Management of Network Service Orchestration and 5G Networks

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Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 28 April 2021

Abstract: The introduction of a new spectrum of expanded communication technologies has allowed telecom companies to provide support for emerging services while maintaining both end-to-end service quality and productivity. NFV has recently been considered in 5G networks for understands the importance of digital services as a cost-saving base technology. Several orchestration problems are, therefore, an important problem relating to cross-domain communications and demonstrated by the diversity of underlying systems and administrative bodies. We must rethink the use of network services as the types of demands that we see today are stricter than in the past. The model of the software-designed network provides new ways to run the network in scalable and efficient methods to satisfy requirements. For example, to track simultaneous traffic loads, to trim the networks and to redirect each flow as per the underlying policies, it allows you to tailor them to the system's needs. This paper discusses how the network orchestration processes apply and communicate with the conceptual and management inputs and what are the benefits.

Keywords: Network services orchestration, Network management, Software defined networking, Network function virtualization, Virtual Network Functions, MANO, Network slicing.

1. Introduction

1.1 Background

Over the past few years, the amount of sales of TSPs has gradually decreased. In this regards, two major causes have been linked to this. On the one side, apparently unsatisfactory traffic requirements of subscribers need physical network expansions done with increased CAPEX and OPEX (Meddour, Rasheed & Gourhant, 2011; Hernandez-Valencia, Izzo & Polonsky, 2015). Telecom infrastructures include a multitude of advanced technological areas, such as radio, connectivity, transit, central and (virtualized) data center networks. End-to-end architecture, deployment and execution are typically managing and long processes conducted by conventional Operational Support Systems (OSS), which lead to long timeframes (weeks or months) (Khan et al., 2011). Software Oriented Networking (SDN) technical advancements (Nunes et al., 2014; Jammal et al., 2014) and Network Feature Virtualization (NFV) (Mijumbi et al., 2015) brings newer methods that enables network operators to create, install, operate and manage their services. SDN and NFV, as well as cloud computing, implemented new tools for the effective and scalable usage of their networks through a software-centered operation model in the European Telecommunications Standards Institute (ETSI) (Sonkoly et al., 2015). In order to understand this paradigm, however, the end-to-end service must be built and physical and virtual tools that provide the service should be summarized and streamlined.

1.2 Network Function Virtualization

Network Function Virtualization (NFV) provides a new concept in implementing and handling the network operations, by removing the network tangible facilities. NFV mainly allows a Network function built on software that is an improvement in the hardware-based network function (Dreibholz 2020; Kaltenberger et al., 2020).

A plausible solution to these problems has been described as NFV (Mijumbi et al., 2015). The key principle of NFV is the disconnection between network functions (NFs) and capacity (the physical infrastructure on which they run). Breaking the link between NFs and hardware provides many benefits. Firstly, OPEX is likely to be lowered substantially by improved procedures, as the bulk of repairs and NF enhancements can be achieved remotely or on a scale.

Recently, because of the immense multitude of systems and services it provides in a range of sectors, for example for telecoms company, NFV is among the most common terms (in relation to TSPs). Capital spending (CAPEX) and operational expenditure (OPEX) has reduced considerably (Wu et al. 2015). In addition, with the addition of many single tech providers, NFV has extended its numerous portfolios in the telecoms market.

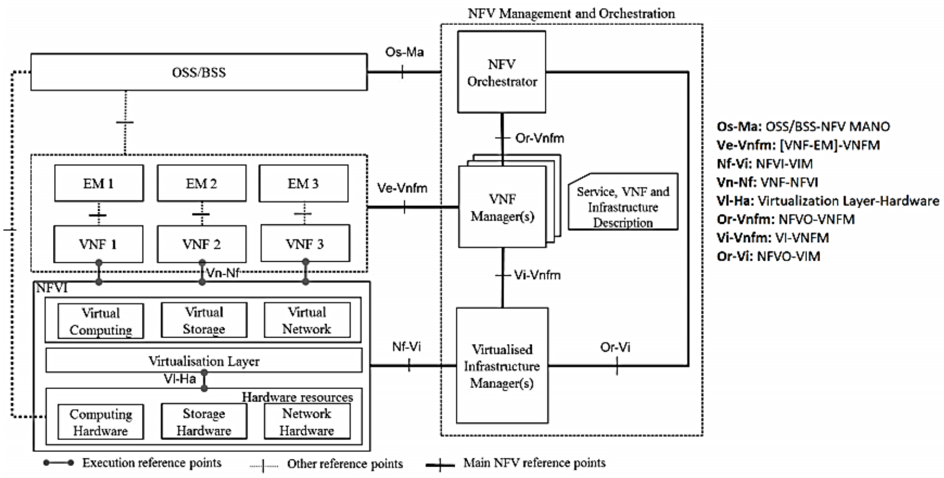

Figure 1: Architecture of Management and Orchestration (MANO) (source: ETSI)

More capacity will also contribute to better utilization of capital and thus lowered CAPEX, since TSPs are able to take advantage of current network capabilities with additional user traffic. Finally, NFV can increase the agility of the infrastructure by encouraging TSPs to launch and/or enable new network services more quicker and inexpensively. The NFV has become an emerging area of study from this viewpoint.

However, while much has been accomplished, there are still many technological problems to be tackled before the expected benefits from NFV can be achieved. MANO problems were among them especially significant. That is because MANO is a vital element of maintaining the proper functioning of the NFV (NFVI) and virtual network functions (VNFs). MANO delivers the necessary features for VNF supplies and related activities, such as the VNF set-up and resources on which those functions work. It requires physical and/or automated assets control and management for the life cycles of the VNFs (Quittek et al., 2014). Much like decoupled NFs, NFV involves a transition from device-driven organizational structures to those that are mindful of the operational needs of virtualized NFs.

A system of virtual network functions, called the virtualization infrastructure network functionality, is divided into a network service (NS) by Network Function Virtualization Infrastructure (NFVI). To model and deploy a service, a more appropriate approach to the composition/décomposition of the systems is necessary, and to automatically pick and manage the underlying physical or virtual resources and services with particular goals (e.g. VNF development, positioning, relocation, tracking etc) (e.g. QoS requirements, costs, etc.). This method is known as the orchestration and provisioning of network services or (NSO) (Rosa et al., 2015).

1.3 Network Orchestration

Network orchestration is the procedure of developing and maintaining an inter-organizational infrastructure where other connected network members carry on the task of the mutual objective (Dagnino et al., 2016). Earlier marketing and organization strategies have separated networks purposely orchestrated from evolving networks requiring no input from a central network agent. By comparison, study further into orchestration of deliberately formed networks presupposes that the leading company is effective in influencing and managing its network in a meaningful way (Muller-Seitz, 2012). It reverberates with network studies that take an actor-defined outlook so that a centralized network player seeks to form its business relations via network-based actions and interactions.

The authors in (Grit et al. 2006) proposed within virtual resource management the term "orchestration". They describe orchestration as a process involving all of the steps required to integrate the application to a shared network architecture (that runs on a VM).

2. Literature Review

Although the literary approaches to service provision related topics, e.g., resource allocation; slicing; scheduling, etc. have been investigated, primarily within single domain networks. In the context of broad-range 5G multi-domain networks, however, several issues remain successfully handled, including a focus on integrated network sharing, multi-tenancies and mutual resource management (Ma et al., 2018). Dieye et al. (2020) suggested the NFV orchestration process of auctioning, which would convert interoperator engagement and network resourcing sharing into buyer/seller and competitive market-driven transaction for network service orchestration (Habiba & Hossain, 2018; Zhang et al., 2012). The auctions, in particular, have the advantage to be economically profitable as a resource distribution as well as orchestration system by automatically finding the value of the service chain and assigns scarce capital to the bidding parties who value it most.

The different questions relating to NFV deployed in Telco were mentioned by Ayankoya et al. (2019). This study notes that the management layer plays an important role in a stable transition to an NFV structure and that it should be able to comply with the exclusive NFV-based architectural requirement. The network control and orchestration systems (MANO) and CORD (Central Office Re-architected as Data-Center) are other works that also concentrate on management layer support for NFV.

3. Orchestration

Cloud-based orchestration is popular and referred to the recognition, coordination and collection of services, comprising computation, memory and virtual networks to satisfy the demands. The implementation of workflow (processes) in the right order is associated with the orchestration. It manages the entire mechanism from start to finish with the intention to simplify as well as automate the implementation of the network services.

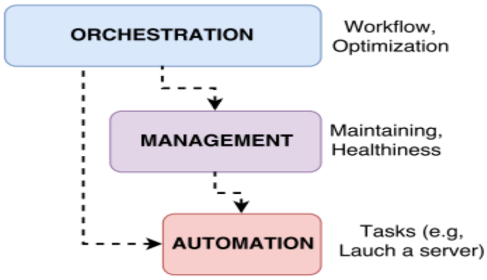

Figure 2: Relationship among different protocols

In short, the network services orchestration NSO tracks the entire network infrastructure lifecycle to provide end-to-end communication through additional services on the basis of all the above relations. For this function, orchestration promotes advancements in cloud computing and technology like SDN and NFV to rapidly reconfigure the network and program delivery and traffic management. We need to know how much traffic the system has on the links to coordinate the allocation of virtual machines, so that our next allotment requests are managed effectively. However to achieve this we need a reporting protocol to establish and execute this.

4. Importance of NSO

Technology for conventional network management cannot satisfy network operators' demands. In addition to the latest hardware, the number of network vendors grows annually (e.g. SDN controllers, Fabric route), including networking mechanisms (e.g. CLI, API, SMMP, NetCONF) begin to evolve. The developer who writes expectations or TCL scripts has quit the business in several industries, and any basic shift is turned into a new project. The majority of digital devices connecting to the 5G network is estimated to be immense. Whenever there is huge demand for software as well as a multitude of resources, the designing of the network infrastructure is a major challenge. Given the high-dynamic, heterogeneous existence of end-user requests and networks themselves (e.g., nodes, paths, etc.), potential NSO structures need to be tailored individually to different network contexts, communication protocols and layout contexts. Finally, in terms of third-party industry competition, e.g., service providers as well as virtual operators, wherein the operators’ productivity must be considered in the network resource orchestration procedure.

The method must, as a result of automation as well as paravirtualization, be prompt, reliable, stable and result in cost savings. The automated monitoring and control procedures in rollout and activities for service operators and service suppliers, covering a variety of various tools and possibly multiple providers, as illuminated in Figure 3, apply to Network Service Orchestration (NSO). Network Service Orchestration is responsible for disconnecting the fundamental resource management layers from the High-Level Application Layer (e.g., OSS, applications, service slices, etc.) (e.g. Element Management Systems (EMS), controllers), Mobility, Services enablement and Ressource enhancement and ultimate implementation of a more scalable architecture for a personalized service. To this end, NSO defines the interaction with (chains of) network functions in underlying technologies and infrastructures through adequate abstractions and a unifying pane glass for service definition and operation.

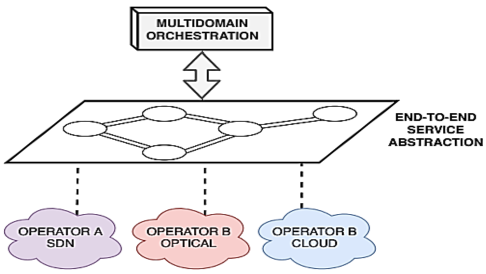

Figure 3: Network Service Orchestration

Network operators eventually use tablets to manage number of VLANs, router keys, etc. The manual settings are slow, costly and easy to manage and control. The EMS/NMS program unique to the supplier is pricey and has to be locked up by the supplier. Therefore, roll-outs of the network takes more than six months. The NSO uses, by contrast, the abstraction principle to collect vendor-neutral network setup, organizational data and policies and to connect with self-service portals. The network architects tailor built-in business models as well as NSO will look after the infrastructure variations. As a result, complicated CLIs of multiple providers and network facilities cannot be implemented within just a few mins by the network operators.

ETSI has created a strategy and standards for architecture including resources in support of NFV management and network services orchestration (Figure 4). The above network management services include element management (EM), support to the operations system (OSS) and support for the business system (BSS).

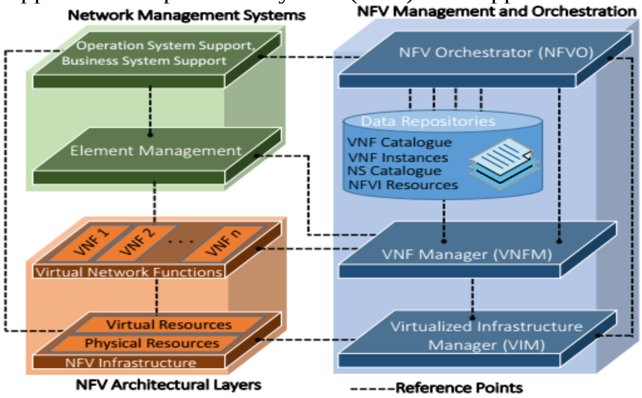

Figure 4: Framework of NFV-MANO (source: ETSI, 2014).

The NFV-MANO contains 3 functional blocks (VNFM, NFVO, and VIM) and 4 data repositories (NFV Instances, VNF Catalogue, NFVI Resources, and NS Catalogue).

Data Repositories: Four repositories NFV-MANO must be taken into account: (1) The NS catalog is a collection of pre-defined models that describe how the systems are generated and implemented as well as the functions required in the service and its communication. Data repositories are data bases that maintain various categories of information in the NFV MANO. (2) The VNF Catalog consists of a series of models that detail the operating and implementation functionality of the available VNF. (3) Information on usable / assigned NFVI services is found in the NFVI repository. (4) The archive for NFV instances provides knowledge over the lifespan of any feature and service instance.

4.1.1 Management of SDN

Although NFV and SDN are not strongly interrelated, they are closely correlated and complementary. Separately, NFV and SDN have high dynamics and uncertainty levels, which limits human operators' control and visibility. Consequently, to satisfy any one of them, existing management methods must be enhanced. While some statements are focused on SDN, all projects as well as technologies surveyed concentrate on the management of virtualized computing resources/infrastructure and functionality. Similarly, the emphasis from the SDN point of view is on the programmatic control of the network systems. The location of SDN controllers is a generally essential problem for optimum physical/virtual resource management. Several papers explored the positioning of SDN controllers in a single/multiple domain networks, which considered diverse reasons like reducing resource consumption, cumulative running cost or network latency (Ros & Ruiz, 2016).

4.1.2 Distributed Management

MANO's existing practices concentrate mostly on centralized solutions that restrict interoperability, particularly in cases whereby services cover many administrative disciplines. This was primarily due to overhead communication and the delay in gathering and processing data from multiple heterogeneous data sources that discourage these procedures being routinely conducted. This makes it difficult to achieve remote reconfiguration operations due to the lack of information about the status of facilities and infrastructure. Effective control systems must be introduced to supply distributed management agencies with the knowledge they need to make complex configuration changes to properly respond to market patterns as well as to changing service demands.

4.1.3 Advantages of Network Service Orchestration

NSO lets consumers boost profits by getting them to the market faster. The time-to-market is shortened from months to only a few hours through planning and using new products and services far too quicker. In 15 minutes, a customizable MIB poll policy or guidelines are used to carry out new computer forms previously unfamiliar to the network. In order to optimize network resilience and programmability, automatic services for prefixed, personalized service models are supported through Interface or REST API.

NSOs are reducing OpEx and CapEx. It significantly enhances the cost structure by completing vendors independence as well as automating main processes on the basis of custom hardware- and silicone-based networks via the complete REST API, putting conventional network management and opening, network programming in the SDN-style style and Operation Lifecycle Orchestration together.

NSO minimized the total network burden by removing operating silos and consolidated any control roles into a single-pane glass platform across end-to-end, multi-provider and multi-layered networks.

Moreover, mobile communications networks (5 G) of 5 generation are required to satisfy a range of high-speed (less than a few milliseconds) and non-mobile network-supported specifications, such as universal networking (connectivity is usable anywhere), no latencies and high-speed links (~10x of 4G). However, 5G requires a scalable and programmable transit, radio and cloud system to be effective. The orchestrater can be placed from the application layer to data plane into every other layer of telecommunication network stack. There should also be multiple orchestrators across each plane, and not limited to just one orchestrator. In this aspect, the service models refer to the various models relevant to the method of orchestration. The Cloud, SDN and/or NFV systems are used in any operation. Three types of services are available in Cloud Computing, including SaaS, IaaS, and PaaS. The production environment in PaaS is supported by CSPs as a product-based service. SaaS is a provider offering cloud-based software services. Finally, In IaaS, a virtual platform is supported by Cloud Service Provider.

5. Conclusion

In this detailed network services orchestration survey, we stress its increasing relevance as well as aim to relate to a summarized overview of common principles and varied strategies to NSO activities. While the VNF is a prerequisite to pick slices to monitor the physical layer, it is well understood from literature that somehow a separate management framework is often important for upgrading and providing VNFs. One of the major goals of the forthcoming 5G networks is the demand for end-to-end services, especially in multidomain networks, has made it possible to establish competitive new structures of collaboration as well as NSO. Therefore, the use of NSO in some scenarios in which the reasons so much motivating in relation to current studies can be potentially described and interpreted.

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