International Journal of Future Generation Communication and Networking
Vol. 13, No. 3s, (2020), pp. 1579–1586

Software Defined Network (SDN) for 5G era an emerging Mega-trend.

Ruchira Borkar[1], Shailesh Bendale[2]

[1]*Student, Dept. of Computer Engineering, NBN Sinhgad School of Engineering, Ambegaon, Pune-411041, Maharashtra, India*

[2]*Professor, Dept. of Computer Engineering, NBN Sinhgad School of Engineering, Ambegaon, Pune-411041, Maharashtra, India*

Abstract

As of now in the near future there is a need of improving data rate, increasing capacity ensuring the quality of service provided to the user .With these demands and prime objectives 5G will be implemented in around 2020, which might provide about 100 times better speed rate. With the implementation of 5G limitless connectivity will come into picture i.e. Everything will be connected and online by default. With the emergence of 5G era the need to develop more flexible and agile networks is felt which is when SDN (software defined networks) comes into picture. SDN as originally defined is an approach to build and design the network and also facilitate the management of networks, which separates the network's forwarding planes and control planes which makes the network control precisely programmable, it also abstracts the elemental infrastructure for network services and applications.SDN is rapidly evolving as an architecture in order to provide flexibility to software driven programmable organizations. The conventional SDN architecture is based upon a centralized controller that manages the entire network, which might be inefficient so a new concept of DBU's (Dedicated Backup Unit) is proposed. SDN basically redefines the requirements to support the network architecture for the upcoming 5G era. SDN for 5G will provides an intelligent platform to build multiple programmable networks.

Keywords: *Software Defined Networks, 5G.*

Introduction:

In this era of growing technology where there is an exponential growth of mobile video services on smart devices and the progresses in Internet of Things have provoked comprehensive initiatives towards development of 5G and wireless communication system, there is an increased consumption of multimedia with demand of higher quality services from consumers due to which we need to change the way we administer the traditional networks. With the increasing demand of 5G it also must some challenges such as growing Service complexities, traffic volumes, increasing number of devices, better affordability, reduced rates and higher quality of user experience. In an attempt to overcome these challenges new design paradigms of 5G network architecture are expecting to make some change. In particular 5G is leveraging Mobile Edge Computing (MEC), Software Defined Networks (SDN), Network Function Virtualization (NFV) to bring out flexible and scalable network management processes.

This perspective of 5G networks can be achieved by logically slicing physical networks of varying sizes dedicated to different specifications, requirements, functions. Network Softwarization of 5G networks using SDN and NFV befit to fill the void of management of network resources and its programmable control. A report on network slicing by Global System for Mobile Communications says that network slicing is an integral component to raise enterprise opportunity of 5G era to $300 billion 2025. The spectral efficiency of 4G is quite low for the increasing number of smart devices and bandwidth ravenous mobile applications which brings 5G into picture. As we know in the traditional networks each node has a control plane and a forwarding plane in which packet forwarding is done hop-by-hop where each node makes its own forwarding decisions. Configuration and troubleshooting are even more complex in a traditional network since it needs a prosaic set of activities like repeated configurations, backup and fulfillments of requests etc. With increase in demands/requirements of the end-users the diversity amongst the network infrastructure increases which in turn needs more skillful set of people, more processes, and more management systems to orchestrate (coordinate) changes over networks.

ISSN: 2233-7857 IJFGCN

SDN only intends to centralize all the intelligence over a network on a software layer allowing all the abstraction underlying the dense network framework. This paper gives us a basic idea about the network virtualization using implementing SDN for 5G [11-17].

About 5G:

5G wireless mobile communication is currently under research thus has to face number of new patterns and applications. It must be basically Application driven as managing and operating of the network depends upon the specific application it also deals with the QoS polices dictated over the network. As 5G networks are still under research there is a need of developing it more accurately. The basic purpose of 5G is to provide a flexible, manageable, programmable interface to evolve more easily than the traditional networks[2].

As compared to the current commercials the 5G systems will need to deliver about 1000 times capacity till 2020 and beyond. Increased coverage and improved performances are also some characteristics which are included as performance indicators indexes of 5G, with up to 100 times higher user data rates also reliability and availability will be increased to about 99.99% also the electro-magnetic field levels will be lower as compared to LTE with energy savings of about 90% and a reduced latency of less than 1ms. About $12.3 trillion output of the world economy is to be anticipated by 5G till 2035 a number of the 5G market drivers embody the requirements of computer games ,rich media services(i.e. 4K,8K,3D)[3] and varied applications like smart cities, education facilities and public safety.

With associate exponential increase within the network traffic volume 4G will currently be replaced by 5G with a complicated technology Beam Division Multiple Access (BDMA) and Filter Bank Multi Carrier (FBMC) multiple access. Bottom station communication with mobile stations is considered to explain the forge behind the BDMA technique. During communication between the mobile stations antenna beam will be divided using BDMA technique in order to keep locations of mobile stations so as to give multiple accesses to mobile station, that correspondingly increase the effectiveness of the system. The drift from 4G to 5G is due to inefficiency of the 4G networks to meet the six major challenges higher rate, higher capability, lower E2E latency, consistent QoE.

Basic requirements of a 5G mobile wireless communication:

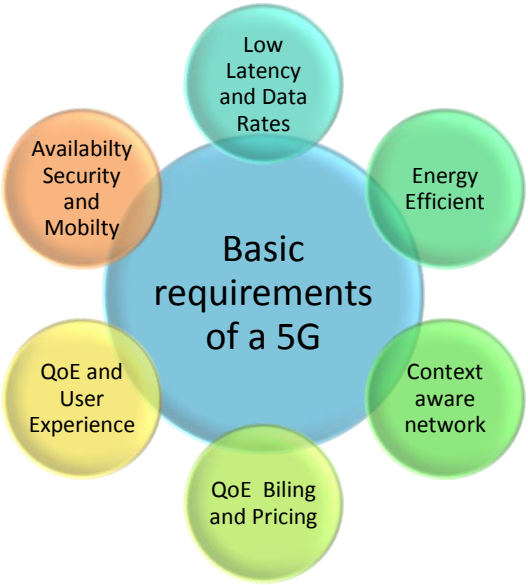

Fig. Basic requirements of a 5G.

Low Latency and Data Rates: The data rates of about 1-10 Gbs are most likely to be provided by the 5G network. The theoretical data rates of 4G LTE networks is Mbps thus, the new provided data rates of 5G is atmost 10 times higher than 4G LTE, due to these data rates are guaranteed with high quality

ISSN: 2233-7857 IJFGCN

services even in crowded areas. These 5G networks are expected to provide 100% convergence connectivity with very low latency time of about 1ms round trip for tactual internet. Due to low latency rates and higher data rate in 5G high definition streaming of videos using VR and other wearable devices based on cloud technologies is easily supported.

Availability, Security and Mobility: As this 5G network is going to be more robust, reliable the security needs also increasing. The M2M/D2D communicating devices with IoT will hold dominance in 5G networks therefore will need high speed connection to internet and enhanced service availability. In order to fulfill demand based mobility on each device and service requirement 5G has to significantly endure the highly centralized mobility management algorithms which are currently being used. The 4G network has limitations for user networks(Encryption and Authentication for billing) For 5G it needs to support new trust models and business with privacy concerns therefore, it needs to be ensured that this 5G network is capable of defending the security attacks like Denial of Service (DoS).

QoE and User Experience: For better user experience consistency has always been a central requirement while delivering service to the customers. Thus to guarantee the users QoE, it should be ensured that the fluctuations in the network quality, performance, interferences should be minimal. It is necessary that 5G should always put efforts to provide services with high Quality of Experience also it should ensure high transparency and hide network complexities.

Context Aware Network: Expansion of IoT applications that involve sensor networks that operates on battery will be acquiring the industry by and beyond 2020. It is possible to deploy these sensor networks provided the regular operations guarantees reduced consumption of energy and a long-lasting battery life by the devices for several years.

QoE Aware Pricing and Billing: Quality of 5G system anticipated by the end user's are strongly related by the end user's are strongly related to the requirements based on QoE service pricing and billing. Well-defined QoE based rules by service providers or billing (charging) policies, services should define the aspects of Quality of Business (QoBiz).

Energy Efficient: High energy consumption and operational costs are some of the factors due to which the base stations (BSs) in 4G LTE are not efficient. These base stations are consuming about 60% to 80% of the whole cellular network energy. While in today's world high quality mobile videos are the most demanding and exhaustive energy consuming services from end user's side.

Network Softwarisation using SDN:

Network Softwarization is an approach which involves the use of software program to design, implement, deploy, manage and maintain network services [3]. The main aim of softwarization of 5G is to achieve greater dexterity and cost-effectiveness. Due to these softwarization techniques used in enhancing 5G networks the Quality of Experience (QoE) is also improved. This 5G era which is still under development needs more technical innovations. The virtualization and softwarization technologies are collectively driving the way of innovations of this era, which enables the operators to manage the network-aware applications as well as application aware networks to meet the business demands.

Softwarization of core networks: Most of the core networks and service planes are designed in such a way that they are likely to be implemented as VNFs that follows the SDN architectural principles. This will make them run in Virtual Machines (VMs) potentially over standard servers enabled on Cloud Computing (CC) environments .These softwarization skills can be used to set up different sites based on specific service requirement.

Softwarization of transport networks: To meet the requirements of 5G RANs programmable transport networks should be implemented in the near future which can be done by SDN programmable interfaces

ISSN: 2233-7857 IJFGCN

here the transport layer allows tightly coupled RAN interactions due to which aspects such as load balancing and mobility are coordinated efficiently.

Programmability aspects of 5G: Due to 5G programmability there is fast, flexible and dynamic deployment of new networks and management services. 5G programmability facilitates the creation of 5G ecosystems which benefits distinct management and control lanes by utilizing open Software Development Kit(SDK) and Application Programming Interface (API)

Software Defined Networks (SDN):

Software Defined Networks (SDN) facilitates a paradigm shift in networks through the ideas of programmable network infrastructure. Software Defined Networks is an approach that brings intelligent and flexible and programmable 5G networks effective of orchestrating and controlling services. The separation of control plane and forwarding plane provides flexibility in managing network resources and it helps to control entire network centrally. SDN has the potential of simplification and management of network resources. Even cellular operators are benefited with SDN due to reduced operational costs through a programmable interface. The control plane represents centralized controller which maintains network wide dynamics and management. Controller maintains intelligence of the entire network on the other hand flow forwarding and routing is carried out by data plane[17]. SDN controller consists of two different interfaces Southbound Interface and Northbound Interface out of which Southbound interface works with the infrastructure layer or infrastructure of the network whereas the Northbound interface deals with the Management and orchestration layer, it also handles the cloud interactions. According to the REST API's (Representational State Transfer- Application Programming Interface) the most standardized interface in all SDN controllers is the Northbound Interface. The southbound interface always works specifically as per the vendor's implementation. Some vendors use open principles based conventions like BGP, Netconf, OpenFlow and so forth, while others utilize restrictive interfaces.

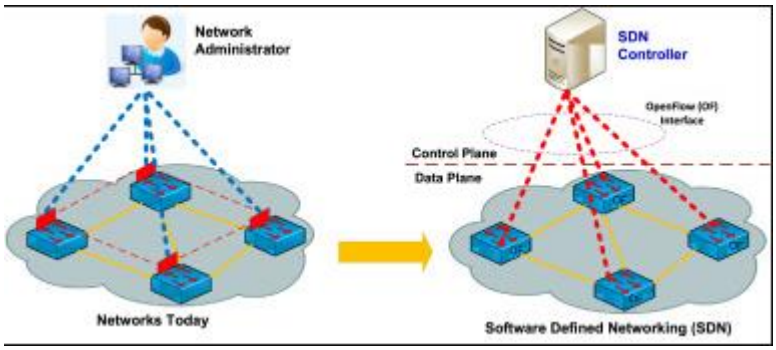

Fig.2 Networks today VS Software Defined Networks (SDN)

The above figure shows how SDN a virtualized control plane is created by the SDN that implements management and decision making amongst network functions and bridges the void between network management and service maintenance.. With SDN network becomes directly programmable using Southbound Interface [2], OpenFlow [2], FoRCES [2], and OpFlex [2]. These standards between forwarding devices in the data plane (which can be implemented onto community server such as VMware's NSX platform which consists of a controller and a switch and elements in the control and management plane. The organizations like Software Defined Networks Research Group (SDNRG) of IRTF and IETF has a realization about the , potential of SDN thus the requirements, architectural components and interfaces for 5G networks are already defined. It is strictly implemented on the requirements, demands of the network. The limitations of traditional networks will be addressed by SDNs the SDN controller facilitates both the creation and installation, it creates the client-server contexts and installs their associated policies. In particular a network slice client context is maintained by the SDN controller therefore, it grants the SDN controller the management of network slices dynamically. This is done by grouping slices of similar context resource orchestration on server context and governing the slices are

ISSN: 2233-7857 IJFGCN

also some of the functionalities performed by the controller. The client context consists of virtual resources, support in order to satisfy any incoming requests from end users.

In SDN architecture, an OpenFlow protocol is the protocol that allows the server to notify the network switches the location where the packets are to be sent. It is a means of communication between switch and controllers. OpenFlow defines the messages, data structures, procedures to describe physical and logical elements of the network. In conventional networks high-level routing and packet forwarding occur on same device. An OpenFlow switch has the basic functionality to separate the control path from the data path[16]. The controller communicates with OpenFlow switches using OpenFlow protocol running over Secure Socket Level (SSL) in order to resolve security related problems to SDN based mobile networks. SDN provides several levels of security services such as access control, authentication, confidentiality and data integrity [12] . SDN enhances the security of 5G mobile networks. As the next 5G networks will be needed to be more flexible, programmable. Therefore the 5G core networks should be cloud based [11] .

Basic features of Software Defined Networks (SDN):

- Most basic yet an important feature of Software Defined Networks is the Plane Separation i.e. separation of forwarding plane and control plane. Forwarding functionality includes tables and logic to choose the way to deal with incoming packets based on the IP address, MAC address and VLAN ID that resides in data plane. The control plane deals with the how the forwarding tables and logic in data plane should be configured or programmed.
- Simplification of Devices and Centralized control is another feature of SDN due to which simplified devices are controlled by a centralized system which manages all the devices in the network.
- Openness: The characteristic of openness of SDN states that the interfaces should always remain definitive, shared (not proprietary) well documented. The outlined APIs should provide software sufficient control for experimenting and various options to control the control plane. Currently the researchers are assuming that by keeping the southbound and northbound interfaces open will allow new innovations for network operation.
- Due to a programmable control interface through controllers network intelligence with higher dynamic control of 5G devices SDN controllers incorporate with several OpenFlow devices.
- Network resources are dynamically configured managed and optimized by the network operators. SDN allows complete virtualized networking, secure cloud services, on demand resource allocation, self-service provisioning, evolving a static network into a flexible service delivery platform which would respond to changes easily and quickly.
- SDN creates a network which does not require any designing or implementation from administrators' side so as to implement fully automated implementation so that it is easy for the administrators to manage the networks through the controller's plane easily.

Advantages/Benefits of SDN implementation of 5G:

- Automated Administration: Due to centralized control, intelligent and programmable platform it is easier to identify changes and implement them dynamically.
- SDN is the main driver of innovations of this 5G era it improves usage of wireless resources and improves user satisfaction and Quality of Experience (QoE) of the end users.
- Providing Quality of Service requirements for 5G applications have potential to address Quality of Service parameters for each type of data flow.
- SDN is a key technology for the Quality of Experience management.
- Flexibility, programmable platform, complete centralized intelligent control, session management, resource sharing helps into decision making support.
- SDN makes it easier to deploy and introduce new applications and services than the classical hardware dependent standards [10].

ISSN: 2233-7857 IJFGCN

- Using SDN standards in 5G cellular networks is beneficial due to effective radio resource allocation through a centralized common plane.
- As SDN achieves a Vendor Neutrality it is also beneficial in implementation of SDN into 5G as the operational costs due to the specialized hardware are reduced and also the tasks are centralized and automated which in turn reduces the operational costs.

Challenges in implementation of SDN and 5G:

Main challenges of SDN implementations with 5G are to provide Quality of Services performances and user satisfaction with OpenFlow controller.

The controller will have capabilities to collect Quality of Service information and will be able to automate, script, and program 5G devices to achieve higher Quality of Service with less cost.

Related Works of SDN:

In these recent years there has been growing interest in 5G due the increasing demand from the user's side, the researchers are also interested to research on Software Defined Networks (SDN) because of its profits. The fundamental role of SDN in 5G mobile networks is to address the challenging issues which are currently faced. Efforts from many researchers have pointed towards the importance of SDN in 5G mobile networks

The primitive definition for SDN and 5G networks has been discussed in various previous works by the authors of papers [1-12]. It puts up for the implication for SDN in 5G mobile networks and proposes certain facts so forth

The Authors approach in[3] paper was focused on the network programmability that offer the possibility of creation of virtual private networks and splitting control and data plane various aspects of the same are discussed by the author throughout the paper and challenges and the role of SDN to address these challenges such that high data rates, Quality of Service (QoS) [7] and Quality of Experience (QoE)[7] of the end users are also discussed.

The authors of paper[6] has discussed about the fundamental architecture of SDN and analyzed the integration and application of this architecture into the next 5G mobile networks the authors have summarized the architectural agility that has been achieved with SDN and 5G.

The authors of paper[7] has studied the current situation of 5G research along with role of network softwarization and the challenges that are to be faced by the new 5G mobile networks, the authors have emphasized on the SDN technology and analyzed the issues faced in correlation with 5G.

As discussed by the authors of paper [11] by emerging 5G networks the need to provide security has also came into picture after a overall study of 5G mobile networks with the traditional 4G networks. A summary of the security services has been given by the author. Different technologies like SDN, Internet of Things (IoT), have lead to the new research in the field of 5G mobile networks which is explained in brief in the above paper.

Along the researches various advantageous factors of SDN and 5G mobile networks and the implementation are addressed by the authors of papers [2,3,7,9] .

Conclusion:

As the topic 5G networks is still under research and researchers are in search of a reliant and faster base for their researches on the other side both industry and academia are grasping Software Defined Networks(SDN) to overcome the challenges such as management and orchestration of resources in order to meet the user requirements. In this paper, we have given a brief idea about 5G networks and

ISSN: 2233-7857 IJFGCN

the Network Softwarization of SDN with basic requirement of 5G wireless communication. With a short description of Software Defined Networks(SDN) and some basic features about SDN With advantages of implementations of SDN for 5G with some challenges faced in implementation of SDN and 5G.

References:

[1] Marcin Markowski ; Przemysław Ryba ; Karol Puchała " Software Defined Networking research laboratory – experimental topologies and scenarios" 2016

[2] A. Gupta ; R. K. Jha "A Survey of 5G Network: Architecture and Emerging Technologies" 2015

[3] Alcardo Alex Barakabitze[a] Arslan Ahmad [b]Rashid Mijumbi [c]Andrew Hines "5G network slicing using SDN and NFV:A survey of taxonomy, architectures" 2017

[4] Muhammad Nauman Irshad ; Liping Du ; Imran Ali Khoso ; Talha Bin Javed ; Muhammad Muzamil Aslam **"**A Hybrid Solution of SDN Architecture for 5G Mobile Communication to Improve Data Rate Transmission**" 2019**

[5] Abdulrahman Almohaimeed ; Abu Asaduzzaman "Dedicated Backup Units to Alleviate Overload on SDN Controllers" 2019

[6] Magri Hicham 1 *, Noureddine Abghour 2, Mohammed Ouzzif 1 **"**5G mobile networks based on SDN concepts"

[7] BegoBlanco[a] JoseOscarFajardo[a] IoannisGiannoulakis[b] EmmanouilKafetzakis[c] ShupingPeng[d] JordiPérez-Romero[e] IrenaTrajkovska[f] Pouria S.Khodashenas[g] LeonardoGoratti[h] MichelePaolino[i] EvangelosSfakianakis[j] FidelLiberal[a] GeorgeXilouris[k] 'Technology pillars in the architecture of future 5G mobile networks: NFV, MEC and SDN".

[8] Maede Zolanvari "SDN for 5G".

[9] Amit Puri, Manjari Sharma, Ramesh Padmanabhan https://www.wipro.com/en-IN/infrastructure/sdn-adoption-in-enterprises/"

[10] Oracevic, Alma & Dilek, Selma & Ozdemir, Suat. (2017) "Security in Internet of Things: A Survey."

[11] S. P. Bendale and J. Rajesh Prasad, "Security Threats and Challenges in Future Mobile Wireless Networks," 2018 IEEE Global Conference on Wireless Computing and Networking (GCWCN), Lonavala, India, 2018, pp. 146-150.

[12] Shailesh Pramod Bendale, Jayashree Rajesh Prasad "challenges in design of intelligent and secure SDN", SITSFIST 2020

[13] Siddhant Shah and Shailesh Bendale, "An Intuitive Study: Intrusion Detection Systems and Anomalies, How AI can be used as a tool to enable the majority, in 5G era.",IEEE ICCUBEA (2019).

[14] Shailesh P. Bendale ; Girish V. Chowdhary," Stable path selection and safe backup routing for Optical Border Gateway Protocol (OBGP) and Extended Optical Border Gateway Protocol (OBGP+)", IEEE ICCICT , 2012.

[15] A S Patil, P S Jain, R G Ram, V N Vayachal, S P Bendale," Detection of Distributed Denial-of-Service (DDoS) Attack on Software Defined Network (SDN)",- IRJET 2018

[16] A S Patil, P S Jain, R G Ram, V N Vayachal, S P Bendale, "Software Defined Network: DDoS Attack Detection", — IRJET 2019

[17] Chinmay Dharmadhikari, Salil Kulkarni, Swarali Temkar, Shailesh Bendale," A Study of DDoS Attacks in Software Defined Networks", - - IRJET 2019.

ISSN: 2233-7857 IJFGCN

[18]Dhumane, A., & Prasad, R. (2015). Routing challenges in internet of things. CSI Communications.
[19] Dhumane, A. V., Prasad, R. S., & Prasad, J. R. (2017). An optimal routing algorithm for internet of things enabling technologies. International Journal of Rough Sets and Data Analysis, 4(3), 1–16.

ISSN: 2233-7857 IJFGCN