Network as-a-Service: the WebRTC case

How SDN & NFV set a solid Telco-OTT groundwork

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***Abstract*—In this paper, we consider networking technologies like Software-Defined Networks (SDN) and Network Functions Virtualization (NFV) to analyze, as a first step, the opportunities that directly address the limitations of today's network architectures and lay a foundation for concrete interactions between network providers and Over-The-Top (OTT) service providers.**

To study the strength of adopting these two emerging technologies in operator networks, we apply this analysis on the case of WebRTC communication services. Indeed, WebRTC presents significant changes in the communication model which makes it an interesting case of study. Thus, our work initiates and discusses the importance of a "Network-as-a-Service" model between network operators and OTT Communication Service Providers (CSPs) in an SDN-NFV network environment.

***Index Terms*—SDN, NFV, Cloud, NaaS, OTT, CSP, WebRTC.**

I. Introduction

With the evolution of the telecommunication ecosystem, new modes of service delivery has emerged mainly with the rise of the Over-The-Top (OTT) players [1]. Also, through the development of Web Real-Time Communication (WebRTC) [2] technology, OTT Communication Service Providers (CSPs) are continuously imposing new service-level challenges since OTT application services stand in for traditional operator services. In addition, these OTT application services, enabled by cloud technologies, express network-level requirements that today's network architectures are unable to address.

Moreover, the flexibility of OTT services, and the case of WebRTC technology in particular, pushes end users to adopt the any device, any network connection mode. This implies non-predictable behaviors and thus an inability of the network to dynamically adapt to the application and user needs. This lack of dynamicity is mainly due to the static nature of network architectures.

In front of the dynamicity of service applications, it becomes crucial for network operators to achieve a higher flexibility. Telcos need to transform their networks for answering these unpredictable demands.

In this sense, Software-Defined Networking (SDN) [3] and Network Functions Virtualization (NFV) [4] are key enablers for this evolution. SDN is axed on network programmability allowing automating and orchestrating networks, and the emerging area of NFV proposes dynamic and automated network operations and network service deployments. Their adoption in operators networks will increase network reaction to service applications needs.

These network transformations would allow more visibility and more efficient interactions between applications and the network even though SDN and NFV advocate abstractions between applications and network. Consequently, for Telco-OTT collaboration objectives, network operators would be able to better offer the network assets that address OTT CSPs service limitations.

In this paper, our objective is to extract the opportunities that SDN and NFV present and how to take advantage of them. Therefore, we analyze in the following Section, the benefits of integrating SDN and NFV based on the state-of-the-art taking into account Telcos and OTT challenges in this context. We then focus on CSPs and WebRTC as a motivating use-case and expose their service issues and network-level needs. Later, we discuss the potential Telcos have in addressing these needs and the need to go for a NaaS service model. Finally, we conclude our analysis and give our future work.

II. Towards SDN-enabled NFV

SDN and NFV technologies have brought significant changes in the networking world. In the network-to-application visibility context, standardization bodies are still working to define specifications and implementation guidelines. The path towards Telcos-OTTs open interactions relies on these two technologies. Cloud technologies also constitute a pillar to achieve this objective. At a network level, NFV is based on Telco Cloud and at a service level, OTT application services rely massively on cloud services.

We here analyze each of SDN and NFV as key opportunities, then study the benefits of their integration based on their parallel evolution.

A. SDN & NFV: The Independency

1) The SDN Value: SDN [5] has proposed to break the vertical integration of Telco networks all along its evolution. It has been one of the pillars of innovation in network infrastructures, allowing the decoupling of the control and data planes through open and standard interfaces that enable the programmability of the network. OpenFlow [6], ForCES [7] are examples of standard interfaces. The control logic is centralized and implemented in an SDN controller maintaining a global view of the network and programs the network elements (mainly forwarding elements) that traditionally process many standards and protocols. The deployment of network policies, usually reffed to as policy enforcement, that used to be performed through configuration processes is thus simplified. SDN contributes as well to the virtualization of the Telco network infrastructure, providing the foundation to isolate, abstract, and share the network resources.

2) The NFV Value: The NFV architecture [8] has been proposed by ETSI to innovate in the service delivery arena by using standard computing virtualization technology to consolidate in Commercial-Off-The-Shelf (COTS) hardware the functions previously performed by specific hardware appliances. This allows to overcome network complexity and facilitates network management.

The underlying network infrastructure, included in the NFV Infrastructure (NFVI), is abstracted to realize virtualized network paths that provide connectivity to support the interconnection between Virtual Network Functions (VNFs) [9] and the endpoints. VNFs, the software boxes that build network services, are dynamically deployed over the virtualized infrastructure. It then reduces service deployment cycles and thus Time-To-Market. NFV covers mainly service deployment issues. VNFs process the frames coming from the underlying network, and consequently, compute resources are the main architectural component to build the NFs. Virtual network resources provide an interface to the underlying network resources, which are mostly considered just for providing connectivity service.

B. SDN & NFV: The Complementarity

SDN and NFV are complementary technologies, and each one can leverage off the other to improve the flexibility and simplicity of networks and service delivery over them. SDN and NFV features are important in order to build flexible Telco networks. Automation is needed at the data, control and management planes, and dynamicity for the service deployment and life cycle management.

Indeed, enabling the dynamic deployment of VNFs is challenging from the networking point of view. It must support multi-tenancy, multiple service chains sharing the same physical resources, and traffic steering between the VNFs to develop the service chain. In this context, the traffic must be isolated not only among service chains but between the Network Functions (NFs) that compose the service as well. SDN is a perfect complement to deal with these requirements and with the dynamicity imposed to the Telco network resources.

Since the initial proposal of the NFV concept, its relationship with SDN was argued to be complementary and potentially of added value when both technologies are combined. The separation of data forwarding from the control plane improves the flexibility of the network and simplifies the dynamic deployment and operation of resources. In addition, the usage of commodity servers and switches, avoiding specific hardware-based components provided by vendors, is a shared objective between NFV and SDN. Moreover, some of the networking challenges of the NFV architecture to be addressed correspond to the objectives of SDN.

However, the added value does not directly address the limitations related to Telco-OTT interactions. Additional features are needed to provide OTTs network interfaces to express network needs. This analysis has drove us to consider this question as a research opportunity to work on.

III. WebRTC: A Motivating Use-Case

Since communication services are much more than network operators' traditional voice services, multimedia services are increasingly integrated as a feature into OTT applications. These applications provide communication services, known as WebRTC services, and are offered by web companies, commonly called OTT-CSPs.

In this Section, we first give an overview of the WebRTC technology, then consider the issues arising from the design and connectivity aspects of this technology. Finally, we discuss the advantages that solutions of future Telco-OTT interactions would bring to deal with these issues.

A. WebRTC Overview

WebRTC [2] is the global term for several emergent technologies and APIs that aim to bring real time communications to the Web. WebRTC is a technological initiative getting considerable worldwide attention.

WebRTC plays a role in browser-to-browser communication field. Reduced costs are needed for integrating WebRTC into the existing web infrastructure and there is no required interoperability between devices since it is integrated into web browsers. Also, WebRTC users do not have to install plugins to use the capabilities. The WebRTC standard [10] enables three modes and APIs for browser-to-browser communication: Peer Connection API offers connection establishment, Media Stream API video streaming functions and Data Channel API arbitrary data sharing operations. It enables real-time communication and introduces UDP based communication to web browsers to complement the normally used TCP communication with HTTP.

WebRTC is based on the fundamental separation between the media path and the signaling path. The data flows containing the media are transmitted directly between browsers in a Peer-to-Peer fashion, without any predefined intermediates in the network topology such as Network Address Translations (NATs) or firewalls. The signaling path implies intermediate servers, but their protocols and architectures are out of the scope of WebRTC.

Based on this lightweight communication technology, WebRTC is bringing significant changes in real-time communications by lowering barriers to entry for communication service providers and application developers. This implies wide adoption expected by a large spectrum of OTT actors. However, WebRTC communication services have some issues and limitations.

B. *WebRTC Structural Issues*

First, it is important to mention that WebRTC standardizes only the media plane and the APIs in the browsers but does not impose anything for signaling. A WebRTC communication establishment is initiated by WebRTC client using signaling messages through a web server. But, as the signaling plane is not standardized, it is hard to ensure a direct connection between WebRTC clients through P2P connections. Also, as WebRTC is integrated in the browser, the congestion management can be assured only at this level using Real-time Transport Control Protocol (RTCP) feedback and local measurements [11]. Morever, regarding the media plane, there are considerable differences between WebRTC media plane and network operators one. For WebRTC, the traffic flows are treated under best-effort conditions in the network. The management of the quality of service is at the WebRTC client device level where it is important to implement audio and video codecs able to adapt the traffic to network quality even though based on unreliable information about the end-to-end network quality. Besides, Since OTT-CSPs rather have their own users' bases, no interoperability exists between OTT-CSPs and all communicating parts of an OTT-CSP WebRTC service will need to be connected via the same OTT-CSP. Furthermore, in WebRTC, there should be no application intermediary in the media plane, the security must be provided by the devices. However, this can not be sufficient against network security threats [12]. Allowing browser-to-browser direct communication without server intervention opens the door for several security threats, unless the presence of media relays acting as transparent intermediaries would be possible.

IV. Discussion

The issues highlighted above are present in today's context, where no collaboration between network operators and communication service providers exist. Unlike OTTs, network operators can manage and control end-to-end connectivity and can ensure QoS and congestion management at a network-level using reliable network information and using strong network mechanisms. Telcos can offer network functions and services that can address these issues and the use of a network infrastructure built based on SDN and NFV principles would offer flexibility to the way they can be offered.

Based on our analysis, an SDN-enabled NFV environment will allow Telcos to efficiently deploy specialized network functions over a virtualized network infrastructure in a form of VNFs and using the programmability offered by SDN APIs, the enforcement of network policy over the network forwarding elements will enable network operators to offer special and adapted network processing and forwarding of flows generated by identified OTT-CSPs or WebRTC communication services. This way, network operators can leverage their network infrastructures and the adoption of flexible SDN-enabled NFV architecture will allow them to present network capabilities in a Networ-as-a-Service model towards OTT actors.

In order to achieve our vision of interaction between Telcos and OTTs, such a NaaS architecture has to integrate an exposition layer where specialized network functions in a form of VNFs would be made available to OTTs through APIs. OTTs would so be able to dynamically use and build adapted Telco network services for their application services.

V. Conclusion & Future Work

This paper discussed a preliminary analysis of introducing Network-as-a-Service in an SDN-NFV environment. The motivation of this study is the need to go for more collaborative interactions between network providers and OTT service providers. We have presented our vision regarding the combination of SDN and NFV, based on the state-of-the-art of both technologies and the work being achieved by standardization bodies. The study of the value offered by each of SDN and NFV independently has led us to highlight the advantages of their complimentarity and thus the benefits of their integration in Telco networks within the context of network openness towards OTTs. We have applied this analysis to WebRTC-based services provided by CSPs. The challenges of WebRTC communication services presented have shown the need for a closer interaction between Telcos and OTT-CSPs. Thanks to the dynamicity and automation provided by an SDN-NFV network environment, Telco network functions would be more efficiently offered to OTT-CSPs to address their WebRTC service limitations.

This work lays the foundations for a Telco NaaS architecture using SDN and NFV as requirements. The design, implementation and validation of this architecture will be our next step.

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