Wireless Network Slicing: A Survey

Dheyab Salman Ibrahim[1], Hassan Hadi Salih[2][a] and Israa Mishkhal[3]
[1]College of Information Technology, University of Babylon, Hilla, Iraq
[2]College of Physical Education and Sport Science, University of Diyala, Diyala, Iraq
[3]College of Science University of Diyala, Diyala, Iraq

Keywords: 5G, SDN, NFV, Network S, Edge Computing.

Abstract: Network slicing has developed as a method to deal with the difficult management of these future nets. These methods splits the wireless network into solitary virtual slices below specific managing, needs. Wireless network slicing is good method to solving the problems of quickly growing needs in mobile data services associated to 5G cellular networks. In this study we survey the studies that focused on the network slicing, architecture, motivations and challenges. Also give definition for some concepts that enable Slice process such as software defined network (SDN), Wireless Network Virtualization (WNV), Network Function Virtualization (NFV) and Mobile Edge Computing (MEC) which can support 5G networks. We highlight the future research directions regarding network softwarization and slicing using SDN and NFV in 5G networks.

1 INTRODUCTION

New digital changes allowed by developing technologies: “Edge computing”, “cloud computing”, “network function virtualization” (NFV), “Internet of Things” (IoT), and “software-defined networking” (SDN), that are consider smart services for consumers. Smart services need more and more connectivity. Network slicing enables connectivity for the smart services with diverse requirements via multiple logical networks over the top of the physical network infrastructure as show figure1 (latif and ibrar, 2020). With high consumption of services, the demand of high-quality services from customers require important change for administer networks. To understand this idea in 5G network, the physical network must be divided into several virtual parts of network with different sizes and structures that provides dissimilar kinds of services. Softwarization is defined by using SDN and NFV in 5G networks that are predictable to give more control and management for resources of network (Alcardo, et al., 2020). Network slice (NS) is a whole virtual network with sharing computing, storing and infrastructure of network. (loe, 2020).. Fifth-Generation (5G) and beyond networks can be provide many services with different conditions. “Network slicing” is a major technique to enable 5G networks with many services (Ibrahim et al., 2018). Each one slice with heterogeneous communication network has special task that related a set of operation metrics (Xuemin, 2017). “5G” architecture, generally recognized as “network slicing”. “5G” networks are necessary work with/ emerging “heterogeneity” services, performance (Wireless Networks, 2020). This technique involves dividing the network into slices with set of resources. But this splitting is needs to NFV and SDN technologies. Slicing allow these functions mostly by SDN, NFV, edge computing (Saleh, et al., 2017). Newly, the “Wireless Network Virtualization” (WNV) idea has played to achieve reducing operational costs (Mishkhal. et al., 2019) Virtualization is every shape as splitting set of resources, and giving it to customers (Marcos , et al., 2019) and (Davit , et al., 2019).

Network slicing has been defined by various standard development organizations in numerous ways. Network slicing refers to all the attempts of enabling availability of the networks-as-a-service according to user demands. Network slicing can be enabled mainly by NFV, SDN, cloud computing, and edge computing (Asma, et al., 2018). NFV offers the use of generic hardware for cost efficient implementations of network functions, while SDN

[a] https://orcid.org/0000-0002-5911-9682

enables separation of the control plane from the data plane to offer efficient and flexible resource management. Therefore, NFV and SDN-based network slicing can be considered as an indispensable networking technology for fifth-generation (5G) (S.-M.Ahsan et al., 2019).

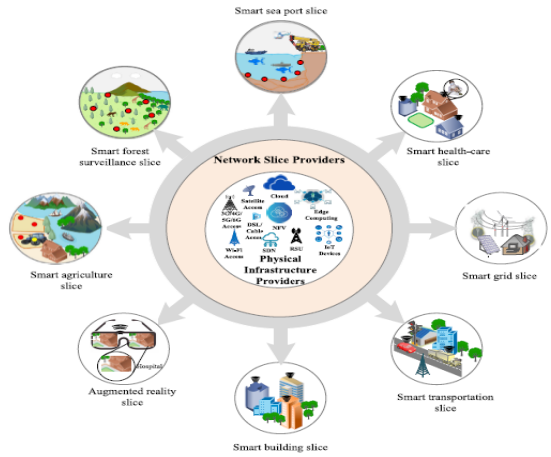

Figure 1: An overview of network slicing in enabling smart services.

"Network slicing" will perform significant task in improving the flexibility for the existing networks and for cellular networks in the future. With the "network slicing", the physical of the "cellular network" is separated in several virtual networks also called "slice" with has heterogeneous abilities. Then, each "slice" operated to perform the tasks for the end user (Hashem, S. H. (2015). The slicing is building the virtual network that may permit flexible and powerful capability to making several "logical networks" on upper the physical infrastructure as explained in Figure 2. Slicing for networks supported by NFV and SDN to making of "slices" of different types of applications (Alcardo et al., 2020). A "slice" is a logical sub network from physical network to provide particular service such as services of "Internet of Things" (IoT). By "logical network" achieving several goals such as: availability, reliability, capacity, efficiency, and latency. The network contains of three elements: "core network", "transport network", and "radio access network" (Ioannis et al., 2020).

In this study we give introduction for the slicing technique. Other sections of the study are structured in the following: Section (2) we presented the relation between 5G and "network slicing technique". Section (3) explain the concepts (WNV, SDN MEC and NFV) that are enablers for the execution of slicing. In section (4) shows the archi tecture based on slicing

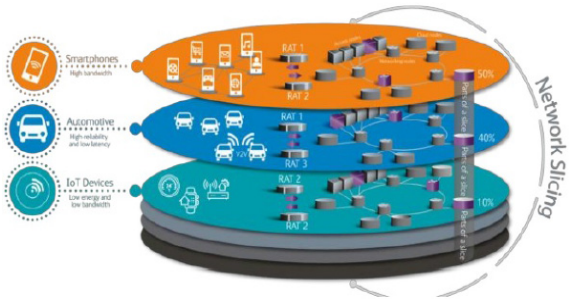

Figure 2: Network Slicing.

technique. Section (5) discussion some the motivations for applying slicing technique within wireless field. Section (6) presented some challenges that are faced for implementing network slicing techniques. In (7) lastly, we give some concluding and future works.

2 5G AND SLICING

Increasing use of multimedia facilities, more needs of services with high-quality by clients initiated major challenge. So, to provide more control for networks we use some concepts: partitioning networks, separate control, planning, management properties for service. The professionals in networks consider the 5G as next generation of the future networks. To achieve this idea, sliding network in many virtual networks in different volumes. Network softwarization is a method that includes using for manage services. Network softwarization goals to provide 5G services with better performance and lower cost. "Softwarization" use SDN and NFV for networks in 5G to more control and management for resources (NAJMUL et al., 2017). Three new concepts: fundamental for the wireless slicing purpose.

1. SDN: a method used to carry flexible programmable 5G networks can be able best controlling services. SDN creates a virtualized control plane. Basic defined for "SDN" is isolated data from control planes, and move control to a central position. SDN Enabler for Slicing: "sliced" wireless network is a difficult to using and management, SDN is the crucial tool for enabling this task. Show figure 3 (Nadia et al., 2017).
2. NFV: making Network Functions (NFs) can be simply used and allocated dynamically. It performs network functions (virtual functions) in virtual machines on servers to provide flexible and scalable networks (Saleh et al., 2019). Basic

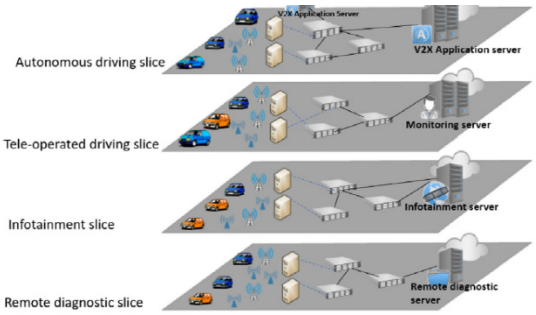

Figure 3: General architecture of network slicing.

defined for NFV is decoupling of "functions" from the "devices" through running. "NFV" Enabler of "Slicing", It enable creation and management to perform their functions. NFV is the virtualization of network functions (e.g., Fire- walls, TCP optimizers) on top of commodity hardware devices. NFV envisages the instantiation of VNFs on commodity hardware (Xenofon et al., 2020).

3. MEC: "Mobile Edge computing" is technology that permits developing "5G" services via provide capabilities of cloud close the user equipment to solving basic challenges for "traditional cloud", for example latency and vulnerable in security. Mobile cloud computing (MCC), as an integration of cloud computing and mobile computing, has provided considerable capabilities to mobile devices and empowered them with storage, computation, and energy resources offered by the centralized cloud. The main purpose of MEC is to address the challenges that are hailed from MCC systems. MEC empowers MCC by deploying cloud resources, e.g., storage and processing capacity, to the edge within the radio access network (RAN). This provides the end-user with swift and powerful computing, energy efficiency, storage capacity, mobility, location, and context awareness support (Saleh, H H 2019). Show figure 4. (a) and (b).

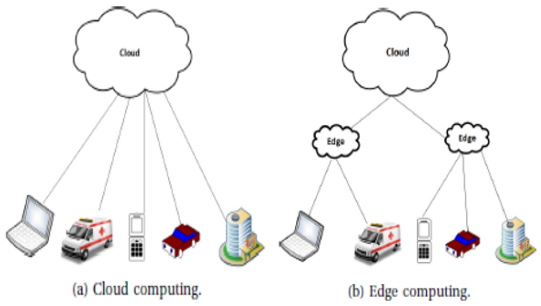

Figure 4: Present cloud computing (a) without edge. (b) with edge.

3 NETWORK SLICING ARCHITECTURE

This unit gives the general architecture of network slicing. Because several challenges, the next-generation wireless networks NGWN architecture must have the some properties: Flexible and scalable. Open and modularized, to support modified slices (Mishkhal, et al. 2020). The main working parts and relatives for matching to the architecture in Figure 4.

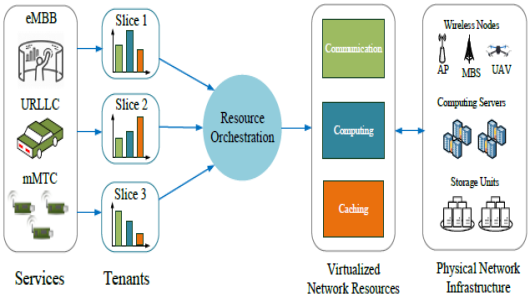

Figure 5: 1 Slicing in next-generation wireless networks (NGWNs) (Alcardo Alex Barakabitze, et al., 2019).

The centralized SDN controller is responsible for "slice". The infrastructure include all physical network that consist some parts: "RAN nodes", devices, "transport network", "storage", and "computing nodes". A control plane summarizes the "logical network" behaviours that "control slice". The "service plane" consist services for each vertical market that slices are "designed". Overall NGMN architecture is split into three layers: infrastructure resource, business enablement and business application (Zbigniew et al., 2018).

4 DISCUSSION

The key aim of this paper is to provide a latest idea of the network slicing, definitions, architecture, motivation, challenges. This study analyses main concepts that enabler network slicing by surveying previous studies on this topic. This study display several advantages of slicing technique to support 5G smart networks. A number of researchers concerned the basic requirements for 5G networks such as SDN, NFV, and MEC technologies that much research lacks an impaired organization, which leads to; inappropriate research activities. A number of research has been conducted on wireless networking of networks from a primary perspective, while other research has focused on developing 5G capabilities. This paper gives a clear research framework and

management complex networks as 5G networks, so this provides researchers with important research ideas related to challenges and solutions in this field. This study gives students and academics various directions for choosing a topic related to network slicing with enabler techniques (Saleh H. H., 2018).

5 MOTIVATION

Slicing for network consider as an architecture for virtual network via operating the similar rules for "SDN" and "NFV" for static networks. Several reasons for applying "slicing" technique within wireless area (Saleh H. H., 2020).

1. Heterogeneous Services: Many different services and devices working in wireless networks, so, slicing becomes good method to separate different requirements concurrently. On sharing resources, slicing will allow to find best features of "QoS".

2. Network Management: Manage unlike applications can be done via slice technique. It is permit to split setting for the networks "edge-to-edge" and describe tasks for each situation. Slicing deliver flexibility through helping with "NFV" and "SDN".

3. Infrastructure Sharing: Any slice can be applied using different worker. Slicing can help the management and give separation among different workers.

4. Flexibility for New Services: Network slicing will support give novel events with same costs. This can let deliver service that 5G needs to do.

6 CHALLENGES

Biggest challenges is actually understanding how to generate those slices and then manage, identifying these slices. 5G networks have large challenges than earlier versions of mobile networks. Large requirements addressed to be suited for the entire network includes bandwidth, latency. This is the idea of dividing a real network into multiple logical networks (Saleh, H. H., 2019). The following some challenges that are faced network slicing with 5G generation:

- Technology Agnostic Solutions: The big challenge to find a method can perform allocation for resource and separation wireless network into several slices freely. This may be difficult when splitting a heterogeneous network into slices.
- Dynamics and Time Limitations: The existing parameters for transmission on the slicing techniques are differs over time dynamically, many standards of wireless choice the greatest transmission parameters for the existing conditions.
- Real Deployments: With wireless area, achieving a real employment is essential for the estimate of solutions. Using slice technique can share many "BSs or Aps" to get novel problems for example the interference among slices.
- User Mobility: Mobility of users is a specific attribute of wireless networks which produces new problems to "slicing". Wireless networks deals with managing of user mobility and try to find and handle the location of the user.
- Compatibility: Well-matched with New Technologies is also big challenge because increasing needs of future wireless networks.
- Security: Main characters of "slicing" is the abstraction, when the "slice" is seen as whole network. The elasticity bring large threats to wireless networks (Saleh et al., 2020).

7 CONCLUSIONS AND FUTURE RECOMMENDATIONS

A. Conclusions.

In this study, we present new technologies that enabling IoT-based smart environments via network slicing, requirements, and challenges. We concluded that network slicing is absolutely necessary to enable a wide variety of 5G and beyond systems. Network slicing is important enabling method to change the existing cities to smart system that uses new technologies in order to enhancing our life. We need control for network traffic via good management using "network slicing" that divided complex network within several virtual networks. Each piece created needs different service. "Slicing" is model of architecture as "virtual network" based on concepts for "SDN" and "NFV". In this study we try to give survey for 5G networks and big problems faced them and present the solutions for these problems such as network slicing, SDN, NFV and MEC (Saleh et al., 2020).

B. Future Recommendations.

Our key recommendations for future research are as follows: "5G networks" offer wide diversity of smart services. So, several restrictions are faced it from heterogeneous Internet of Everything (IoE) services.

For example, high-reliable and low latency communication in “5G” networks. The problems that affected of “5G” research actions. The “slicing” is a main technology to support 5G networks. Three-dimensional (3D) cellular networks includes user devices and BSs that may be support of “6G” cellular networks. So, it is recommended to use slicing for “3D cellular networks”.

REFERENCES

Latif U. Khan, Ibrar Yaqoob, “Network Slicing: Recent Advances, Taxonomy, Requirements, and Open Research Challenges”, Digital Object Identifier, 2020. 10.1109/ACCESS.2020.2975072

Alcardo Alex Barakabitze, Arslan Ahmad, Rashid Mijumbi, Andrew Hinesd, “5G network slicing using SDN and NFV: A survey of taxonomy, architectures and future challenges “, Computer Networks 167 (2020) 106984. www.elsevier.com/locate/comnet

Loe. ” View on 5G Architecture”, 5G PPP Architecture Working Group, 2020. http://doi.org/10.5281/zenodo. 3265031

Ibrahim Afolabi, Tarik Taleb, Konstantinos Samdanis, Adlen Ksentini, Hannu Flinck, “Network Slicing & Softwarization: A Survey on Principles, Enabling Technologies & Solutions “, IEEE Communications Surveys & Tutorials (Volume: 20, Issue: 3, third quarter 2018). https://ieeexplore.ieee.org/document/ 8320765

Xuemin (Sherman) Shen, “AI-assisted Network-slicing based Next-generation, 2017.

Wireless Networks “, Journal of Vehicular Technology. DOI 10.1109/OJVT.2020.2965100, IEEE.

Saleh, H. H. (2017). Increasing Security for Cloud Computing By Steganography in Image Edges. Al-Mustansiriyah Journal of Science, 27(4).

Abida Perveen, Mohammad Patwary, Adel Aneiba,” Dynamically Reconfigurable Slice Allocation and Admission Control within 5G Wireless Networks “, 978-1-7281-1217-6/19/$31.00 ©2019 IEEE.

Mishkhal, I., Kareem, S. A. A., Saleh, H. H., Alqayyar, A., Hussein, I., & Jassim, I. A. (2019, October). Solving Course Timetabling Problem Based on the Edge Coloring Methodology by Using Jedite. In 2019 1st AL-Noor International Conference for Science and Technology (NICST) (pp. 68-72). IEEE.

Marcos Toscano, Federico Grunwald, “Machine Learning Aided Network Slicing”, 978-1-7281-2779-8/19/$31.00 ©2019 IEEE.

Davit Harutyunyan, Riccardo Fedrizzi, “Orchestrating End-to-end Slices in 5G Networks “, 15th International Conference on Network and Service Management (CNSM 2019).

S. M. Ahsan Kazmi, Latif U. Khan, “Network Slicing for 5G and Beyond Networks “, Springer Nature Switzerland AG 2019. Available: https://doi.org/ 10.1007/978-3-030-16170-5

Asma Chiha, Marlies Van der Wee , Didier Colle, Sofie Verbrugge,” Network Slicing Cost Allocation Model “, Journal of Network and Systems Management ,2018

Hashem, S. H. (2015). Critical and important factors related with enhancing wireless communication using mimo technology. Diyala Journal of Engineering Sciences, 8(1), 42-63.

Alcardo Alex Barakabitze, Arslan Ahmad, Andrew Hines, “5G Network Slicing using SDN and NFV: A Survey of Taxonomy, Architectures and Future Challenges”, 2019, Published by Elsevier B.V., https://doi.org/ 10.1016/j.comnet.2019.106984.

Ioannis P. Chochliouros, Pavlos Lazaridis, “Dynamic Network Slicing: Challenges and Opportunities “, IFIP International Federation for Information Processing 2020. Published by Springer Nature Switzerland AG 2020. https://doi.org/10.1007/978-3-030-49190-1_5

Najmul Hassan, Kok-Lim Alvin Yau (Senior Member), “Edge Computing in 5G: A Review “, Digital Object Identifier 10.1109/ACCESS.2017.

Nadia Mouawad, • Rola Naja, • Samir Tohme, “Inter-slice handover management in a V2X slicing environment using bargaining games “,Springer Science + Business Media, LLC, part of Springer Nature 2020. https://doi.org/10.1007/s11276-020-02292-5 (0123456789(), volV) (0123456789,-().volV).

Saleh, H. H., & Hosoon, S. T. (2019). A survey on VANETs: Challenges and solutions. Int. J. Eng. Technol., 8(4), 266-274.

Xenofon Foukas, Georgios Patounasy, Ahmed Elmokashfiy, Mahesh K. Marina,” Network Slicing in 5G: Survey and Challenges “, IEEE Communications Magazine, vol. 55, no. 5, pp. 94-100. 2020. https://doi.org/10.1109/MCOM.2017.1600951.

Saleh, H. H., & Hasson, S. T. (2019). Improving Communication Reliability in Vehicular Networks Using Diversity Techniques. Journal of Computational and Theoretical Nanoscience, 16(3), 838-844.

Mishkhal, I., Kareem, S. A. A., Saleh, H. H., & Alqayyar, A. (2020, November). Deep Learning with network of Wearable sensors for preventing the Risk of Falls for Older People. In IOP Conference Series: Materials Science and Engineering (Vol. 928, No. 3, p. 032050). IOP Publishing.

Zbigniew Kotulski1, Tomasz Wojciech Nowak, “Towards constructive approach to end-to-end slice isolation in 5G networks “, Kotulski et al. EURASIP Journal on Information Security, 2018. https://doi.org/10.1186/ s13635-018-0072-0

Saleh, Hassan Hadi, and Saad Talib Hasoon. "Capacity Enhancement for the Vehicular Network using Spatial Multiplexing." International Journal of Engineering & Technology 7.4.19 (2018): 772-777.

Saleh, H. H., Mishkhal, I. A., & Mohammed, R. S. (2020, November). Implementing an Electronic Management System for Managing Graduate Students’ Information in Iraqi Universities. In IOP Conference Series: Materials Science and Engineering (Vol. 928, No. 3, p. 032012). IOP Publishing.

Saleh, H. H., & Hasson, S. T. (2019, April). A survey of routing algorithms in vehicular networks. In 2019 International Conference on Advanced Science and Engineering (ICOASE) (pp. 159-164). IEEE.

Saleh, Hassan Hadi, and Saad Talib Hasoon. "Capacity Enhancement for the Vehicular Network using Spatial Multiplexing." International Journal of Engineering & Technology 7.4.19 (2018): 772-777.