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# The Use Cases of Common Operation and Management of Network Slicing
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Abstract

The Common Operation and Management of network Slicing (COMS) intends to provide a comprehensive approach for the overall operation and management of network slicing in the scope if IETF. The system is designed in a hierarchical and inter-operative manner. COMS is capable of recursive adaption in a hierarchical network management system. It is also independent of data plane technologies used in different administrative domains. Both network slice operator and network slice tenant may benefit for COMS for the purpose of slice management and maitenance.The purpose of this document is to discuss the use cases of COMS in different views.

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## 1. Introduction

Network Slicing is a mechanism which a network slice provider can use to allocate dedicated infrastructures and services from shared systems to a network slice tenant. COMS acts as a technology-independent and resource-centric approach according to which the operation and management of network slice can be performed.

This document lists the use cases of COMS from various OAM aspects of network slicing. It provides a general reference of how COMS may be used from both network slice provider and network slice tenant viewpoint. The COMS community (the proposed WG) will consider these use cases and decide which related technology is going to be investigated under the problem scope of COMS.

All of the use cases are introduced in this document followed by a brief analysis regarding the relationship with COMS. As the document is being continuously worked on, the list of use cases is as follows:

- Heterogeneous Resource Management for Network Slicing
- Interoperation between Multiple Slice-aware Administrative Domain
- End-to-end Orchestration of Network Slicing
- Customized OAM for Network Slice Tenant
- Interaction with 3GPP Network Slicing
- Network Slice FCAPS - to be specified in -01 version
- Network Slice Stiching and Recursion - to be specified in -01 version

### 1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

## 2. Heterogeneous Resource Management for Network Slicing

### 2.1. Use Case Introduction

Network slice is a specific partition of resources. The resources are deliberately associated together for the purpose of fulfilling both functional and performance requirements of various applications. Heterogeneity is the nature of those underlay resources based-on which network slices are created. In order to provide end-to-end orchestration of network slices, it is required that all resources are manageable by a network slice provider. COMS will be used as the fundamental technology for the purpose of heterogeneous resource management.

#### 2.1.1. Combination of Networking and Computing

Networking used to be the absolute major asset and resources of a telecommunication service provider. As the rapid development of cloud computing and NFV technology in recent years, computing infrastructures such as data center, distributed edge cloud, CDN and cache facilities start to play more and more important roles. Nowadays, not only is the amount of data centers dramatically growing in service providers' network, but also network/service functions are migrating to NFV deployment, which depends heavily on common computing and storage resources. An obvious trend of more interactive relationship between networking and computing resources (computing resource referred in this section also includes storage resources) deployment is seen worldwide.

The goal of network slicing is to provide a "turn-key" solution for vertical application provider, where certain performance and functional demands can be met according to specific SLAs. This is achieved by providing infrastructure and functional dedication to vertical application providers. It is expected that a vertical application provider, as a network slice tenant, will purchase a network slice which is equipped with both preferred connectivity topology and associated computing/storage resources. Hence, the vertical application provider is able to deploy whatever applications according to its preference.

Relying on the underlay network infrastructure, computing resource has become an inevitable part of the network slice. In general, it may comes in various forms in a manner of IaaS as follows.

- Bare metal equipment with required specifications
- Hypervisor-based virtual machine

- Container-based infrastructures
- Other customized type of presentation of computing resources

Under the regime of network slicing, computing (including storage) resources provided in any form above need to be specified with geographical or logical location information. These computing resources may distributed among the network slice topology as terminal or intermediate network nodes. This location information is essential for the purpose of associating these resources with connectivity components within a network slice.

It is not always easy to jointly manage both computing resources and the underlay networking. Connectivity is normally supervised by using traditional EMS of the connected devices, or by using more advanced SDN approaches for more advanced systems. In contrast, computing resources are typically managed by VIMs. A manager who understands both EMS/SDN controller and VIMs is requirement for overall orchestration of an end-to-end network slice.

### 2.1.2. Technology Diversity of Network Infrastructure

Due to architectural and commercial reasons, the underlay technology choices for different administrative domains are unlikely to be the same. For example, regional administrative domains may be favor of choosing single-vendor solutions for its backbone network. This minimize the complexity of intra-domain OAM. However, adjacent regional administrative domains may use equipments from different vendors. This makes the overall backbone network infrastructure resources heterogeneous. The technology diversity of the resource consisting a network slice mainly results from the following reasons.

- Various technology choices for access, aggregation and backbone networks
- Legacy equipments due to deployment iteration
- Administrative concerns caused by geographical reasons
- Vendor-specific technology for customized deployment

It is common for an end-to-end network slice asking for resources from various administrative domains with distinctive technology options. This include data plane, control plane and management plane technologies. COMS, as an management tool, can be used for operation and management of such systems.

### 2.1.3. Network and Service Functions Variety

A complete network slice may consist of many types of network ans service functions. This functions are likely to be deployed either in NFV or physical forms. In practice, virtualized network functions are managed by VNFM under MANO system, whilst physical network functions are managed by resource management system (RMS). Meanwhile, the management plane of service functions is even more diversified which may associated with extremely customized service management platforms.

In order to make network and service function usable and manageable as a part of network slice, it is necessary to have an overall management system on which the orchestration of such functions can rely. Existing technology such as SFC already provides a comprehensive solution for the purpose of service-level integration. It would be interesting to investigate how underlay network infrastructure can better serve and map with requirements of particular SFC or interconnection between SFCs under network slice regime. Such system should be capable of associating service function resources to required network infrastructure, making the formation of an end-to-end network slice possible.

## 2.2. Use Case Analysis

It is always preferred to have more diversified resources on which network slices can be built. Heterogeneity becomes an inevitable issue caused by this nature of variety. At present, countless management systems are being used by service providers for different types of resource domains. COMS may help to aggregate and coordinate the management plane of such systems and provide unified slice-level OAM.

# 3. Interoperation between Multiple Slice-aware Administrative Domain

## 3.1. Use Case Introduction

As mentioned in section 2, the slice orchestrator need to supervise heterogeneous resources in various administrative domains in response to diversified demand from the network slice tenants. For example, the network slice orchestrator needs to supervise some heterogeneous technology domains, which obviously have separated administrative systems. Examples include optical transport network, IP routing network in terms of network infrastructure and SFCs in terms of service function. Administrative domain may also isolated for technology-evolution reasons. For instance, the slice orchestrator is necessary to be compatible with either controller-based networks or EMS-based networks. Furthermore, as computing plays more and more

significant role as infrastructure resource, the requirement of coordinating between networking and computing in management plane is obvious.

### 3.2. Use Case Analysis

Either it is a green field implementation or not, given the heterogeneity property of resources, the administrative domains can only be more diversified. Meshed interoperation between these administrative domains is infeasible. Hence, a higher level management entity is one of the most cost effective and straight forward solution.

## 4. End-to-end Orchestration of Network Slicing

### 4.1. Use Case Introduction

When a network slice tenant purchases a network slice service, it does not necessarily know the what underlay resources exactly are allocated for the purpose of the network slice creation. It is the network slice orchestrator who takes care of this process. As the network slice orchestrator receives network slice service delivery model from service provider's OSS/BSS, it executes slice-level operation and management accordingly. End-to-end orchestration is an essential part of this process.

The main functionality of end-to-end network slice orchestration may include the following aspects:

1. Coordinating underlay network infrastructure and service function resources

2. Life-cycle management, which includes the common operation of network slice creation, activation/de-activation, modification, deletion and status monitoring.

3. Pre-defining templates of common types of network slices and provide repository for network slice instances created by templates or full customization

#### 4.1.1. Resource Registration

In the process of end-to-end orchestration of network slice, resource registration is one of the fundamental prerequisite. The network slice orchestrator needs to know exactly what resources are available under the overall management. The information for resource registration may include the the following aspects:

- The type of resources (whether it is a connectivity, computing, storage or pre-defined network/sevice function)
- The physical/logical location of the resources
- Data plane and control plane technology capabilities
- Performance capabilities
- Availability information
- Domain topology information

The network slice orchestrator can only use registered resources in the process of network slice creation. Any change of resource information caused by equipment upgrading, new deployment or abolishing of legacy system need to be reported to the network slice orchestrator.

#### 4.1.2. Life-cycle Management

It is important that the network slice orchestrator can continuously manage the creation, activation/de-activation, modification, deletion and status monitoring processes of the network slice for a complete life cycle. In general, a network slice profile can be created in several ways:

- A network slice profile can be created according to the network slice templates. In this way, the network slice profile is create by direct configuration of the parameters in a pre-defined network slice template according to exciting index.
- A network slice profile can be created by customized parameter index and value.

In both cases, the value of parameters come from the service delivery interface of the network slice orchestrator. Particularly for the latter case, a complete network slice profile is needed from the service delivery interface.

Additionally, the operation of life cycle management also comes from the OSS/BSS service delivery model. After receive such operation request, the orchestrator need to map certain them to different administrative domains respectively.

### 4.1.3. Network Slice Template and Repository

As mentioned in section 3.1.2, network slice orchestrator can use templates to create network slice profiles. Templates are extremely useful in cases where multiple network slice tenants require exact same type of network slices. For example, URLLC is regarded as one of the most popular scenario in 5G application. It would be useful to pre-define a URLLC network slice template, to which the network slice orchestrator can refer, upon request of network slice tenants.

A network slice repository make it handy to manage the templates of different types. It also helps to categorize different network slice profiles created under given templates. A category of "Customized network slice" might also be useful for the cases where network slice is created from scratch.

## 4.2. Use Case Analysis

End-to-end orchestration is the most essential functionality of network slicing management. COMS information model will act as a significant reference for resource registration, network slice template definition and and the creation of network slice profile. At the same time, life-cycle management will be enabled by the COMS service delivery model.

# 5. Customized OAM for Network Slice Tenant

## 5.1. Use Case Introduction

As a network slice instance is activated, the network slice tenant is able to access the network slice and apply intra-slice configuration under network slice provider's policies. This include operation and management functionalities, which are likely to be a subset of the overall network slice management. Typical functionalities a network slice tenant may prefer to have include the following aspects:

1. Network slice life-cycle status monitoring

2. Performance dash board of individual/set of resource components in a network slice

3. Slice-level parameter adjustments under network slice providers' policies, strictly avoiding conflicts with other network slices.

4. Slice subset operation and management based on COMS at network slice provider's permission

### 5.2. Use Case Analysis

The network slice orchestrator has two NBI interfaces respectively. One of them is designed for the purpose of customized OAM. A network slice tenant may use this interface to perform the actions listed in section 5.1. COMS is in the position of defining the NBI interface

## 6. Interaction with 3GPP Network Slicing

### 6.1. Use Case Introduction

3GPP is the born-place of the concept of 5G network slicing. However in 3GPP, only radio access network and core network are considered as the resource pool for network slices. The transport network is modelled as a link between them. Technically in 3GPP language, network slicing does not include transport network.

In 5G, the requirements of network slicing focus on the guaranteed end-to-end quality in terms of Bandwidth (eMBBs), Latency (URLLC) and connections (eMTC). For the purpose of end-to-end network slicing is to provide guaranteed service for vertical user. Transport network will also play an important role in this scenario. One of the most straight forward solution for service-guaranteed mapping to the sliced 3GPP network is to make the TN also slice-aware.

As 3GPP SA5 delivers the performance requirements from 3GPP slice manager to IETF network slice orchestrator, the orchestrator will treat the requirements similarly to a general service delivery model received from OSS/BSS. It is not 3GPP's concern weather IETF is using slice or not toe fulfill this requirements

### 6.2. Use Case Analysis

Network slicing is one of the key technology in 5G network. It is important that transport network can provide certain quality guarantee, so that the end-to-end network slice run over can fulfill the overall requirements. COMS provides NBI for the purpose of gathering transport network requirements. These requirements will be further broken down into underlay systems requirements accordingly, where COMS can help the mapping by providing the general information model.

## 7. Network Slice FCAPS

### 7.1. Use Case Introduction

This is a place holder for slice-level FCAPS use cases for COMS. It is due to be updated in 01 version of this document

### 7.2. Use Case Analysis

## 8. Network Slice Stiching and Recursion

### 8.1. Use Case Introduction

This is a place holder for inter-slice operation use cases for COMS. It is due to be updated in 01 version of this document

### 8.2. Use Case Analysis

## 9. IANA Considerations

This document makes no request of IANA.

## 10. Security Considerations

There is no security consideration in this draft.

## 11. Acknowledgements

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## 12. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

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