Network Slice Life-Cycle Management Towards Automation

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***Abstract*—We present a method of orchestrating end-to-end network slices and managing their life-cycle. Through this method, we propose management and orchestration processes and operations and describe them one by one in order to provide a global view applicable to different scenarios.**

The proposed solution is based on software modeling of services and resources which allows a customized software design and an intelligent and optimized deployment over heterogenous IT and Network ressources modeled as graph databases.

***Index Terms*—NFV, 5G, Network slicing, Management and Orchestration, Automation, Graph modeling, Software design.**

I. Context and Motivation

An important objective of Network Slicing [1] is to go far beyond resource sharing and consumption reduction.

Indeed, Network Slicing aims at providing customized networks and tailored services for vertical actors and all Network-as-a-Service (NaaS) users [2]. This requires more flexible models and mechanisms for network service provisioning and deployment, as well as the the automation of the orchestration of network services and resources [3]. Many initiatives are targeting agile and automated management frameworks of network slices on the basis of Open Source tools and platforms. Various methods are proposed in the context of Multi-Access Edge Computing (MEC), Core Networks, Radio Access Networks and also for end-to-end networks [4]–[7].

Following previsous work on resource federation for cross-domain network slicing [8] and research directions approved as fundamental requirements for networking slicing in legacy and 5G networks [9], we present a method for network slice life-cycle management based on software modeling of resources and services to consider end-to-end network slices. We describe the main management operations in Section II and the planned demonstration in Section III.

II. Network Slices Life-Cycle Management

Global orchestration relies on control and management functions as well as operations that compose the management of the life-cycle of network slices. Figure 1 summarizes our view of a network slice life-cycle. Specific requests for network services and/or virtual networks are issued by business vertical actors to an orchestration platform, which is part of the Telco OSS/BSS systems through B2B APIs.

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Requests trigger establishement procedures of Service Level Agreement (SLAs). The application service requirements and QoS constraints are then detailed and completed by network-related requirements.

The orchestrator is in charge of building a network service over an adequate virtual network infrastructure. The network service logic consists of selecting Virtualized Network Functions (VNFs), themselves resulting from a software composition of VNF components. This design phase produces network slice templates. These templates are used for the infrastructure resource provisioning (virtual embedding) and placement (effective embedding). The provisioning accounts of the service and resource constraints for the placement of functions, which relies on a proposed optimized resource provisioning and allocation Algorithm [10].

Thus, the selected virtual nodes fulfill the requirements for the network slice components deployment and execution over the infrastructure resources.

In order to maintain the requested QoS level, a continuous monitoring is performed at the infrastructure level for re-designing and/or re-provisioning, for instance upon an application service request change related to new QoS constraints.

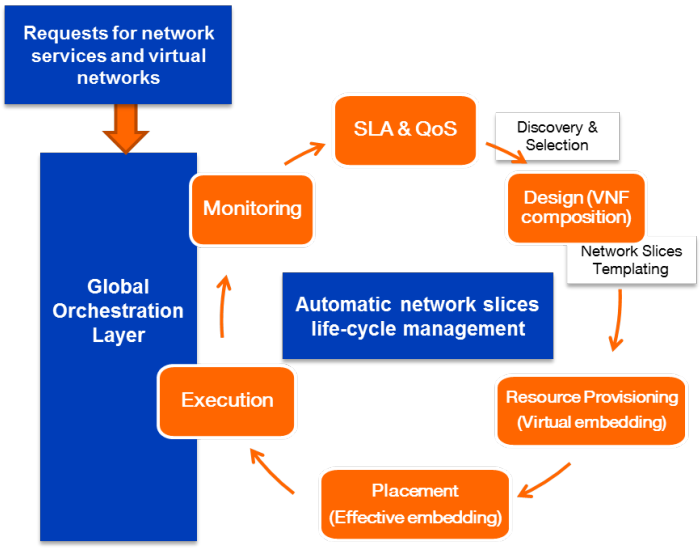

Fig. 1. Network Slices Life-Cycle Management

III. Proof-of-Concept & Planned Demonstration

In the light of the life-cycle defined above, we present a demonstration of an orchestration platform showing step-by-step an end-to-end network slice life-cycle management. The network slice is conceived as a service requested by a tenant.

Figure 2 shows the definition of the service and network requirements for a network slice such as: the service type, targeted service performance, optional specific capabilities (security), load (number of devices/users) and coverage area.

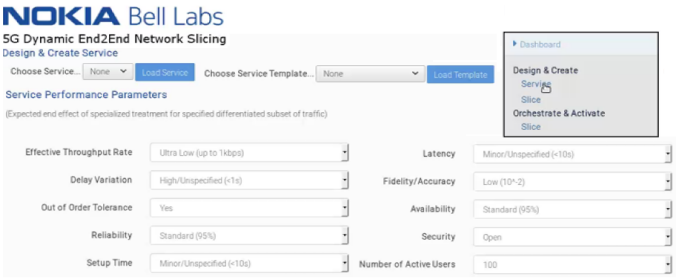

Fig. 2. Definition of Network Slice Requirements

The software design studio of the network slice through composition is captured on Figure 3. VNFs can be added in a drag and drop mode from a VNF catalog and connected through virtual links to form a composed service template, which is the network slice template as shwon in Figure 4.

Such a slice template contains the description of the slice composition from interconnected network and applicative functional components, and other descriptions useful to deploy and operate the slice across its entire lifecycle. Once a slice design is validated, it is added as a new slice service into a B2B service catalogue.

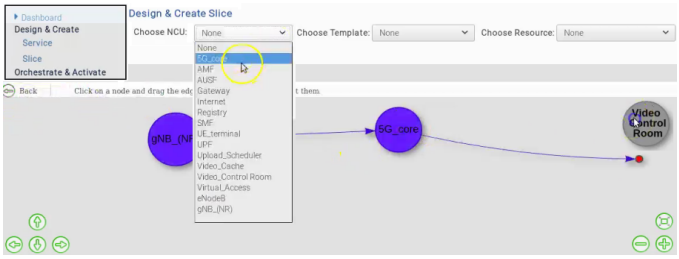

Fig. 3. Network Slice Design and Customization

A key element of our orchestration platform is a graph-based database. We rely on graph models to model and structure heterogenous IT and network infrastructure resources. Building such a database offers an organized global view of all considered resources for the orchestration platform.

As shwon through Figure 5, it represents an inventory of all resources with detailed information and parameters (technology, capacity, availability, location,...) and used by the resource provisionning and AI-based placement algorithm to identify the adequate resources and perform an intelligent and optimal deployement of network slice components.

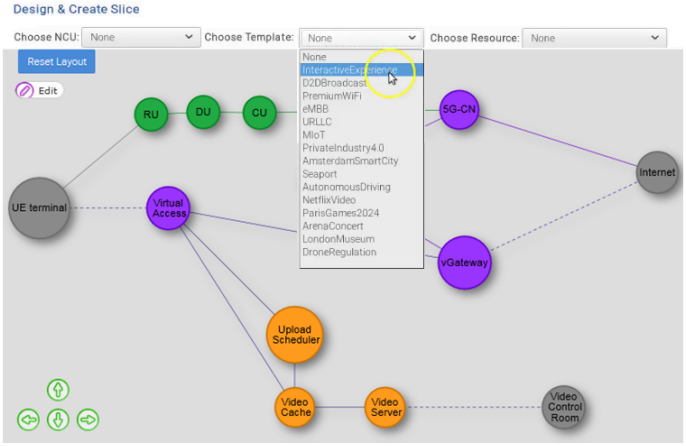

Fig. 4. Network Slice Template and Catalog

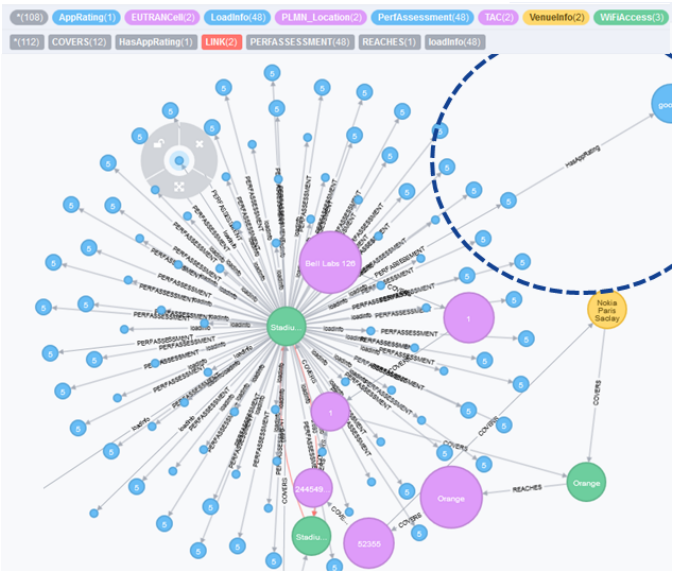

Fig. 5. Graph DataBase Modeling Network and Infrastructure Resources

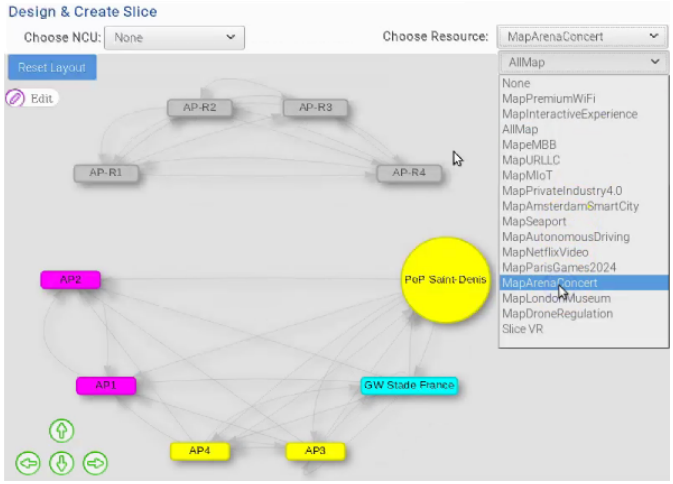

Fig. 6. Resource Provisionning and Placement

IV. Conclusion

We have presented an automation-oriented orchestration platform that integrates a proposed methodology for network slice life-cycle management from a customized design based on composition of software components to an intelligent and optimized deployment over heterogenous IT and Network resources federated and modeled through graph databases.

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