A survey on Software Defined Networking based on Cognitive Radio Networks

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Abstract:-Traffic Engineering (TE) and Security are the most wide topics for applications based on SDN in the fields of industrial environments. It is a very important concept which relates to cognitive network systems, where the aim is to study control real-time network traffic. When cognitive radio networks are designed, much care is needed to safeguard the transmissions of primary consumers so that their quality of service (QoS) is not infected by the transmissions of secondary users. Traffic engineering is also used for designing various routing techniques for scheduling and controlling network traffic used for improving utilization of network resources, or requirements of the control management and network Quality of Service (QoS) in CRN. This is the survey paper in which traffic engineering and optimization to improve the performance of TE under CRN has been discussed. The cost effective measurements and management used in SDN has also been presented in this paper. Various approaches used for Quality of service in SDN and infrastructure based cognitive radio networks has been the part of the review.

Keywords: *SDN, QOS, TE, H-SDN, Radio cognitive networks.*

I. INTRODUCTION

In the area of industrial environments, Security [9] and Traffic Engineering both are the research topics used for applications in SDN. The main aim of traffic engineering (TE) in a network is to maintain and handle the traffic so that it can travel from sources to their destinations. In in this paper main focus is on the TE problem of SDN. SDN is a paradigm that separates the control plane and data plane. The advantages of SDN are that it can simplify the network management so that new functions can be easily controlled without physical access to the network switches. TE is one of the main applications which relates to network systems. Designing routing mechanisms for scheduling and guiding the network traffic to improve utilization of network resources, or better meet requirements of the network Quality of Service (QoS).

CRAHN: Cognitive radio network (CRN) is one of a widely used wireless communication network of CRs, in which the network is used for improving the end-to-end performance of the system by reconfiguring its various parameters. There are two types of users in CRN, primary and secondary user [14]. Primary User, also called as the primary service licensed user, have the full rights on the radio spectrum. Where as Secondary User (SU) are the secondary service or we can call them unlicensed user, which are also known as the cognitive user, which help in utilizing the free spectrum and have to vacate the spectrum band as early as the PU appears to them. Mostly in CR system, the secondary user tries to seek the opportunity for using free radio spectrum mostly when the primary user is not active [15]. Cognitive Users are allowed to use the licensed spectrum for a given time and location only when Primary user is idle [16]. So in CRN, the Secondary User can use the spectrum temporarily, that help in making Secondary User more important component in CRN architecture [17]. For a particular area, the locations of the primary users and information regarding the usage of spectrum used in CRN. Such information is obtained through spectrum database or by sensing spectrum [19]. The database can help in providing detailed radio environment map with additional features like quality of the channels and all. CR can ask queries to spectrum database regarding availability of spectrum [10]. On the other side, when there is a lack of spectrum database, sensing through spectrum can be invoked into CR. CR helps in allocating the channels for communication. However, this allocation mostly depends on internal and external policies, both [12]. Addtionally, it may be possible that many CRs concurrently try to access the spectrum, where coordination between the radios is needed for avoiding the collision in portions of overlapping on the

spectrum [13]. So choosing the best channel within the unoccupied channels for communication is one of the main task in spectrum sharing [18].

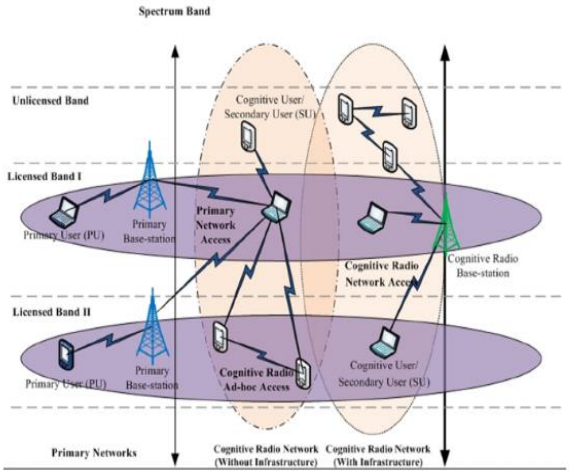

Figure1: Cognitive radio networks

II. TRAFFIC ENGINEERING (TE)

The main aim of traffic engineering [4] in a network is to maintain and handle the traffic so that it can travel from sources to their destinations. Thus, path from the source to destination and splitting flow among path(s) for all flows in the network is required. A source-destination pair is the identification of a flow. A source destination pair is called as a commodity. The multi-commodity flow problem while considering limited capacity of network links, the demand for multiple commodities must be satisfied simultaneously.

Hamid Farmanbar, et.al, (2015) has presented a SDRAN TE problem into a wired network, by introducing a cross layer solution and alternating the direction of multipliers is being used for user problem scheduling.

Jun He, et.al, (2015) has described a traffic engineering (TE) in H-SDN where SDN traffic is strategically routes by SDN controller that helps in optimizing TE performance over all network links shared with uncontrollable conventional traffic. The barrier and hybrid modes are studied where in separated capacity spaces two forms of traffic are routed and other form of traffic is fully occupied by each link in case of hybrid mode.

III. SOFTWARE DEFINED NETWORK (SDN)

SDN is a paradigm that separates the control plane and data plane. The advantages of SDN are that it can simplify the network management so that new functions can be easily controlled without physical access to the network switches. For backbone and data center network, SDN is becoming the important technology behind many traffic engineering solutions [1].

Main characteristics of SDN are discussed below:

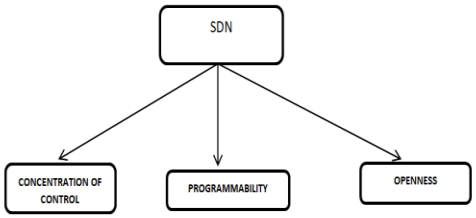

Figure 2: Software defined network

A. Concentration of control: SDN controller help in saving the full network data which may include network topology and application requirements, dynamic changes of the network status like security requirements and QoS [26].

B. Programmability: Network operator in this can program independently and can manage the data forwarding layer devices for providing the location of network resources [28].

C. Openness: A unique interface is being used for forwarding the equipment for the communication with SDN controller and the SDN controller can have access to the network status data for managing the network traffic.

1) Framework for TE in the SDN is discussed below. Fig 3 shows the various components of the framework of the TE in the SDN.

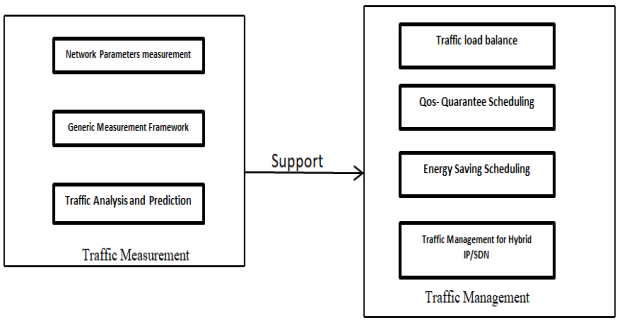

Figure 3: Framework for TE in SDN.

Traffic management and Traffic measurement are the main parts of SDN. The work of Traffic measurement is for monitoring, measuring and acquiring the network status information in the SDN environment. The network status information may contain the end-to-end network latency, current topology connection status, various kinds of packet counters, dropped packet counters, end-to-end traffic matrices and utilization ratios of link bandwidths so on [22]. Depending on this network status information, one can check the status of current networks, whether it is correct or not, and can assume the future traffic trend by checking packet counter statistics, to get rid of network congestions and increase network efficiency. The main work of traffic engineering (TE) in a network is for maintaining and handling the traffic so that one can travel easier from the sources to the destinations. The path from the source to destination and dividing the flow among path for all flows in the network is required [21]. A source-destination pair is the identification to a flow. A source destination pair is known as a commodity. The multi-commodity flow problem while considering limited capacity of network links, the demand for multiple commodities must be satisfied simultaneously.

A. Cost Effective Measurements For SDN

Kuljeet Kaur, et. al, (2018) has presented with a scalable and programmable network paradigm SDN which helps in taking care of these existing problem domains. Multi-objective evolutionary algorithm has been proposed using Tchebycheff decomposition for getting the routing in SDN and flow scheduling.

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Klaus-Tycho Foerster, et. al, (2017) presented it for computing fast network update schedules which help to minimize the number of interactions among various controller and network nodes. Generally this problem is difficult and but can be over come by showing that the relaxed loop-freedom admits for much shorter update schedules and is presented as a new scheduling algorithm which requires very less number of rounds.

2) Traffic Measurement in SDN

Traffic measurement is one of the research branch of TE. The three aspects of TE are as discussed below.

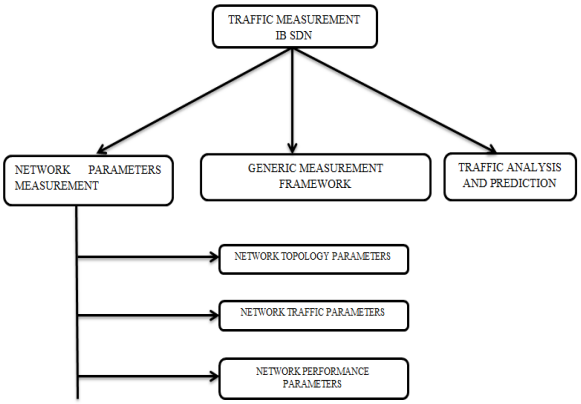

Figure 4: Traffic measurement in SDN

a) *Network parameters measurement:*-Network parameters are used for representing the current network status and are used for designing the effective network management. So the primary task of network measurement is of a network parameter design. There are 3 types of SDN network measurement parameters which are network topology parameters, network traffic parameters and network performance parameters.

b) *Generic measurement framework :*-Two typical modes of Network traffic measurement are Active and passive modes. The passive measurement mode only helps in monitoring the traffic which passes along SDN switches whereas the active mode help in providing extra detecting traffic. Traffic monitoring is a method of traditional IP networks, which is based on packet sampling, which is adopted by many SDN measurement systems. NetFlow developed by Cisco is a famous system for packet sampling and analysis [25].

c) *Traffic analysis and prediction :*-Traffic analysis and prediction is one of the parts of network measurement and distinguishing the network anomalous traffic is one of the major aims and to check possible contingencies in the network, such network congestions. In such a way a

better data for network traffic scheduling and management can be associated. Another important thing is to check whether the current status of the network is true or not.

3) Traffic Management in SDN

Network management mainly focuses on managing the network availability and help to increase the network performance. In general, the destination and the source node in the SDN may contain multiple paths, which may results in traffic scheduling. Traffic management technologies used in the SDN have following terms that are discussedbelow.

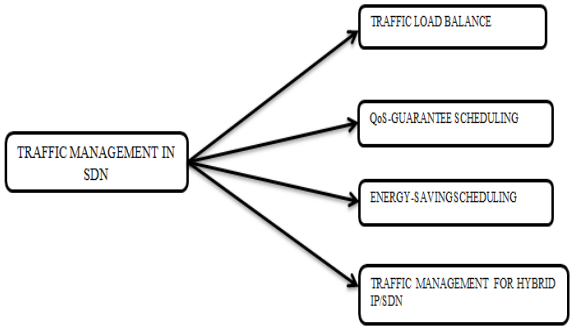

Figure 5: A Traffic management system

1) *Traffic load balance :*-SDN contains 2 types of network traffic, data layer traffic and control layer. Forwarding decision calculations are centralized in load balancing in SDN and not distributed, considering multiple optional link utilization rates and flow characteristics more comprehensively, to make the method of load balancing better.
2) *QoS-guarantee scheduling*:-The main problem of traffic management is reasonable scheduling of network resources to give QoS for business. The SDN help in providing the an open control interface for handling the flexible network traffic scheduling approaches, that can manage QoS requirements of various network applications.
3) *Energy-saving scheduling*:-Reduction of energy consumption has become a major issue in today's technology. In developed countries, the energy consumption network gets for 5% of all energy consumption, and the annual rate of 10% [28, 29]. Therefore a down fall in network energy consumption is meaningful. The main consumers of energy are the servers currently, with the minimum research in resolving the problem of energy consumption [11].
d) *Traffic management for hybrid IP/SDN* :-In network optimization SDN-based Traffic Engeering technologies help in providing the most effective solutions. Not every node of an IP/SDN hybrid network has functions of an SDN switch, partially only an accurate global view of the network is obtained. The IP/SDN hybrid network is more complicated as compared to pure SDN.

IV. QOS IN CRN

Quality of service may be defined as the ability of the system for providing the guarantee for the assuring level of service. This may consist of the latency, the service response time and the signal-to-noise ratio, etc. In a traditional wireless network, all devices are provided with equal priority and access. So, if the total demand for the traffic from overall nodes in the system increases the available bandwidth, then the traffic throughput from all the nodes are equally reduced [22]. The impact of it, on user experience is totally depending on the type of application. For example, in web browsing a delay in loading a page will not bother the user, but if the delay is experienced during a Video call, the user will get annoyed. To avoid such problems, traffic from various applications need to be managed and prioritized on the basis of QoS.

The IPv4 network, supports a level of prioritization of traffic using Type of Service field in the IP header. But this field is now replaced by Differentiated Service Code Point field, which help in supporting more priority levels than that of Type of Service. Same path is provided for QoS support in Wi-Fi network by Wi-Fi Multimedia (WMM) [11]. The system has to accomplish the task of Channel Selection, Spectrum Sensing and Spectrum Sharing [14] for a cognitive radio to work properly. Spectrum sensing takes detecting unused spaces in the primary bands, channel selection and spectrum sharing. A Lot of work has been done on spectrum sensing techniques [16] and all they may require the cooperation among secondary users to avoid false alarms [19].

Software defined networking (SDN) one of the suitable approach that allows administrators for providing the network services by abstraction of functionality of low-level network [11]. In the SDN model, both the control and the data plane are separated. A standard for communication between the 2 planes is done through openflow. In the technology of big data, different applications, like online interactive gaming and video on demand, depicts much about the quality of service (QoS) which is a needed requirement at latency, error rate, bandwidth and so on. QoS has become one of the growing and the hot topic for architecture in SDN. The network traffic, mostly takes up the shortest path with the help of internal and

external routing protocols So, there is an emergency need for novel methods to improve QoS in SDN.

V. COGNITIVE RADIO TECHNOLOGY

In past years a tremendous growth is made in the use of wireless devices like laptops, smart and tablets. Especially in vast wireless technologies like Wi-Fi suffers a lot issues based on their performance due to lack of free radio spectrum, which in return results in high interference and contention from both the sources i.e Wi-Fi or non-Wi-Fi.

One of the promising approach used these days is cognitive Radio (CR) which help in overcoming of such spectrum crisis by throwing light on the fact that irrespective of static spectrum allocation, in which government sector gives wireless spectrum to license holders on the term of a large number of frequency bands have considerable temporary, large geographical regions, leading to underutilization of a significant amount of spectrum [10].

Cognitive radio technology is one of the most promising technologies, which helps in enabling a CRAHN for using the spectrum in a dynamic manner. The cognitive radio can be defined as [18]:- A ‘‘Cognitive Radio” is a radio that changes its parameters which is based on interaction among the environment in which it operated.

From the definition, two main characteristics of the cognitive radio come up, which is discussed as under [32,30]

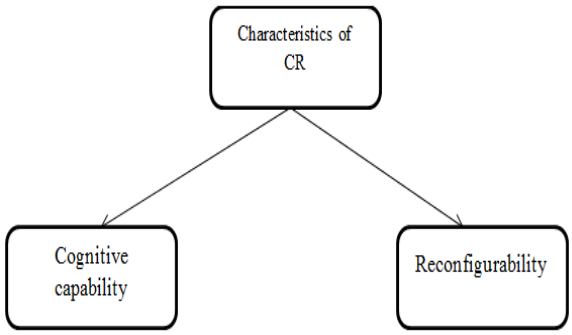

Figure 7: Characteristics of Cognitive radio networks.

1) *Cognitive capability*: It defines to the ability of the radio technology for capturing and sensing the information from the radio environment. This type of capability cannot be done by just monitoring the frequency bands of our interest, but more wide techniques like action decision and autonomous learning are being used in order for capturing the temporal and spatial variations in the radio environment and also help in avoiding the interference between other users.
2) *Reconfigurability*: The cognitive capability helps in providing the spectrum with the awareness, whereas Reconfigurability helps in providing dynamic programming according to the radio environment. More importantly, the cognitive radio can be worked for transmitting and receiving a variety of frequencies [13].

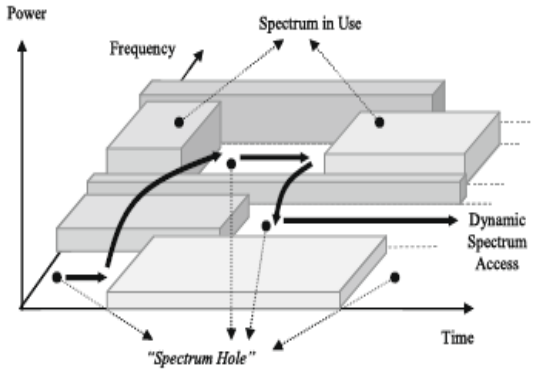

Figure 8: Reconfigurability[33]

The main underlying objective of the cognitive radio is to attain the best spectrum available through reconfigurability and cognitive capability as described before. Since most of the spectrum is being assigned earlier, the important challenge among them is to share the licensed spectrum without interfering with the transmission of other licensed users as illustrated in Figure above.

Infrastructure Based Cognitive Radio Network

Ian F. Akyildiz, et.al, (2009) Presented a CRAHNs intrinsic properties and existing challenges**.** The Software defined Networking (SDN) has also been used. In most of the case CRN deployments interference is worked and managed by using cloud computing and SDN together.

Anatolij Zubow, et.al, (2015) Proposed a new CR, which has SDN based architecture in which Spectrum Broker and centralized controller based cloud takes over spectrum assignment to CR Base Stations. The wireless statistics are aggregated to the SB under CR-BSs control report, in the network of CRN traffic conditions and up to date information is drained by SB controller with the help of configuring proper rules in Open Flow-enabled CR-BSs.

VI. CONCLUSION AND FUTURE WORK

Traffic analysis is a major part of network measurement and to distinguish network anomalous traffic is one of their goals

which may be a better way for network traffic scheduling and management. Another important objective is to check whether the current status of the network is true, such as correctness of current network equipment configurations, routing loop problems, etc. Traffic measurement and traffic management are the two main parts of SDN. The main work of Traffic measurement is to monitor, measure and acquire network status information in the SDN environment. The network status information includes the current topology connection status, utilization ratios of link bandwidths, various kinds of packet counters, dropped packet counters, end-to-end network latency, end-to-end traffic matrices and so on. Based on the network status information, we can check the status of current networks, whether it is correct or not and can assume the future traffic trend by checking packet counters statistics, to get rid of network congestions and increase network efficiency.

In the future the author will deal with the balancing of the multipath flows for the traffic engineering using cognitive radio network. Due to the multipath flows there is a chance of congestions and overhead that results in high energy consumption and will achieve the high load which is not the best solution. So an optimize approach will be needed using optimization to get low energy consumption of the nodes and the centralized unit with correct routing with the route having less load in the SDN network. This will result in an achievement of high quality of service.

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