المجلة العربية للنشر العلمي

العدد الرابع والعشرون
تاريخ الإصدار: 2 – تشرين الأول – 2020 م
www.ajsp.net
ISSN: 2663-5798

"Isolation Model for Network Slicing in 5G Network"

Researcher:

Daifallah Zaid Alotaibi

Faculty of Computing and IT
King Abdulaziz University, Jeddah, Saudi Arabia

Professor: Viejy Thayananthan

AJSP
المجلة العربية للنشر العلمي
العدد الرابع والعشرون
تاريخ الإصدار: 2 – تشرين الأول – 2020 م
ISSN: 2663-5798
www.ajsp.net

Abstract

5G technology is the future of mobile networks, and in different countries, 5G mobile networks are launched. Different use cases have different requirements for the function and the performance of 5G network. They would require different types of factors and networks which include data rate, delay and scalability. Those requirements will be met in 5G by using network slice architecture, which uses network virtualization technology. In this paper, we present network slice architecture for 5G network, analyze the state-of-the-art 5G network slice, address several network slicing architecture issues, and highlight some open research questions.

Keyword :Snetwork slice, Management, 5G network.

I. INTRODUCTION

The 5G technology is providing high-speed communication services because it is using millimeter waves to transfer data from one location to another location. 5G is also supporting many devices because the network speed is very high. It can be improved by introducing a new architecture, and this architecture is known as network slicing. Network slicing is an important architectural technology for 5G [1], [2].

Network slicing is the most important concept to realize personalization of mobile networks for users [3].

Basically, logical networks will be virtually representing the 5G single physical network, and each one called network slice. Every network slice will have specific network functions to provide different services for different requirements. Network slicing offers better business agility, flexibility, and cost-efficiency

It is challenging to design a robust network slice architecture. Currently, it is found that the full network slice isolation is not met yet. Full isolation means that each network slice instance has its own function without sharing with the other slices. Each slice should have its own path for its data traffic and store its data in separate storage or memory without sharing that with network slice instances.

Currently, the 5G networks are supporting high speed with many numbers of connections. But this speed can be affected because 5G is going to support IoT devices and these devices are increasing day by day [4]. Thus, the main issue is to enable 5G networks to behave like multiple slices, and each slice must be working independently.

This paper begins by presenting the key management issues of 5G network slice. Next, the state-of-the-art, including existing architectures, is discussed in section 2. Section 3 subsequently discusses the existing work relevant to it. Then network slice architecture model is presented in section 4. Finally, this paper is concluded in section 5.

2. Literature Review:

This section presents a literature review of network slice and the current trends of network slice management. An outline of recent trends in slice isolation and a set of challenges are presented. There are four main fields within the research area: network slicing (concept and architecture), network slice challenges, network slice management and orchestration, and network slice isolation.

2.1 NETWORK SLICING: CONCEPT, USE CAXE, AND SYSTEM ARCHITECTURE:

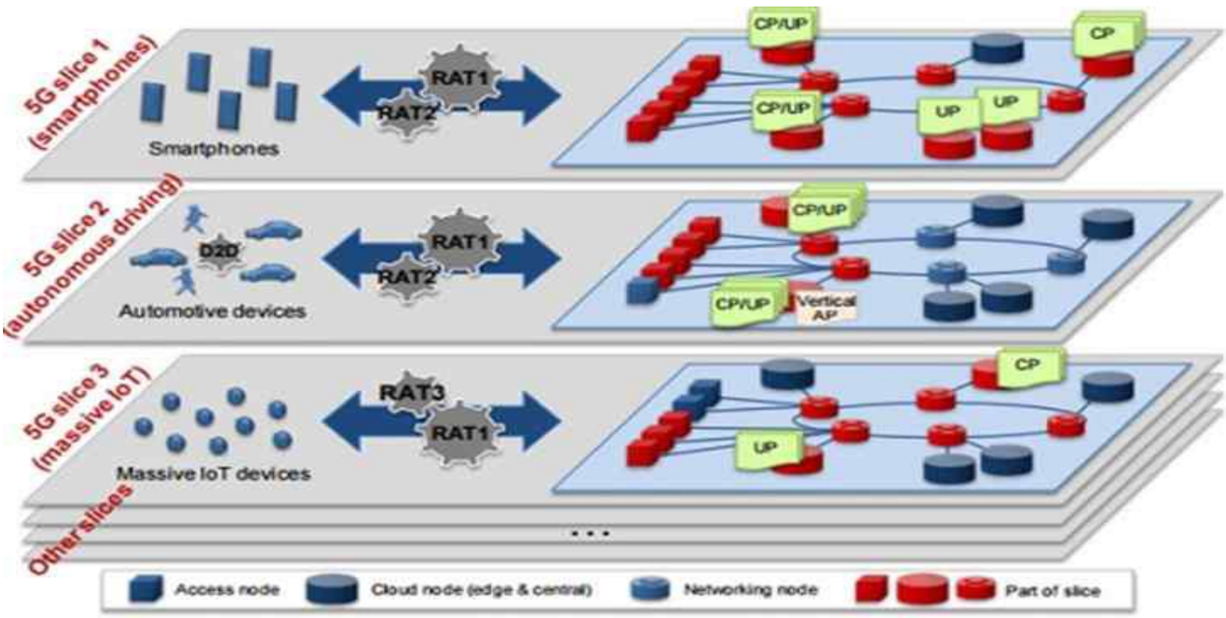
5G is the fifth generation mobile network which has been designed from the beginning for a broader scope than previous generations like 4G Long-Term Evolution (LTE) .The key goals for the fifth generation are to provide widespread, high-speed, high-quality wireless broadband coverage to meet social and industrial needs beyond 2020.

The fifth-generation mobile system will need to support all the connecting devices that benefit from the connection and support a wide variety of services. It needs to provide the expected capacity, optimize the end-to-end delay and flexibility in a cost-effective approach. Networks need to cover their entire service coverage areas including challenging locations such as remote areas, basement, and office buildings. Challenging requirements are expensive to be met in the entire network at the same time. This includes over 300Mbps of bandwidth, very little latency of just a few milliseconds and provide up to 200,000 devices / km2 with reliability rating of 99,999%. This is the reason for using the concept of Network slice in 5G mobile network for splitting one physical network into many logical networks. Each logical network (network slice) has its own service type and properties (Key performance indicator) to meet the required service. This is better than on-size-fits-all network as the requirements from user equipment (UE) will be distributed to different virtual network slices in order to satisfy all requirements. A network slice is basically a logical network that provides specific network capabilities and characteristics. Network slicing helps the operator to build tailored networks in order to provide integrated solutions for various needs.

], the author believes that one of the most critical developments in the fifth-generation networks is network slicing. 5 In [
Slicing mechanism allows virtual networks to provide personalized services on request.

By 2020, a wide variety of services and applications will be provided by the 5G mobile networks to meet the connected], the author believes that in the fifth generation (5G) mobile networks, network 5]. Also, in [7], [6users' requirements. [slicing has been considered one of the key technologies. Slicing mechanism allows virtual networks to provide personalized services on request. The 5G E2E network slicing is seen as a key factor in achieving this challenging goal]. The 5G technology is going to accommodate many areas of life, but it is the chance, that IoT devices will reduce the 8[speed of this 5G technology. To overcome this issue and to get more reliable network speed, the network slicing is the].9natural solution, because this solution can easily accommodate multiple services [

A network slice is a logical network which provides specific network capabilities and network features to serve a client's specified business purpose. Network Slicing allows for the development of several virtual networks on top of a single physical shared infrastructure. A network slice consists of various subnetworks, for example: subnet Radio Access]. Additionally, network slicing is to use 10Network (RAN), subnet Core Network (CN), subnet Transport Network [virtualization technology i.e. NFV or SDN Designing, partitioning, organizing and optimizing physical infrastructure communication and computing resources into multi-logical networks to provide a wide variety of services to connected]. Each slice will have its own architecture, connected users, packet and signal processing capacity, and is 11users [customized and configured to provide particular services to particular end user.



]12 the concept of network slice [1Figure.

], the author believes that the reason of having different slices is to provide various services and to ensure a certain 9As in [shows different types of slices that are customized to meet a specific requirement by 1Fig. form of QoS within the slice. specific type of application. Like a high-throughput service for smart-phones, a low-rate non-critical service for Internet of Things (IoT) or Machine to Machine (M2M) communications and a low-latency service for critical real-time communications.

], the author shows that different verticals have different requirements and different key performance indicators 13In [(KPIs).

The Third Generation Partnership Project (3GPP) divided all the areas of operation into four groups, as follows:

- Enhanced mobile broadband (eMBB), characterized by remarkably high data traffic and bit rate
- Critical communications (CriC), characterized by low latency, ultra-high reliability, high density distribution, and high precision accuracy
- Massive Internet of Things (mIoT), featuring massive numbers of connections in environments with high user density
- Vehicle-to-X (V2X) communications, marked by high reliability, low latency, high speed, and high positioning accuracy.

Therefore, the current architecture is not able to handle those requirements so there is a need for a novel isolated network slice architecture to provide functional and operational support.

]14Table.1 5G use cases and their requirements [

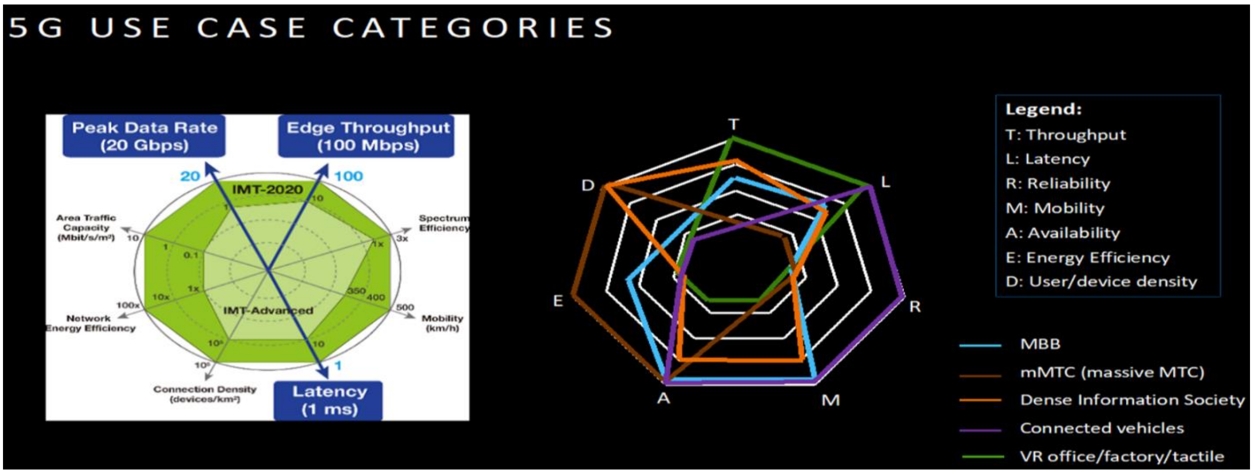
Cases	Applications	Requirements
Enhanced mobile broadband access in dense areas (eMBB)	Hologram, high-definition (HD) video, user mobile broadband in a stadium	High traffic volume, high throughput
Small-volume, critical communications (s-VCC)	Robotic control, industry control	High reliability, ms latency, small traffic volume
High-volume, critical communications (h-VCC)	e-Health, virtual reality (VR)	High reliability, ms latency, high traffic volume
Extreme real-time communications (eRTC)	Autonomous driving, driving assistant, automotive factory	Sub-ms latency, mobility, high traffic volume
Massive Internet of Things (mIoT)	Smart wearables, meters, sensors	Massive connection, low power

As shown in table.1, in 5G mobile networks, there are a wide variety of use case that have different requirements simultaneously. Therefore, it is impossible to create different physical networks for each of the above use cases due to the high cost. Hence, network slice plays a significant role in creating different logical network for a wide variety of use cases using only one physical network.

shows heterogenous 5G use case performance requirements as well as the varied collection of underlying 2Also, Fig. network parameters needed for a particular category of application

]. 15cases [

ISSN: 2663-5798



]15 A diversity of 5G use cases [2Figure.

]:16According to recent studies and designs, the network slicing concept is based on the three-layer model [

- Service Instance Layer,
- Network Slice Instance Layer,
- Resource Layer.

NGMN defines that network slicing concept is consisted of three layers: Service Instance Layer, Network Slice Instance]:17. [3Layer, and Resource layer. Each of these three layers are described below and shown in Fig.

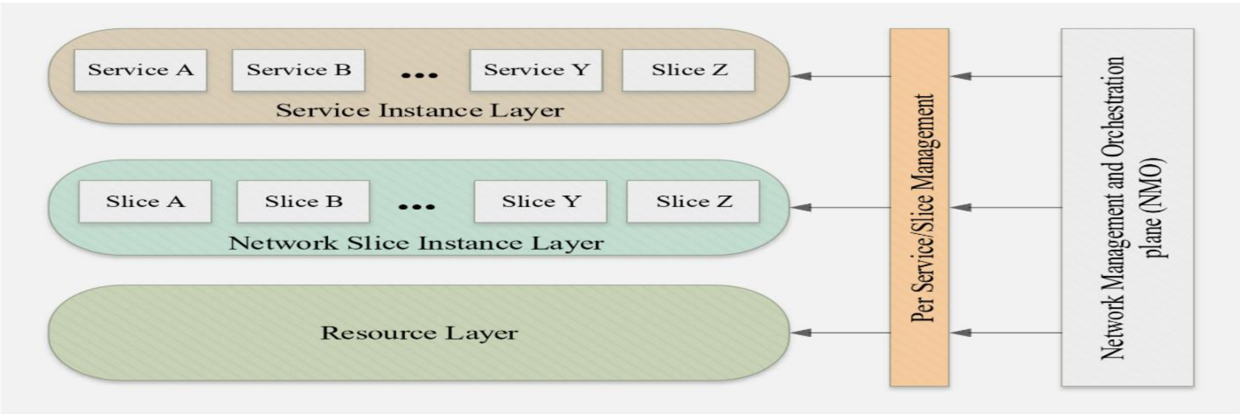


Figure.3 network slicing management architecture

• Service Instance Layer:

This layer represents end user and business services, that are expected to be provided by the network. Each service is represented by a Service Instance. Such services may be delivered either by the network operator or by a third party.

• Network Slice Instance Layer:

A Network Slice Instance is a set of (virtualized) network functions that are implemented at resources to allow these network functions to be run.

The network slice instance provides the network characteristics required by a service instance. Also, the network slice instance can be shared across multiple instances of service, which a network operator provides. The network slice instance may consist of none, one or more subnetwork instances shared by another network slice instance. In addition, a network slice instance may be isolated from another network slice instance in many ways, e.g., full or partial isolation and logical or physical isolation.

• Resource Layer:

The actual physical and virtual network functions are used to implement a slice instance. At this layer, network slice management function is performed by the resource orchestrator, which is composed of NFV Orchestrator (NFVO), and of application resource configurators.

2.2 Network slice management and orchestration:

This section is focused on different trends of network slice management and orchestration at present. In order to make network slicing models a reality, a significant integration with NFV orchestration systems is required to implement all lifecycle management frameworks for the slices and the virtualized functions and services they provide. Bellow, we highlight some existing management architectures and orchestrators used for the 5G network slicing.

], the author presents two layers for managing the network slice. Service management layer that is responsible for 18In [service operations and Network slice control layer that Provides the abstraction of resources for service management and manages network slice resource management as well as plane control operations. Fig.4 shows Service management summary and Slice Monitoring

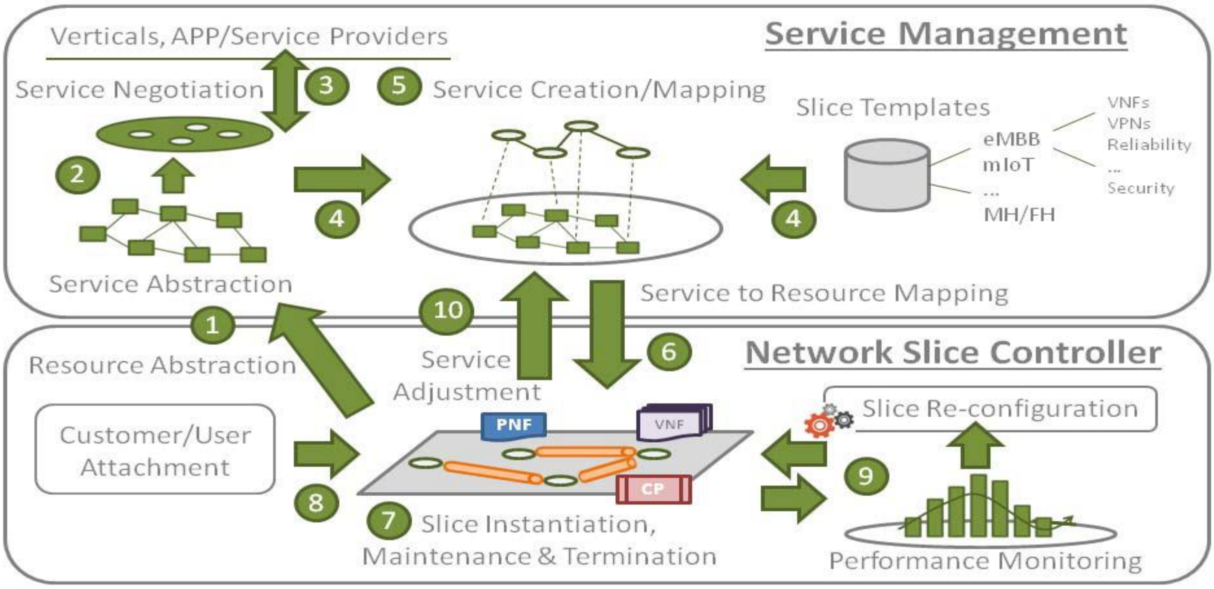


Figure.4 Service management and network slice control

], The defined management functions for the network slices are the function of communication service 19In addition, in [management (CSMF) and the function of network slice management (NSMF). The first is used to translate the specifications of the communication networks into network slice specifications, while the second is responsible for the control and orchestration of network slice life cycle. Also, the network slicing management and orchestration architecture (MO) is also introduced in Fig.5 to provide an comprehensive context knowledge of network slicing when the]. 20requirement of a specific network service is converted to the requirement of a network slice by CSMF. [

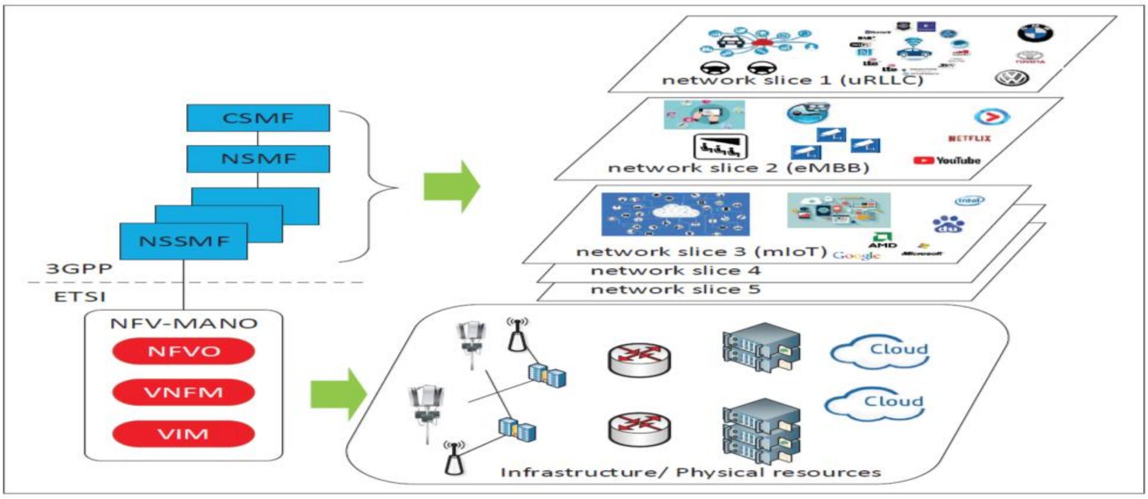


Fig.5 The MO architecture of network slicing.

], the author presents that Management and Orchestration (MANO) is the management orchestration 21Furthermore in [feature of Network function virtualization (NFV), which consists primarily of three entities: Virtualized Infrastructure Manager (VIM), Virtual Network Function Management (VNFM), and Orchestrator. It is mainly responsible for complex infrastructure configuration and for the functions of the entire network

] states that the use of the single orchestration unit increases complexity and delay. 22The author in [

An integration with NFV orchestration systems is significant to implement all the lifecycle

management mechanisms for the slices and the virtualized functions and resources they include.

To allow for rapid innovation, orchestrators for 5G network slicing are becoming complementary, which is why most of the existing solutions are open source Many open source orchestrators have been developed to realize the management and].. Some orchestrators used for the 5G network slicing have 23orchestration of dynamic network slices in 5G networks [been surveyed below:

2,.2.1 OpenBaton

an open source to Enhance NFV efficiency and ensure overall infrastructure security through the integration of It is underlying software and hardware architectures, networking, management and orchestration.

OpenBaton offers an external module "Network Slicing Engine," allowing such QoS

configurations to be implemented across resources that belong to the same slice. Additionally, The OpenBaton combines two separate engines: (1) the auto scaling engine for

scaling operations and (2) the event management engine for network functions dispatch. Fig.6 shows the OpenBaton].24architecture [

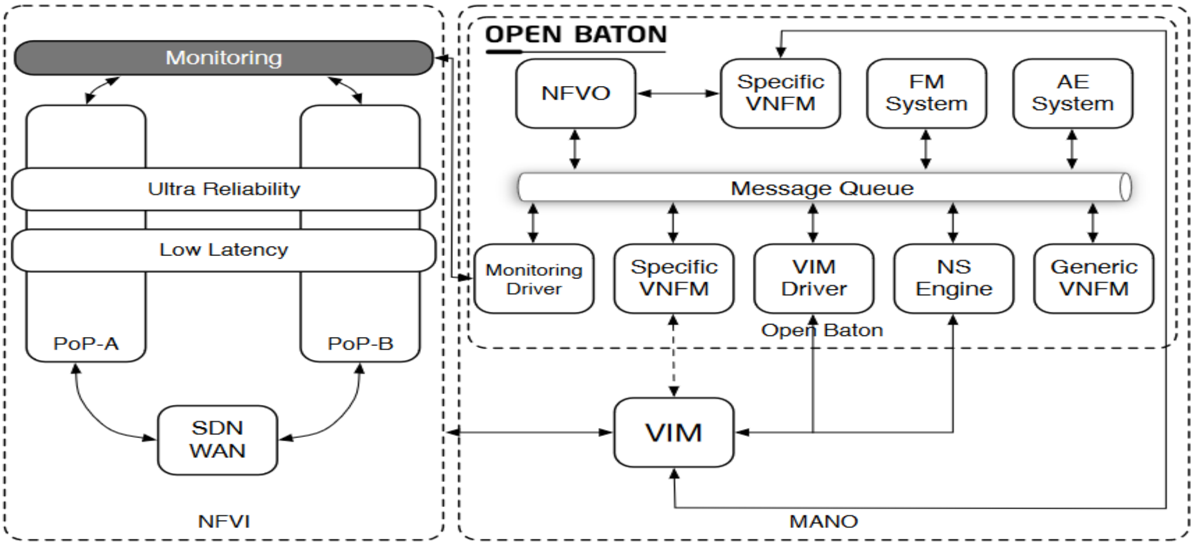


Figure 6 the OpenBaton framework

2.2.2 ONAP

Open Network Automation Platform (ONAP). ONAP working documents include some guidance (i.e. steps required) for the description, creation and management of network slices. Also, it Provides a robust framework for real-time, policy-driven or physical and VNF automation, allowing developers and service providers to automate and support full life-cycle management of new services. It consists of both VNF and PNF design times at run-time. Fig.7 shows the architecture].25design of ONAP [

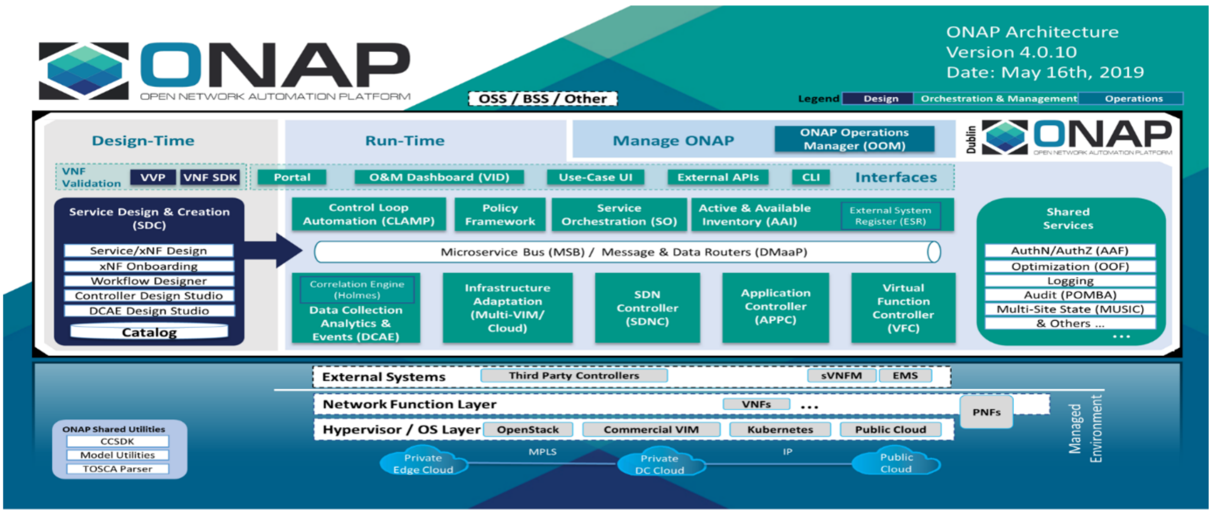


Figure 7 ONAP framework

2.2.3 OSM

Is An open source management and orchestration (OSM) stack that is delivering a production quality open source Management and Orchestration (MANO) stack along with ETSI NFV information models. The OSM contains the SO, RO and a configuration manager, and targets commercial NFV network requirements. By using the OSM orchestrate, automatic insurance and

]. 26DevOps in service chains and 5G network slices are explained in [

]. 27Fig.8 bellow shows the framework of OSM [

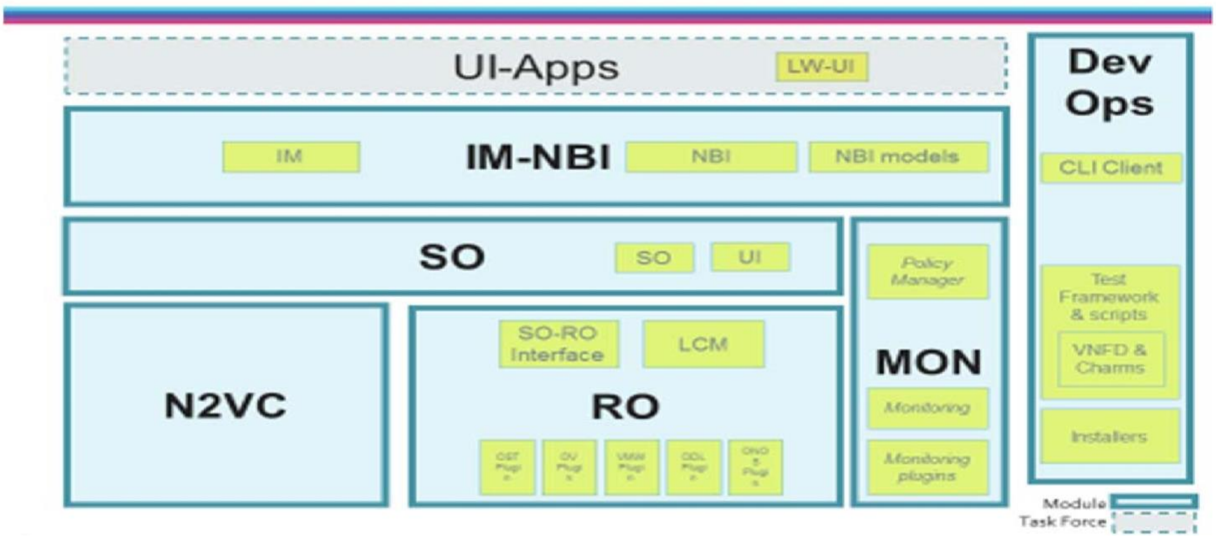


Figure.8 OSM framework

2.2.4 CloudNFV

It is an open source platform for implementing NFV- based on cloud computing and SDN in a multivendor environment. CloudNFV has three main components: the orchestrator, manager, and an active virtualization. The orchestrate directs the VNF location and the connection between them for a specific service. The manager works with current resources and manages the information base of the running services. an active virtualization represents The NFs and resources using the active service and active contract sub-elements.

2.3.5 T-NOVA

T-NOVA leverages the advantages of architecture and SDN cloud management to allow the automated provision, monitoring, configuration, and efficient operation of Network Function-as-a-Service (NFaaS) in addition to a virtualized 5 G network infrastructure. The T-NOVA consists of two elements, including (1) the Virtualized Resource Orchestrator (VRO), which is responsible for computing, storing, and networking resources, and (2) a Network Service Orchestrate (NSO), that preserves network services access lifecycle.

We summarize a wide range of Orchestration technologies in 5G networks. Table.2 shows a summary of them including each one organization, objective, and technology and management features.

Table 2. a summary of Orchestration technology in 5G

Orchestrator	Technology	Organization	Objectives	Technology Features	Management Features
OpenMANO	SDN, NFV	Telefonica	To provide a practical implementation of the NFV MANO reference architecture	OpenMANO, OpenVIM, REST API	–
OSM	Cloud networks and services	ETSI NFV	MANO with SDN control, multi-site/multi-VIM capability	OpenMANO, OpenVIM, Juju, OpenStack	–
OPNFV	NFV	Linux Foundation	To facilitate the development of mult- vendor NFV solutions across various open source ecosystems	OpenStack, OpeDaylight	–
ECOMP	SDN/NFV, Cloud and legacy networks	AT & T	Software centric network capabilities and automated E2E services.	TOSCA, YANG, OpenStack, REST-API	Improved OSS/BSS, service chain, policy management
T-NOVA	Network services and virtual resources	European Union	Network function as a service.	OpenStack, OpenDaylight	OSS/BSS, service lifecycle
OpenBaton [121]	Heterogeneous virtual infrastructures	FOCUS	Enables virtual network services on a modular architecture.	TOSCA, YANG, OpenStack, Zabbix	Event management and auto-scaling
Cloudify	NFV, Cloud	Gigaspaces	A multi-cloud solution for automating and deploy network services data centers.	TOSCA, OpenStack, Docker, Kubernetes	Service chaining, OSS/BSS
ZOOM	NFV and cloud services	TM Forum	Monitoring and optimization of Network Functions-as-a-Service (NFaaS).	–	Improved OSS/BSS
CloudNFV	SDN/NFV enabled cloud services	European Union	Enables the NFV deployment in a cloud environment	OpenStack, TM Forum SID	Service chaining and OSS/BSS
HP OpenNFV	NFV	European Union	An NFV-architecture that allocates resources from an appropriate pool based on global resource management policies.	Helion OpenStack	–
Intel ONP	SDN & NFV	Intel Corporation	Accelerates the adoption of SDN and NFV in telecom, enterprise, and cloud markets.	OpenStack, OpenDaylight	–
M-CORD	SDN, NFV- edge clouds for mobile networks	ON.Lab and partners	Anything as a Service, Micro-services architecture.	ONOS, OpenStack, XOS	Real-time resource management, monitoring/analytics, service chaining
OPEN-O	SDN, NFV and Cloud	Linux Foundation	Enable an E2E service agility across SDN, NFV, and legacy networks via vendor-specific data models (e.g., TOSCA and YANG)	TOSCA, YANG, OpenStack, REST-API, OpenDaylight, ONOS, Multi-VNFM/VIM	Improved OSS/BSS, service chain, policy management
ExperiaSphere	SDN, NFV & Cloud	CIMI Corporation	Flexible service model	USDL, TOSCA	Service events, derived operations

3. Isolation in network slicing

5G mobile networks are expected to deliver a significant digital revolution that will provide unparalleled information-sharing opportunities to individuals, businesses and governments. The consensus of the industry is that 5 G should be recognized not only for its state-of - the-art wireless connectivity technology but also for the manner in which it incorporates cross-domain networks so that operators can provide networks on a consumer basis. In [28], “Each network slice works independently and virtually represents the end-to-end network, and all slices work simultaneously because of slicing architecture”.

In [5], the author believes that in the fifth generation (5G) mobile networks, network slicing has been considered one of the key technologies. Slicing mechanism allows virtual networks to provide personalized services on request. The 5G E2E network slicing is seen as a key factor in achieving this challenging goal. [29]. The challenge is how to provide very different types of services and support 5 incompatible 5G core features with a single network infrastructure. The solution is to create multiple networks customized to each service and main capabilities. The distinction from the current network model is that each network is a logical network based on a single network infrastructure that is virtualized. Logical network consists of a collection of network functions chosen for a service and is known as a network slice [30]. A network slice is a logical network that provides unique network capabilities and network features.

In [31], where to go from a high-level definition of the service to a practical slice in terms of infrastructure and network functions is a major challenge for the realization of a network slice. The question of service definition has been described in the literature, but without satisfactory resolution

. The 5G technology is going to accommodate many areas of life, but it is the chance, that IoT devices will reduce the speed of this 5G technology. To overcome this issue and to get more reliable network speed, the network slicing is the natural solution, because this solution can easily accommodate multiple services. In [32] these slices can be controlled by using the software. In this technique, the networks will be transformed by using the solutions of software-based. For this purpose, the Software-Defined Network technique is being used. SDN is providing software-enabled virtualization where many virtual or logic networks can be created. These virtual and software-enabled networks are known as slices of the network. These slices will be enabled on one network; it means, one network will be divided into multiple logical networks. In [33] this technique is not new, because on traditional networks VPN is the example of the slice. But slices will be independent mutually, and all the control and management system of each slice is independent. These slices can be created according to the requirement or on-demand. This technique can be helpful for different business domains to work on their one slice which same sharing infrastructure of the networks. In [34] the main requirement of this 5G network slicing is the isolation of all the slices. Thus, strong isolation is required, where all the slices will be working parallel by sharing the same network architecture. The isolation must be considered based on the performance of each slice like each slice must provide all the required services. The performance of isolation is measured in the end to end connections. That’s why in isolation, each slice must provide the performance according to the specific performance requirements.
In [35] also the isolation of each slice is measured in the form of privacy and security, like if there will be any security threat or security issue with anyone slice, then this threat to security will not affect the performance of other network slices. Each slice must be working independently based on defined security measures and security solutions provided for each slice. In this way, only authorized people can access the slice; the unauthorized access can’t change any configuration of the slice. That’s why the security impact of each slice must be isolated from other slices. Isolation of each slice also depends on the management, like every slice must be managed independently because each slice must be working as a separate network. In [36] 5G network slicing can be configured based on layers, and each layer must be working to provide isolated services to all the slices. This architecture can improve the overall connectivity of the networks. Because right now, the complete isolates networking slicing technology is not working, because still, slices of the network depend on the other slices, that’s why the performance is not according to the requirements. Network slicing architecture is based on the software because the software will virtually divide the network into multiple slices. The author [1] is stating that the network slicing can also work for edge nodes and this node can easily offer low latency services to the end-users. The centralized applications, services and can be shifted towards the edge slices of the network to perform better services. For this purpose, a complete management model is required to hand over all the services and applications to the edge slices of the network. In [37], a complete 5G network slicing architecture is proposed and presented based on physical resource allocation to the virtual slices. This slicing architecture can be implemented in the local area network by introducing scheduling between all slices. SDN can easily manage all the workings of the resource allocation for central slices because the management of mobility can be performed by the SDN quite accurately in slicing networks. Also, the designing of slicing network architecture for the 5G network is based on the control of hardware and infrastructure of software. The slicing is interconnectivity or interworking between software and hardware. The slices of the network must be sharing the same network resources, and physical infrastructure will be shared between all slices, but they will be working separately as an isolated network [37]. The [2] is identifying SDN as a software control because SDN is being used widely for implementing the slicing in the network and for this purpose the network virtualization is used. In [38], the novel network slicing mechanism is introduced in 5G networks. There are three-fold involve, in the first-fold, there are 3 layers, the first layer is introducing the service layer of the network slice, the second layer is introducing the applications and network idea, and third is being used for the realization of network slicing. This architecture is generic because this architecture can be used for LTE and 5G as well. This is called novel slicing network architecture. The author [39] is stating that the slicing networks are providing many advantages. Like slicing, networks will be more flexible as compared to the tradition networks because network equipment is very costly, and when many slicing networks are the same share hardware, then the overall cost of the network will reduce. That’s why slicing networking architecture is very strong to provide flexible services. Table 3 show the comparison of 5G slice modelling approaches [31].

Comparison of 5G slice modelling approaches.

	Service-driven	Resource-driven	Deployment-driven
Slice lifecycle development	+ The entire slice lifecycle management can be implemented via OSS/BSS extensions that interact only with the NFVO. – Modelling everything that needs to run on the set of slice resources as a standard NS might be undesired due to complexity of NSD creation, lack of ETSI NFV expertise, or conceptual distance of the deployables with the ETSI NFV standard.	+ Cloud resource orchestrators can be used for the slice resources management, while services can be potentially modelled with less complexity than ETSI-based solutions. – The absence of linking to NS descriptors can lead to duplications or incompatibilities between the slice lifecycle management implementation and the NS lifecycle management implementation.	+ The implementation of the slice resource management can be done outside of the NFVO (as in the resource-driven approach), while services deployed on the slice during its lifecycle are not restricted to be modelled in a specific way. – The conformance of the models of the deployable instances (right part of Fig. 3) with the resources-related part of the slice model (left part of Fig. 3) might be challenging to achieve in complex systems. This refers mainly to correctly modelling the weak dependencies of Fig. 3.
Standards alignment	+ Intuitively close to the 3GPP and ETSI NFV expectations of how a slice data model should look like. – Heavily dependent on the endorsement of ETSI NFV-based modelling of (network) services.	+ Intuitively close to the Cloud-native way of modelling resources (e.g., note the similarity to OpenStack resource types and hierarchy). – Structurally disconnected from other existing standard models.	+ Aligned to Cloud-native standards for the modelling of resources as well as to 3GPP and ETSI for the modelling of services. – Risks incompatibilities with those standards by having the loosest integration between the “services part” and the “resources part”.
Supported standards	+ 100% support of any ETSI NFV-modelled solution. – Support of the deployment of services modelled based on other standards (e.g. ETSI MEC or Cloud-native standards) is possible either with additional efforts or not at all.	+ Supports the inclusion of any kind of services in the slice instance. – It requires its custom service modelling even for services that are already modelled based on other standards.	+ It supports ETSI NFV and ETSI MEC service descriptors, as well as any other standard descriptor that can be linked to its resources representation. – It does not support NSs that describe their (required) “host” resources in a way that cannot be mapped to any of the slice resource chunks.
Network sharing functionality	+ It can be built on top of existing NFVOs. – All the aspects and the phases of the network sharing functionality are dependent on the NFVO and its way of operation.	+ Slice resource sharing is decoupled from runtime constructs (e.g., service instances), so that it can be implemented at a pre-runtime phase and without having to go into the heavyweight details of NS design. – Limited flexibility with regard to quickly building slices by composing off-the-shelf services from NS catalogues.	+ Slice resource sharing is decoupled from runtime constructs (as in the resource-driven approach), while service creation and instantiation can also be facilitated by an NFVO and other NFV-related modules such as NS catalogues. – Higher complexity during operation due to the heterogeneity of the models of the diverse service instances that are deployed on the slice.

In [40], the slicing networks can provide unified management, where centralized networking services will provide perfect network control, particularly this logical centralized control is helpful for heterogeneous networks, and the traffic requirements are controlled by the network according to the demand of the slices. Each slice must have a self-management and run as a separate network [41], [42]. In [43], the author states that Software-Defined Networking (SDN) and Network Function Virtualization (NFV) are the main technologies for implementing network slicing.

The author [44] also is stating that the slicing networks are used for simplification of the network operations because network operators are going to control few centralized networking operations and entities and these few entities are enough to control the whole network perfectly. In [45], the slicing network architecture is enabling to innovate things, because the functions of the controller are modified according to the performance requirements of each slice. In this way, the new services and new functions can be introduced in the core architecture. This whole process can be completed in a few hours because SDMC apps are providing a controller to modify any service and any function of the slicing network. The [17], the slicing network can improve the programmability of the network admins because it is allowing to schedule the functions, services, and selection of the channel. In the way, this architecture is providing inter-slice resources control mechanism as well, this will help to allocate resources in compliance with users' requirements. SDMC is also allowing to assign idle resources to the other slices, and even services of the third party can utilize all the unutilized resources. The way we classify users and ensure isolation is an open research topic, while the network operator must provide slice / system monitoring APIs for slice life management. [13]
Author [46] is stating that the slice network architecture is going to face many challenges as well like resource sharing can be a big issue, because in traditional slicing networks we can add more hardware devices to the network to avoid hardware constraints. However, in 5G the limited spectrum can cause an issue of limited hardware resources. In RAT (radio access

العدد الرابع والعشرون
تاريخ الإصدار: 2 – تشرين الأول – 2020 م
ISSN: 2663-5798
www.ajsp.net

technology) the sharing of the spectrum can be a big issue for slicing networks. Sharing constraints like information sharing, MAC layer sharing, physical resource sharing, and physical layer sharing constraints can be more difficult to manage during the resource management process. In [47], the author states that the problem of isolation is still less dealt with in the literature, despite being one of the major research challenges in this area

In [48], the transparency is another big challenge, because the slicing networks will be extended to different countries, that's why it could be difficult to manage transparency of the network when the network expands. Unlimited requests of slices will also cause a big issue because we can't keep the network architecture to access all requests and if all request is accepted, then the whole network will go down due to overwhelming requests.

4. Proposed network slice architecture in 5G:

Figure 9 is the network slice architecture model proposed in this paper. As it shows that each slice manger has a slice manager (SM) with a unique ID. the slice manager is very important to manage all functions and operations of each slice. In this methodology, each slice must be equipped with a slice manager, because without this slice manager the slice can't work independently. the slice manager has a set of network functions to control the data and manage the path. The data control and path identification or path selection is a basic function of the slice manager because slice manage must control the data flow and path selection to guide data towards the required destination is required. The idea is that each a user equipment (UE) is associated with only one network slice instance (NSS).

Also, Provide SDN/ technology for each slice, because the software-defined network can be helpful to manage all the operations of each slice. If each slice is equipped with the latest SDN, then each slice must work as an entire network.

This model assists to achieve isolation of storage for each slice. data related to a slice will be stored separately from data used by another slice. In this methodology, the resources are not shared with the other slices. Like each slice must use its own virtually allocated memory and migrate the data to the slice without interfering with other data.

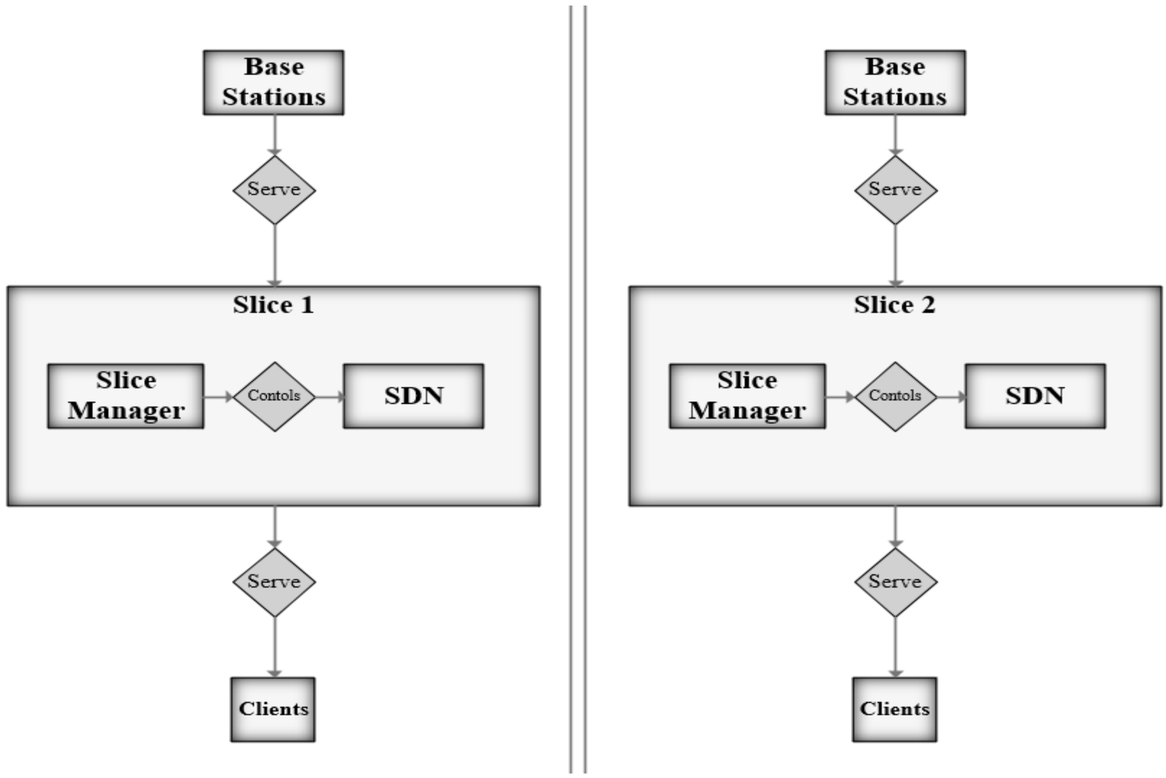


Figure 9 Network slice Isolation Model

ISSN: 2663-5798

5. Conclusion and future direction

In this paper, new architecture of network slice in 5G is proposed to achieve the objective of making all slices work independently without sharing resources with other slices, providing network selection, isolation / separation between storage network slices, traffic, etc., and a routing system for transmitting end-user data to the network slice. In future, the next step is using network simulations (eg: OMNET++) to analyze and evaluate the proposed 5G network slicing isolation architecture in different mobility scenarios.

References

Alliance, N. G. M. N. (2016). Description of network slicing concept. NGMN 5G P, 1.

Parvez, I., Rahmati, A., Guvenc, I., Sarwat, A. I., & Dai, H. (2018). A survey on low latency towards 5G: RAN, core network and caching solutions. IEEE Communications Surveys & Tutorials, 20(4), 3098-3130.

32- Tarik,T. Badr,M. Marius,C. Akihiro,N. and Hannu,F. (2017). PERMIT: Network Slicing for Personalized 5G Mobile Telecommunications. Available at: http://mosaic-lab.org/uploads/papers/e706274e-8955-49c0-8385-b9a4808 7b99f.pdf [Accessed on 10 Jul. 2019]

NGMN Alliance. Description of Network Slicing Concept. Available at: https://www.ngmn.org/fileadmin/user_upload/161010_NGMN_Network_Slicing_framework_v1.0.8.pdf [Accessed 12 Aug. 2019]

Abbas, M. T., Khan, T. A., Mahmood, A., Rivera, J. J. D., & Song, W. C. (2018, April). Introducing network slice management inside M-CORD-based-5G framework. In NOMS 2018-2018 IEEE/IFIP Network Operations and Management Symposium (pp. 1-2). IEEE.

Li, R., Zhao, Z., Zhou, X., Ding, G., Chen, Y., Wang, Z., & Zhang, H. (2017). Intelligent 5G: When cellular networks meet artificial intelligence. IEEE Wireless Communications, 24(5), 175-183.

Perepelkin, D., Ivanchikova, M., Byshov, V., & Tsyganov, I. (2018, April). Algorithm and software of virtual slices formation in software defined networks. In 2018 28th International Conference Radioelektronika (RADIOELEKTRONIKA) (pp. 1-4). IEEE.

Velasco, L., Gifre, L., Izquierdo-Zaragoza, J. L., Paolucci, F., Vela, A. P., Sgambelluri, A., ... & Cugini, F. (2018). An architecture to support autonomic slice networking. Journal of Lightwave Technology, 36(1), 135-141

Minami, Y., Taniguchi, A., Kawabata, T., Sakaida, N., & Shimano, K. (2018, April). An architecture and implementation of automatic network slicing for microservices. In NOMS 2018-2018 IEEE/IFIP Network Operations and Management Symposium (pp. 1-4). IEEE.

Slicing, G. N. Use Case Requirements. April 2018

Li, Q., Wu, G., Papathanassiou, A., & Mukherjee, U. (2016). An end-to-end network slicing framework for 5G wireless communication systems. arXiv preprint arXiv:1608.00572.

Choi, Y. I., & Park, N. (2017, July). Slice architecture for 5G core network. In 2017 Ninth international conference on ubiquitous and future networks (ICUFN) (pp. 571-575). IEEE.

Kaloxylos, A. (2018). A survey and an analysis of network slicing in 5G networks. IEEE Communications Standards Magazine, 2(1), 60-65.

Li, W., Zi, Y., Feng, L., Zhou, F., Yu, P., & Qiu, X. (2019). Latency-Optimal Virtual Network Functions Resource Allocation for 5G Backhaul Transport Network Slicing. Applied Sciences, 9(4), 701.

The Evolution of Security in 5G- 5G Americas White Paper (July 2019)

Kotulski, Z., Nowak, T., Sepczuk, M., Tunia, M., Artych, R., Bocianiak, K., ... & Wary, J. P. (2017, September). On end-to-end approach for slice isolation in 5G networks. Fundamental challenges. In 2017 Federated conference on computer science and information systems (FedCSIS) (pp. 783-792). IEEE.

N. Alliance, "Description of network slicing concept," NGMN 5G P, vol. 1, 2016.

Afolabi, I., Taleb, T., Samdanis, K., Ksentini, A., & Flinck, H. (2018). Network slicing and softwarization: A survey on principles, enabling technologies, and solutions. IEEE Communications Surveys & Tutorials, 20(3), 2429-2453.

Kaloxylos, A. (2018). A survey and an analysis of network slicing in 5G networks. IEEE Communications Standards Magazine, 2(1), 60-65.

Su, R., Zhang, D., Venkatesan, R., Gong, Z., Li, C., Ding, F., ... & Zhu, Z. (2019). Resource allocation for network slicing in 5G telecommunication networks: A survey of principles and models. IEEE Network, 33(6), 172-179.

Chen, Q., Wang, X., & Lv, Y. (2018, May). An overview of 5G network slicing architecture. In AIP Conference Proceedings (Vol. 1967, No. 1, p. 020004). AIP Publishing LLC.

Devlic, A., Hamidian, A., Liang, D., Eriksson, M., Consoli, A., & Lundstedt, J. (2017, May). NESMO: Network slicing management and orchestration framework. In 2017 IEEE International Conference on Communications Workshops (ICC Workshops) (pp. 1202-1208). IEEE.

Katsalis, K., Nikaein, N., & Huang, A. (2018, April). JOX: An event-driven orchestrator for 5G network slicing. In NOMS 2018-2018 IEEE/IFIP Network Operations and Management Symposium (pp. 1-9). IEEE.

Carella, G. A., Pauls, M., Magedanz, T., Cilloni, M., Bellavista, P., & Foschini, L. (2017, July). Prototyping nfv-based multi-access edge computing in 5G ready networks with open baton. In 2017 IEEE Conference on Network Softwarization (NetSoft) (pp. 1-4). IEEE.

ONAP. (2017). Open Network Automation Platform.

PoC-Demonstrates Automated Assurance and DevOps in Service Chains and 5G Network Slices, (https://osm.etsi.org/wikipub/images/3/3c/PoC _ 1 _ White _ Paper.pdf). [Online: accessed 20-November-2018].]

Hoban, A., Israel, A., Tierno, A., Boyer, C., Salguero, F., Garcia de Blas, G., ... & Marchetti, M. An ETSI OSM Community White Paper. OSM Release FOUR: A Technical Overview.

Alfoudi, A., Dighriri, M., Otebolaku, A., Pereira, R., & Lee, G. (2018, May). Mobility Management Architecture in Different RATs Based Network Slicing. In 2018 32nd International Conference on Advanced Information Networking and Applications Workshops (WAINA) (pp. 270-274). IEEE.

Velasco, L., Gifre, L., Izquierdo-Zaragoza, J. L., Paolucci, F., Vela, A. P., Sgambelluri, A., ... & Cugini, F. (2018). An architecture to support autonomic slice networking. Journal of Lightwave Technology, 36(1), 135-141.

Foukas, X., Patounas, G., Elmokashfi, A., & Marina, M. K. (2017). Network slicing in 5G: Survey and challenges. IEEE Communications Magazine, 55(5), 94-100.

Minami, Y., Taniguchi, A., Kawabata, T., Sakaida, N., & Shimano, K. (2018, April). An architecture and implementation of automatic network slicing for microservices. In NOMS 2018-2018 IEEE/IFIP Network Operations and Management Symposium (pp. 1-4). IEEE.

Katsalis, K., Nikaein, N., Schiller, E., Ksentini, A., & Braun, T. (2017). Network slices toward 5G communications: Slicing the LTE network. IEEE Communications Magazine, 55(8), 146-154.

Li, X., Samaka, M., Chan, H. A., Bhamare, D., Gupta, L., Guo, C., & Jain, R. (2017). Network slicing for 5G: Challenges and opportunities. IEEE Internet Computing, 21(5), 20-27.

Raza, M. R., Fiorani, M., Rostami, A., Öhlen, P., Wosinska, L., & Monti, P. (2018). Dynamic slicing approach for multi-tenant 5G transport networks. Journal of Optical Communications and Networking, 10(1), A77-A90.

Han, B., Lianghai, J., & Schotten, H. D. (2018). Slice as an evolutionary service: Genetic optimization for inter-slice resource management in 5G networks. IEEE Access, 6, 33137-33147.

Zhu,K. and Hossain (2015). Virtualization of 5g cellular networks as a hierarchical combinatorial auction,"CoRR, vol. abs/1511.08256, 2015.

Nikaein, N., Schiller, E., Favraud, R., Katsalis, K., Stavropoulos, D., Alyafawi, I., ... & Korakis, T. (2015, September). Network store: Exploring slicing in future 5G networks. In Proceedings of the 10th International Workshop on Mobility in the Evolving Internet Architecture (pp. 8-13). ACM.

Pearce,M. Zeadally,S. and Hunt,R. (2013). Virtualization: Issues, security threats, and solutions. ACM Computer Surveys (CSUR), vol.45, no.2, Feb. 2013, pp. 1-38

Zhou, X., Li, R., Chen, T., & Zhang, H. (2016). Network slicing as a service: enabling enterprises' own software-defined cellular networks. IEEE Communications Magazine, 54(7), 146-153.

EU H2020 5G NORMA, Deliverable D4.1,"RAN architecture components –intermediate report", https://5gnorma.5g-ppp.eu/wp-content/uploads/2016/12/5g_norma_d4-1.pdf, Nov 2016 [Accessed: 13 Apr. 2019]

Wen, R., Feng, G., Tang, J., Quek, T. Q., Wang, G., Tan, W., & Qin, S. (2019). On the robustness of network slicing for nextgeneration mobile networks. IEEE Transactions on Communications, 67(1),

Ordonez-Lucena, J., Ameigeiras, P., Lopez, D., Ramos-Munoz, J. J., Lorca, J., & Folgueira, J. (2017). Network slicing for 5G with SDN/NFV: Concepts, architectures, and challenges. IEEE Communications Magazine, 55(5), 80-87.

Bektas, C., Monhof, S., Kurtz, F., & Wietfeld, C. (2018, December). Towards 5G: An Empirical Evaluation of Software-Defined End-to-End Network Slicing. In 2018 IEEE Globecom Workshops (GC Wkshps) (pp. 1-6). IEEE.

NGMN Alliance, "NGMN 5G White Paper," Tech. Rep. Version 1, Feb.2015

Bernardo and Chua (2015). Introduction and Analysis of SDN and NFV Security Architecture (SA-SECA). 29th IEEE AINA 2015. pp. 796–801.

Claudia,C. Antonella,M. Antonio,I. and Francesco,M. (2017). 5G Network Slicing for Vehicle-to-Everything Services. Available at:
https://www.researchgate.net/profile/Antonio_Iera/publication/322259401_5G_Network_Slicing_for_Vehicle-to-Everything_Services/links/5b29f6924585150c633fb37d/5G-Network-Slicing-for-Vehicle-to-Everything-Services.pdf [Accessed on 11 Apr. 2019]

Richart, M., Baliosian, J., Serrat, J., & Gorricho, J. L. (2016). Resource slicing in virtual wireless networks: A survey. IEEE Transactions on Network and Service Management, 13(3), 462-476.

Liyanage, Madhusanka (2015). Software Defined Mobile Networks (SDMN): Beyond LTE Network Architecture. UK: John Wiley. pp. 1–438. ISBN 978-1-118-90028-4.

ملخص الدراسة:

تقنية الجيل الخامس هي مستقبل شبكات الهاتف المحمول, وفي بلدان, يتم إطلاق شبكات الهاتف المحمول للجيل

الخامس. مستخدمي هذه التقنية لهم متطلبات مختلفة لوظيفة وأداء شبكة الجيل الخامس. قد تتطلب أنواعا مختلفة من العوامل والشبكات التي تشمل معدل البيانات والتأخير وقابلية التوسع. سيتم تلبية هذه المتطلبات المختلفة في شبكة

الجيل الخامس بإستخدام بنية شريحة الشبكة والتي تستخدم تنقية المحاكاة الإفتراضية للشبكة. في هذه الورقة

العلمية, نقدم بنية شرائح الشبكة لشبكة الجيل الخامس ونحلل شريحة الجيل الخامس الحديثة, ونعالج العديد من

مشكلات بنية عزل الشبكات, ونبزر بعض اسئلة البحث المفتوحة,

الكلمات الاستدلالية : شريحة الشبكة , إدارة شريحة الشبكات, الجيل الخامس.