44. Improved End to End Delay Bound analysis in Software Defined Mobile Edge Vehicular Networks

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ABSTRACT

Optimization of the data traffic has an essential role for efficient congestion control in software defined vehicular networks (SDVN). Recently, software-defined mobile edge vehicular networks (SDMEVN) have been emerging as promising for the future generation of vehicular networks. It controls the vehicular ad hoc networks systematically. In SDMEVNs, link connectivity of moving vehicles may fail from central SDN controller. This affects the efficiency and communication performance in terms of loss connectivity between vehicles to infrastructure. We analyse network performance in dense and sparse network. Maximize the buffer occupancy in Software-defined vehicular networks to control the low latency and delay bound analysis in communication by integrating the heterogeneous systems like IEEE 802.11p and mobile base station technologies in vehicular ad-hoc networks (VANETs).

Index Terms— *Software Defined Vehicular Networks, Mobile Edge Computing, Intelligent Transportation System, End to End Queueing Bound.*

INTRODUCTION

In future vehicular networks, emerging technologies have integrated into 5G mobile communication, and Softwaredefined networks are overcoming to reduce latency and improve the reliability [1], [2]. SDN provides reliable data and flexible problems to solve and to control the entire systems. Moreover, to connect wired and wireless networks to the users. SDN controller controls the whole networks with the help of the control plane, and the data forwarding from vehicle-to-vehicle communication helps with the data plane. With cooperative data dissemination, based on SDN is to develop the performance of the V2V and vehicle to infrastructure (V2I) communications [3], [4]. The main enabling platforms playing a vital role in the traffic of next-generation intelligent transportation system (ITS), includes cellular networks dedicated short-range communications (DSRC)-based IEEE802.11p. SDN controls the controller to provides priority for the connected vehicles as flexible and road safety and efficiency (e.g., collision avoidance) [5]. Using information exchange from V2V and V2I cooperative data dissemination service provides and controlled the entire network is SDMEVN towards RSUs and V2BS(vehicle to base station) to reduce the latency and packet loss [6]. With SDVN provides logically centralized controlling for reliable communications in VANETs. On the other hand, the mobile edge computing (MEC) to deal with a variety of services, such as data scheduling and resource utilization of multi-hop cooperation vehicular networks [7].

In queuing theory, we have an analysis of M/G/1 queueing model analysis that can provide stochastic QoS provisioning for any of the traffic arrival and service approximation, and the servers are statistically independent. Our contribution is as follows.

- Edge nodes have to improve resource utilization for an end to end-users. Applying the queueing theory model, the number of flow rules increases to optimize the control the traffic congestion control.
- SDVN-based heterogeneous architecture to control the packet scheduling based on priority and non-priority considered resource utilization, to minimize the latency and end to end delay.

The remainder of the paper is organized as follows: related work has discussed in the next section. Section 3 describes system models and preliminaries. Section 4 presents our problem formulation. In Section 5, we present the performance analysis. Finally, we conclude the paper in Section 6.

RELATED WORK

In this section, the literature works have done in SDN concepts to vehicular networks and confirmed it to be an excellent solution to enhance the traffic of resource utilization and data distribution, SDN the centralized controller has a comprehensive view of the network topology, being able to make better decisions in network-wide. Table 44-1 represents the comparison of related work in SDN based mobile edge vehicular networks. We have compared the majority of workrelated of a centralized SDN architecture. The main issue of these networks is connectivity loss, reliability, and delay in VANETs. Our solution is to improve the network performance analysis with the help of SDN based mobile edge VANETs. Moreover, high mobility of vehicles, due to more connectivity losses in the VANET system, the authors have been proposed to reduced latency control in SDMEVN in [2]. Moreover, the proposed buffer management creates the queueing model to develop the quality of service (QoS) parameters or resource utilization needs with the network status to attempt the user's request.

Table 44-1 Comparison of Related work

Work Done	Architecture	Contribution	Method	Delay Bounds
2	Centralized	SDMEVN	Optimization	√×
3	Centralized	SDUDN	Queueing model	√
4	Centralized	CPU Utilization	Queueing Model	√
5	Centralized	Packet Scheduling	Queueing Model	
7	Centralized	SDN-based VANETs	QoS Resources	√×
8	Centralized	Data Scheduling	Queueing Model	√
9	Hierarchical	SDVN	CPP	√
10	Hetrogeneous	SD5GNet	Queueing Model	√
Our Analysis	Heterogeneous	SDMEVN	Queueing Model	

SYSTEM MODEL

The SDMEVN, considering service provisioning of network function virtualization, is to control whole network data in the SDN system in this paper have illustrated in Fig. 44-1. The SDN controllers are the main components of SDMEVN in the ITS. Resource utilization and quality of service (QoS) are the essential functions of SDN controllers. SDN controllers have connected with the IP of the internet via packet scheduling [2], [3]. With the SDN-based controller for data scheduler in a cooperatively disseminates data in a roadside unit (RSU) have controlled the heterogeneous vehicular environment [7], [8]. Consider an SDMEVN architecture shown in Fig.44-1, in which the SDMEVN required appropriate resource allocating at the events based because resource allocation is available on an Adhoc basis and must be used efficiently and effectively for V2V and vehicle to base stations (V2BSs) communication. Although the separate control plane of SDN intelligently allocates resources should be enabled to ensure the successful management of road traffic and vehicular networks. In VANETs, various types of systems are involved in providing connectivity among vehicles. However, the lack of efficient internet-working mechanisms leads to connectivity issues among heterogeneous networks in a VANET. In the

SDHVN model was a Reliable packet transmission with prioritization of minimum transmission delay is the main challenge in designing broadcast schemes for [9], [10]. We create a novel packet scheduling solution on top of SDMEVN. In this solution, we perform centralized data scheduling of all network resources in the control plane of SDMEVN is to minimize the end to end connectivity of delay bounds [15]. However, SDMEVN can adaptively choose the optimal path from all available vehicles.

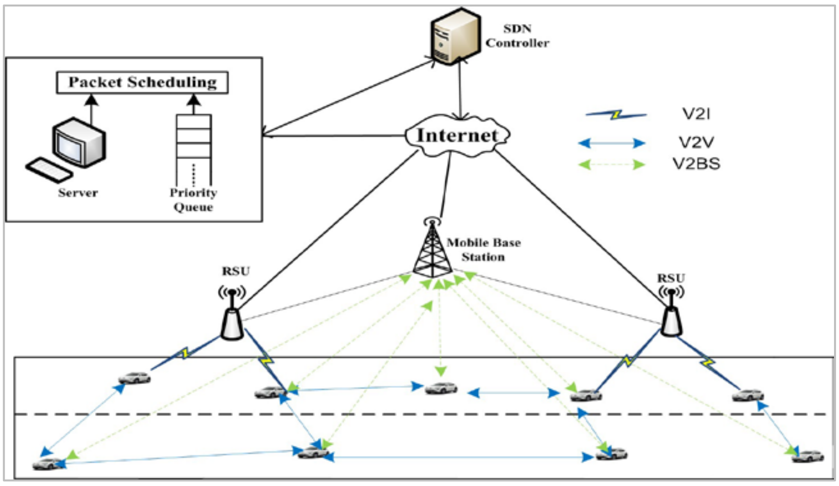

Figure 44-1 Service Provisioning of NFV in SDMEVN system.

PROBLEM FORMULATION

In this section, we defined the proposed model to evaluate the performance of buffer management and data scheduling for V2I, and V2V connectivity in SDN controlled heterogeneous networks. SDN is an essential technology for ITS. SDN controller is programmable and connected through infrastructure with open-flow switch [14]. The trade-off between latency, throughput, and cost. The proposed work considers both service priority of network utility performance and QoSguarantee resource allocation of vehicles in the roadside unit and base station to decide for better data dissemination across a highway in the VANET system.

A. BUFFER OCCUPANCY IN SDMEVN

The packet scheduling algorithm is needed to decide which data packets have toe served first from the buffer queue to perform efficiently in a vehicular ad-hoc environment when the buffer occupancy of waiting for queue length is more, work focused in [16]. Routing strategy awareness provides a higher priority randomly to the traffic flow classes for data packets that have gives the highest positions. It is helpful to optimize the congestion control at the intermediate node through the destination node and fully utilize resource allocation. We propose a packet scheduling techniques on the arrival rate of new traffic flow rules is calculating its arrival rates and degree of centrality values to reduce delivery delay, while maximizing throughput [16]. The first type of packet scheduling algorithm uses non-priority scheduling. The second type of packet scheduling algorithm has used for priority considered packet scheduling in data packets. Therefore, multiple scheduling algorithms are available for prioritization in traffic such as multi-hop packet scheduling [11], [12], [16]. The simple priority based scheduling scheme cannot perform efficiently in real networks when the rate of congestion is high, since simple scheduling algorithm do not have the information of wireless channel capacity from its neighbors [16].

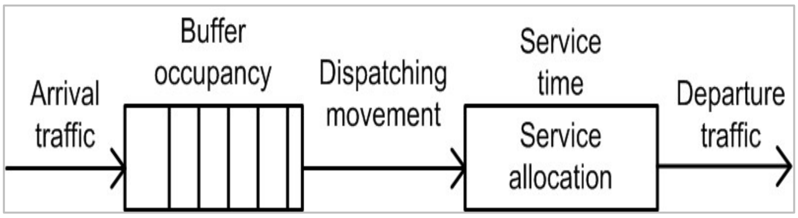

Figure 44-2 M/G/1 Queueing System.

B. M/G/1 QUEUEING SYSTEM

In this section M/G/1 queueing model used in network performance analysis, we assume arrival is Poisson, and service time is exponential. We have focused on delay bound performance play an important role in real-time traffic modeling in the SDMEVN system. M/G/1 queueing system, in Fig.44-2, where the number of vehicles arrived according to a Poisson process with arrival rate λ_t and have served by a single server of general service time distribution x_t. The capacity of the waiting queue or buffer occupancy is, as usual, infinite and vehicles have served in the order they arrived service discipline is FCFS. Performance measures of M/G/1 queue. We calculate the number of customers are waiting in the queue [13]:

$$N_{W_Q} = \lambda_t W_Q = \frac{\lambda_t^2 x_t^2}{2(1-\rho_t)} \quad (1)$$

We calculate the number of vehicles time spent in the queue

$$t = x_t + \frac{\lambda_t x_t^2}{2(1-\rho_t)} \quad (2)$$

The number of vehicles in the SDMEVN system response time (mean queue size of packet flow distribution):

$$N_t = \rho_t + \frac{\lambda_t^2 x_t^2}{2(1-\rho_t)} \quad (3)$$

Resource utilization for no.of users given by

$$U_r = \lambda_t N_t \quad (4)$$

PERFORMANCE ANALYSIS

In this section, we have performed the delay bound analysis and response time as a key role for SDN improving the network performance evaluation of edge nodes in VANETs for analytical and simulations analysis using MATLAB and Java Modelling Tools (JMT). In Table 44-2 as shown in the simulation performance of various parameters, we have considered. The SDMEVN performance analysis depends on packet arrival rate, service rate, and flow in the queue for providing resource allocation. We have compared the dense and sparse traffic of networks if the flow distribution is increasing due to high vehicle density. According service rate distribution in sparse traffic $\mu_t = 1$. The maximum confidence interval is 99%; the infinite system capacity and station queue policy is preemptive scheduling of FCFS queue policy. With the routing, the strategy is random. We set the N= 2000 is traffic flow and time (t) = 20μs. We have focused on data transmission with packet arrival rates in VANETs with performance evaluation of delay bound analysis. We have considered the customer classes type is open arrival rate is 0.1 to 1 packets/sec, service rate is 1 to 2 packets/sec ($\lambda_t \geq \mu_t$) has model in service demands. In sparse traffic medium traffic density (ρ_t)=0.998veh/sec. It has seen that the SDN based on the traffic flow rules in denser medium is N=2000 to 8000 flow distribution probability leads to response time decreases. We have shown the relationship between average response time and traffic flow distribution probability.

Table 44-2 VARIATION OF NETWORK PARAMETERS IN DIFFERENT CASES

Network Performance	**SDMEVN**	**VANET**	**Packet Scheduling**	**M/G/1**

Avg.Response Time	Low	Medium	High	Moderate
Resource Utilization(%)	Provides Excellent	Good	Less	Good
System Throughput ($\lambda_t \leq \mu_t$)	Packet Loss Less	Medium	More	Good
System Response Time ($\lambda_t \leq \mu_t$)	Service Good	Service Provides Less	Congestion more	Better Controlling
System Utilization(%)	Performance Good	Medium	Congestion	Provides Better Utilization

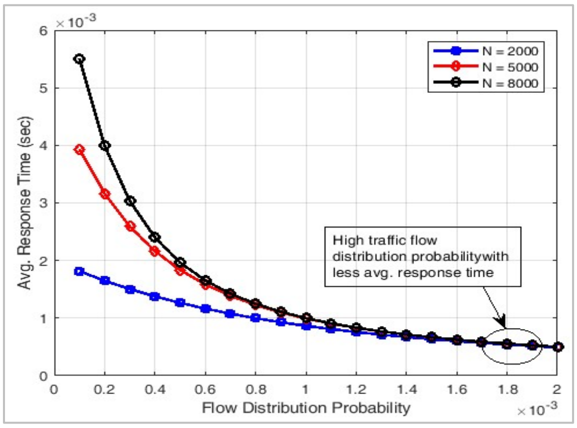

Figure 44-3 Avg. Response Time analyzed by the Traffic flow distribution in SDMEVN.

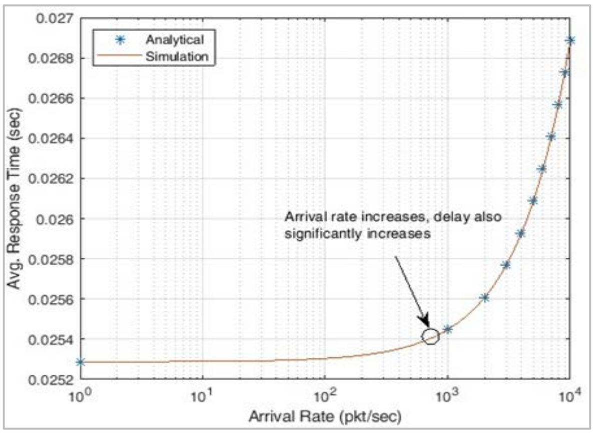

Figure 44-4 Response Time analyzed by the Arrival Rate in SDMEVN.

However, the high flow rules of packets distribution probability results in the average number of response times are less, as shown in Fig.44-3. As we illustrated in Fig.44-4 shows that the average response time with arrival rate; however, the arrival rate increases in the system by the significant delay increases. Fig.44-5 indicates traffic is the denser medium the resource utilization and given the arrival rate of different flow rules increases, the utilization curve increases. We have focused on priority scheduling of low and high priority queueing for flow modeling of data transmission. Fig.44-6 shows the data distribution with a random unit of time in the SDMEVN system. Moreover, the arrival and service rates depend on system performance of the number of classes for the server are fixed service time is to increases of arrival rate with increases of system response time due to increases of waiting time and service time accordingly. With the help of the M/G/1 queueing system is improved the system response time.

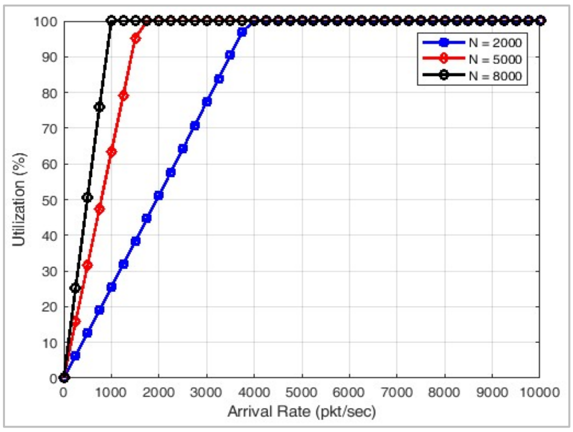

Figure 44-5 Resource Utilization with different arrival rate of the SDMEVN system

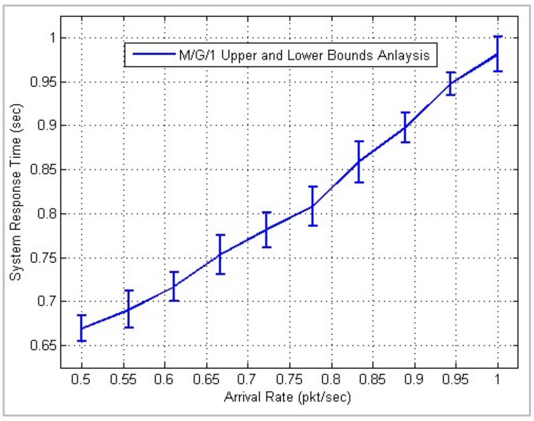

Figure 44-6 System Response Time with different arrival rate of the SDMEVN system

Fig.44-7 shows that the system throughput to improve the SDMEVN to maximize the data transmission and to receive from edge nodes, i.e., for RSUs, which provides better performance with the order of increasing arrival rates. Here, the number of customers is received and transmits the data from the station (RSU or BS), the number of requests completed in a time unit. Fig.44-8 shows that the utilization based on SDN observed to the different base stations and RSUs to users utilized the resource utilization with respective of increasing order of arrival rate. It depends on load balancing in queue; the SDMEVN system improves the resource utilization. Fig.44-9 shows that the system utilization of packet scheduling is to connect the internet based on the SDN controller control the base station and RSUs to provide better resource utilization used customers. SDMEVN provides as the end to end connectivity for maximizing the service rate. It depends on the traffic queue in the buffer; SDMEVN system maximizes the bound delay analysis.

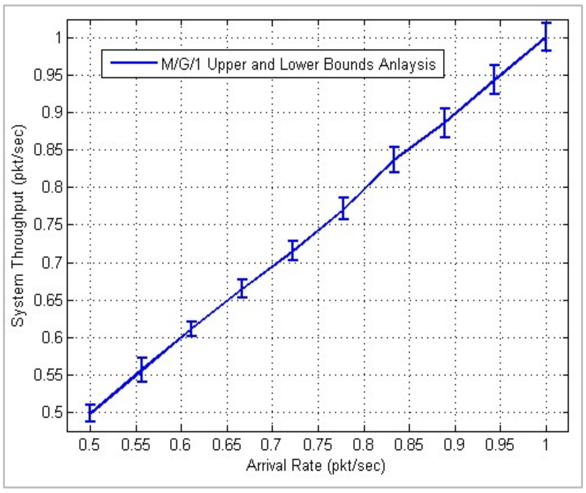

Figure 44-7 System Throughput with different arrival rate of the SDMEVN system.

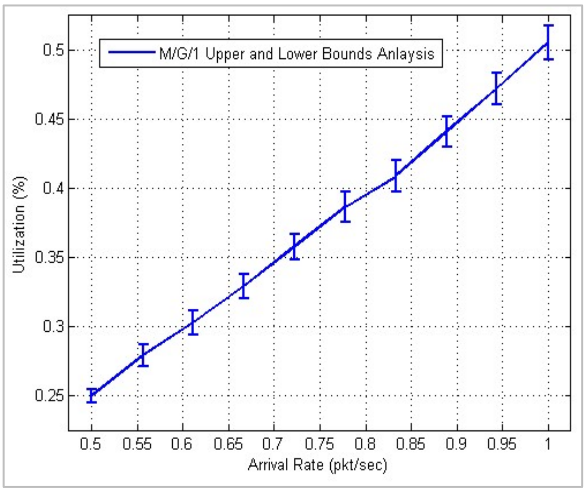

Figure 44-8 System Utilization with different arrival rate of the SDMEVN system.

Fig.44-10 shows that the no.of customer's utilized data is 100% causes of increment utilization about the 10% of server utilization. However, each customer spent a particular time to wait for service at stations. Moreover, service time increases customers' increases uniformly.

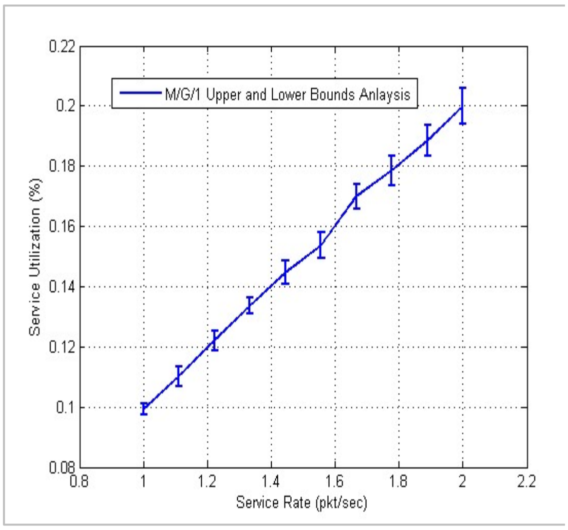

Figure 44-9 Service Utilization with different service rate of the SDMEVN system.

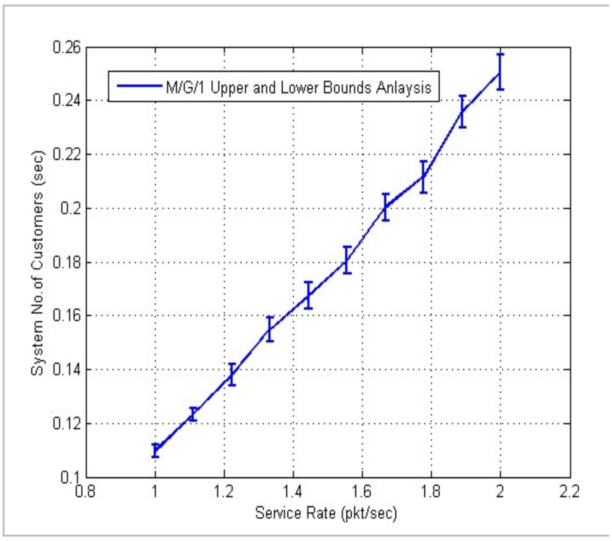

Figure 44-10 System No.of Customers with different service rate of the SDMEVN system

Fig. 44-11 shows that the packet scheduling for delay bound analysis of improved with an increased service rate of the system. However, in the system number of customers waiting for service, when the queue length is more, therefore the system reliability down due to more number of customers waiting for service. As we observed, the system performance is reliable, and we have maximized the service time.

Fig. 44-12 shows that the system throughput with the service rate of a single server monitoring the system with the time to increment of per unit time. From the server or base station user uploading and downloading of data, the controller sends the data to the user at the particular waiting time that happened in the system for increases the delay and throughput performance has reduced. The SDMEVN system provides better system performance to maximize throughput.

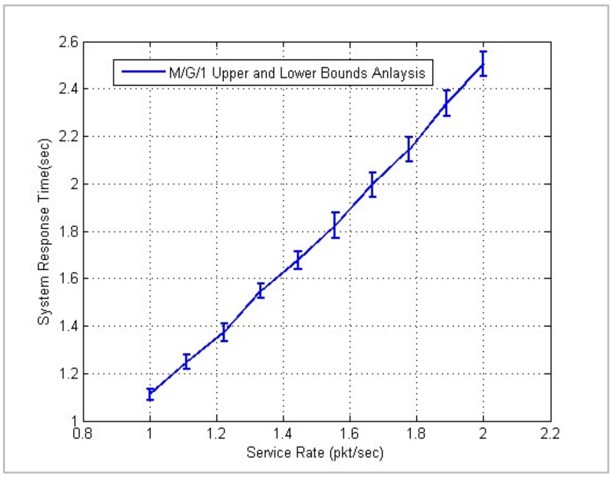

Figure 44-11 System Response Time with different service rate of the SDMEVN system

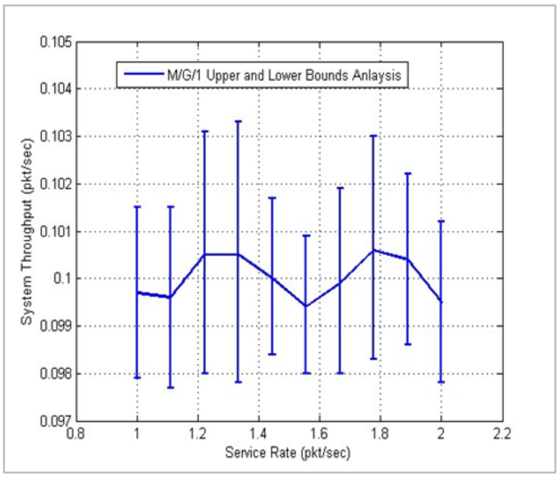

Figure 44-12 System Throughput with different service rate of the SDMEVN system

CONCLUSION

In this paper, we have focus on the dense and sparse network performance for software-defined mobile edge vehicular networks. With the help of M/G/1 buffer occupancy for selection of FCFS scheduling policy towards improving delay bound analysis. Moreover, in SDMEVN, we have analyzed different network performance parameters of arrival and service rate increases due to measures the avg.response time, utilization, and throughput for different network scenarios. Applying queueing models, With the analytical results have verified that the proposed SDMEVN system model performs the M/G/1 queue with an internet-based SDN controller in terms of delay bound analysis. We have improved the system performance and resource utilization. In the future, we have evaluated the network utility maximization using software-defined heterogeneous vehicular networks at different parameters of network scenarios using SDN.

ACKNOWLEDGEMENT

This work has supported by the Electronics Engineering Department of Indian Institute of Technology(Indian School of Mines) Dhanbad, India.

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