networks. It describes the synergy management structure and the composition of the function set and explains the functions of each component in the function set. The functional requirements for the synergy management of cloud and SDN-based networks are also described.

This Recommendation focuses on the management of synergy services composed of both cloud computing services and SDN-based network services provided by telecommunication operators. The synergy services mentioned in this Recommendation refer to the services provided by the same operator to customers.

### 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.3372] Recommendation ITU-T M.3372 (2018), *Requirements for resource management in cloud-aware telecommunication management systems*.

[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 cloud service** [b-ITU-T Y.3500]: One or more capabilities offered via cloud computing (see clause 3.2.5 in [b-ITU-T Y.3500]) invoked using a defined interface.

**3.1.2 private network** [b-ITU-T I.570]: A network which provides services to a specific set of users only.

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 cloud data centre**: Infrastructure for operators to provide cloud computing services to customers.

**3.2.2 inter-cloud network**: The network that provides access services by an operator to its customers, including networks from customer intranets to cloud data centres, networks between cloud data centres, and networks within a cloud data centre.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CDC Cloud Data Centre

CE Customer Edge

CPU Central Processing Unit

E2E End to End

GW Gateway

IaaS Infrastructure as a Service

IP Internet Protocol

NE Network Element

OTN Optical Transport Network

PaaS Platform as a Service

PE Provider Edge

PON Passive Optical Network

PTN Public Transport Network

RAN Radio Access Network

SaaS Software as a Service

SDN Software Defined Network

STN Spatial Transformer Network

VLAN Virtual Local Access Network

VM Virtual Machine

VNF Virtualized Network Function

## 5 Conventions

None.

## 6 Overview of synergy management of cloud and SDN-based networks

### 6.1 Background

Nowadays, telecommunication operators use cloud computing to deliver cloud services to their customers. The cloud service types provided by telecommunication operators include infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). Cloud data centre (CDC) is the infrastructure supporting cloud services. Cloud services are typically deployed on different CDCs for reasons such as backup, security and business.

The inter-cloud networks include the network between an enterprise's intranet and a CDC, and the network between different CDCs. For inter-cloud network connections, telecommunication operators usually provide customers with private network services. Nowadays, software defined network (SDN) technology is being used for private network services. In SDN-based private networks, SDN controllers centrally acquire and control end-to-end (E2E) network resources. On the SDN-based network management system, the orchestration engine achieves E2E service orchestration and resource consumption.

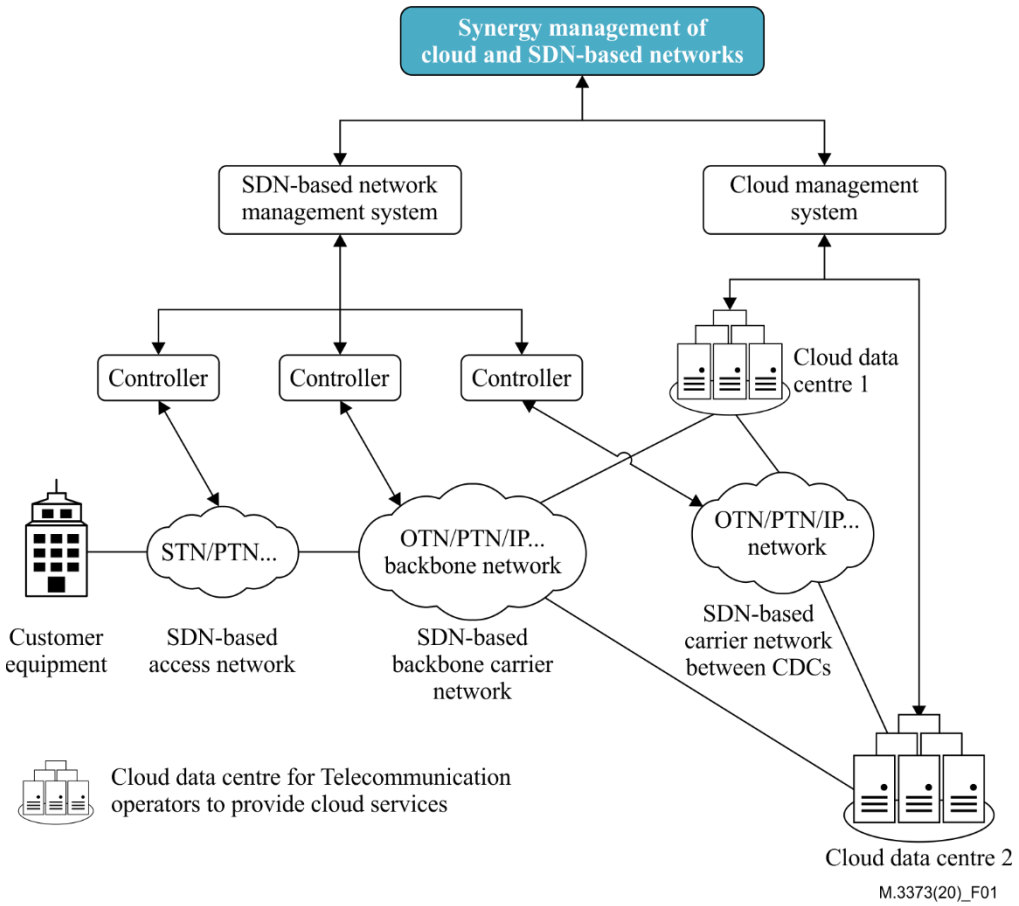


**Figure 1 – A physical architecture example for synergy management of cloud and SDN-based networks**

In order to provide better synergy services of cloud and networks, resources and services of both cloud and network should be effectively managed. In the example shown in Figure 1, an enterprise customer purchases the operator's cloud service, and the cloud services are provided by multiple CDCs. At the same time, the enterprise customer can also purchase the private network services to connect the customer's intranet and different CDCs. The networks and resources within a CDC are managed by the cloud management system, and the management functions are defined in [ITU-T Y.3521] and [ITU-T M.3372]. The private networks include access networks and bearer networks. The private network services are managed by the SDN-based network management system. The SDN-based network management system provides management functions of different types of SDN controllers for access networks and carrier networks, such as spatial transformer networks (STNs) controller, OTN controller, PTN controller, etc. An SDN controller provides a management interface of network resources to the upper layer management system. The synergy management system of cloud and SDN-based networks realizes the functions of synergy service fulfilment and resource management of both cloud and SDN-based networks.

More information about the background can be found in Appendix I.

## 6.2 Concepts

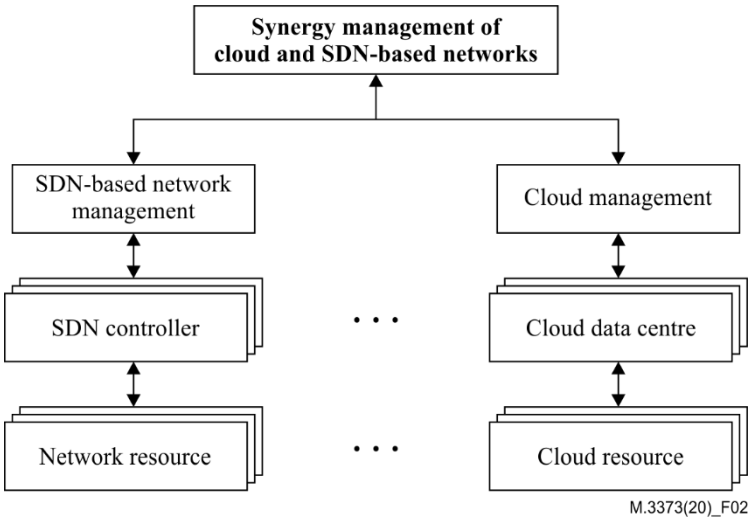


**Figure 2 – Logical architecture of synergy management of cloud and SDN-based networks**

As shown in Figure 2, the cloud and SDN-based network synergy management function block is located above the SDN-based network management function block and the cloud management function block. The cloud and SDN-based network synergy management function block supports the fulfilment and deactivation of both cloud services and network services, and it also provides operators the advantages of customizable parameters and maximizing differentiated services. At the same time, by implementing unified scheduling and control of E2E services, the synergy management function block can realize fast service fulfilment and flexible scheduling of network resources.

The synergy management of cloud and SDN-based networks focuses on the following two aspects:

1) Management of synergy services (cloud services and the corresponding network services): including the creation, delivery, update, suspension, resumption and deletion of services. At the same time, it also includes the flexible network bandwidth adjustment based on service requirements or faults, thereby improving service reliability and resource utilization.

2) E2E resource management: including management of cloud resources and network resources, and connection management of CDCs and private networks.

# 7 Function set of synergy management of cloud and SDN-based networks

Figure 3 shows the synergy management function set. As shown in Figure 3, the synergy management function set for cloud and SDN-based networks includes the following parts:

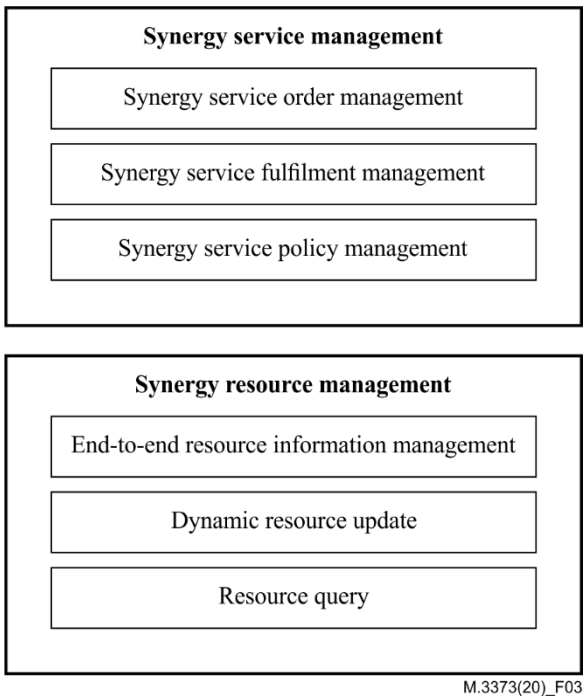


**Figure 3 – Synergy management function set**

– Synergy service management
  - Synergy service order management
  - Synergy service fulfilment management
  - Synergy service policy management
– Synergy resource management
  - E2E resource information management
  - Dynamic resource update
  - Resource query

The descriptions of the synergy management functions for cloud and SDN-based networks are as follows:

1) Synergy service management: It includes the synergy service order management, synergy service fulfilment management and synergy service policy management.

   Synergy service order management includes the creation, query, modification and deletion of synergy service order information. Order management allows customers to customize service attributes.

   Synergy service fulfilment management includes the creation, delivery, modification, suspension, resumption and deletion of cloud and SDN-based network synergy services. The synergy service fulfilment of cloud and SDN-based networks includes creating a virtual data centre/dedicated cloud/cloud server, creating basic routing schemes for the network (the network types include IP networks, OTNs, etc., all with SDN controllers). Service fulfilment management decomposes service requirements according to business logic and distributes them to the SDN-based network management system and the cloud management system.

   Synergy service policy management provides operators with a set of service condition definitions and service action definitions to optimize the required synergy services of cloud and SDN-based networks. The service policy supports pre-setting cloud service types and network type configuration templates for different customers and different business scenarios for customers to choose.

2) Synergy resource management: The synergy resource management provides functions to manage the E2E resource information, including the resource information of the CDCs and the inter-cloud network, the port information between different networks, and the port information between the CDCs and the inter-cloud network. The resource management function supports the acquisition of dynamic configuration information of the CDCs and the inter-cloud network. The resource management function can better support rapid provisioning of services and adjusting network bandwidth, by planning network resource pools.

## 8 Functional requirements of cloud and SDN-based network synergy management

This clause provides the detailed functional requirements of synergy service management in a synergy management system of cloud and SDN-based networks.

### 8.1 Synergy service management

In a synergy management system of cloud and SDN-based networks, the synergy service management requirements include requirements for synergy service order management, requirements for synergy service fulfilment management, and requirements for synergy service policy management.

#### 8.1.1 Requirements for synergy service order management

The requirements for synergy service order management include the following:

1) Support the order information management functions. The order information includes the basic information of the customer, the type of service that needs to be provided, the start and end time, and the initialization parameters corresponding to the automatic provisioning of a service.

   An order for the service type of "cloud resource application" shall include cloud host information, sub-network information, etc. An order for the service type of "private network application" shall include the network line information, such as network type, private network rate, configuration information, etc. An order for the service type of "cloud and SDN-based network synergy application", shall include both the cloud server information and the private network information.

2) Support the creation, modification, deletion and query functions of orders.

3) Support customized service parameters in the order. For example, for network services, customers can customize network bandwidth, quality, and access restrictions as needed.

4) Support the monitoring of order status, which can be one of the following: running, abnormal, completed, partially completed, and so on.

#### 8.1.2 Requirements for synergy service fulfilment management

The requirements for synergy service fulfilment management include the following:

1) Support the creation, modification, suspension, resumption and deletion of synergy services of cloud and SDN-based networks.

   According to the service type and service parameters in the order, the synergy management system of cloud and SDN-based networks schedules the lower layer controllers or cloud management system to realize the creation or modification of the network service and the instantiation or modification of the cloud service.

   The suspension of the cloud service will only temporarily prevent customers from accessing resources in the specified cloud and will not change the status of the related resources. Deletion of the cloud service will clear the information of the provisioned cloud service and release the cloud service resources. The suspension of the private network

service will only temporarily prevent the customer from accessing the peer end, and will not change the service of the private network. Deleting of the private network service will clear the resources information of the provisioned private network and release the network resources.

The creation/modification/suspension/resumption/deletion of the synergy service of cloud and SDN-based networks converts the order into a specific cloud operation and a network operation. Specific steps may include:

a) Disassemble the order and match the corresponding network type and cloud service type.

b) Map the requirements of the order to different service operation types: creation, suspension, resumption, deletion, modification.

c) Associate the resource management module for resource preemption.

d) Send the orchestration requirements to the SDN-based network management system and the cloud management system respectively.

e) Conduct a verification test to determine whether the synergy service is available.

f) Activate the service immediately or on schedule according to the order information.

2) Support network bandwidth adjustment of the synergy service of cloud and SDN-based networks. Customers can adjust the network bandwidth temporarily or periodically. The customer sets the start time and end time of the bandwidth adjustment, and the value to which the uplink and downlink bandwidths need to be adjusted. Then, the operations of bandwidth increase or reduction will be automatically performed.

### 8.1.3 Requirements for synergy service policy management

The synergy service policy management provides the functions to manage the types of services supported by the existing network controllers, including customer basic information, cloud server information, and leased line information. The requirements for synergy service policy management include the following:

1) Support service policy information management functions. The service policy includes cloud service information and the private network information.

Cloud service information is the default value of configuration parameters for cloud services, including suggestions for opening or closing ports. For example, if the cloud service type is "cloud host service", the policy should set default values to central processing unit (CPU), memory, hard disk, operating system, intranet/extranet IP address, and other parameters.

The private network information includes the basic information of various network types and the service rules of the private network, such as the best path selection strategy: node optimization, minimum delay, avoidance of lines and equipment cutover, etc.

2) Support service policy management of existing service types, including the creation, modification, query and deletion of policies.

3) When the basic service types supported by the underlying controllers or cloud management system are extended or adjusted, the synergy management system of cloud and SDN-based networks supports the update function of the service policy template.

## 8.2 Synergy resource management

In a synergy management system of cloud and SDN-based networks, the requirements for synergy resource management include the following:

1) Support E2E resource information management. The resource management module contains the provisioned cloud service resources and network resources, as well as all the synergy service instances that have been created.

   The E2E resource information includes cloud service resource information and network resource information. The cloud service resources include the types of cloud service, the types and quantities of cloud resources owned by the cloud service, the currently used resources, and so on. The cloud service resource information includes hardware resource information (including servers, disk arrays, etc.) and virtualized resource information (including VMs, virtual storage resources, and virtual network resources, etc.). Network resources include access network information, carrier network information and gateway information. The specific information includes network type, network topology, detailed configuration information of NE devices, and so on. The path connection information of the cloud service and the network service is also managed, such as the connected port, IP address, virtual local access network (VLAN) information, etc.

2) Support the capabilities of receiving real-time resource change information, and dynamically updating resource information to ensure consistency with the underlying resource information.

3) Support resource information query. The cloud resource management supports querying all the cloud service resources of the customer, including the type of cloud service, and the type, quantity and current usage of the cloud resource under the specific cloud service type. Network resource management supports querying information about NE device resources corresponding to various network types, including NE configuration information and NE status.

# Appendix I

## Background

(This appendix does not form an integral part of this Recommendation.)

Traditionally, telecommunication operators provide private network services to enterprises, governments and other customers with higher service requirements for data interconnection. Private network services connect corporations' headquarters, corporation branches, and data centres.

Nowadays, based on cloud computing technology, telecommunication operators can provide a variety of cloud services to customers. Cloud services have become an independent business that can be compared with network services, the traffic generated at the same time is becoming one of the largest revenue sources for telecommunication operators. The types of cloud services provided by telecommunication operators include infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). Infrastructure products include elastic computing, cloud storage, server, etc. Platform service products include databases, video services, etc. Software service products include cloud security, business management, etc.

An example of CDCs providing cloud services and the private networks for CDCs is shown in Figure I.1.

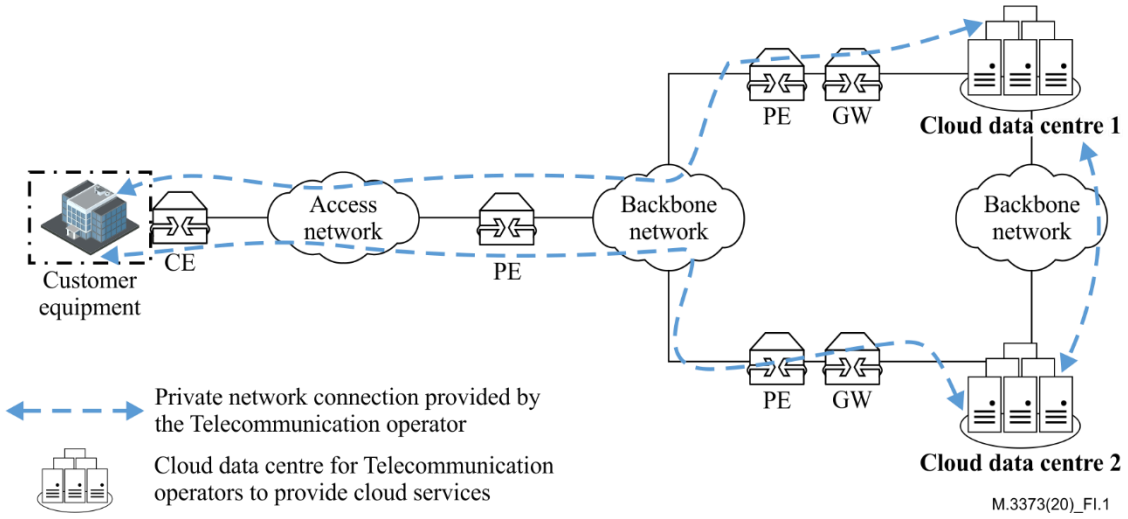


**Figure I.1 – An example of CDCs and the private networks for CDCs**

In SDN-based private networks, SDN controllers are the core of the SDN architecture, which is used to manage and control the underlying network resources. Figure I.2 illustrates the architecture of SDN controllers. Logically, SDN controllers centrally acquire and control E2E network resources. The network resources include physical network resources, logical network resources and virtualized network functions (VNFs). Figure I.3 illustrates an example of the SDN-based private networks. Different SDN controllers are directly connected to different types of network resources for management. On the SDN-based network management system, the orchestration engine achieves E2E service orchestration and resource consumption.

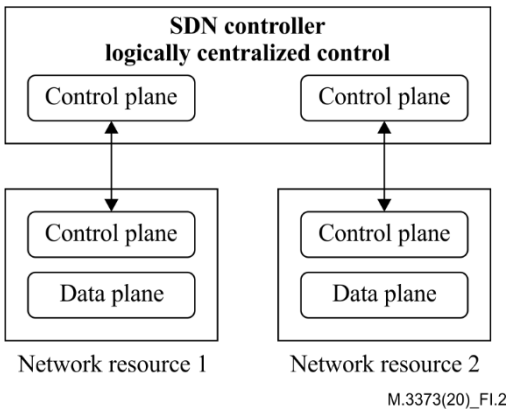


**Figure I.2 – The logical architecture of the SDN controllers**

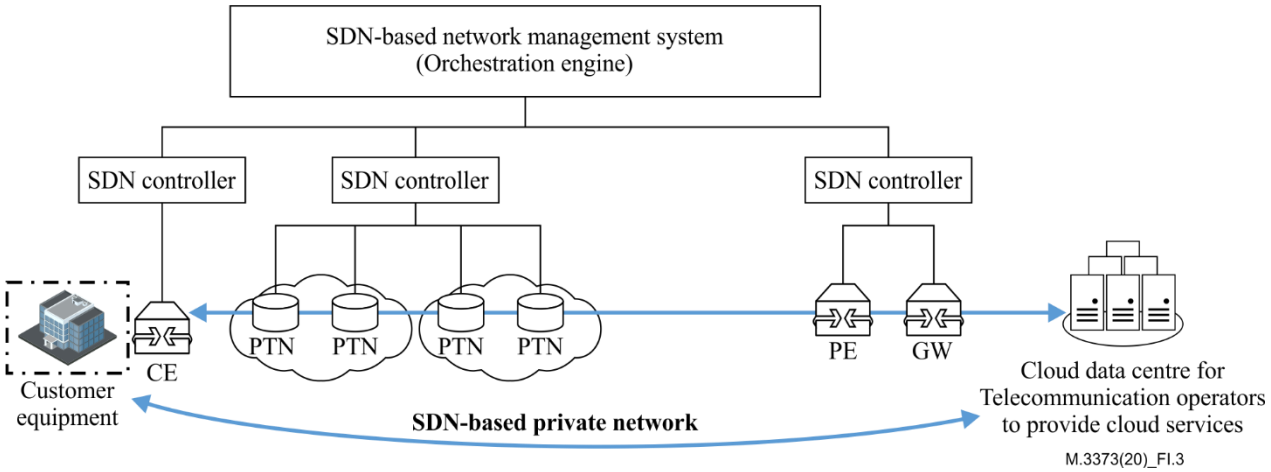


**Figure I.3 – An example of SDN-based private networks**

In the SDN-based network, the logically centralized control makes the operator's cloud and network resources fully visible and manageable. Thus, operators can provide synergy services of cloud and SDN-based networks to customers. The synergy service may bring the following benefits:

1) Through synergy of cloud and SDN-based networks, operators can manage the end to end resource of both cloud and inter-cloud networks, to achieve automatic resource deployment and service fulfilment in seconds.

2) The synergy deployment of the inter-cloud networks and cloud resources enables operators to provide customers with customizable services and effectively improves the resource utilization.

3) The SDN-based networks guarantee the flexibility and extensibility of cloud services. For example, when a failure occurs, the network bandwidth must be able to increase within a short period of time to ensure that critical data are instantly recovered from the cloud. In another example, explosive growth such as real-time video can produce massive predictable or unpredictable data on the CDCs, and operators can solve this problem by providing automated services such as flexible data traffic patterns. In addition, customers can also be provided with the lowest cost network carrier service.

In order to provide better synergy of network services and cloud services, services and resources of both cloud and network should be effectively managed. Establishing a synergy management functional module for cloud and networks can realize E2E service management and shorten the time of service fulfilment process. At the same time, the synergy management of cloud and SDN-based networks includes the interconnection management of cloud service and networks, and can implement an E2E service verification test in order to quickly locate faults.

In the cloud computing management domain, there are already some achievements, such as [ITU-T Y.3521] *"Overview of end-to-end cloud computing management"*, and [ITU-T M.3372] *"Requirements for resource management in cloud-aware telecommunication management systems"*. However, the synergy management based on SDN network management and cloud management has not yet been addressed. In [b-ITU-T M.3041] *"Framework of smart operation, management and maintenance"*, the cloud and network collaborative scenes are described, but specific management functions are not covered. Thus, this Recommendation considers the synergy management functions of both cloud and SDN-based networks, providing assurance and support for cloud services and network services.

# Appendix II

## Use cases of synergy management of cloud and SDN-based networks

(This appendix does not form an integral part of this Recommendation.)

Based on the synergy management system of cloud and SDN-based networks, operators can provide cloud services and network services to customers at the same time in order to achieve business expansion. As shown in Figure II.1, customers can choose multiple private networks to access cloud services. At the same time, operators also provide customers with multiple cloud services in different cloud data centres. The SDN-based network management system provides different types of controllers to manage and control all the underlying network resources. The cloud service and the intra-cloud networks are managed by the cloud management system.

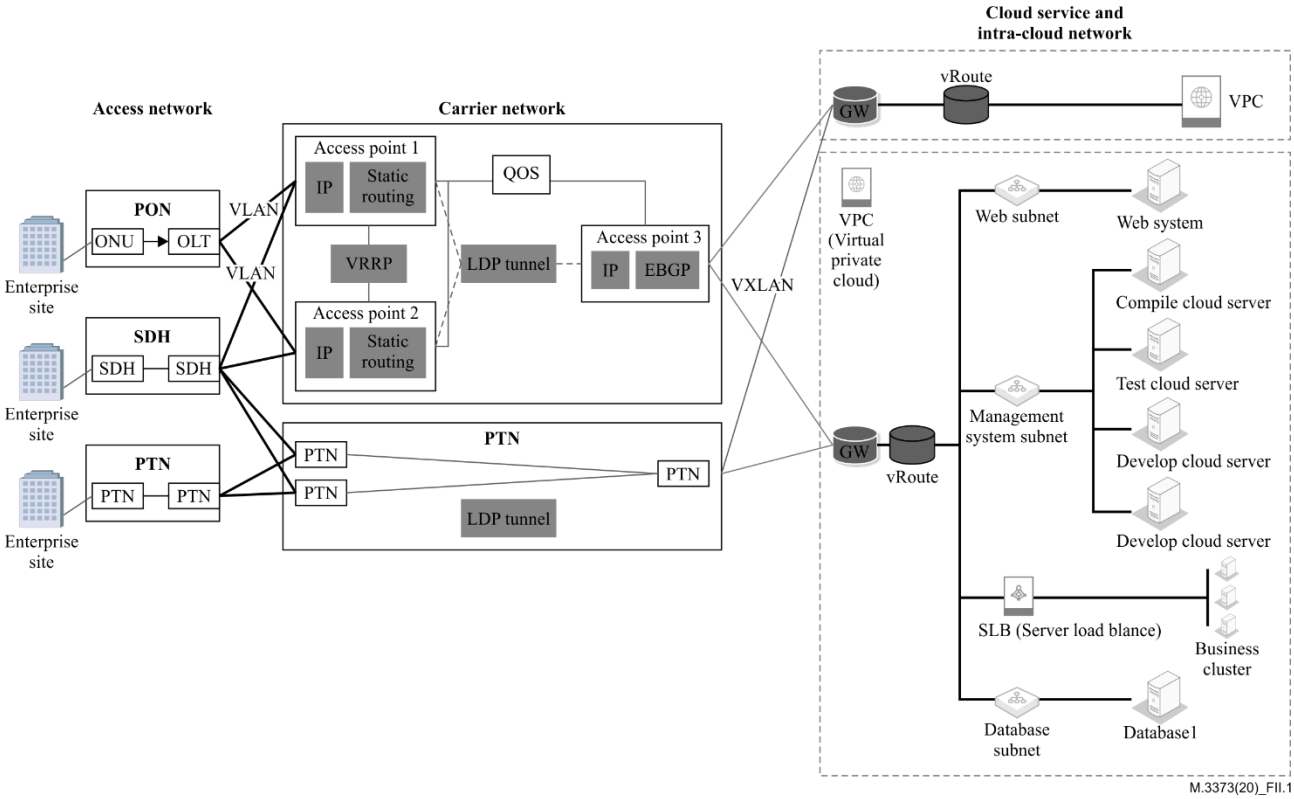


**Figure II.1 – E2E business scenario of synergy management of cloud and SDN-based networks**

The activation process of a synergy service of cloud and SDN-based networks is illustrated in Figure II.2. A customer submits the service requirements from the portal. The requirements are disassembled and adapted with the service policy template, on the synergy management system of cloud and SDN-based networks. The network service requirements are sent to the SDN-based network management system for orchestration and configuration. After the network service configuration succeeds, the cloud service requirements are sent to the cloud management system for configuration. After the entire E2E service is successfully launched, customers can use the synergy service.

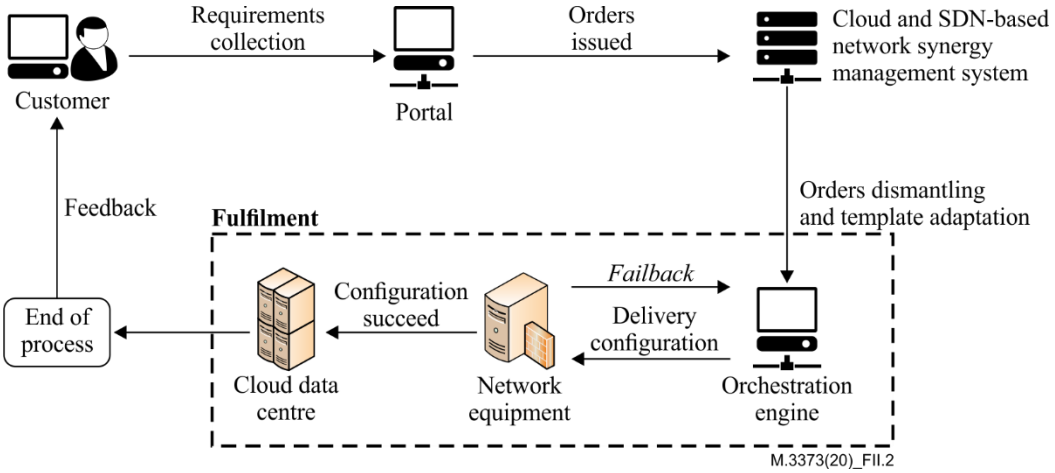


**Figure II.2 – Service fulfilment process of synergy management of cloud and SDN-based networks**

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[b-ITU-T I.570] Recommendation ITU-T I.570 (2018), *Public/private ISDN interworking*.

[b-ITU-T M.3041] Recommendation ITU-T M.3041 (2020), *Framework of smart operation, management and maintenance*.

[b-ITU-T Y.3500] Recommendation ITU-T Y.3500 (2014) | ISO/IEC 17788:2014, *Information technology – Cloud computing – Overview and vocabulary*.

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