Load Balancing in Software Defined Networking: A Review

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Abstract: Software Defined Networking is an adaptable way of networking, which disconnects data forwarding plane and control-plane of system equipment's and also solves issues in existing network infrastructure. More specifically, the control-plane of software defined network decides the advancing way of network flow with Centralized Control Manner (CCM). SDN (Software Defined Networking) is a strategy for making, planning and overseeing systems which intend to change this present unfortunate circumstance. It has been used in dissimilar areas, like a campus networks and data center systems. In this survey paper, we've reviewed the concept of (SDNs) Software Defined Networks, its architecture and applications. In the survey, it h as been found that SDN load balancing has become more smart and efficient and reduces the statistic collection overhead and maintain better QoS (Quality of Service) data rates. In addition, we reviewed the direct routing based algorithms of Load Balancer and compare with Round Robin Strategy. Furthermore, we've reviewed and compared the existing work to get better idea about the concept of Load balancing.
Keywords: Software Defined Networking, CCM (Central Control Manner), Data center systems and QoS (Quality of Services)

I. INTRODUCTION

Today internet applications requires fast networking which causes large amount of traffic and deploys number of distinct ,dynamic applications and services. This management makes network highly complex and is more difficult for the network administrator to handle concepts like network virtualization also interchangeable data is added [1]. The configuration and installation of the network demands skilled personnel. The interactions between network nodes (like switches, routers) are complicated. System based approaches requires simulation of elements but due to programming interfaces it is difficult to access [2].

In SDN (Software Defined Network), controller plays important role to improve the control plane and monitor the behavior of network as supervisor provides software interfaces of system and maintenance of global viewpoint of network**.** In this manner new functions and management job can be done by the several applications. Data plane forwards conventional flows allowing to the protocols resulting from the supervisor and restrictions are put by the controller on all flow through consecutively of user-defined control requests. Benefits of software defined network are lost due to the failure of controller in the network [3]. The information travels from one place to another in the form of digital packets from the router and switches through

distributed control and protocol of transport network. It is not easy to maintain older IP (Internet Protocol) networks as they are complicated but used widely. By parting of the networks switch plane from the system equipment's which are answerable for the furthering of the system, vertical integration is break down. [1]

A. Characteristics of SDN

The features of software defined network are Separating switch plane after data-plane, network view, central supervisor, open boundaries between the equipment and network program ability [2]. System devices include control plane and data plane that decide how network traffic is handled, and traffic forwarding according to the control plane decision respectively [1]. Communication network is made up of end users, hosts connected by the infrastructure of network and hosts share the infrastructure and use routers, communication links, and switches to carry data [5].

B. SDN Architecture

SDN (software defined network) has three layered architecture comprised of Control layer and Data forwarding layer, the application layer shown in fig .1.
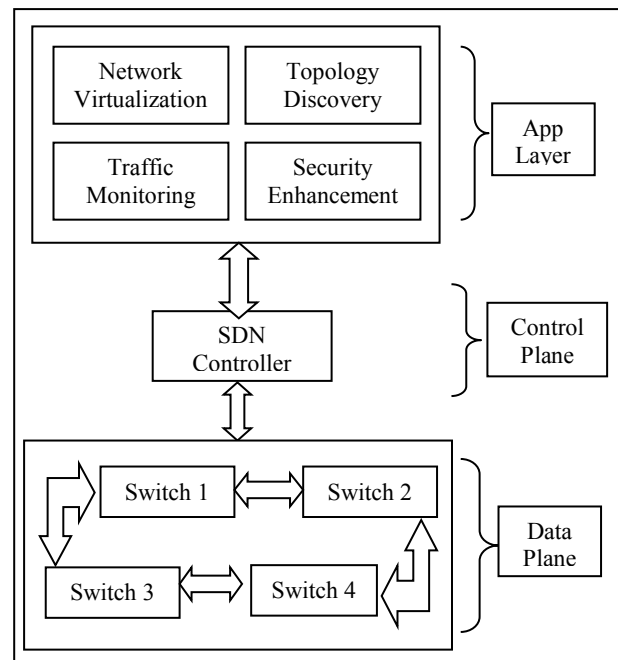

Fig. 1 SDN Architecture [9]

C. Controller

Plane of data is interconnected forwarding systems in network environment and connected by wireless radio channels or wired cables while control plane can be called as brain of the network as it has control logic. Southbound Application Programming Interface is a usual of instructions for the forward devices that is part of southbound interface. It also defines the protocol for communicating forward devices and elements of control planes. While northbound API (Application Programming Interface) is given to application layer by network working framework. This interface is recycled to application development. Separations of control-plane and data-plane are the main advantage of software defined network (SDN) that enables the centralized control. It makes system organization (which is reasonably central in the control-plane) simple while program ability of networks enables the innovations. Packet transferring and Packet dispensation methods is done by device of the network which are present in the data plane and requires programming by applications through interfaces (some northbound and southbound) example Open Flow [3].

II. APPLICATIONS OF SDN IN LOAD BALANCING

These are used, they distribute the incoming load to the several servers, to protect single server from overloading.

1. Network virtualization secures physical network and separates the network into many components. When new software component is added, network virtualization improves speed and automation of the network.
2. Topology discovery is service that is allotted by the SDN controller. It provides and maintains a global view of network.
3. Traffic monitoring provides the required data to alert the derivers regarding problems and statistics essential to road engineers like vehicle count, speed, occupancy, etc.
4. Security enhancement is the improvement of security abilities and offerings beyond the basic specification.

A. *Load balancing*

Load balancing works as an aware routing protocol in (SDN) software defined networking, it is a necessary entity that assists the availability and scalability that leads to obtain the minimal response time of application. Millions of peoples are connected with the internet which causes web traffic that conduct network congestion and losses packets. So, to solve this problem Load balancing techniques method increases the network efficiency [6].

Present framework method of balance the load isn't useful aimed at the framework of Software Defined Network (SDN), where the main station or manager of network basics is completed by programs. To manage the load of server is easy which is connected to the controller of the

framework. But various criteria for server management are required to balance the load for servers on SDN (software defined network) network [7].The workload is divided into CPU, or describes, computer cluster, network link or computer. In load balancing process the inbound IP(internet protocol) traffic can be divided into multiple servers, is also improve the working capacity of servers. It forwards the request of the client to the backend servers and gets replies from servers, which it replies to the client. It also helps the clients from connecting directly to the backend servers which secure the structure of internal network and prevents from attack on the network [8].
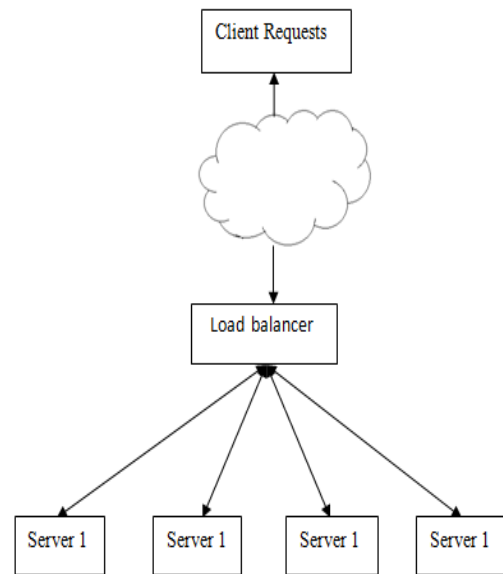

Fig. 2 Load balancing architecture

Load balancing technique maximizing the throughput and minimizing the interval of response time and reducing the jam. The traditional networks of load balancing method haven't detailed but Software Defined Networks are much efficient with high performance. According to the industrial concerns the issue in load balancing the most important issues in software defined network connected research. The balance load is a constituent of software defined network manager, which is situated in a reasonable central-point of choice and methods could be connected on it. The load balancing can implement in physical equipment or in software. It has different methods like still, lively or grouping of both. In these methods the user cannot be predicted as the rules are specifically customized in stack balancer. The static load is adjusting strategy can be in-productive in a system on the other hand the vigorous method are additional effective as the load is distributed dynamically [9].

III. RELATED WORK

In this section, various papers study software defined network in load balancing. In these paper found that the various issues in software defined network to overload the

information in the network. To overcome the load in the software network studied various optimization approach used.

Sukhveer Kaur *et al.,* [10] introduced an SDN application for executing server load balancing. The basic idea of SDN consists of logical centralized network control in SDN controller. To solve the issue of unnecessary latency they implemented direct routing based load balancing algorithm.

Mu Sub *et al.,* [5] proposed a two LVS based technique to decrease the problem of over-head of the supervisors and forward loop, and to reduce controller synchronization. When load of a server exceeds an amount more than the threshold the LVS handles the synchronization state. Min

Luo *et al.* [11] proposed PTAA that can erase the problem of balancing in a way of effective parallel. Addressed load balancing of in band manage rush and evaluated the performance confirmation of demonstrating communication of PTAA with least eighty percent delay reduction through an approach which is fast and had low complexity. The location of the controller is additional used for the finding the optimize network end to end delay.

D. Perepelkin *et al.* [12] developed software application and visualized design environment in software defined networking with quality of service. The paper has focused on set pavement of reserved routes that are set accordingly to the indicator of QoS and paved route based on paired shifting with balance the load. Giving to the indicators of way difference the alignment and optimization of load is done.

V. Byshov *et al.,* [13] has dynamic load balance algorithm with quality of service. The parts of links that are loaded and network routes are balanced.

S. Attarha *et al.,* [14] to avoid the over utilization of link in the environment of software defined networking proposed an efficient algorithm. The manager is accountable for the monitoring the condition of the system and decide switches to be used occasionally. The new flow is routed towards the possible shortest path but in case the path is not blocked with traffic otherwise controller find a back-up path. To resolve the issue of traffic overloading the algorithm selects the lowest possible number of flows and if not they are directed to the backup paths.

U. Mahlab *et al.,* [15] proposed a strategy called discontinuity aware load adjusting for optical systems that upgrade the heap dissemination over the system. The localization minimizes cost for the new link development. To measure load imbalance, proposed entropy based metric.

P. Wang *et al.,* [16] considered the size of flow table; capacity of data link with packet in message load, study has been conducted on the control link problem of load balancing.

C. Yu *et al.,* [17] has stated software defined networking architecture that is center based and a new technique for load balancing. Dijkstas and Q-learning based are simple than the DNQ which is more complex than two. To optimize the interval of time for path re-selection the center based architecture will store suboptimal paths.

HeejuneAhn *et al.,* [18] by proposed algorithms, topological based filtering rules to set up and maintain stage and the three layered structure in switch-flow benches and Flow Tracker could reduce the challenges in an important level. For the dynamic control of the firewall, the delay and overload are inherent.

HongliXu *et al.* [19] on the software defined networking test bed the proposed partial statistical collection and the re0routing methods are implemented on it.

Anil Kumar Rangisetti *et al.* [20] proposed a QALB algorithm that is centralized so that load unbalancing in the network and improve the quality of service for GBR USE.

Lin Mao *et al.* [21] analyzed the benefits of Software Define Network in production with load balancing in cloud computing, Quality of Services assurance and multi-manner deployment, and suggest an examination leaning load adjusting mechanical assembly in Software Defined Network. Objective at the issue of load lopsidedness in partitioned administrator, a heap mindful development relies upon stack detecting is proposed.

D. Li *et al.,* [22] developed an efficient migration model based on greedy model that can use to tradeoff cost between migration and load balance rate.

HongliXu *et al.,* [23] proposed a technique called TRPS (tag based protocol placement) used aimed at the wild-card direction-finding. The results of TRPS and HR, JPT evaluated with other wild card direction-finding and hybrid routing has been shown higher efficiency.

IV. COMPARISON TABLE

Table I describes various methods, advantages, limitations and performance parameters of previous researches. In this survey paper, we've studied various methods of SDN in load balancing POX open flow controller and Load tester and Web server.

V. CONCLUSION

With the usage of internet by so many people, the network is congested by traffic of data. The congestion of traffic put pressure on the network infrastructure. So load balancing is essential component that can erase burden from the network. Load balancing finds the shorter path to communicate with user requests through switches. We checked on Load balancer with coordinate directing based calculations and its examination with Round Robin Strategy.

TABLE I COMPARISON OF EXISTING WORK

S. No.	Name of paper	Methods	Limitations	Advantages	Parameters
1	Implementation of Server Load Balancing in Software Defined Networking (2016) [10]	POX Open-Flow Controller, Siege (LTT) Load Testing Tool, Apache Web Server.	Load balancer can be particular failure point.	Direct Load balancing algorithms avoid latency. Server responds directly to clients and Improved performance.	Response Time Throughput Transaction Rate
2	Improving the performance of load balancing in software-defined networks through load variance-based synchronization (2014) [24]	LDVS: - Least loaded domain variation synchronizes. LSVS: - Least Loaded Server variation synchronizes.	These methods are not considered in an actual test-bed.	Attain circle free transfer and high-quality load balancing presentation with less organization over-head of supervisors.	Flow arrival rate Flow durations
3	Control traffic balancing in software defined networks (2016) [25]	Polynomial interval of time approx... algorithm (PTAA) for switch rush balancing	Considered for online configurations	Solves load balance issue in an effective and similar manner	Delay
4	Visual Design Environment of Dynamic Load Balancing in Software Defined Networks [12] (2017)	Multi-path adaptive direction-finding process with load corresponding in SDN	Integrate only with Mininet	Incorporate with Mininet virtual condition and fare arrange topology to Mininet, and additionally stack adjusting administration input as per calculation stacked into the Open Flow controller.	Distance and Cost metric
5	Approach of Dynamic Load Balancing in Software Defined Networks with QoS (2017) [13]	Active load balancing algorithm with QoS	Does not considered for real networks	An extra switch likelihood of method work. The m ajority segment of overloaded associations and routes in network are stable (are unpacked)	delay, bandwidth, packet loss rate
6	A Load Balanced Congestion Aware Routing Mechanism for Software Defined Networks (2017) [14]	An efficient algorithm for avoiding link overutilization in SDN environment.	Cannot accept new load.	This technique has small running interval of time and is fast and efficient	Packet Loss and Throughput
7	Entropy-Based Load-Balancing for Software-Defined Elastic Optical Networks (2017) [15]	Fragmentation aware load balancing strategy for optical networks	Does not considered the failure of equipments	The hit usefulness achieves the lowest hit value, as predictable, while deliver the worst entropy performance.	Weighted Entropy and Hits
8	Control Link Load Balancing and Low Delay Route Deployment for Software Defined Networks (2017) [16]	MCSF depends on the algorithm for the CLB issue and a turning based method for the LRD issue	Reason excess crowding on s witch links as no s witch link constraint is measured	Optimize the manager connection load by around 50% and enhance the system throughput by about 65% associated with preceding approaches.	Packet Loss, Uplink Load Fairness and Network Throughput
9	Intelligent Optimizing Scheme for Load Balancing in Software Defined Networks (2017) [17]	An intelligent center based on SDN architecture.	Considered some network features only.	Load balancing becomes additional intellectual and efficient.	Latency Packet Loss
10	Challenges of and solution to the control load of stateful firewall in software defined networks (2017) [18]	Denial of Services detection and optimize method considered by intruding packets processed / rejected and time to avoid all malicious packets.	Network features require to be taken into measurement to choose the sampling frequency.	Distributed denial of services attack detection become much simpler in software defined network than in non-SDN network.	Simulation period 50 Time-slots Singe Attack Wave Duration Packet Arrival Rate
11	Partial flow statistics collection for load-balanced routing in software defined networks (2017) [19]	adaptive flow figures collection for load balanced direction finding	It work for less application and limited controllers only	reduce the statistic group overhead	Link load Measure Recall and Peak Load
12	QoS Aware load balance in software defined LTE networks (2017) [20]	software defined networking structure with OFeNBs for generating central LTE RAN	QoS parameters: delay and jitter are not considered.	maintain better QoS data rates	Throughput
13	A Switch Migration-based Decision-making Scheme for Balancing Load in SDN (2017) [21]	migration algorithm based on greedy approach	Applicable for small-scale wireless access network only.	Enables the elasticity of software defined network managers via switch optimize and can enhance migration affectivity.	Over load Ratio

14	Load-Balancing Software-Defined Networking Through Hybrid Routing (2017) [22]	New tag based protocols placement method for wildcard routing and hybrid routing issue that combined optimization of routing and tag based routing (HR-JPT)	Online algorithms are not considered.	High competence of TRPS (related with other wild-card routing methods, e.g., OSPF) and HR-JPT.	Network Throughput, Load link and Delay
15	Service-aware adaptive link load balancing mechanism for Software-Defined Networking (2018) [23]	enhance the network state info collection phase and route evaluation phase on Flood -light controller, and validate service aware adaptive link load balancing mechanism	Focus on bandwidth operation only.	Enhance mean connect bandwidth application rate upto 79%, with lesser association load jitter and average association delay.	Link Avg. Utilization, Link load Jitter, Average Jitter and end to end delay

Besides, we've additionally contrasted the inspected existing work with show signs of improvement thought regarding the idea. Through this survey, software defined network has been prevailed and applied in network environments. The concept of software defined network, its architecture, and applications has been studied. Software defined network reduces control link load and increase the network throughput.

REFERENCES

[1] Pooja and M. Sood, *"SDN and Mininet: Some Basic Concepts", Int. J. Adv. Netw. Appl.*, Vol. 7, No. 2, pp. 2690–2693, 2015.

[2] S.Sezer, S. Scott-Hayward, P.K. Chouhan, B. Fraser, D. Lake and N. Rao, *"Are we ready for SDN? Implementation challenges for software-defined networks," IEEE Communications Magazine*, Vol. 51, No. 7, pp. 36-43, 2013.

[3] J. Xie, D. Guo, Z. Hu, T. Qu, andP. Lv. *"Control plane of software defined networks: A survey", Computer communications*, Vol. 67, pp. 1-10, 2015.

[4] D. Kreutz, F.M. Ramos, P.E. Verissimo, … andS. Uhlig, *"Software-defined networking: A comprehensive survey," Proceedings of the IEEE*, Vol. 103, No. 1, pp. 14-76. 2015

[5] G. Zehua, M. Sub, X. Yang, L.W. ZheminDuan, and H. Jonathan, *"Improving the performance of load balancing in software-defined networks through load variance-based synchronization," Published in: Computer Networks*, Vol. 68, pp. 95-109, 5 August 2014.

[6] P. Kumari and D. Thakur, *"Load Balancing in Software Defined Network.,"* 2017.

[7] S. Raghul, T. Subashri and K.R. Vimal, *"Literature survey on traffic-based server load balancing using SDN and open flow", In Signal Processing, Communication and Networking (ICSCN), 2017 Fourth International Conference on IEEE*, pp. 1-6, 2017.

[8] P. Pathak and E. K. Mahajan, *"A Review on Load Balancing In Cloud Computing. International Journal Of Engineering And Computer Science*, Vol. 4, No. 06, 2015.

[9] A.A. Neghabi, N. Navimipur, M. Hosseinzadeh and A. Rezaee, *"Load balancing mechanisms in the software defined networks: a systematic and comprehensive review of the literature," IEEE Access*, 2018.

[10] S. Kaur and J. Singh, *"Implementation of Server Load Balancing in Software Defined Networking", In Information Systems Design and Intelligent Applications,* Springer, New Delhi, 2016, pp. 147-157..

[11] L. Shih-Chun, P. Wang and M. Luo, *"Control traffic balancing in software defined networks", Published in: Computer Networks*, Vol. 106, pp. 260-271, 4 September 2016.

[12] D. Perepelkin and V. Byshov, *"Visual design environment of dynamic load balancing in software defined networks," 27th International Conference Radioelektronika (RADIOELEKTRONIKA),* pp. 1-4, 2017.

[13] V. Koryachko, D. Perepelkin and V. Byshov, *"Approach of dynamic load balancing in software defined networks with QoS," 2017 6th Mediterranean Conference on Embedded Computing (MECO)*, pp. 1-5, 2017.

[14] S. Attarha, K. Haji Hosseiny, G. Mirjalily and K. Mizanian, *"A load balanced congestion aware routing mechanism for Software Defined Networks," 2017 Iranian Conference on Electrical Engineering (ICEE)* , Tehran, pp. 2206-2210, 2017.

[15] U. Mahlab, *"Entropy-based load-balancing for software-defined elastic optical networks," 2017 19th International Conference on Transparent Optical Networks (ICTON)*, pp. 1-4, Girona, 2017.

[16] P. Wang, H. Xu, L. Huang, J. He and Z. Meng, *"Control Link Load Balancing and Low Delay Route Deployment for Software Defined Networks," in IEEE Journal on Selected Areas in Communications*, Vol. 35, No. 11, pp. 2446-2456, Nov. 2017.

[17] C. Yu, Z. Zhao, Y. Zhou and H. Zhang, *"Intelligent Optimizing Scheme for Load Balancing in Software Defined Networks," 2017 IEEE 85th Vehicular Technology Conference (VTC Spring)*, pp. 1-5, Sydney, NSW, 2017.

[18] T.V. Tran, HeejuneAhn, *"Challenges of and solution to the control load of stateful firewall in software defined networks" Published in: Computer Standards & Interfaces*, Vol. 54, No. 4, pp. 293-304, November 2017.

[19] H. Xu, X.Y. Li, L. Huang, Y. Du and Z. Liu, *"Partial flow statistics collection for load-balanced routing in software defined networks" Published in: Computer Networks*, Vol. 122, pp. 43-55, 20 July 2017.

[20] A.K. Rangisetti, T.V. Pasca and S.B. Reddy, *"QoS Aware load balance in software defined LTE networks Author links open overlay panel," Published in: Computer Communications*, Vol. 97, pp. 52-71, 1 January 2017.

[21] C. Wang, B. Hu, S. Chen, D. Li and B. Liu, *"A Switch Migration-Based Decision-Making Scheme for Balancing Load in SDN," in IEEE Access*, Vol. 5, pp. 4537-4544, 2017.

[22] G. Zhao, L. Huang, Z. Li and H. Xu, *"Load-Balancing Software-Defined Networking Through Hybrid Routing" Published in: International Conference on Wireless Algorithms, Systems, and Applications WASA*, pp. 96-108, 2017.

[23] F. Shang, L. Mao and We. Gong, *"Service-aware adaptive link load balancing mechanism for Software-Defined Networking" Published in: Future Generation Computer Systems*, Vol. 81, pp. 452-464, April 2018.

[24] Z. Guo, M. Su, Y. Xu and H.J. Chao, *"Improving the performance of load balancing in software-defined networks through load variance-based synchronization.," Computer Networks*, Vol. 68, pp. 95-109, 2014.

[25] S.C. Lin, P. Wang and M. Luo, *"Control traffic balancing in software defined networks.," Computer Networks*, Vol. 106, pp. 260-271, 2016.