C2017/3-8 RELIANCE

Deliverable 3.2 – Description of the models for scalable resource composition

WP3 – **SCALABLE SLICING**

Working Version of Deliverable

.....

Dissemination level:	Public
Version:	0.1
Authors:	Ulak
Contributors:	RELIANCE CONSORTIUM

C2017/3-8 RELIANCE
REsiLIent ANd scalable sliCing over multiplE domains
https://projectreliance.com/

Supported by

Spain – CDTI

Sweden – VINNOVA

Turkey – TÜBITAK

Participants in project (RELIANCE) are:

- SII Concatel S.L. (CCTL)
- Keyland Sistemas de Gestión S.L. (KEYLAND)
- Saint Patrich Technology S.L. (TyP)
- RISE Research Institutes of Sweden AB (RISE)
- Bombardier Transportation Sweden AB (BOMBARDIER)
- Westermo Network Technologies AB (WESTERMO)
- Eduro AB (EDURO)
- Turkcell Teknoloji (TURKCELL)
- Netas Telecommunications A.S. (NETAS)
- ULAK Communication Inc. (ULAK)

Project coordinator: Elio Saltalamacchia, SII CONCATEL

Disclaimer for public CELTIC-Plus project reports (delete one disclaimer)

Disclaimer for confidential CELTIC-Plus project reports (delete one disclaimer)

Disclaimer

1. Preface

As described for WP3 definition, the target was to develop the new resource abstraction based on the slate concept, which provides isolated resource share offerings within a domain for the slices.

This new abstraction required dynamic management procedures via which resources can be aggregated and partitioned to introduce unified control and management.

Slices can also be created by composing resources from different providers across multiple administrative domains.

Each involved domain allocates a share of its resources, i.e., a slate, for the sake of federating them with the shares (slates) offered by other providers.

The ultimate objective is to support slice scalability by exploring how to expand (shrink) federations without disrupting existing services.

This is realized by including new resources and removing unnecessary ones at run-time.

To this aim, the choreography plane has defined novel interfaces and operations for the seamless coordination between the domain-specific orchestration-planes to establish slice federation.

To achieve this goal, there were three defined objectives:

Objective 3.1 – Define procedures for dynamic resource abstraction within a single domain (‘slate’) with the recursive support to scale up and down the resource share offerings

Objective 3.2 – Research on how to manage a dynamic virtual environment where resources and components can be federated on-demand, through automatic capability discovery, in an elastic way.

Objective 3.3 –Research on solutions to develop a choreography plane for automating the process of establishing federations of resources issued from different providers

1 Executive Summary

This document covers the last two objectives for this work package. The first objective is been described and documented in D3.1.

The following sections provide the outcome from the described research processes for fulfilling objectives two and three.

Objective 2: Models for scalable resource composition as a solution. The outcome of exploring the strategies and mechanisms for end-to-end resource composition.

Objective 3: Slice choreography research. On the integration of scalable monitoring and feedback systems to infer QoS of federated slices and, in case of deviation from the expected behaviour, trigger appropriate actions.

In this term, besides continuing efforts to implement different network slicing methods, research has been done on methodologies to manage end-to-end slices among operators and a workflow has been proposed.

For this purpose, 3GPP 23740, 5GPP, ETSI VE GSMA specifications have been investigated for further Multi-Domain Network Slicing Research.

The next sections display the results of these researches, which have been accomplished, providing all the configurations and environmental conditions required.

In terms of the methodology that implements a network slice; network architecture, network slice design and slice management sequence diagram have been explained. Later, federated multi-domain network slicing methodologies are described with technical requirements, architectural subcomponents and roles. Generic Slice Template (GST), which enables the coupling of network slices among MVNOs, is also given in detail. In the end, a methodology to enable the coordination of the network slice management actions among operators and to manage the federated network slices is depicted.

2 Table of Contents

3 List of Figures and Tables

4 Abbreviations

B2B Business to Business

B2B2C Business to Business to Consumer

B2C Business to Consumer

CPU Central Processing Unit

CSMF Communication Service Management Function

DPDK Data Plane Development Kit

GHz Giga Hertz

GST Generic Network Slice Template

IDS Intrusion Detection System

IPS Intrusion Prevention System

MVNO Mobile Virtual Network Operator

NBI North Bound Interface

NEST Network Slice Type

NSI Network Slice Instance

NSMF Network Slice Management Function

OvS Open Virtual Switch

PGW Packet Data Network Gateway

QoE Quality of Experience

QoS Quality of Service

RAM Random Access Memory

SDN Software Defined Networking

SLA Service Level Agreement

UPF User Plane Function

VM Virtual Machine

VNF Virtual Network Functions

5 Definitions

A list of definition of terms used in the main body is strongly recommended.

B2B: It means business to business. The term encompasses all companies that create products and services geared toward other businesses.

B2B2C: It means business to business to consumer. It focuses on creating a better customer experience and buying journey for the end consumer.

B2C: It means the process of selling products and services directly between a business and consumers who are the end-users of its products or services.

CPU: CPU is the electronic circuitry that executes instructions comprising a computer program.

CSMF: It is responsible for generating allocation requests for new Network Slice Instances.

DPDK: It is an open-source software project managed by the Linux Foundation.

GHz: It is a unit of measurement for AC (alternating current) or EM (electromagnetic) wave frequencies equal to one billion Hz (hertz).

GST: It defines a set of common slice attributes the industry can use on which to base the description of a network slice type.

IDS: The technology that monitors a network or a computer system for malicious activity or policy violations.

IPS: The technology that evaluates malicious activities and takes actions to eliminate or minimize their effects.

MVNO: It means that a wireless communications services provider does not own the wireless network infrastructure over which it provides services to its customers.

NBI: It is an interface that allows the component to communicate with a higher-level component, using the latter component's southbound interface.

NEST: It means a template from which Network Slice Instances (NSIs) are created.

NSI: It is an activated network slice. It is created based on a network template.

NSMF: It provides the management services for one or more NSI and may consume some management services produced by other functional blocks.

OvS: It is an open-source implementation of a distributed virtual multilayer switch.

PGW: PGW is a critical network function for the 4G mobile core network. It acts as the interface between the LTE network and other packet data networks, such as the Internet or SIP-based IMS networks.

QoE: It is a measure of the delight or annoyance of a customer's experiences with a service.

QoS: It is the measurement of the overall performance of a service.

RAM: It is a form of computer memory that can be read and changed in any order, typically used to store working data and machine code.

SDN: It is an approach to network management that enables dynamic, programmatically efficient network configuration to improve network performance and monitoring.

SLA: It is a commitment between a service provider and a client.

UPF: It is responsible for packet routing and forwarding, packet inspection, QoS handling, and external PDU session for interconnecting Data Network (DN), in the 5G architecture.

VM: It is the virtualization/emulation of a computer system.

VNF: VNFs are virtualized network services running on open computing platforms formerly carried out by proprietary, dedicated hardware technology.

6. Network Slice Data Plane Management Method With MAYA SDN Controller

In this work package, the extent of network slicing and the layer in which network slicing is executed are described and evaluated. 5G Core Network will be deployed on Openstack in a “Leaf Spine” architecture. MAYA SDN Controller will be used to manage OvS in Openstack architecture to establish logical networks as network slices and to provide and maintain reliability. Besides, UPF/PGW network functions are deployed in VMs supported by DPDK in Openstack nodes (Figure 1).

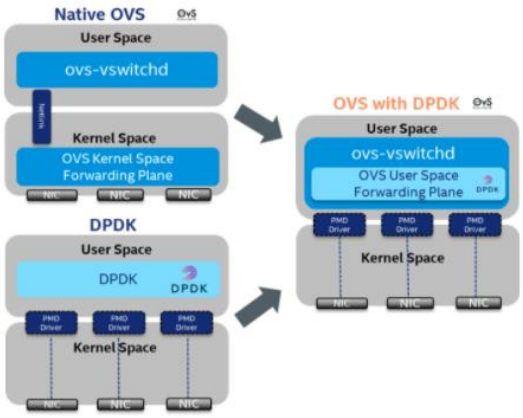

Figure 1:VM architecture with DPDK support

In this architecture, the MAYA SDN Controller defines the policies to be implemented in OvS switches. In this regard, Table 1 shows QoS requirements for network slices in 5G concept.

	Bandwidth		Delay Budget		Error Rate	Traffic Density	ULAK Planned Queue	Sample OVS Command
	Peak Rate	User Exp.	User Plane	Control Plane				
Control							q7	
High Priority Mgmt.							q6	
URLLC		300Mbps*	1ms*	20ms	10^{-9} - 10^{-5}*		q5	Slice Definition: sudo ovs-vsctl -- set Port <int> qos=@newqos -- - -id=@newqos create QoS type=linux-htb queues=5=@q5 -- --id=@q5 create Queue other-config:min-rate=300000000 other-config:max-rate=300000000
eMBB **(3GPP 23.501: Mission Critical Video user plane)**			100ms		10^{-3}		q4	Meter Definition: ovs-ofctl add-meter <switch> meter=1,kbps,band=type=drop,rate=100000 Flow Assignment: ovs-ofctl add-flow <switch> dl_type=0x0800, nw_src=10.0.0.3,nw_dst=10.0.0.4, priority=50010,actions=meter:1,set_queue:4,normal
(3GPP 23.501: Non-Conversational Video)			300 ms		10^{-6}		q3	
mMTC **(NGMN)**		1-100 Kbps	Seconds to hours			200.000 devices/km^2	q2	Policing on egress port (not tested / in MB): ovs-vsctl set interface <int> ingress_policing_rate=10000
Low Priority Mgmt. (Monitoring etc.)							q0	

Table 1: QoS requirements for Network Slices in 5G

7. Parameters for Each Network Slice

Login information for the Compute and Controller nodes in question:

- IP
- Username
- Password

User Equipment (source):

- IP, Subnet

UPF (destination):

- IP, Subnet

QoS parameters:

- Maximum Bandwidth
- Minimum Bandwidth
- Packet Delay Budget (ms)
- Packet Error Rate
- Priority Level

8. Qos Management of Network Slice

In the Reliance project, 5G Core Network Slicing will be implemented by first attaching the VNF's to proper networks and second assigning proper QoS parameters to these networks. Slice Management Sequence Diagram can be seen in Figure 2.

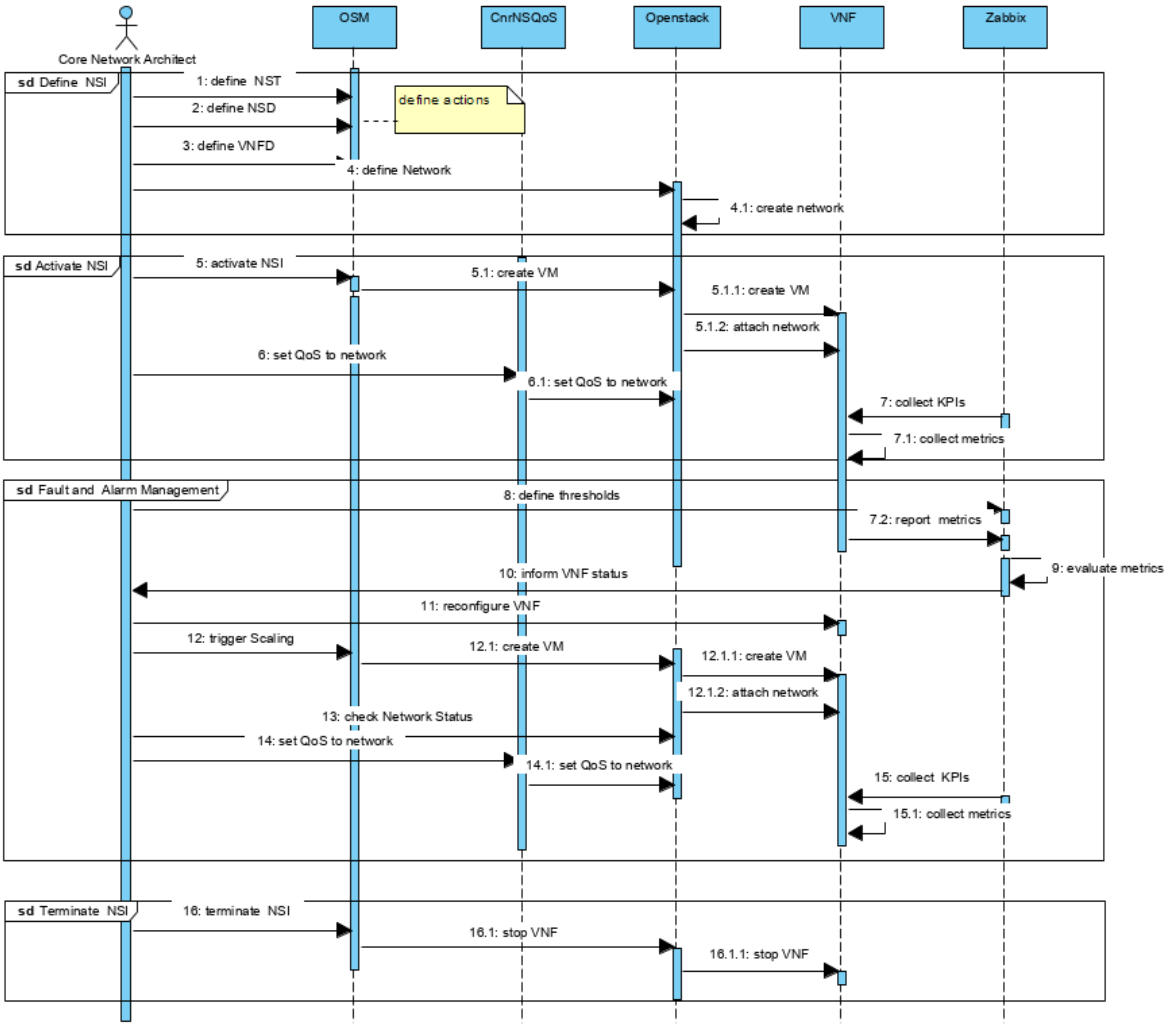

Figure 2: Slice Management Sequence Diagram

9. Federated Multi-Domain Network Slicing Methodologies

Another research topic in the Reliance project is Federated Multi-Domain Network Slicing Methodologies. In this aspect, methodologies of different sources and telecom operators have been investigated and a proposal has been made.

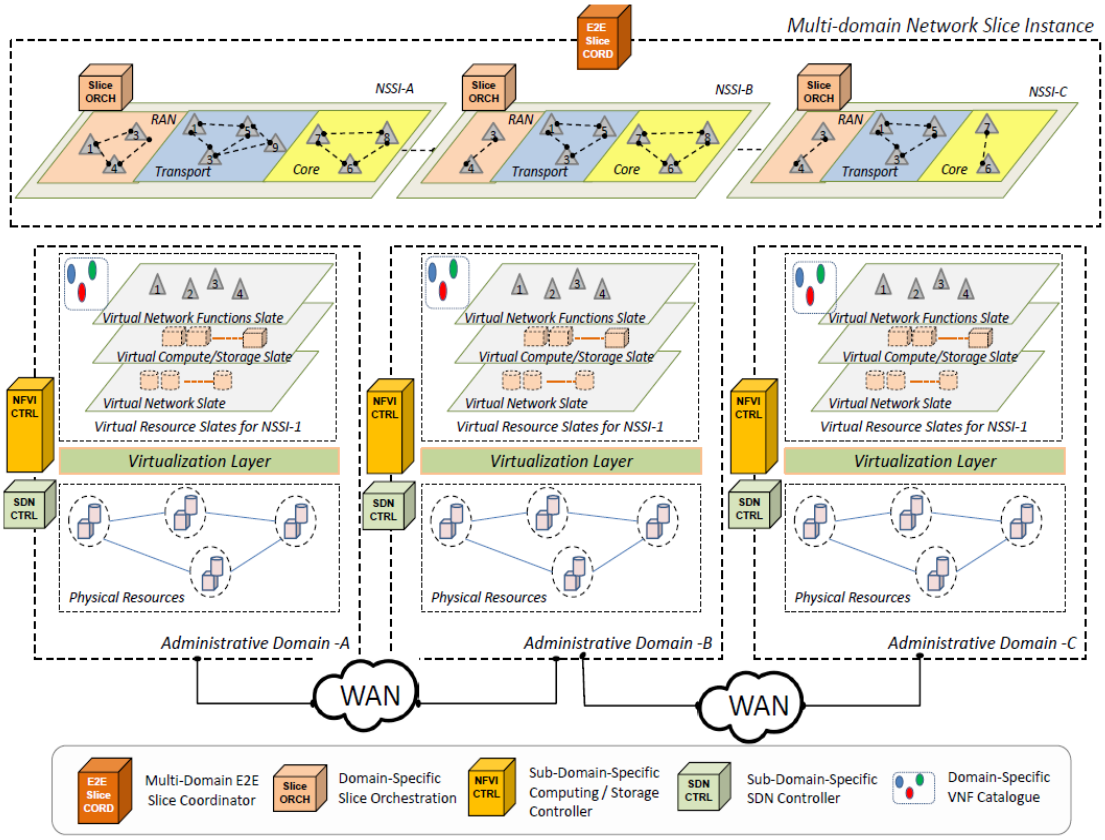

Figure 3: Components of Multi-Domain Network Slicing

To comply with the architecture presented in Figure 3, the following requirements should be executed:

1. Coupling service requirements among operators.
2. Defining and coupling end-to-end infrastructure requirements.
    a. NSI resource requirements (compute node, storage, network)
    b. NSI network topology, security, network isolation and QoS/QoE rules
3. Composing all resources to support the end-to-end network slice.
4. Provision of network slice in terms of SLA among operators and following the requirements defined above.
5. Management and maintenance of federated network slices with Run-Time coordination.

a. Subcomponents of Multi-Domain Network Slicing Architecture

- **Service Conductor:** This is the component that transmits the end-to-end multi-domain slice requests to related operators and decides on the network slice to be used for the SLA. Conveys initiation information necessary for Cross-Domain Slice Manager Function to enable life cycle of network slices. Responsible for initiating network slice units with Cross-Domain Slice Manager and life cycle management.

- **Cross-Domain Slice Manager:** Manages the life cycle of resources assigned to end-to-end network slices by enabling each operator to work following NSMF units. Manages the compute node, storage and network resources assigned to federated network slices following the NSMF of the related MVNO.

- **NSMF:** Manages the intra/inter network slice units of an MVNO. Couples the network slice selection rules with the physically deployed network slices. Manages the life cycle of each subcomponent.

b. Generic Network Slice Template (GST)

Additionally, GST is provided as a network slice model template by GSMA to enable the coupling of network slices among MVNOs and the communication of the Cross Domain Slice Manager unit with every MVNO through the same template. An end-to-end network slice will be provisioned with the parameters resulting from building a NEST with the requirements table extracted from the B2B/B2C/B2B2C user specifications using GST (Figure 4).

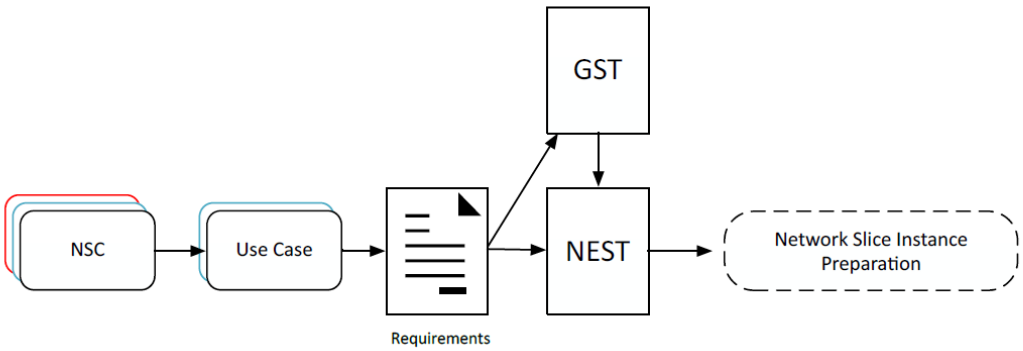

Figure 4: Provision of a network slice with GST and NEST

The general scheme and actions of NSMF unit defined in 3GPP 28801 are shown in Figure 5.

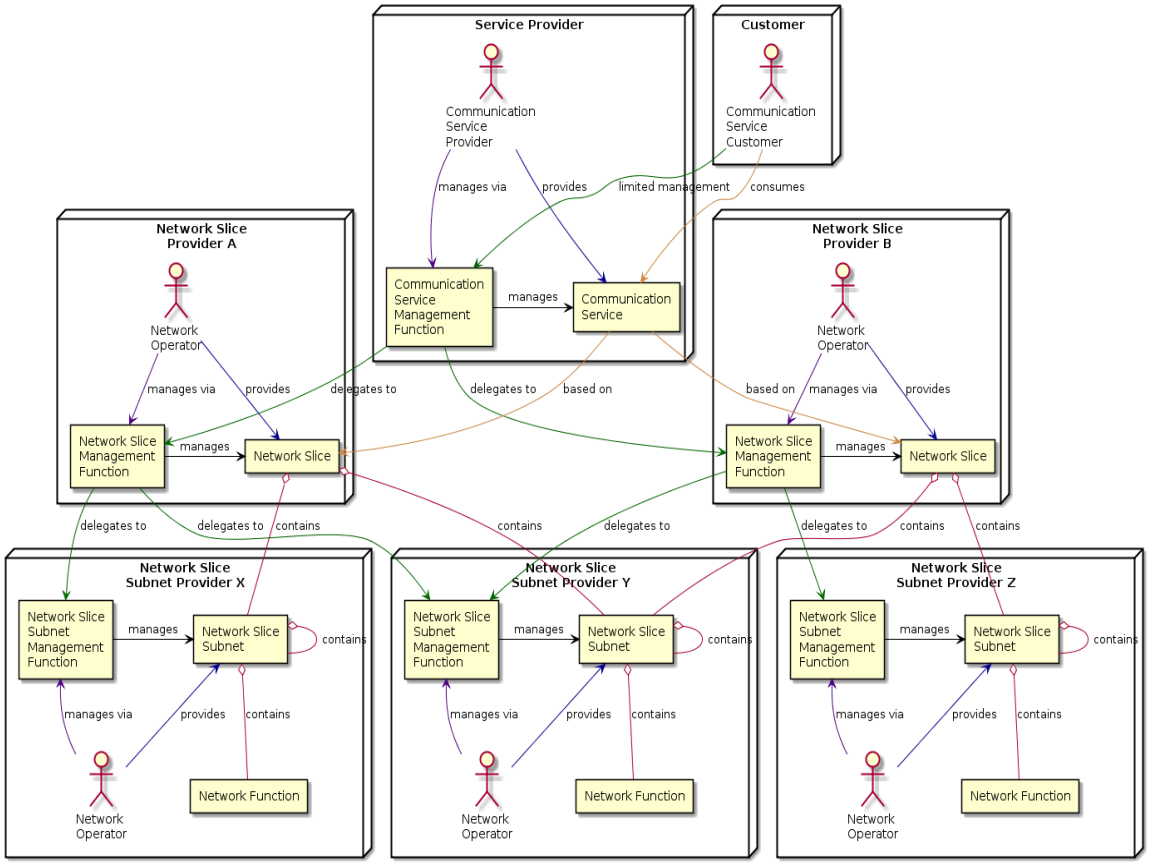

Figure 5: General Work Flow of NSMF

Orchestration and Admin Roles of Network Slice Management are defined in Table 2.

Actor	Role	Description
Customer	Communication Service Customer	Consumes a Communication Service
Service Provider	Communication Service Provider	Provides a Communication Service Consumes Network Slice(s)
Network Slice Provider	Network Operator	Provides a Network Slice Consumes Network Slice Subnet(s)
Network Slice Subnet Provider	Network Operator	Provides a Network Slice Subnet

Table 2: Federated Slice Management System Roles

In Reliance Project the main goal is to enable the coordination of the above-listed network slice management actions among operators and to manage the federated network slices. In this regard, a methodology is proposed by leveraging chapter 7.2 in 28801 3GPP documents:

1. The CSMF located on the client-side provides the templates defined by GSMA.
2. CSMF sends an NSI request to NSMF of the related MVNO.

3. NSMF, which is responsible for the network slice management of MVNOs, provisions the end-to-end network slice or assigns an existing slice to this service after security and authorization controls.

4. Every MVNO provisions the network slices for the related service or client and the UEs will be served over this network slice.

Multi-Operator NSI Life Cycle Management System Architecture is shown in Figure 6.

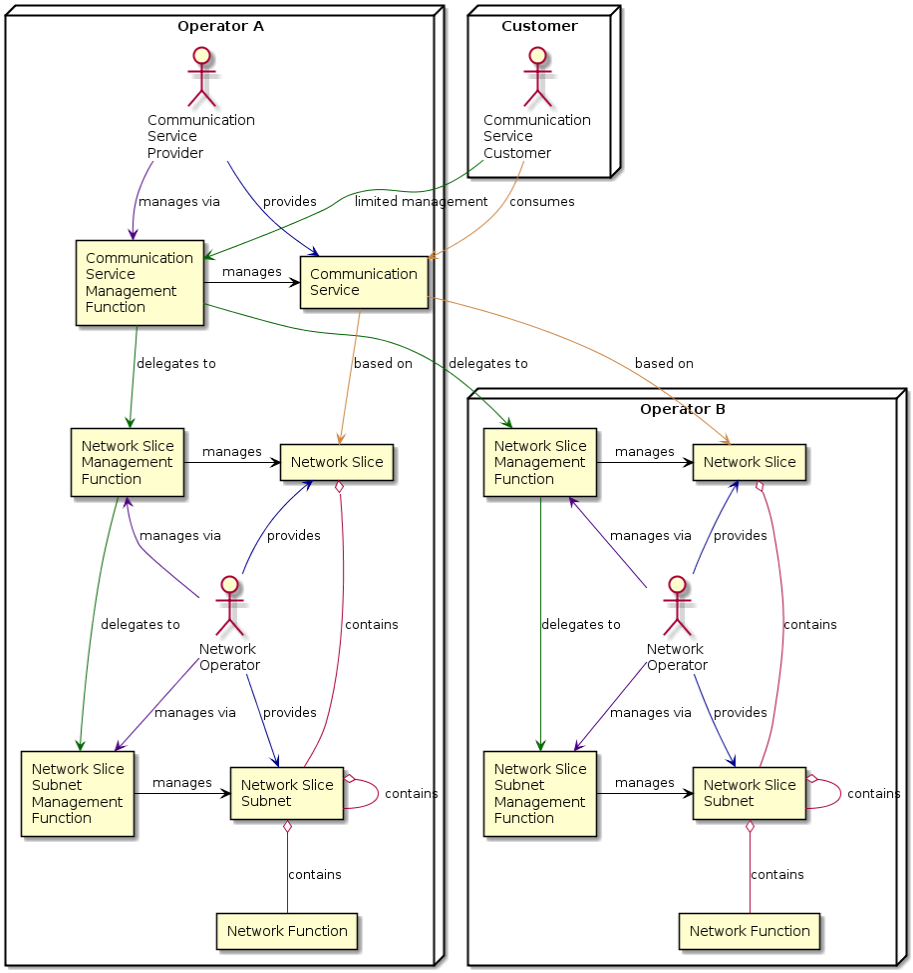

Figure 6 : Multi-Operator NSI Provisioning Management System

10. References

1. 3GPP 28801, Telecommunication management; Study on management and orchestration of network slicing for next generation network, Rel15.0.0
2. NG.116 Generic Network Slice Template v4.0