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Network Function Virtualization (NFV) Design Considerations for a 5G Network using Network Slicing Methodology

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Abstract - *Network slicing (NS) includes all the essential techniques for a 5G network to accommodate different type of network services using most of the network functions in a common architecture carving out only certain group of networking nodes. This paper discusses the advantages of using Network Function Virtualization (NFV) for a 5G Sliced network while compared to a traditional BareMetal Server deployment model. Also, this paper discusses several design considerations and the challenges faced during Network Slicing 5G Deployment.*

Key Words: Network Function Virtualization (NFV), 5G networking, network function (NF), Network slicing (NS), Virtual machines (VM), Virtual Network Function (NFV).

1. INTRODUCTION

5G network slicing is known as a network architecture that helps in multiplexing of the virtualized and independent logical network on the same infrastructure of the physical network. Under 5G network slicing, each networks slice is isolated to a network and fulfill various requirements that are requested by a particular application. As a result, this technology mainly considers a central role that provides effective support to the 5G mobile network and is also designed to efficiently by embracing a plethora of service with different service level requirements.

To examine, the realization of this service-oriented view of leverage of network in the concept of software-defined networking and network function virtualization. It can be said that it helps for the implementation of flexible and scalable network slices on top of a common infrastructure of a network. To examine a business model point of view, it can be said that each network slices is commanded by a mobile virtual network operator. As a result, the infrastructure provider leases its physical resources to the mobile virtual network operator and distributes the entire underlying physical network. To examine the availability of assigned resources, it can be said that mobile virtual network operator mainly includes various multiple network prices that are customized to different applications that are provided to their user.

2. 5G NETWORK SLICING REVIEW

Network slicing also includes all the essential techniques in the 5G network to accommodate different and possibly opposite of the quality of service requirement and exploiting a single physical network infrastructure. As a result, it includes several techniques such as network functions which Express the elementary network functionality that is used as a building block and useful for creating every network slice. In addition to this, virtualization is also considered as a technique that provides an abstract presentation of all the physical resources that are homogenous scheme and help a scalable slice deployment (Zhang, Liu, Chu, Long, Aghvami & Leung, 2017).

To examine the impact and application of 5G network slicing, it can be said that in commercial terms network slides. Network slicing helps the mobile operator to create a various specified virtual network with a particular client and use cases. It also includes certain applications that are in the form of mobile broadband, machine to machine communication, Smart cards which are useful for leverage in different aspects of 5G Technology. It also requires higher speed with low latency and it also includes another access to age computing resources. As a result, it can be said that by creating separate slice 5G operator can provide a tailored solution to a particular industry slicing also enhance the continuity of service with the help of improved roaming across Network and also creating a virtual network by running on a physical infrastructure with multiple local and national network. It also has a host network to create an optimistic virtual Network and provide a roaming device for home network effectively.

To examine 5G network slicing enabling Technology, it mainly includes software-defined networking that is considered as an approach that provides Intelligence and flexible Programmable 5G network that are capable of controlling applications and services with fine-grained and wide network manager. It also includes an open network Foundation that also considers as software-defined networking which is also known as a physical separation of the network control plane from the forwarding plane. It also includes a control plan that controls several services, as a result, the separation of the result into flexibility and centralized control provides a global view of the entire

network. It also helpful for enhancing the capability of responding increasing changing network condition in the field of the business market and the need of the end-user software-defined networking create a virtualized control plane that enforces intelligent management decision among the various function of the network and also join the gap between service provisioning and network management software-defined networking also control the network which is become a direct Programmable by using a standardized southbound interface such as OpFlex, FoRCES and OpenFlow (Doria, Salim, Haas, Khosravi, Wang, Dong & Halpern, 2010). On the other hand, all these kinds of implementation depend on the requirement and capacity of performance of software-defined network environment. As a result, it can be said that it is a set 2 to address the limitation of all the traditional network that are ill-suited for the configuration of dynamic networks their controlling management and storage of requirement as per the today's data center campus and heterogeneous environment (Devlic, Hamidian, Liang, Eriksson, Consoli & Lundstedt, 2017).

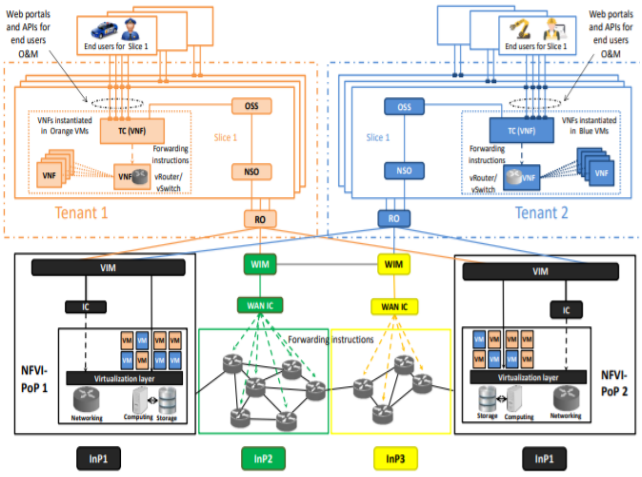

Fig1: 5G Network Slicing using NFV

Network function virtualization is also configured as virtualization of network functions with the help of Firewall VPN /BPI which is considered as the top of the commodity hardware devices. It mainly examined the sanitization of VP, VNF, virtual network function on the commodity hardware. It also breaks the unified approach with the use of Software and Hardware and it also exists in the offering of traditional vendor network function can also easily deployed and dynamically allocated. It also includes network resources which are efficiently allocated to the virtual network function with the help of dynamic scaling and also receive service function chaining. As a result, it can be said that with the help of a software-based network function virtualization solution they are moved to the service provider and run on a shared infrastructure that is in the form of a general-purpose server. It also includes adding removing and updating a function for all the subset of the customer which is known as more manageable since the changes could be done at ISP rather than a customer premises (Wang, Feng, Tan, Qin & Sun, 2017). In the field of future 5G network function virtualization mainly include optimization of provisioning of resources to the end-user with the QOS and guarantee. The performance of virtual network function operation by including minimum latency and failure rate. As a result, it also ensures the compatibility of virtual network functions with nonvirtual network function (ETSI, 2014).

Distributed computing offers on-request provisioning of different applications, stages, and heterogeneous figuring frameworks, for example, workers, organizations, stockpiling, administration, and applications. As indicated by Mijumbi et al., the conventional part of specialist co-op on a distributed computing climate is separated into two classifications in particular: (a) the Infrastructure Providers (InPs), and (b) Service Providers (SPs). The InPs oversee cloud stages and rent assets as indicated by a utilization based evaluating model while SPs lease assets from one or numerous InPs to serve the end clients. The cloud model comprises three help models as appeared in Fig. 12 which likewise show their planning to the NFV reference engineering portrayed in Section 4.3. The client can use a few applications and administrations running on a cloud framework. A help supplier has the applications at its server farm and a client can get to them through a standard internet browser. : Provides a stage that permits clients to create, run, and oversee various applications without the multifaceted nature of building and keeping up the cloud framework. : Provides self-administration models for getting to, checking, and overseeing distant server farm foundations, for example, process, stockpiling, and systems administration administrations. Instances of IaaS incorporate the Amazon Web Services (AWS), Microsoft Azure, and Google Compute Engine. Virtual Machine (VM) empowers the virtualization of an actual asset where an experimenter can run his/her own Operating System (OS). The fundamental guideline of a VM is that assets such as figuring, stockpiling, memory, and organization are shared among VMs. In any case, the whole operational elements of a VM are disconnected totally from that of the host and another visitor VMs. It is additionally conceivable to run different VMs at a time on one physical machine.

3. DESIGN CONSIDERATIONS OF NFV

According to Yi, Wang, Li & Huang, (2018) the design consideration of NFV include different parts hardware hosting platform, hypervisor platform for VNF elements, orchestration engine, and virtual network function (VNF). While considering the hardware hosting platform, it consists of a server blade and x86-based server that help in running the routing platform. The x86-based server can be in the form of a generic or customized form to ensure high-performance encryption capability. The Generic x86-based server is of low cost and readily available. It can leverage the crypto library from CPU vendors by widening the vendor selections. However, the major issue with the Generic x86-

based server is that it has a limited life-span of 3-5 years and requires an external specialized device for establishing WAN-based connections. The other major issue with the Generic x86-based server is that it creates difficulty in the determination of performance assurance and averts several vendor environments. On the other hand, in the case of a customized x86-based server, there is optimizing of NFV environment and supports a specialized NFV environment. It also provides accessibility to WAN and 4G/LTE and is considered to be ideal for greenfield deployments. It has a longer lifespan and provides support to the hardware applications. However, the major issue with the implementation of the customized x86-based server is that it has a higher initial CAPEX and restricted vendor selection process. The server blade is placed between the routers and switches and helps in simplifying the workings of the prevailing infrastructure. The server blade is also responsible for integrating different applications such as 4G/LTE and WAN. It has a longer lifespan that supports the hardware functionaries to up to 7-10 years. The server blade is also useful in supporting the embedded cryptology related to offloading modeling. It is also essential for deploying brownfield and converging footprints with the networks. The server blade also assists in computing and storing routers in the same platform that reduces additional charges. However, the use of the server blade gets restricted owing to limited vendor selections and additional cost related to installing the blade. The application of the server blade also differs as per the router version and requires upgrading of working router code.

Hawilo, Shami, Mirahmadi & Asal, (2014) analyzed that the hypervisor platform for VNF elements is an essential part of the NFV. While considering a hypervisor, it is defined as the functionary that isolates the operating system and its applications with the underlying hardware. It also includes abstraction that helps in the independent working of the virtual machines and guest machines. It supports physical systems such as memory space and network bandwidth. Hypervisors can be classified into two types which are A type 1 hypervisor and A type 2 hypervisor. The A type 1 hypervisor uses bare metal x86 hardware architecture as the operating system and facilitates the working of another operating system. On the other hand, the S type 2 hypervisor uses the OS platform as the operating system to host the environment. However, type 1 hypervisor is known to be better performed as compared to type 2 hypervisor as it is directly linked to the hardware. The commonly available hypervisors are KVM, Microsoft Hyper-V, and Citrix XenServer that help in the successful hosting of the network function. The hypervisors also help in meeting throughput and data plane latency requirements for VNFs.

Lemke, (2015) analyzed that orchestration engine when used in a centralized form creates certain limitations such as poor network agility and limited IT agility. Moreover, it is performed in a box-by-box manner which becomes a repetitive process and consumes high labor time. The risks of human error are also included in the use of a centralized orchestration engine that negatively impacts the network and increases downtime. It includes high cost which becomes a constraint for the company to allocate additional cost for installing the orchestration engine. It is also plagued with a lack of automation that increases the cost of ownership. Thus, while selecting the orchestration engine, the businesses must consider Plug and Plug for Day 0 aspects. The centralized policy automation and change of management aspects are also to be considered while implementing the orchestration engine. The other features such as Public-key-infrastructure (PKI) certificate management and VPN deployment are also to be considered selecting orchestration engines.

Mell & Grance, (2011) analyzed that VNF elements form an integral part of the design consideration of NFV. VNF is responsible for managing network related functionaries that are specifically associated with routing, Unified Communications, and Application Optimization. The other elements such as Firewall, Session Border Controller, and Wireless LAN controller aspects are also included in VNF elements. The individual elements are either supported by hardware or software so that they function and provide connected virtual networking communication services. It helps in the attainment of optimized throughput levels and efficacy in terms of supporting SR-IOV.

4. RESEARCH CHALLENGES OF NFV

Several operators are jumping on the board of the network function virtualization and highly provided those service and their service provider with the speed and necessary to pump out with the automated network function. As a result, there is no technological transition that provides without growing pain so that it is considered as some of the issues that are facing by network function virtualization deployment. It mainly includes the issue related to the new technology. There are several studies have found the experience with the cloud which has the operator with network function virtualization deployment, but they still find difficulty while staying up to date with the latest technology as for the leading of the switch. In addition to this, network function virtualization operation also provides strap contrast to conventional operation and all the operator also have to adjust all the innovative system that mainly related to the management of virtual services and function. As a result, all these management and virtual services do not provide the entire necessary feature which ensures a smooth migration. As a result, to make a shift of success, it is essential for the service provided to consider automation policies and management effectively. In addition to this, the network function virtualization also faces the challenges related to the Legacy infrastructure because it reduces the capital expense and operating expense and helping them to administer to spend less time managing data centers. It is

also considered a significant challenge because of the adoption and scale of is Legacy network. As a result, several older products will not upgrade to support the technology. It also includes an operator who is still deploying the network function virtualization in various developing application and it can run virtually on the Legacy infrastructure. As a result, the operator only focuses to take the profit from virtual network function and invest more as compared to the network fluctuation virtualization related to the project the security issue is also considered as the biggest challenge of network function virtualization because it provides various kind of new network function which is always open up as a Window for a new security risk. It also includes software that is very less secure as compared to hardware. It also includes a Firewall that highly dedicated hardware and also harder to crack some security issues. It also includes software which is more authentic to distributed denial of service attack and it also provides form from constant threat and can fit the network lack of standard also considered as another challenge that is facing by the virtualized market as per the need for a standard for communication among network function virtualization components. As a result, it was found that developing a standard of these types of systems usually takes many times of year, but the Telecom industry is ready to start deployment as for the present time. For example, European Technology telecommunication standard Institute highly focused on forcing setting standards for the market. They also provide completing standard which has been proposed and it also includes lack of industry to the overall situation on the matter network function virtualization face the problem related to the not enough strong business cases because of lack of carefully define business cases.

5. CONCLUSIONS

From the above discussion, it's evident that Network Function Virtualization (NFV) is the key enabler for Network Slicing using 5G Technology. NFV can greatly support several aspects of 5G Slicing network such as Operations & Maintenance (OAM), Network Design, Network Deployment, Key Performance Indicator (KPI) monitoring etc. Operators worldwide should consider NFV deployment model over the traditional Bare Metal servers for Network slicing.

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