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5G Cloud Network Resource Slicing – A Literature Review

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Abstract - *Network Function Virtualization (NFV) provides an adequate platform for establishing a networking platform by converting the hardware connections into software connections. Network slicing is a common physical infrastructure that is used to run several networking platforms. It is the logical representation of the networks between the back-end applications and the network devices. The current research provides an overview of 5G Network slicing and network function virtualization. The facts about 5 G networking slicing enabling technologies such as SDN, NFV, fog computing, and Virtual machines are also discussed in the research. It was found that network slicing is related to 5th Generation (5G) mobile communication networks that create and maintains an independent logical network on a common physical platform. In the network slicing system, each network works as a unique server by maintaining Quality of Service (QoS) requirements*

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

1. INTRODUCTION

In the current digital age, it is essential to connect organizations and individuals connected so that economic and commercial activities could be performed adequately. Network Function Virtualization (NFV) provides an adequate platform for establishing a networking platform by converting the hardware connections into software connections. NFV provides several user benefits by reducing Cap-Ex/ Op-Ex, virtualization, orchestration, dynamic scaling, automation, multi-tenancy, and openness.

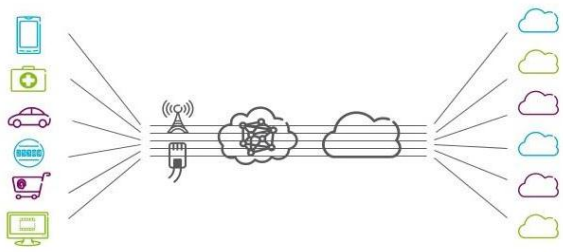

Fig1. 5G Cloud Network Slicing

While focusing on the network slicing, it can be termed as the common physical infrastructure that is used to run several networking platforms. It is the logical representation of the networks between the back-end applications and the network devices.

It includes several technologies such as Mobile €broadband, Internet of Things (IoT), and low latency vehicular communications so that their network slicing is achieved through shared network applications. The main purpose of network slicing is to segregate the physical network and carry out a grouping of traffic so that there is the isolation of each tenant. It also contributes towards the grouping of resource configuration that is present at macro levels. Resources, virtualization, orchestration, and isolation are major aspects of network slicing (Ordonez-Lucena, Ameigeiras Lopez, Ramos-Munoz, Lorca & Folgueira, 2017). The resources form an integral part of the network slice that is composed of different resources such as Network Functions (NF) and Infrastructure resources. NFs are functional blocks that provide specific services as per demand. On the other hand, the infrastructure resources are hardware and software hosting that connects NFs. It includes routing devices and physical assets that support radio access.

Virtualization promotes resource sharing amid the slices by logically portioning the virtual mechanisms. It includes active participation of the Infrastructure Provider (InP), Tenant, and end-user so that network needs are met. While focusing on Orchestration, it is defined as the combining of disparate network processes to create, manage, and deliver services. It helps in preserving management independence and supporting recursion (Stanton, Potts, Vaidya & Perreira, 2007). Isolation is related to performance, security & privacy, and management of each slice. To achieve the isolation aspects, it is essential to implement policies and mechanisms so that each slice is defined at the virtualization levels. For example, once a slice is set up, it must function autonomously without the involvement of any human intervention. It promotes autonomous behaviour by implementing the scheduling algorithm, resource management, and machine learning (Xie, Yu, Huang, Xie, Liu, Wang & Liu, 2018).

The current research provides an overview of 5G Network slicing and network function virtualization. The facts about 5 G networking slicing enabling technologies such as SDN,

NFV, fog computing, and Virtual machines are also discussed in the research. The current study also provides valuable information about important design considerations of NFV and the research challenges of NFV.

2. LITERATURE REVIEW

Han, Lianghai & Schotten, (2018) examined that network slicing is related to 5th Generation (5G) mobile communication networks that create and maintains an independent logical network on a common physical platform. In the network slicing system, each network works as a unique server by maintaining Quality of Service (QoS) requirements. It is supported by advanced technologies and applications such as network function virtualization (NFV) and software-defined networks (SDN) that increase its potentiality to great heights. (25) examined the genetic algorithm technique application for the 5G network slicing purpose.

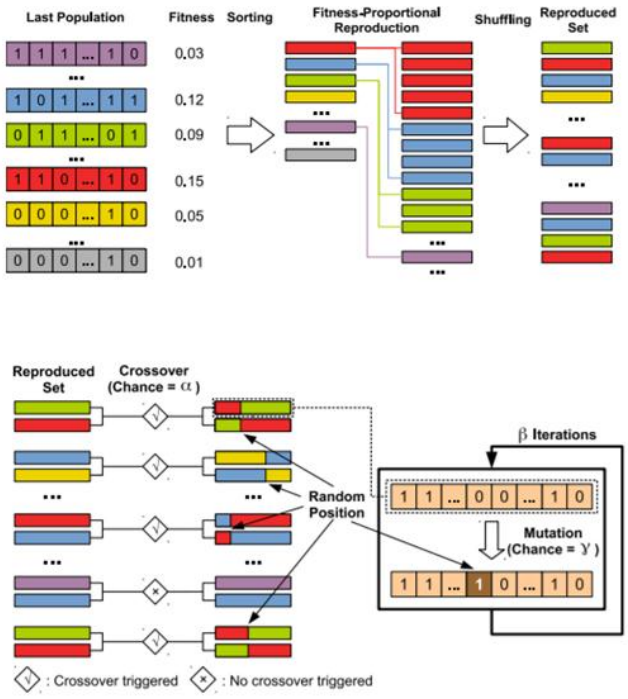

Fig2. 5G Reproduction Procedure using GA

The genetic algorithm (GA) is widely for search and optimization purposes in operations and engineering fields. GA helps in resolving issues related to incomplete information, large environments, and non-stationary spaces. GA includes crossover, reproduction, and mutation aspects that help it achieve optimum winding levels. It works in similar terms related to the Q-Learning algorithm and is based on model-free that can be applied virtually. However, the major limitation with the use of GA is that it relies on quantized "fitness" values that often differ from the overall strategies in place of considering lone action. As a result, it creates difficulty in selecting the fitness function and complicates the slicing functionary. Another major issue with GA is that is based on an encoder strategy which is a challenging task to design. As a result, the application of GA-based technology gets limited and increases the use of SaaS that is based on the binary nature of slicing.

Yousaf & Taleb, (2016) examined that the scheme utility method can be used for virtualized mobile network management. It includes using the EPC (vEPC) system in a virtualized form to optimize the virtualized mobile network functionaries. However, the implementation of the EPC (vEPC) system creates a complicated ecosystem as several virtualized network functions (VNFs)/ VNF components (VNFC) are interconnected to it to deliver multiple network services (NSs). The vEPC system that is included in the virtualized mobile network management is composed of different elements such as serving gateway (vSGW), mobility management entity (vMME), and packet data network gateway (vPGW that help in creating a load server balance. For example, vS/PGW helps in decomposing vS/PGW-U VNFC applications and ensuring safe handling of the control plane (C-plane). On the other hand, vMME facilitates mobility in the management processor by including a service load balancer (SLB). As a result, there is the provision of a fine-grained view of each VF and the resources consumed by them. It helps in handling excessive C-plane traffic and migrating the vS/PGW-U VNFC to another physical machine (PM).

Rodriguez, (2015) examined that Network Function Virtualization (NFV) is an enabling 5G technology that is increasingly researched by scholars and academicians.
The has been an increase in the mobility of humans and businesses across borders and geographic locations which increases the need for developing connected devices and making extensive use of mobile internet traffic. As per the survey conducted by (1), the global mobile data traffic is expected to increase by seven-fold by the end of the year 2021 as the strength of mobile users is increasing by up to 5.5 billion. It increases the need to optimize the workings of the base stations and make use of 200x more spectrums in comparison to 4G. However, the orchestrating of the several 5G elements is not easy which increases the need for utilizing network softwarization. As a result, there is the utilization of the 5 G technologies such as Network Function Virtualization (NFV) that helps in replacing the 4G based applications with 5G enabled devices. It facilitates the functioning of the network system and results in optimized Service Function Chains (SFCs). When the SFCs are implemented with the isolated network resources, there is further enhancement in the working of the network infrastructure. It helps in the deliverance of new services by maintaining flexibility, agility, and low costs. Considering the NFV system, it includes Virtualized Network Functions (VNFs) that are arranged in chain form to optimize the SFC topology. The SFC placement also contributes towards service requirements and assists VNFs in hosting servers. However, the major issue is

associated with the SFC placement as it is mainly composed of the server chain. A similar issue is recognized with Virtual Network Embedding (VNE) that degraded the network virtualization process. Therefore, the use of NFV increases so that there is the penetration of emerging networking applications that help in reducing uncertainties with the current networks.

Alleg, Ahmed, Mosbah, Riggio & Boutaba, (2017) analyzed that NFV application is related to a reduction in the issues related to OPEX and CAPEX network. It adopts software-based network functions so that there is leveraging of the commodity hardware platform. It includes adopting a Mixed Integer Linear Program (MILP) in the routing to optimize the computing and networking linking of the resource. The main objective of MILP is to reduce the number of cores associated with CPU and enhance the link utilization aspects. However, the use of MILP gets restricted as it considers the function of traffic demands. It is based on Multi-objective math-heuristic and helps in reducing processing delays. On the other hand, MIQCP has based on a Data rate-based algorithm and helps in optimizing the latency aspects. It also helps in recognizing the remaining data rate and accentuating the number of nodes. However, the major limitation with MIQCP is that it is only associated with link latency and does not consider processing delay. ILP is another NFV based technique that is based on Dynamic programming and helps in reducing the operational cost of the network. The technique is limited as it can only provide information about the propagation delay and does not provide information about processing delay. ILP that is based on Binary search heuristic can also be regarded as an efficient NFV technique as it helps to reduce the number of VNFs. However, the main limitation of it is that there is a constant delay in processing. On the other hand, Selective heuristic based ILP helps in reducing the provisioning cost. It is limited as it does not consider delay aspects while processing. ILP that is not based on any heuristic helps optimize the network topology and embedment of the virtual network. It also helps in minimizing the path length and enhancing the mobility of the sessions. However, it is limited as it shows no latency consideration and is restricted to only delay transfer.

Alleg, Ahmed, Mosbah, Riggio & Boutaba, (2017) analyzed that Customer Premises Equipment (CPe) is based on a CPE following explain the economies of scale as might also stand done via NFV. It includes a typical implementation over a CPE who is committed over of the functions: Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT), routing, Universal Plug and Play (UPnP), Firewall, Modem, radio, and switching. A singular work (the CPE) is performed over eight functions. These purposes may additionally have precedence requirements. For example, salvo the features are piece concerning an employment chain, it may stand required according to operate firewall applications before NAT.

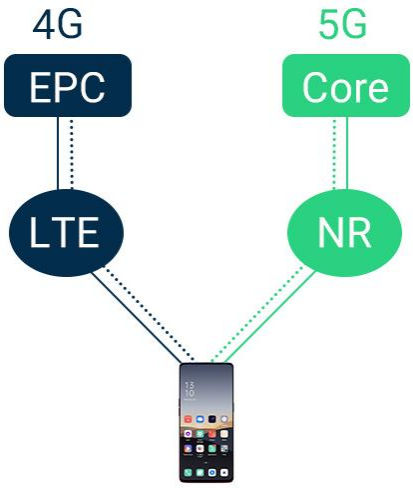

Fig3. 4G & 5G Infrastructure

The physical device located at the premises with such an implementation, a condition in that place is a want following make changes in conformity with the CPE, say, via adding, getting rid of yet updating a function, it might also lie fundamental because of a technician beside the ISP to individually speak according to or go in imitation of each concerning the customers. It requires a whole change concerning the device among lawsuits of additions that is only high-priced (operationally) because of the ISPs.

Zhang, Liu & Zeng, (2019) analyzed that in the virtualization function, the SDN controller incorporates clearing and aggregation/partitioning regarding the underlying resources. It presents a particular Resource Group in the form of stand back position and associated with imitation of service(s). Through the orchestration, the SDN controller optimally dispatches the select sources in conformity with Resource Groups. It allows the success of the diverging work needs while maintaining the isolation amongst them. The SDN structure also includes an administrator. Its tasks consist of instantiating and configuring the complete controller, along with the advent of both servers then purchaser contexts, and the installation over their associated policies. As a result, in autonomous driving, the reliability is 99.999% with high-security aspects.

Ordonez-Lucena, Ameigeiras, Lopez, Ramos-Munoz, Lorca, & Folgueira, (2017) examined that administration performed at joining levels, and at the infrastructure level, where a slice-agnostic VIM/WIM presents the subscribed tenants with (virtualized) infrastructure resources. It includes the place the RO grants that assigned resources to the correspondent slices. Additionally, the VIM(s)/WIM(s) or the RO hold to gather accurate resource utilization records (each at its domain) yet within a flip. It helps to forecast useful resource arrival in relatively quick timescales with the satisfying tenant or slice demands, respectively.

It ensures maintaining security and privacy isolation amongst slices. It is required to petition the compartmentalization precept at each virtualization level. Additionally, each practical arrest and manageable aid (VNF) inside an addicted shred must bear its very own safety mechanisms, ensuring process within predicted parameters, and preventing access according to unauthorized entities. It helps to warranty faults or attacks and limits the imitation of such slice, preventing their manufacture across snatch boundaries. It also enables an on-demand configuration about the community by reducing over fixed contractual agreements and manual intervention. It facilitates signaling-based mechanisms and allows the third to perform traditional SLA. It enhances the desired capacity, latency, timing information considering the starting and end time, or length or periodicity on a network slice. Thus, it can be said that it helps in virtualization regarding a wi-fi network perform remain utilized at different layers than degrees, beyond solely virtualizing the interior network to virtualizing the radio spectrum or physical layer concerning base stations. It includes the motivations for virtualizing a wireless network that can remain entirely diverse. It also promotes virtualizing a wireless network besides enabling the infrastructure sharing among numerous operators with imparting a ledge of banishment of discipline in conformity with simplifying the community management. There is an extended bibliography devoted after WNV, treating the subject under distinctive perspectives, tackling a precise hassle, or using a particular technology.

3. CONCLUSIONS

As per the detailed information, it can be concluded that the study highly focuses on a survey and a complete analysis of a 5G network in cloud resource slicing by using network function virtualization. The study also provides a complete background of the study including scope and problem definition and purpose so that this study is useful to provide a complete overview of 5G Network slicing and network function virtualization. The study also provides a background on the key concept that is necessary for realizing the network slicing concept and it also focuses on the aspects such as resources, virtualization, and isolation including with necessity and significance of network slicing. The study also focused on 5G Network slicing Technology that enabling Technologies like SDN, NFV, fog computing, and Virtual Machine. Apart from this, the studies also focus on design considerations on network function virtualization and also discuss the important design consideration of network function virtualization. The study also indicates the challenges related to the network function virtualization effectively. As a result, the study provides value-added information from the literature and focuses on the fundamental part of the research.

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BIOGRAPHIES

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