Chapter 91

Virtualization Evolution: From IT Infrastructure Abstraction of Cloud Computing to Virtualization of Network Functions

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ABSTRACT

This chapter discusses the evolution of the cloud computing paradigm and its applicability in various sections of the computing and networking/telecommunications industry, such as the cloud networking, the cloud offloading, and the network function virtualization. The new heterogeneous virtualized ecosystem that is formulated creates new needs and challenges for management and administration at the network part. For this purpose, the approach of Software-Defined Networking is discussed and its future perspectives are further analyzed.

INTRODUCTION

The latest years, cloud computing, as a technology, has exhibited significant growth and in acceptance, being a primary trend for deploying and developing IT services. Cloud computing supports flexible and scalable management of IT resources, through the respective abstraction of the IT resources, which lower the barriers to future changes, with reduced capital expense risk and pay-as-you-go (i.e. usage-based) pricing models (Ernst & Young, 2011). The elasticity that the cloud computing environment offers,

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creates an opportunity for the evolutionary upgrade of legacy data centers in order in order to support innovative business models either in the field of pricing or resource utilization, reducing operational expenditures and minimizing market entrance costs, while at the same time the cloud computing technology maximizes the return of investment and the internal return rate.

The success of the cloud computing platforms have expanded their usage in the mobile communication industry as well, where Mobile Cloud Computing (Mousicou, Mavromoustakis, Bourdena, Mastorakis, & Pallis, 2013) refers to an infrastructure where both the data storage and data processing are offloaded outside of the mobile device, supporting therefore innovative services and applications. Mobile devices have recently become so popular that they are increasingly replacing personal computers. However, due to limited resources, mobile devices cannot offer the same performance as the personal computers. One approach to overcome both computational and storage limitation is offloading mobile-related recourses to the cloud. In this case, and with the help of offloading, the mobile device runs only a thin layer of software which interfaces with application-specific services in the cloud. This trend is called Networking Cloud and supports cloud applications that move the computing power and data storage away from the mobile devices into powerful and centralized computing platforms located in clouds. However, such an approach requires that source data are available to the remote service and this might require transferring data from the mobile device to the cloud, therefore transferring the resource availability issue for the support of sophisticated applications at the network side.

Following the paradigm of the cloud computing success in the abstraction of IT infrastructures both in the mobile and computing industry, the virtualization trend has recently expanded its field of application in the networking industry as well.

Current networking infrastructures basically rely on hardware-based devices as their building elements; most in-network functionalities (routing/switching, filtering, analysis, adaptation, signaling control, security provision etc.) are carried out by stand-alone hardware appliances. This approach, while having worked well for several decades, is now seen as a major factor which contributes to the so-called "ossification" of the Internet. Solely relying on hardware platforms with fixed resources/capabilities, significantly slows down and hampers the introduction of new network services. The advent of network innovations in the context of Future Internet (new protocols, algorithms and standards) calls for continuous upgrades (or even replacement) of the existing appliances in a much faster pace than their average lifetime.

Although modern networking appliances exhibit remarkable performance in transmission speeds and spectrum efficiency as well as satisfactory interoperability in terms of compliance to network protocols (TCP, IP, HTTP etc.), their deployment as "closed", heterogeneous hardware platforms presents several key limitations, such as manual establishment and configuration of networking services, especially across heterogeneous domains (e.g. mobile/terrestrial), thus involving considerable setup and reconfiguration delays. New network technologies, algorithms and protocols cannot be rapidly introduced into the market since they involve time-consuming and costly hardware upgrades and are thus associated with significant CAPEX investments. Network resources are assigned statically to each user, without the capability to automatically up/down scale according to user's needs, which would also assume new, flexible billing models.

A promising solution to alleviate the aforementioned limitations in all infrastructure technologies is the Network Function Virtualization (NFV) model. Following the paradigm of the Cloud Computing for the virtualization of computing and storage resource, the concept of NFV is being used in the literature as well as in the market with various meanings in order to efficiently support the transferring of cloud computing advantages to the network. Depending on the context, NFV can be used to refer to the