Performance Analysis of Mobile Ad Hoc Routing Protocols in Vehicular Ad Hoc Networks using NS3

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ABSTRACT

Vehicular Ad hoc Networks (VANET) is an emerging technology that brings tremendous technological advancement in the method of communication among smart vehicles. Due to its complex infrastructure and vehicle speed, data routing remains difficult at VANET. A VANET is also considered similar to Mobile Ad Hoc Network (MANET), and MANET routing protocols can be adapted for VANETs for performance evaluation. In this work, we have selected a real world scenario from our locality with high traffic issues, Nanthoor Mangalore City Karnataka, India and a Map is generated using Open Street Map using SUMO and the MANET routing protocols AODV, OLSR, DSDV and OLSR are evaluated using NS3.

Keywords: Routing protocols, AODV, DSDV, OLSR, DSR, Good Put, PDR.

1. INTRODUCTION :

The VANET is a network, formed when there is a need arises among vehicles for the communication, and to exchange safety messages to avoid accidents and traffic jams [1]. Since the VANET wireless range is available for communication for only a few hundred meters, the unavailability of wireless range after hundreds of meters requires a data packet to hop through several network nodes [1]. VANET's also popularly known as Intelligent Transportation System (ITS) that provides safety for the drivers and comfort for the passengers. To provide such safety features VANET requires an efficient routing protocol by which vehicles can share safety messages [2]. The advent of VANET is due to the increase in the number of vehicles and increase in road accidents, which led to the development of wireless access in vehicular environment (WAVE), a standard used by US government, and it is also known as dedicated short-range communications (DSRC) for Intelligent Transport Systems (ITS) [3]. WAVE is the main part of DSRC. The collection of vehicle nodes (VN) tending to communicate forms a VANET, The VN is a vehicle equipped with Board Units (OBU), and a fixed node called Road Side Units. In VANET three types of scenarios can be seen, Vehicle to Vehicle (V2V), Vehicle to Roadside (V2R) and Road Side to Road Side (R2R) [3-6]. The WAVE protocol has another standard called IEEE802.11 [3], which is a commonly used standard for network communication in vehicular AdHoc Networks [7-10]. An updated variant of IEEE 802.11 is also available, known as IEEE 802.11 p and IEEE 802.111609, which primarily supports WSM (WAVE Short Messages) [8-11]. In this research paper, we picked a real world scenario and conducted a position simulation for Nanthoor, Mangalore City in Karnataka state, India. Selected Scenario is a Mangalore traffic-packed area, and this traffic includes all kinds of vehicles, including cars, buses, trucks, and motor bikes as shown in figure 1. Here, real world map is converted to SUMO format and then analysed using NS3. In NS3, we have analysed the MANET routing protocols such as AODV, DSDV, DSR and OLSR in VANET and generated results such as ratio of packets received, packets received, packet delivery ratio, MAC Overhead and AverageRoutingGoodput.

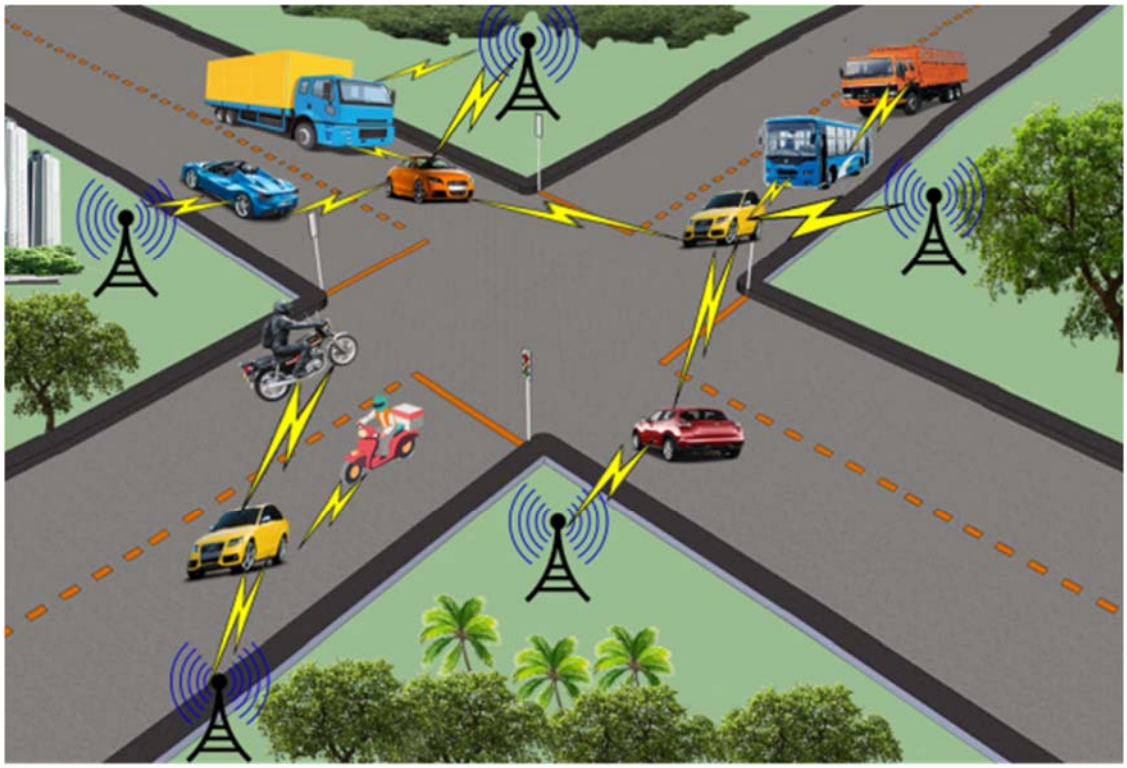

Fig. 1: A scenario of VANET architecture in Nanthoor, Mangalore City.

2. RELATED WORKS :

In the area of vehicular ad hoc networks, numerous studies have been conducted. These studies mainly focus on the timely propagation of safety messages from one vehicle to another. The delay in transmission of messages is due to the traffic congestion of the vehicles mainly in urban areas, and a realistic traffic environment scenario in highly dense areas will require, long duration for performance analysis. So, use of network simulator helps perform effective research in VANET. In this paper, we have used network simulator called NS3 and SUMO for the performance analysis and evaluation of Ad hoc network protocols. Many researchers have also conducted tremendous research in this area, a MANET routing protocol is compared and analyzed for VANET and this study states that the MANET routing protocols are not sufficient and suitable for VANET, this paper also found that AODV performs better than other protocols of MANET for VANET [12]. A protocol called GPSR has been proposed that effectively maximizes the delivery ratio without raising the usage of electricity. The Greedy Perimeter Stateless Routing (GPSR) is also compared with MANET routing protocols by adapting the protocols in VANET [13]. LAR1, AODV, and DSR protocols was evaluated and reported that Location Aided Routing 1 (LAR1) outperforms in packet delivery ratio in sparse conditions than other protocols [14]. OLSR and AODV protocols was compared and analysed and concluded that these protocols are well suited for single cross road but not for multiple cross roads [15]. Adaptive Distance Vector algorithm (ADV) was proposed and compared both the ADV and Adhoc On Demand Vector (AODV) protocols and reported that the packet drop is high in both protocols due to obstacles and stated that the absence of RSU can cause glitches in the communication [16].

3. OBJECTIVES OF THE STUDY :

The objectives of this study are to compare and analyze the performance of Mobile Ad Hoc Networking protocols based on a realistic scenario of VANET from our locality and to find the efficiency of MANET protocols based on its applications such as safety, collisions and delay in data transfer. The

main objective also includes the quantitative analysis of different metrics based on the selected scenario, and the analysis metrics are listed below.

- Comparison of received rates among protocols DSDV, DSR, AODV and OLSR.
- Comparison of Packet received of OLSR, AODV, DSDV and DSR protocols.
- Comparison of Packet delivery ratio of OLSR, AODV, DSDV and DSR protocols.
- Comparison of MAC/PHY Overhead of OLSR, AODV, DSDV and DSR protocols.
- Comparison of Average Routing Good put of OLSR, AODV, DSDV and DSR protocols.

As a result of the analysis a study can evaluate a performance of a protocol and its efficiency.

4. SIMULATION SETTINGS :

The simulation is performed using two simulators called NS3 and SUMO, which can be interconnected to generate our scenarios. NS3 is a discrete event network simulator and less expensive than realistic scenarios, also provides an efficient modularity development environment. Simulation of urban mobility (SUMO) [17] is the road traffic simulator and to integrate, a Traffic control Interface (TaCI) used to implement the communication between SUMO and NS3, [18]. In our simulation, we have selected different protocols such as AODV, DSR, OLSR and DSDV with our simulation scenario.

5. TRAFFIC SIMULATION :

The SUMO traffic simulator is used to generate traffic based on a real map, which can be exported from OpenStreetMap (OSM) [19], as seen in figure 2 and later, the same trace file is used as an input to the NS3. In our traffic simulation osm web wizard is used and the position for the simulation selected is from our own locality Nanthoor, Mangalore, India. The selected scenario is Cross Street Road, a road formed by intersecting NH 66 and Solapur Mangalore Highway. This cross street road is highly dense during peak hours and creates unbearable traffic issues. In the simulation, vehicles such as cars, bus, trucks and motor bikes are chosen and the duration of the simulation is 100 seconds. The xml file is generated and processed once the simulation is completed. The xml file is created during the traffic simulation is then converted as Tcl file using Python. The number of nodes created during the simulation is 27 and total simulation time taken is 255 seconds.

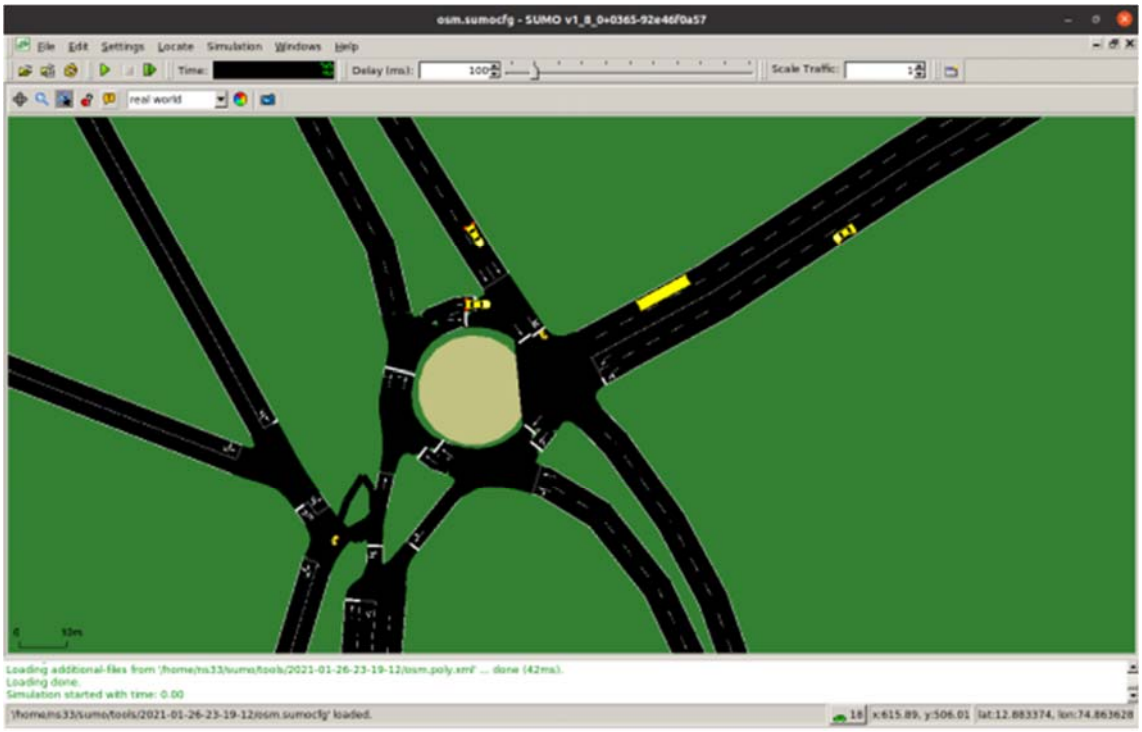

Fig. 2: A detailed view of Nanthoor Junction using SUMO simulator.

6. NETWORK SIMULATION :

Network Simulator for our scenario, we have chosen NS3 and Wi-Fi is IEEE 802.11p with continuous access to a 10 MHz control channel. Two ray ground reflection models are used as propagation model and nodes are moving according to TwoWaypoint Mobility Model. In our network simulation, two simulation scenarios are used, scenario 1 generates 40 nodes (vehicles) and completes the simulation in 10 seconds. Furthermore, in Scenario 2, trace file generated during the traffic simulation is given as the input and a log file is created, traffic generator created, 27 nodes which will be assigned, and csv file is generated because of scenario 2. Network animation of the scenarios is presented in figure 3, by which more statistics of the scenario can be obtained.

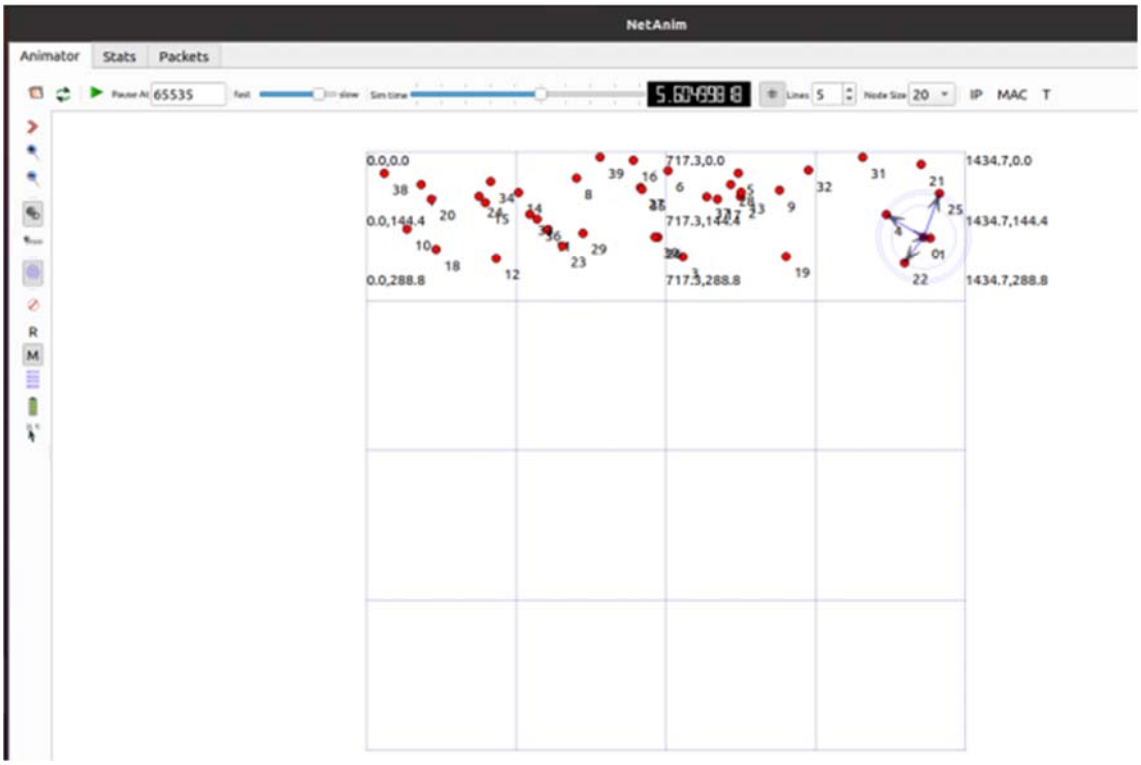

Fig. 3: Network Animation of 40 nodes using NS3 and NetAnim.

7. RESULTS AND DISCUSSIONS :

We assessed and compared the performance of the MANET routing protocols, and the different metrics of the routing protocols. We have analysed 4 routing protocols in network simulation and its simulation parameters are reported in Table 1.

Table 1: Simulation Parameter.

Parameter	Value
Area (m*m)	300 x 1500 m
Simulation Time(s)	500 Seconds
Speed (m/s)	20 m/s
MAC type	802.11 p MAC
Traffic type	Two-Ray Ground
Packet size	64 byte packets
Protocols	OLSR, AODV, DSDV, DSR
Mobility Model	RandomWayPoint Mobility Model

The rate of packets received varies from protocol to protocol, the simulation is performed for 27 vehicles for 500 seconds and Fig. 4 shows how receive rate varies from one protocol to other. The simulation

result shows that after 200 seconds, the protocol DSR's receives rate is stable, and AODV has a high performance compared to other protocols. In this result, it can also be concluded that the performance for AODV protocol is remarkably high.

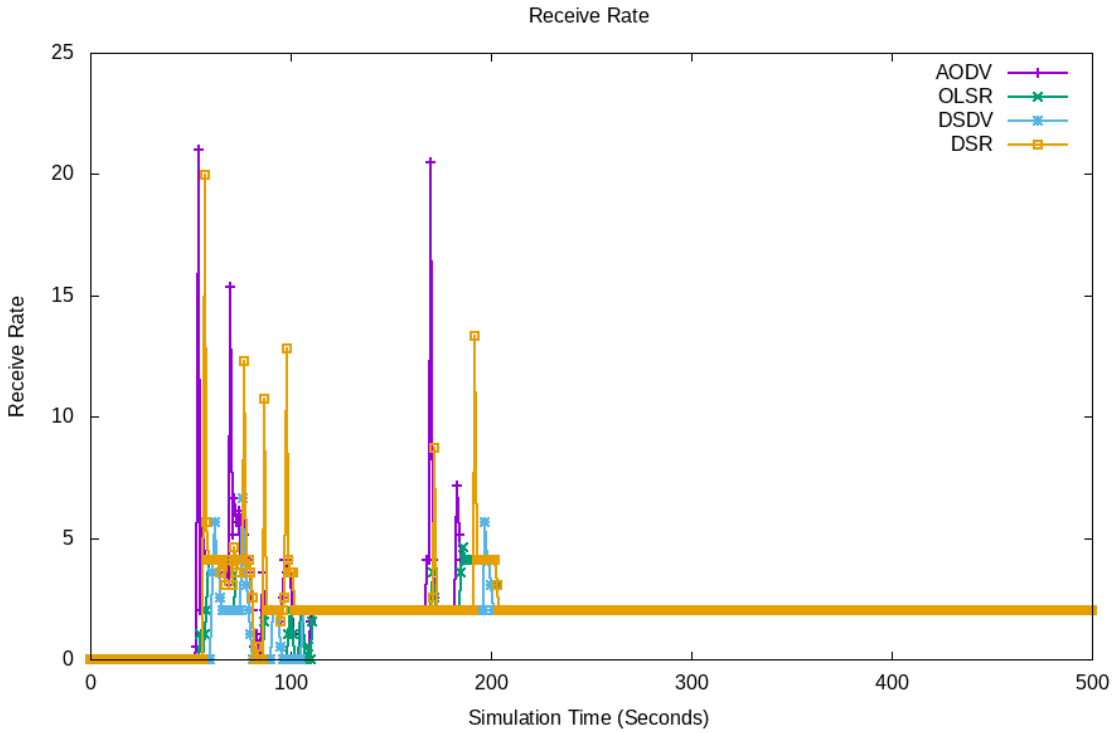

Fig. 4: Comparison of Received rate of OLSR, AODV, DSDV and DSR protocols.

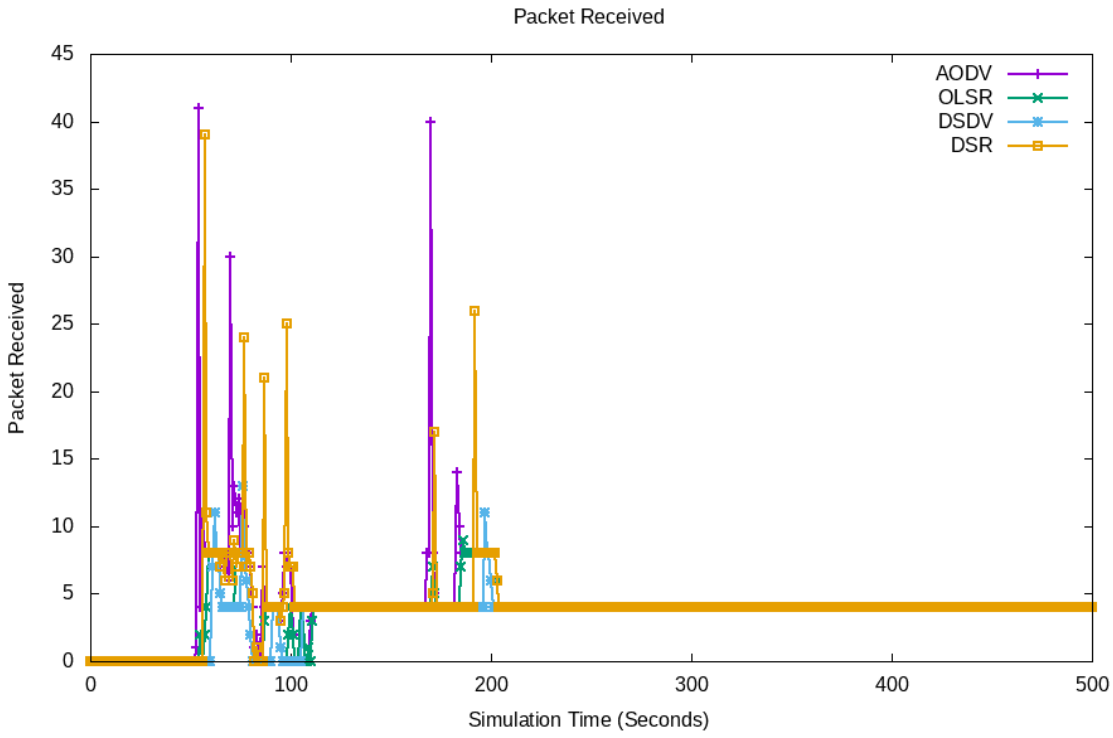

Fig. 5: Comparison of Packet received of OLSR, AODV, DSDV and DSR protocols.

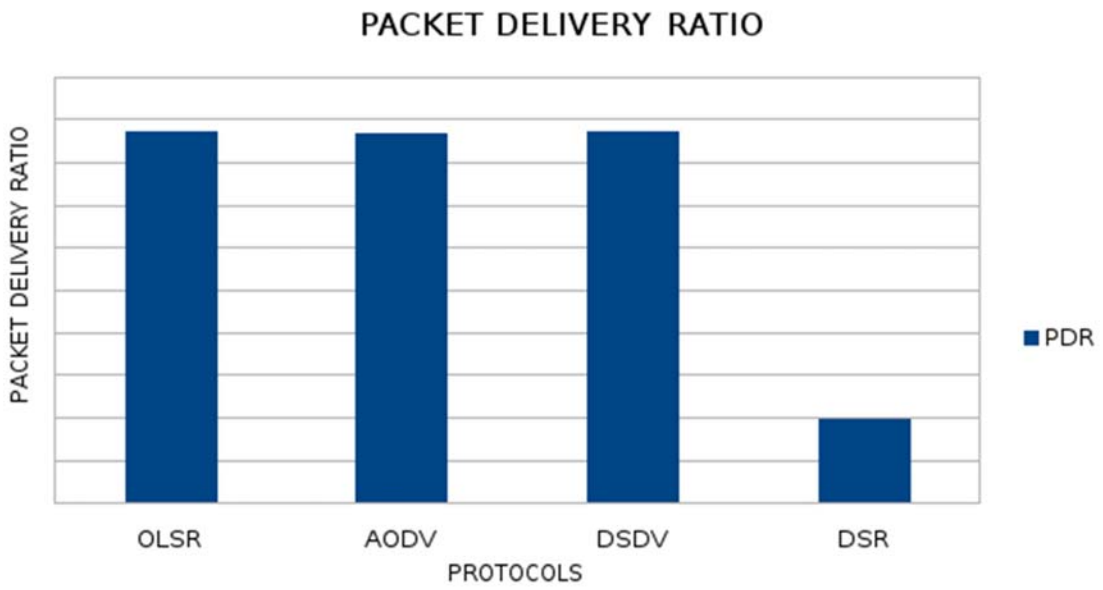

Fig. 6: Comparison of Packet delivery ratio of OLSR, AODV, DSDV and DSR protocols.

A comparison of the distribution ratio of packets to all four protocols shows that all three protocols packet delivery ratio is good at the simulation as shown in figure 6, except for DSR protocol.

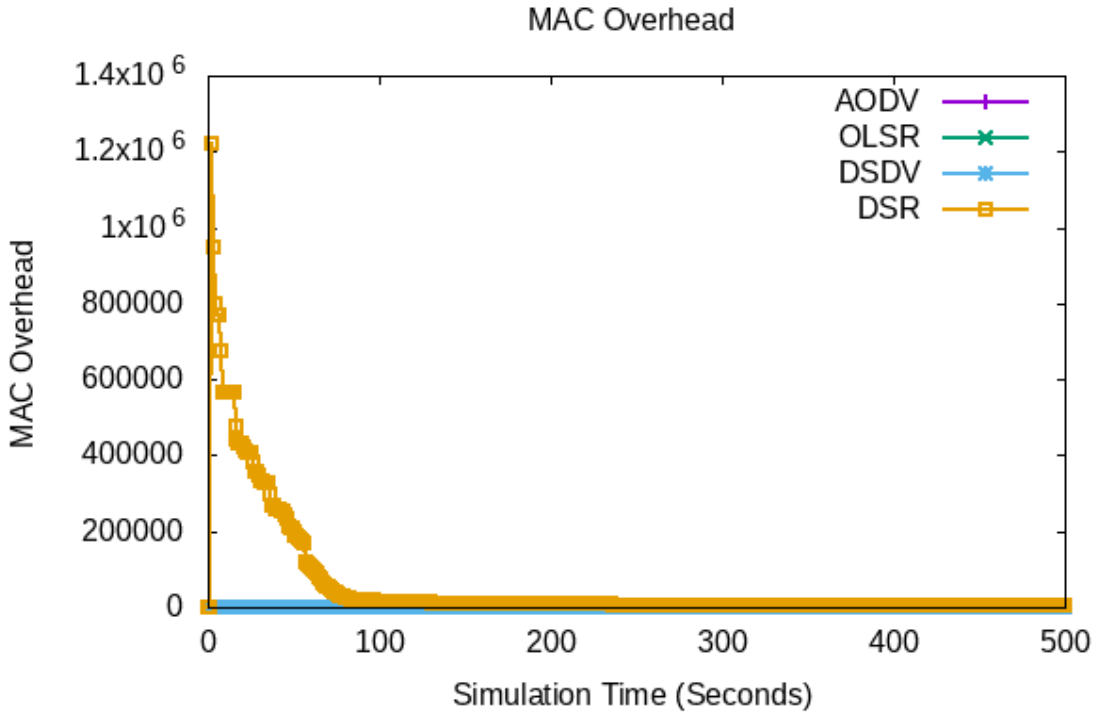

Fig. 7: Comparison of MAC/PHY Overhead of OLSR, AODV, DSDV and DSR protocols.

MAC/PHY Overhead is related to effective usage of the bandwidth, MAC/PHY Overhead is less, and then more data can be sent in each packet [20-23]. In our simulation result, it is shown in Fig. 7 that the protocols AODV, OLSR, and DSDV have less or zero MAC/PHY Overhead compared to DSR protocol.

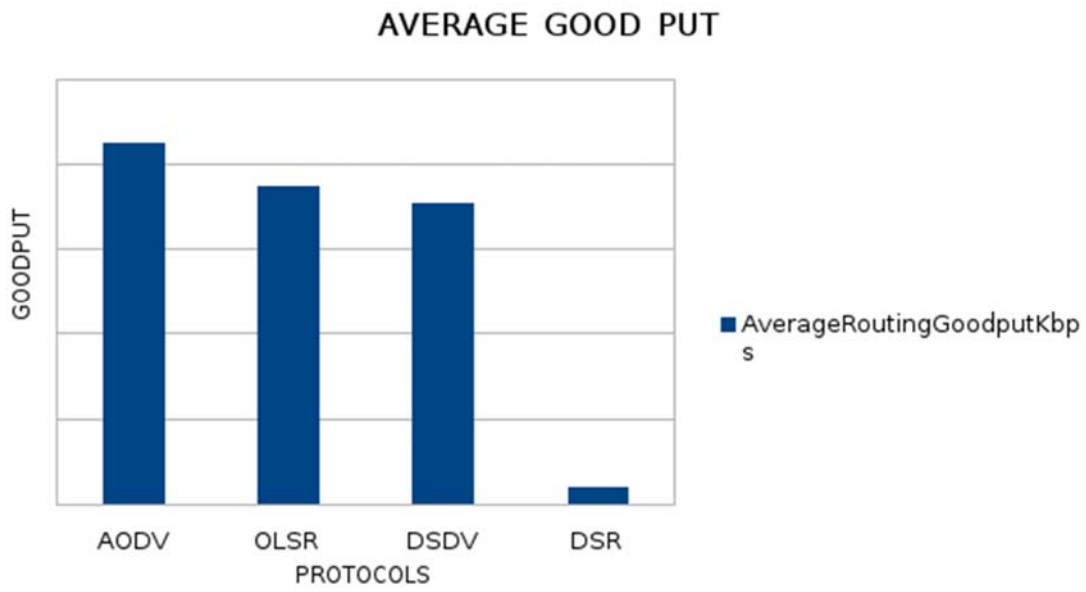

Fig. 8: Comparison of Average Routing Good put of OLSR, AODV, DSDV and DSR protocols.

Average Routing Good put is not the same as the throughput, because in throughput, information such as retransmission and overhead is involved, but Good put contains only necessary information [24]. In our simulation, the average Routing Good put is high for AODV as shown in figure 8, when compared with other protocols [25-27].

8. CONCLUSION :

In this research paper we have chosen realistic scenario at Nanthoor, Mangalore City in Karnataka, India and performed, brief analysis of MANET routing protocols in VANET and possible quantitative metrics are analysed. By the analysis it can be concluded that AODV has higher performance than other protocols, and the MANET routing protocol can be adapted for VANET, also the AODV performs efficiently for high density traffics since our simulation has taken scenario from our locality at Nanthoor, and with the help of simulator, it was possible to evaluate the performance of the protocols and identify that AODV protocol is efficient than other protocols in all performance metrics.

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