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QoS Based Routing Algorithm for Software Defined Network Using Ant Colony Optimization

Raghavendra Kulkarni and Kalpana Sharma

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QoS based routing algorithm for Software Defined Network using Ant colony optimization

Raghavendra Kulkarni[1],Dr. Kalpana Sharma[2]

[1]Research Scholar, Department of Computer Science, Bhagwant University, Ajmer, Rajasthan, India. raghavendra.kulkarni82@gmail.com

[2]Assistant Professor, Department of Computer Science, Bhagwant University, Ajmer, Rajasthan, India. kalpanasharma56@gmail.com

Abstract: Recently, software-defined networking (SDN) is the most promising solutions for future network. In SDN, networking architecture combines central management and along with network programmability. It separates network management from the underlying network infrastructure, allowing administrators to dynamically adjust network-wide traffic flow to meet the changing needs. Due to these unique features SDN easily manage network, gives better performance than traditional network, and higher flexibility. In this paper, we have proposed an ant colony optimization based routing protocol targeting to achieve significant value of various QoS parameters. The proposed methodology is based on the classification of various types of traffic. To classify the traffic we introduce to the bandwidth requirement for multimedia traffic like audio, video and text. Here, our method is compared with PSO-SDN (Particle Swarm Optimization- Software Defined Network). The results obtained in terms of various QoS parameters show that using Ant Colony optimization is outperform to PSO-SDN. Finally, we concluded the paper with few suggested open research challenges.

Keywords: *Software defined network, PSO, ACO, QoS, controller, routing.*

1.Introduction

Software Defined Networks (SDN) [2][3][4] is a novel type of networking technology used for smart grid. The network traffic is controlled in a flexible manner. Traditional network having lots of limitation, and SDN is expected to mitigate the limitations of the traditional network system.

In SDN networking[5] architecture combines central management along with network programmability. Here, control plane separate from data plane[3]. A central point which is control overall network management known as controller. This can be programmed and act as the brain of the whole network. Due to these unique features SDN easily manage network, gives better performance than traditional network, and higher flexibility. Recently, many

researches shows advancements in the artificial intelligence domain and optimization domains, which provide learning abilities and enhance the better decision making in SDN.

The Quality of Service (QoS) is focus on [14]adjust the allocation of various network resources as per the requirements of services and administrating in the network, increase the performance of the network[4][5][6]. The QoS is an essential criterion for many communication network applications. The multimedia network applications need high level of QoS to maintain various the network services [7], the smart grid [8] and networked control systems [9]. In transmitting multimedia data in real time required on time delivery of data, QoS parameter like delay should be always nil.

The paper is organized as follows: Introduction section describe the different issues related to software defined network in the section-1, in section-2 various literatures related to the proposed scheme are reviewed, in section-3 the proposed algorithm and methodology is discussed, in the section-4 discusses the experimental setup and results . The paper is concluded in the section-5.

2. Literature Review

There are so many work has been done by various researchers for load balancing, resource utilization, network performance for SDN environment. Still this area of research attracts attentions of researchers to explore the area for improving the network performances of SDN. Till date there are so many algorithms, routing protocols, and techniques are proposed on for better load balancing, improve the robustness of the SDN. So, better the load balancing in this environment better the utilization of network resources achieved. In literature review section, we have summarized many researchers work based on ant colony algorithm.

In this paper [2][3][4]authors proposed multicast based an ant colony cleaning behavior algorithm based cluster approach for the SDN to perform the smart multicast cluster. The multicasting is an important issue for SDN, because of distinctive features like flexible, programmable and dynamic features. The implementation system of the multicast scheme is designed in SDN controller. The proposed technique tested with random walk method and as result it achieves higher throughput and lower transmission delay. Finally, reliability and communication performance of SDN is also improved.

In this [14][9] author proposed an ant colony optimization (ACO) based routing protocol for SDNs. The SDN uses flow-based routing strategy, and this is the reason ACO is most effective as it also uses same technique. The packet delivery ratio, delay and the first packet arrival time are used for performance analysis. The results show that ACO outperforms others in term of higher packet delivery ratio and first packet arrival time is less in low density traffic.

In this paper [15][7] authors proposed a link load-balancing framework for SDN. The proposed ACO used link load, delay and pack-loss to minimize search scope of path. This also simplifies multi-objective optimization problem by setting dynamic load threshold. The simulation works proven better balancing of load and significant improvement in QoS, increases stability and rapidity of network traffic forwarding.

In [16][4][5] authors shows well utilization of resources can improve system and network performance. This is achieved through Load balancing. The traditional load balancing techniques are not suitable for SDN. In this paper, a dynamic load balancing technique for SDN is proposed, which aims to load balancing both the servers and the paths leading to the servers. The

best server is chosen and uses the least loaded server LB policy. The Ant Colony System (ACS) algorithm is used to find the best path toward the server. This algorithm considered the server-load and network statistics by the controller to find both the best server and the best path for network flows. In term of network throughput and delay protocol achieved good.

In paper [17] authors thoroughly studies various routing mechanism exist for SDN. A fusion genetic ant colony (GAC) routing algorithm is proposed for SDN[6]. The advantages of genetic algorithm and ant colony algorithm are combined together in this method. This GAC algorithm uses positive feedback technique to minimizes the search times and obtain an optimal path[6]. The result comparison with other well known algorithm show that speed of the algorithm is improved as well as the efficiency and high accuracy of selecting best path.

3. Methodology

The major aim of this research is to develop a routing protocol for SDN environment using ant colony optimization by maintaining reasonable level of various Quality of Service (QoS) parameter. The proposed methodology is discussed below.

The methodology is based on the classification of the traffic. To classify the traffic we introduce to the bandwidth requirement of multimedia traffic like audio, video and text. The same network for the need for a class, labeled as N class where N=1,... C.

Under normal circumstances, the network traffic may be of different size of packets which may involve multimedia traffic like audio, video, image & text items.

Aspects of classification:

Ports and sockets:

All the packets audio , video , image & text packets involves different ports and protocols. Let Pt be the port used to for text & in Pa and Pv be the ports for audio & video respectively.

Factor to improve QOS:

Bandwidth utilization:

Bandwidth utilization is different for different type of multimedia data to increase the QOS in the simulation setup multiple connections with different bandwidth used and different multimedia data would channeled through appropriate bandwidth so that QOS is improved.

Ant colony optimization:

Adaption ACO in SDN:

The ant colony algorithm is defined as the link in the SDN network, which is defined as the link load. When the link usage rate is higher, the pheromone concentration is lower.

SDN we classify the network based on type of packet. Each packet type of packets needs different QOS. As defined in the architecture SDN is connected with different type of con-

nection like wireless, wired, internet. SDN checks the ports and protocols for each packets and allots suitable network segment using previous learning.

Minimal bandwidth needed: Br = Minimal bandwidth needed

$$Br = \min \{Ba(1),\ldots..Ba(j),\ldots.Ba(C)\} \quad \textbf{(1)}$$

The minimal critical value is related to high bandwidth demand. W(j) Weight of Bandwidth needed

$$W(j) = Bc(J)/Bm \text{ , } J \in \{1,\ldots..,C\} \quad \textbf{(2)}$$

The relationship between the pheromone concentration and the link utilization is given.

$$\tau_{ij}(t)=k(1/load_{ij}(t)) \quad \textbf{(3)}$$

Which represents the t time node i and node j between the link between the pheromone, which represents the link between the node i and node j, K for the link between the pheromone and the conversion constant.

The probability formula of ant m from node i to node j in ant colony algorithm is as follows.

$$P_{ij}= \{[\tau_{ij}(t)]\alpha * [\eta_{ij}(t)]\beta \} \ / \sum\{[\tau_{ij}(t)]\alpha * [\eta_{ij}(t)]\beta \} \quad \textbf{(4)}$$

Among them, the set L is ants m may want to choose a route set, said routing link pheromone of ant the influence factor, the greater the value, indicating that ants of information element more depend on, the smaller the value of, said the pheromone of ant smaller. Said the ants to explore new path of the opening rounds, the greater the value that ants are increasingly interested in the new path, the value smaller said ants on a new path to less interested. In which the ant to explore the new path of the heuristic function, the formula is as follows.

$$\eta_{ij}(t) = 1 / (load_{ij}) \quad \textbf{(5)}$$

Algorithm:

```
step1: Input: Traffic Data
step2: Output: Suitable Segment of network begin
step3: For all collected data
step4: Compute the similarity between data;
step5: Check port and protocol of respective packet; send to
the lower bandwidth segment; collect information and time to
delivery; compare with previous delivery time
step6: If previous delivery time > current delivery time
       Then update previous delivery time = current delivery;
Else
     No change
step7: End if
step 8: Go to Begin.
```

4. Experimental Results and Discussions

The simulation work is carried in NS-3 simulator. The analysis of performance of both the protocols, we used a topology of a campus network. It consists of a partial mesh topology

comprising 100 hosts and 11 switches, illustrated in following Fig.1. The simulation parameter considered is shown in Table-1.

Table.1 simulation parameters

Parameter	value
Hosts	100
Switches	11
Traffic profile	40%web, 30%video, 30% audio
Model	Open switch

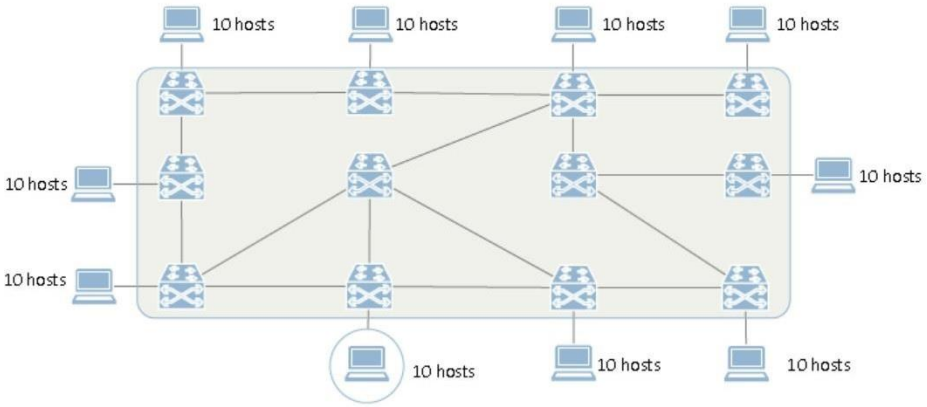

Fig. 1. Topology of a campus network used in simulation.

Above setup consist of multiple sources of multimedia data. Like web servers generating regular text traffic, video streaming & audio streaming servers. The end-to-end delay, packet delivery ratio, control overhead, and throughput QoS parameters are considered for performance evaluation of both the protocol.

(i) End-to-End Delay

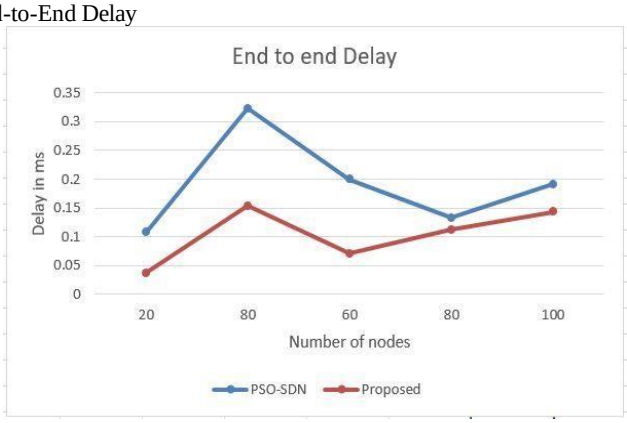

Fig.2 End-to-End Delay analysis of PSO-SDN and Proposed Scheme.

The Fig.2 we have shown the End-to-End Delay analysis of PSO-SDN and Proposed Scheme. The delay throughout different node density the performance of the proposed protocol is much better. The value of delay is lowest for number of node is 20. The performance of the proposed protocol based on average delay is 20% lower than the PSO-SDN.

ii)Delivery Ratio

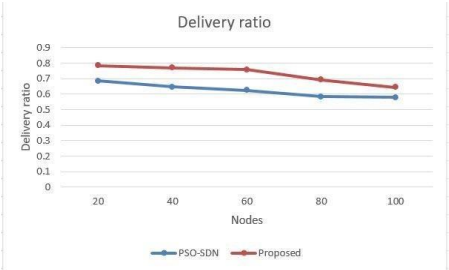

Fig:3 Delivery ratio analysis of PSO-SDN and Proposed Scheme

The Fig.3 we have shown the packet delivery ratio analysis between PSO-SDN and Proposed Scheme. The delivery ratio throughout different node densities is decreasing for both the protocol as the number of node increases. As the number of node increases, the network congestion is also increases. The highest packet delivery achieved is about 79% by our proposed protocol. The performance of the proposed protocol based on PDR is average 10% higher than the PSO-SDN.

(iii)Control packet Overhead

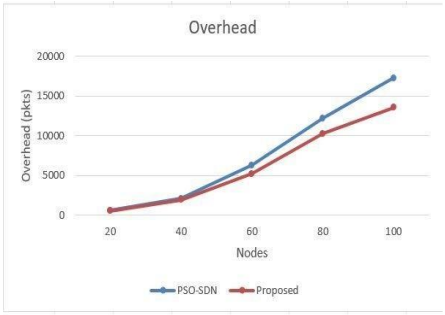

Fig:4 Overhead analysis of PSO-SDN and Proposed Scheme

The Fig.4 we have shown the overhead analysis between PSO-SDN and Proposed Scheme. The overhead for different node densities is gradually increasing for both the protocol with increasing number of node. The highest overhead encounter when number of node is 100. Throughout different node densities overhead occurred is lesser than the PSO-SDN protocol.

(iv)Throughput

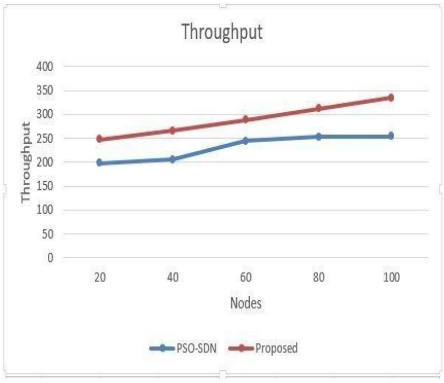

Fig:5 Throughput analysis of PSO-SDN and Proposed Scheme

The Fig.5 we have shown the Throughput analysis between PSO-SDN and Proposed Scheme. To maintain good QoS's of the network many parameters are evaluated. The throughput analysis is also a QoS parameter. The value of throughput throughout different node densities is increasing for both the protocol. The highest value of throughput is achieved when number of node is 100. The performance of the proposed protocol based on throughput is average 20% higher than the PSO-SDN.

Here, our method is compared with PSO-SDN (Particle Swarm Optimization- Software Defined Network). The results obtained in terms of various QoS parameters show that using Ant Colony optimization is outperform to PSO-SDN. Overall, the performance of our proposed protocol is better than PSO-SDN. Our protocol achieves average delay is 20% lower, average PDR is 10% higher, and average throughput is average 20% higher than the PSO-SDN. The various QoS parameters are considered for performance evaluation of both the protocol.

5. Conclusion

The paper is mainly focused on various types of multimedia traffics flow in the network. The multimedia traffics may be an image, a video etc., and their bandwidth requirements also different. We here considered different types of traffics like 40% web , 30% video , 30% audio is considered in the analysis. Our protocol achieves average delay is 20% lower, average PDR is 10% higher, and average throughput is average 20% higher than the PSO-SDN. Overall, the performance of our proposed protocol is better than PSO-SDN with respect to all the QoS parameters considered in this work. Further, in future more efficient routing protocol can be designed with other nature inspired optimization algorithms.

6. References

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