

# Performance Analysis of AODV Routing Protocol in VANET Using NS-2 and SUMO.

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## Abstract

VANET (Vehicular Ad-hoc Network) is a self-sorting out impromptu organization wherein vehicles go about as a hub and every hub comprises of an On-Board Unit (OBU) which forwards data packets to different hubs through Road-Side Unit via routing. VANET has a few issues among which routing is one of the indispensable issues to course the packets effectively from source to destination. In this paper, our work centers around dissecting the different routing protocols utilized in VANET for example AODV Routing Protocol (Ad-hoc On-Demand Distance Vector), DSR Routing Protocol (Dynamic Source Routing), and DSDV Routing Protocol (Destination-Sequenced Distance Vector). AODV is a reactive topology-based routing protocol that is the most regularly utilized. In this paper, we are working to assess the presence of the AODV routing protocol and exploring the parameters like End To End Delay, Throughput, Packet Delivery Ratio (PDR), Packet Loss Ratio, and so on We have chosen the AODV routing protocol for investigating the performance of VANET because it condenses disproportionate use of memory requirements and route redundancy. Likewise, it has a destination sequence number, subsequently, it is in the know regarding destination pathway. We are considering a Linux platform to play out the assignment with the assistance of Network Simulator-2 (NS-2), SUMO (Simulation of Urban MObility).

## Keywords

AODV, NS-2, SUMO & VANET.

## 1. Introduction

VANET (Vehicular Ad-hoc Network) is a self-organizing ad-hoc network wherein vehicles act as a node and every node consists of On Board Unit (OBU) which forwards data packets to another node through Road-Side Unit by using routing. VANET has several concerns among which routing is one of the significant concerns to route the packets efficiently from source to final destination.

VANET has frequently changing topology which results in a frequent disconnection between nodes (Vehicles). A routing protocol is responsible for communication between nodes (Vehicles) by establishing the route, forwarding packets, and maintaining the routes. Communication in VANET can be done by two types; [11]

1. Vehicle to Vehicle (V-V). i.e. Node-Node.
2. Vehicle to Infrastructure (V-I). Node-RSU.

The following figure illustrates the taxonomy of routing protocols used in VANET;

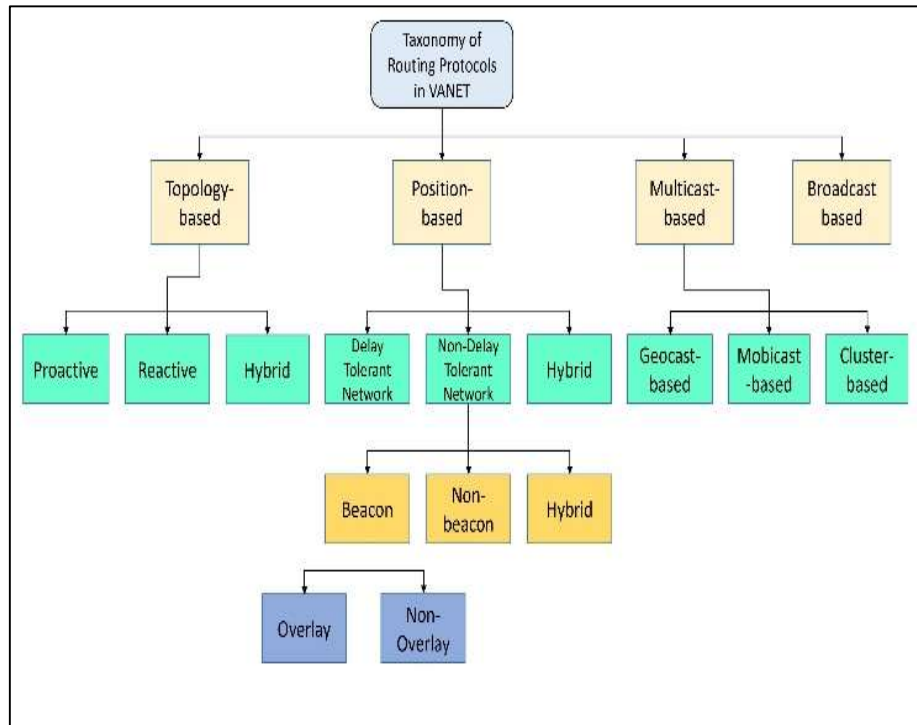
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**Figure 1:** Taxonomy of Routing Protocols in VANET.

VANET [17] is planned to act self-arranging in a environment of moving nodes/ vehicles, enduring a variety of organization exhibitions, for example, Node mobility, Link failure, and Packet loss. Vanet has higher versatility and much of the time-evolving geography. The mobility models of VANET are responsible for the pattern of nodes on the road in real-time.

In AODV, [17] at every node, it maintains a routing table. The routing table is a passage for a destination node that contains the accompanying three significant fields; [17]

1. **A next-hop node:** All packets that are going to be sent to the destination are directed to the next hop node.
2. **A sequence number:** Method of time stamping & it is a degree of freshness & route.
3. **A hop-count:** Contemporary distance to the destination node.

In AODV, Nodes choose courses/routes in the requesting response cycle;

1. A node requests a way to the endpoint node by spread of RREQ (Route Request) message to each neighboring node.
2. When the node gets the RREQ message anyway doesn't have the way to the referenced destination it, thus, broadcast the RREQ message. This measure refreshes until the RREQ arrives at a node that has a substantial path to the destination. Also, it brings out a converse course to the requesting node which can be used to progress resulting responses to this RREQ.
3. This measure reiterates until the RREQ shows up at a hub that has a considerable way to the destination.
4. The end node reacts with RREP (Route Reply) message. The RREP message is unicast along the contrary course of the transitory node until it appears at the demanding node.
5. When the node setbacks its accessibility to its next bounce, the node invalidates its route by sending RERR (Route Error) message to all nodes that potentially received the RREQ message.
6. On acknowledgement of these three messages: RREQ, RREP, RERR; The node updates the next hop, sequence number, and the hop counts for its route.

7. The remaining paper includes: Section 2 presents the literature study and different routing protocols, approaches to investigate network parameters for different scenarios in VANET. Section 3 presents proposed work and methodology. Section 4 presents the performance of quality of service parameters. Section 5 includes the study of AODV routing protocol and results. Section 6 includes the conclusion of this paper and gives an idea about the scope of VANET in the future and last, section 7 includes references.

## 2. Literature Studies

Authors in [5] and [14] import the real-time map from OSM (Open Street Map) Wizard for vehicle mobility patterns constrained to realistic map topology. SUMO does not consider some parameters such as Left-Handed Traffic, Traffic signals, speed limit, and other details. The author considers two radio propagation models in [13] i.e. Two Ray Ground model and the Nakagami model. The platform used by the author in [13] is NS-2 along with MOVE & SUMO. The author considers the AODV & OLSR routing protocol for investigating packet-delivery ratio and end-to-end delay for two different radio propagation models.

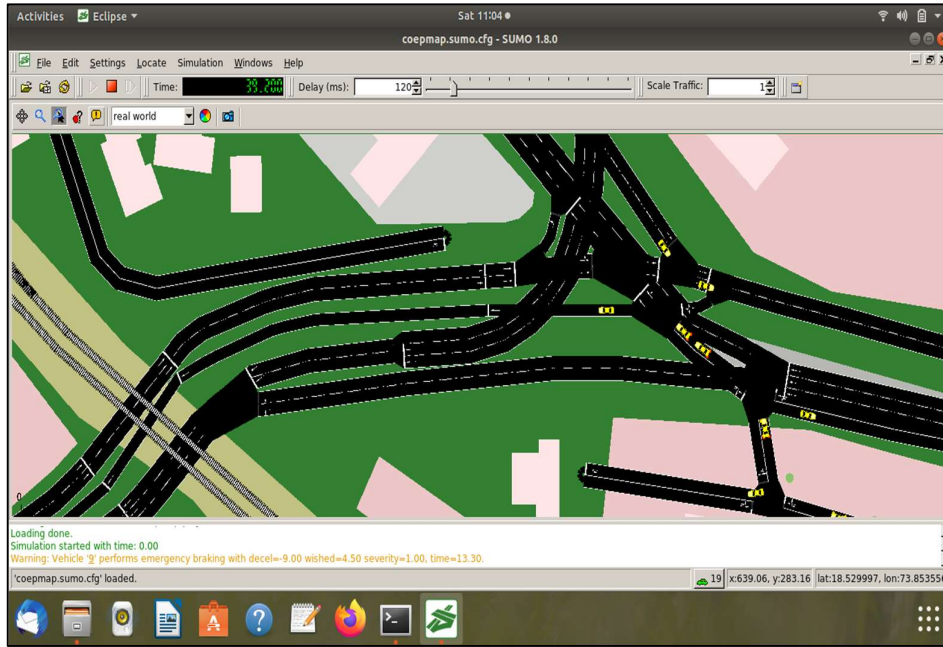
## 3. Methodology

1. Browsing openstreetmap.org, select the specific region physically then export it..
2. map.osm record will be downloaded for that specific zone. Rename it according to your comfort.
3. By utilizing sumo commands, for example, netconvert and polyconvert we changed over the osm map in a setup document for example .cfg. You will discover the osmpolyconvert.typ.xml document in sumo/information/typemap path. Netconvert imports advanced street networks from different sources and makes street organizations. Polyconvert imports polygons from different sources and converts them into the representable pictured structure utilizing sumo-gui.
4. We have downloaded map.osm file just and map.net.xml, map.poly.xml, polyconvert.typ.xml records are produced through map.osm file.
5. The next step is to create a route file using the randomTrips.py file and the further configuration file is created.
6. The FCD command is useful for integrating the map with NS-2. The FCD is a floating vehicle information trade that incorporates area and speed alongside other related data for each vehicle in that selected region of map at each time step.

Generating trace files;

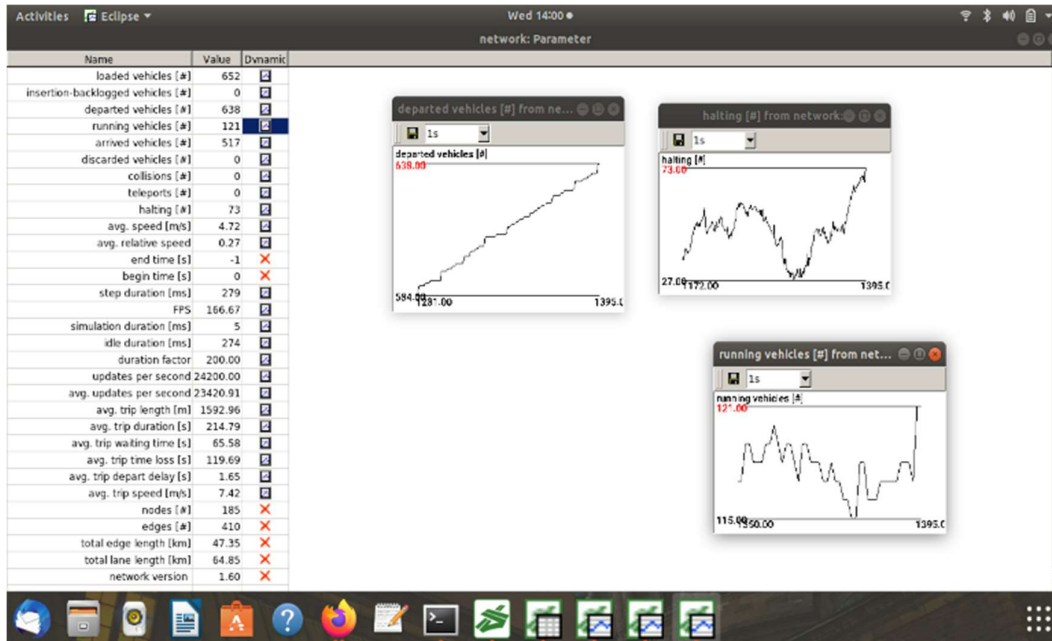
Various applications read "vehicular traces", files containing mainly position of vehicles over the time. traceExporter.py produces such records by changing over SUMO's fcd yield into a few upheld designs

```
$python/home/user/sumo/tools/traceExporter.py -fcd-input coepmap.sumo.xml -ns2config-output coepmap.tcl -ns2mobility-output mobility.tcl -ns2activity-output activity.tcl
```



**Figure 2:** Coep/ Sancheti bridge Traffic Simulation in SUMO.

We can likewise examine the vehicular behavior in SUMO while running the simulation. An illustration of it is appeared in the accompanying figure.



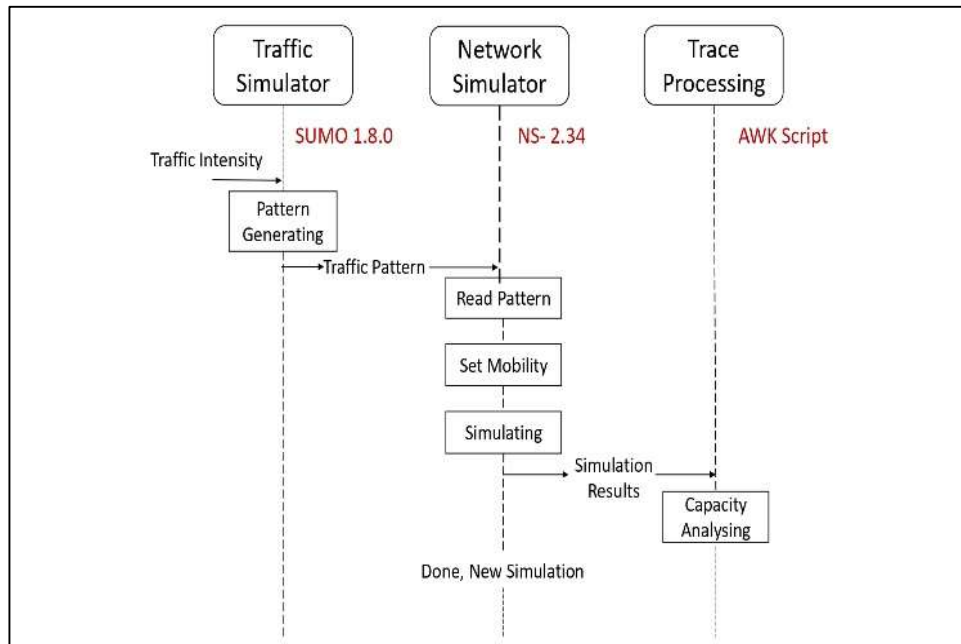
**Figure 3:** Vehicle behavior using SUMO and OSM Wizard.

SUMO is a real-time traffic simulator used to investigate research in vehicular ad-hoc networks. this framework is used in different projects to simulate automatic driving or transportation management strategies.

**Table 1:** VANET Simulation Parameters.

Parameters	Value
Channel type	Wireless
Network Simulator	NS-2.34
Traffic Simulator	SUMO
Map Model	COEP/Sancheti Bridge, Shivaji Nagar, Pune.
Routing Protocol	AODV
Transport Protocol	TCP, UDP
MAC Type	IEEE 802.11
PropagatioModel	Two Ray Ground
No. of nodes	20/ 40/ 60 (Total 100)
Min. speed	1 km/hr
Max. Speed	40 km/hr
Application type	CBR
Simulation time	100 sec
Time step	0.1 sec

Various parameters of VANET simulation are shown in Table 1. With a network density of 100 vehicular nodes, we have made a traffic situation utilizing SUMO and coordinated the map into NS-2. The Trace exporter file created by SUMO is traded to NS-2 for investigating the network parameters. The accompanying figure shows the way toward incorporating the traffic simulator system and network simulator;



**Figure 4:** The process of integrating traffic simulator and network simulator.

Utilizing SUMO varying topology pattern is produced. The produced traffic design is then incorporated with Network Simulator-2 (NS-2) with the assistance of Netconvert and Net.Polyconvert. The code is open source with the goal that the examination local area can alter it according to prerequisite. NS-2 backings the quantity of hubs up to 20000 with the goal that it is simpler to examine the outcomes for a real-time.

In the wake of incorporating traffic design with Network Simulator, We will make an awk content for dissecting and plotting the consequences of quality of service parameters like delay, throughput, packet delivery ratio, end-to-end delay, and so on.

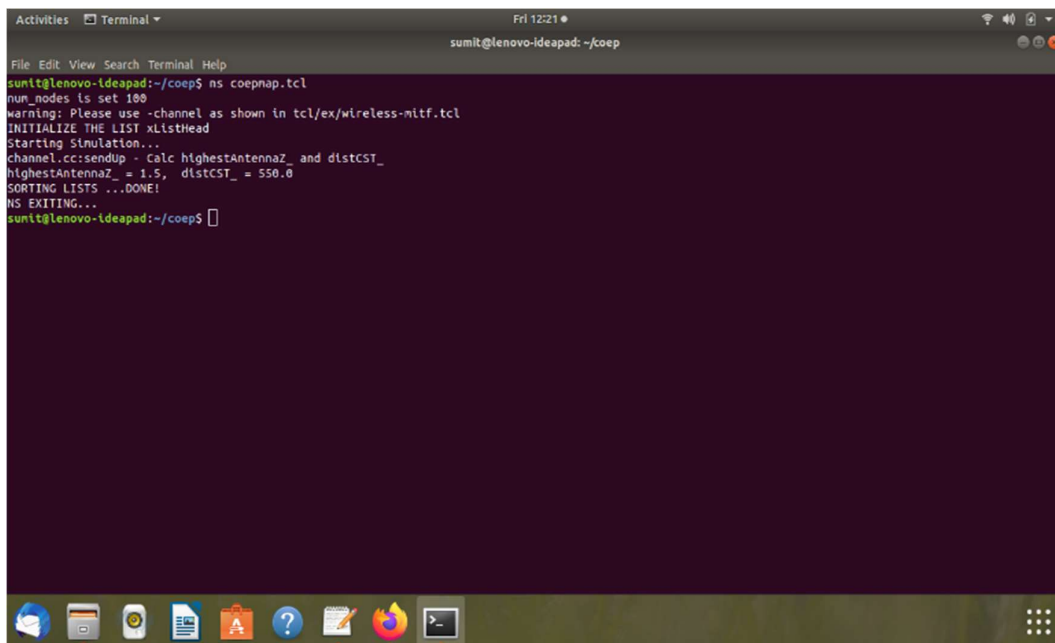
The tcl file is to be modified and need to set network parameters like Channel type, Transport protocol, MAC type, propagation model, number of nodes, speed, Application type, etc.

The tcl file can be changed according to client prerequisite and can be controlled by utilizing NS-2 simulator by providing the accompanying command:

```
$ ns filename.tcl
```

If your code is correct then you will get NS Sorting List...Done message.

The following figure illustrates how to run tcl script in NS-2;



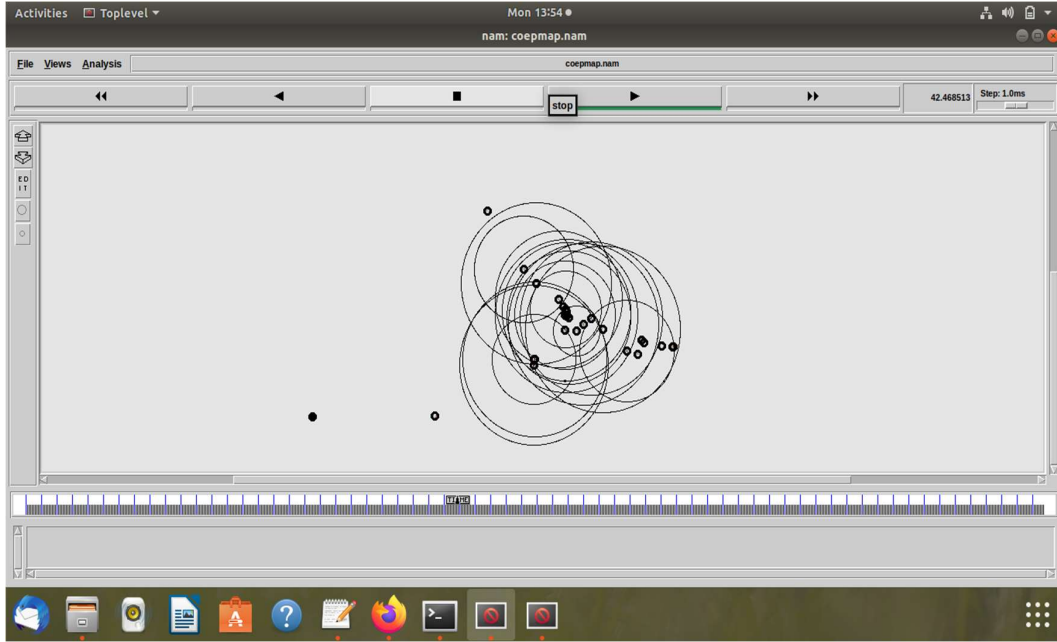
**Figure 5:** Running the tcl script using NS-2.

The next step is to visualize the animation of your tcl script by using NetAnimation with the help of the following command:

```
$ nam filename.nam
```

NetAnim is an offline animator which animates XML trace files and user can observe the animation with the help of its GUI.

The following figure demonstrates the simulation of the selected map with the help of Net Animation (NetAnim);



**Figure 6:** Simulation of traffic created by using SUMO with the help of Net Animation.

#### 4. Performance of QoS Parameters.

The performances of quality of service parameters are considered in terms of Packet Delivery Ratio, Throughput, End-To-End Delay, etc.

##### 1. Packet Delivery Ratio:

It is defined as the ratio of the number of packets received by the destination node to the number of packets sent by the source node. The higher the packet delivery ratio, the better the performance of the network is.

$$\text{pdr} = \frac{\sum Pr}{\sum Ps}$$

Equation 1

##### 2. Throughput:

It is characterized as the measure of information imparted from the source node to the destination node per unit time.

$$\text{Thr} = \frac{\sum_{i=1}^n Nbi}{Ti}$$

Equation 2

##### 3. End-To-End Delay:

It can be termed as the time occupied by the packet to be transmitted from the source node to the destination node.

## 5. Study of AODV Routing Protocol and Results

### 1. Throughput:

In the graph given underneath, we considered random waypoint mobility model. The propagation model considered is Two-Ray-Ground model and investigate the throughput. Likewise we considered TCP transport protocol since it has retransmission facility which would expand the throughput when contrasted with UDP transport protocol.

The accompanying figures shows the graph for throughput utilizing GNUPlot.

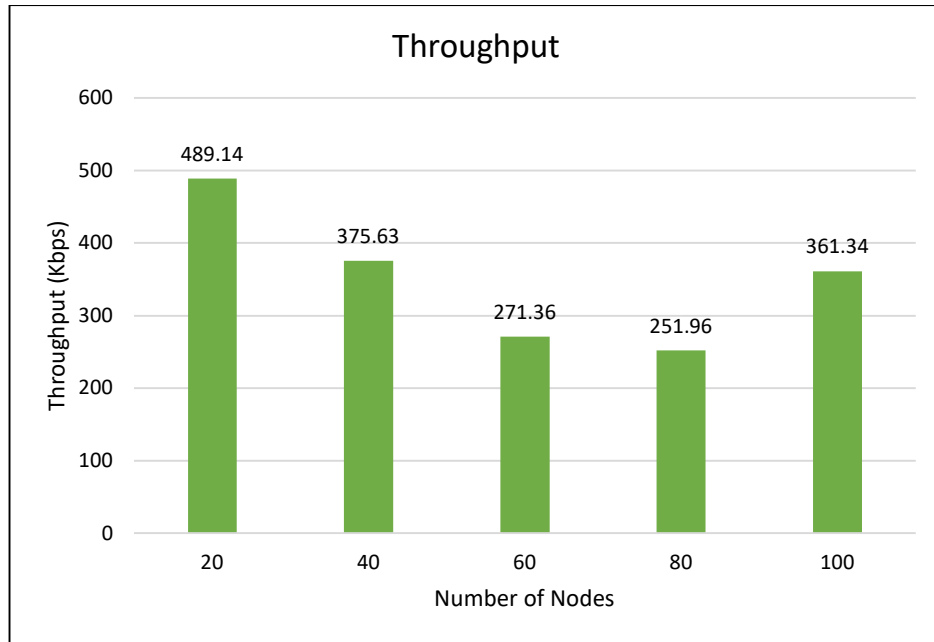


Figure 7 (a): Throughput.

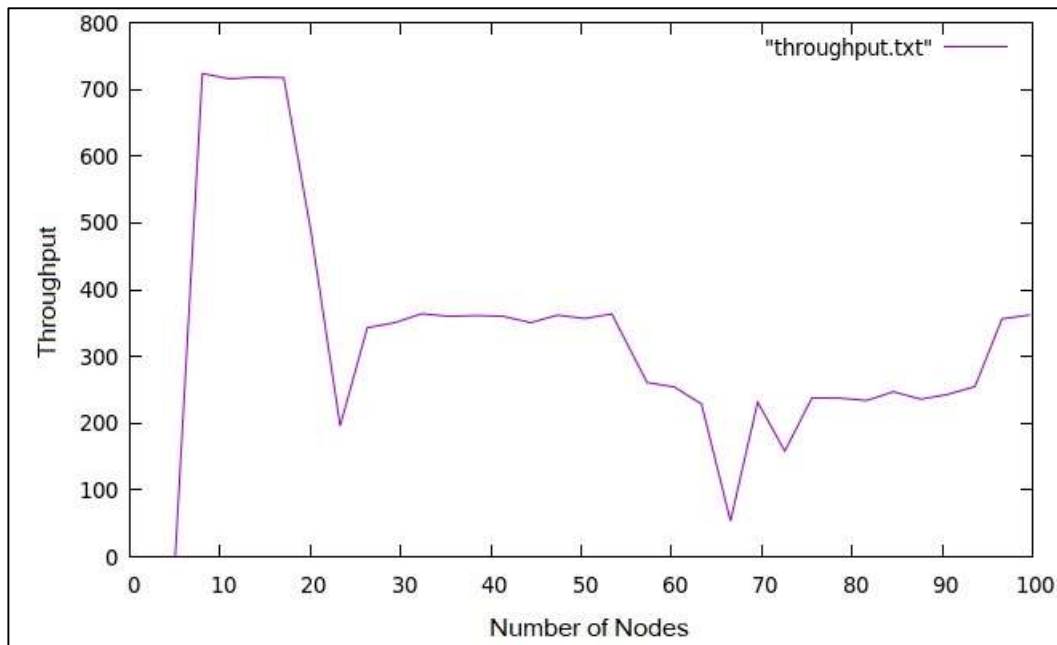


Figure 7 (b): Throughput using GNUPlot.



## 2. Packet Delivery Ratio:

The Packet Delivery Ratio can be observed by using GNUPlot for varying node density. Here, we acquired PDR=97.996596 for 100 moving nodes which is very better.

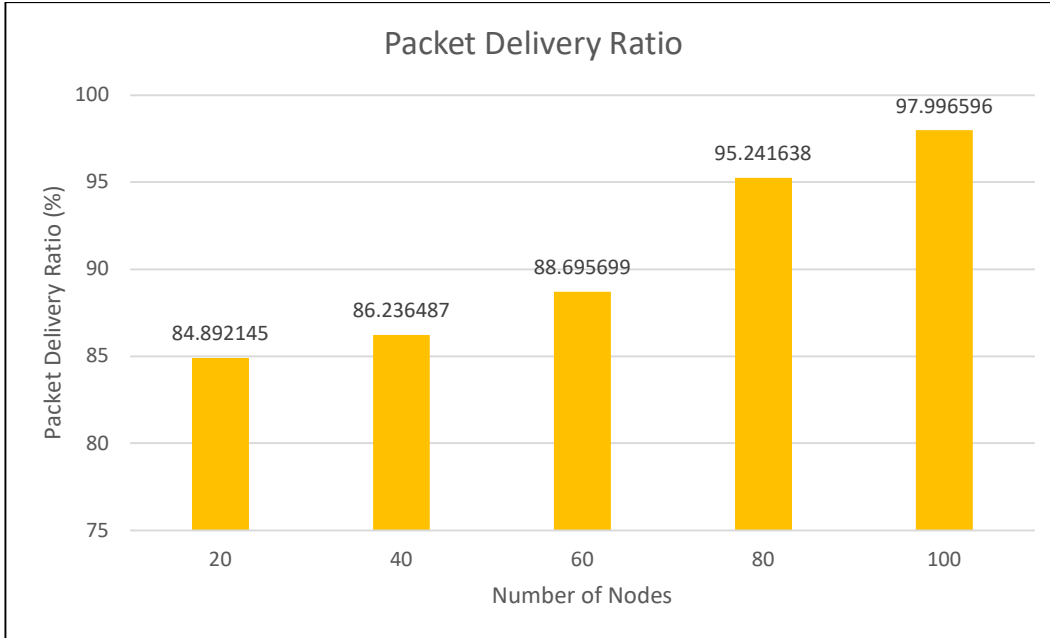


Figure 8 (a): Packet Delivery Ratio.

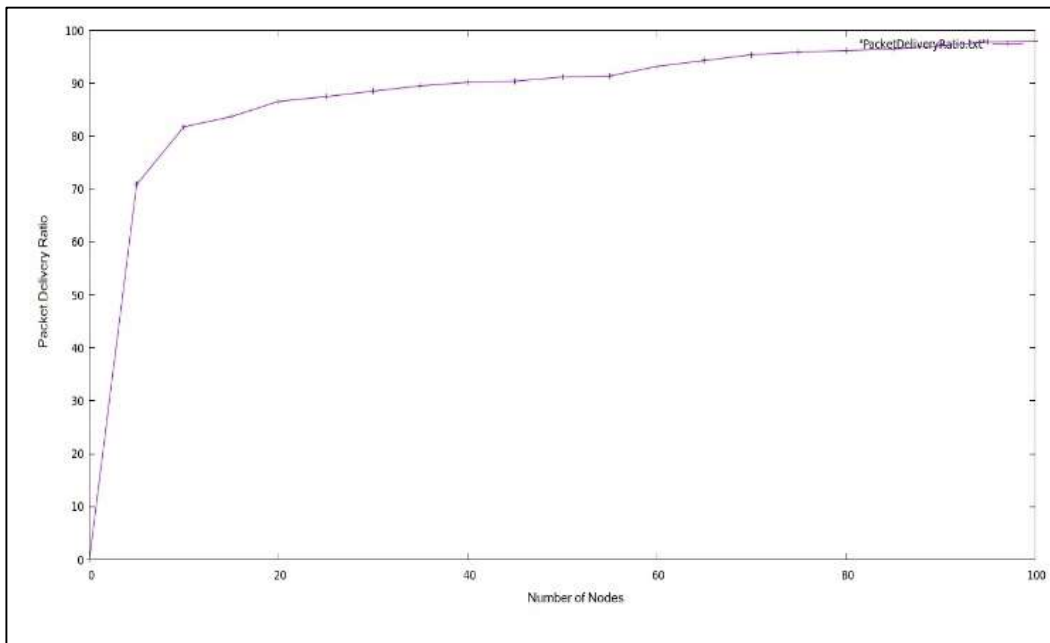


Figure 8 (b): Packet Delivery Ratio using GNUPlot.

## 6. Conclusion and Future Scope

The principle objective of this paper is to understand the VANET behavior for the real-time scenario. The detailed literature review is carried out in accordance to improve the quality of service parameters. We set up the real traffic scenario of COEP / Sancheti Bridge, Shivaji Nagar, Pune considering 100 node density which will help us analyzing performance metrics of VANET such as packet delivery ratio, end-to-end delay, throughput, etc. The main uniqueness of this paper is to implement a realistic movement scenario of vehicles and improving their network parameters with the help of SUMO and NS-2. We have selected the AODV protocol for improving its performance metrics because it can be applied to large-scale ad-hoc networks and its responses to link failure. In the future, we will concern about improving the security, mobility, and reliability of the VANET network using the AODV routing protocol.

## 7. References

- [1] M.V.S Phani Narasimham<sup>2</sup> Product Engineering Services Wipro Technologies Hyderabad, India phaninarasimham.mvs@wipro.com, “Secure Routing Protocol for VANETS using ECC”. PragathiYellanki<sup>1</sup> Stanley College of Engg. & Tech for Women Hyderabad, India ypragathi@stanley.edu.in, 2020.
- [2] Lina Zhu, Changle Li, Member, IEEE, Bingbing Li, Xinbing Wang, Senior Member, IEEE, and Guoqiang Mao, Senior Member, IEEE. “Complex network analysis of VANET topology with realistic vehicular traces”, 2020.
- [3] 1st Kim Youneng dept. Electrical Engineering and Information Technology Universitas Gadjah Mada Yogyakarta, Indonesia kimyouneng@mail.ugm.ac.id, 2nd I Wayan Mustika dept. Electrical Engineering and Information Technology Universitas Gadjah Mada Yogyakarta, Indonesia wmustika@ugm.ac.id, 3rd Selo Sulistyio dept. Electrical Engineering and Information Technology Universitas Gadjah Mada Yogyakarta, Indonesia selo@ugm.ac.id. 2019. “A Comparative Study Cluster-Based Routing Protocols in VANETS for City Environment”, 2019.
- [4] Ranjit Sadakale, Dept. of E & TC Engg., College of Engineering, Pune, [sadakaler.extc@coep.ac.in](mailto:sadakaler.extc@coep.ac.in), Akshay Bhosale, Dept. of E&TC Engg, College of Engineering, Pune, [bhosalear17.extc@coep.ac.in](mailto:bhosalear17.extc@coep.ac.in), N V K Ramesh, Dept. of ECE, K L University Vijayawada, [nv.krishnaramesh@gmail.com](mailto:nv.krishnaramesh@gmail.com), “Performance Analysis of Traffic Types in AODV Routing Protocol for VANETS”, 2019.
- [5] BENGAG Amina MATSI Laboratory, ESTO Oujda, Morocco Email: [engag.amina@gmail.com](mailto:engag.amina@gmail.com) & ELBOUKHARI Mohamed MATSI Laboratory, ESTO Oujda, Morocco Email: [elboukharimohamed@gmail.com](mailto:elboukharimohamed@gmail.com). “Performance evaluation of VANETS routing protocols using SUMO and NS3”, 2018.
- [6] Simulation and Analysis of AODV routing protocol in VANETS, Rajeev Paulus, Aditi Agrawal, Neelesh Agrawal. 2018.
- [7] Pandey, V. Deep, and P. Sharma. “Enhancing ADOV routing protocol for Vehicular Ad Hoc Networks”. In: 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN). Feb. 2018.
- [8] K. M. A. Alheeti and K. McDonald-Maier. “An enhanced DV protocol for external communication in self-driving vehicles”. In: 2017 Seventh International Conference on Emerging Security Technologies (EST). Sept. 2017.
- [9] Barakat Pravin Maratha, Tarek R Sheltami, and Khaled Salah. “Performance Study of MANET Routing Protocols in VANET”. In: Arabian Journal for Science and Engineering 42.8 (2017).
- [10] S. Mittal et al. “Improvising-AODV routing protocol by modifying route discovery mechanism in VANET”. In 2017 3rd International Conference on Advances in Computing, Communication Automation (ICACCA) (fall). Sept. 2017.

- [11] J. J. Ferronato and M. A. S, "Analysis of Routing Protocols OLSR, AODV, and ZRP in Real Urban Vehicular Scenario with Density Variation", IEEE LATIN AMERICA TRANSACTIONS, VOL. 15, NO. 9, SEPTEMBER 2017 Trentin.
- [12] Khattab M. Ali Alheeti, Klaus McDonald-Maier, 2017 Seventh International Conference on Emerging Security Technologies (EST). "An enhanced AODV protocol for external communication in self-driving vehicles", 2017.
- [13] Pranav Kumar Singh Assistant Professor, Department of Computer Science & Engineering Central Institute of Technology (CIT), BTAD, Kokrajhar, Assam-783370, India. "Influences of Two Ray Ground and Nakagami Propagation Model for the Performance of Adhoc Routing Protocol in VANET", 2012.
- [14] VANET Routing Protocols: Pros and Cons, Bijan Paul, Md. Ibrahim, Md. Abu Naser Bikas, Dept. of Computer Science & Engineering, Shahjalal University of Science & Technology, Sylhet, Bangladesh. 2011.
- [15] Moez Jerbi, Member, IEEE, Sidi-Mohammed Senouci, Member, IEEE, Tinku Rasheed, and Yacine Ghamri-Doudane, Member, IEEE. "Towards efficient geographic routing in urban vehicular networks", 2009.
- [16] Feliz Kristianto Karnadi\_ Zhi Hai Mo\_ Kun-chan LAN†\_ School of Computer Science and Engineering University of New South Wales Sydney, NSW 2052, Australia {fkka085, zhmo487}@cse.unsw.edu.au †National ICT Australia Ltd Bay 15, Australian Technology Park Eveleigh NSW 1430, Australia Kun-han.Lan@nicta.com.au, "MOVE: A MObility model generator for a Vehicular network", 2009.
- [17] "CMC", ACM SIGOPS Operating Systems Review Madanlal Musuvathi, David Y. W. Park, Andy Chou, Dawson R. Engler, David L. Dill, 2002
- [18] NAM (Network Animator).  
URL: <http://www.isi.edu/nsnam/nam/>
- [19] Network Simulator-2.  
URL: <https://www.isi.edu/nsnam/ns/>
- [20] NETWORK SIMULATORS.  
URL: <https://www.nsnam.com/>
- [21] NS- Tutorial for Beginner.  
URL: <https://slogix.in/introduction-to-ns2/>
- [22] SUMO- User Documentation  
URL: <https://sumo.dlr.de/docs/index.html/>