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Performance Analysis of Routing Protocols in Vehicular Ad Hoc Networks for Cbr Applications Over Udp Connections

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Abstract: ***In this paper, the performance of routing protocols DSDV, OLSR and AODV using performance metrics like Packet Delivery Ratio, Average End to End delay, Packet Loss Ratio and Average Throughput within Vehicular ad hoc networks for CBR applications over UDP connection has been analyzed. Network Simulator (NS-3.19) along with mobility model generated through Simulation of Urban Mobility (SUMO) tool is used for analysis. The results are analyzed by varying node density in the network. The comparison shows that reactive protocol AODV performs better as compared to DSDV and OLSR proactive routing protocols for vehicular ad hoc networks.***

Keywords: VANETs, NS-3.19, SUMO, AODV, DSDV, OLSR, CBR, UDP

1. INTRODUCTION

Vehicular Ad hoc Networks (VANET) is the emergent technology. VANETs are distributed, self-organizing communication networks. Each vehicle acts as a node within VANET. Vehicular Ad-hoc Networks are used for communication among vehicles and between vehicles and roadside equipments. Some characteristics that distinguish VANET from MANET are [1]:

- High mobility of vehicles leads to extremely dynamic topology.
- Regular movement, restricted by both road topologies and traffic rules.
- Vehicles are usually aware of their position and spatial environment.
- Vehicles have sufficient power, computing and storage capacity.

VANETs focuses on the improvement of Intelligent Transportation System (ITS) in order to provide a wide spectrum of applications, including safety applications like to avoid road accidents, traffic jams, speed control, free passage of emergency vehicles and unseen obstacles etc. Besides safety applications VANET also provide comfort applications to the road users. For example, weather information, mobile e-commerce, internet access and other multimedia applications [2]. There are many difficulties in VANETs systems design and implementation, including: security, privacy, routing, connectivity, and quality of services.

The objective of this paper is to perform the simulation of routing protocols to analyze their applicability in VANET environment by generating a real scenario mobility model with vehicular constraints. Rest of the paper is organized as follows: Related work is presented in section 2, while section 34 presents proposed work and methodology; Simulation results and performance analysis is explained in section 4. Finally, some conclusions are drawn from results obtained through simulations conducted and outline of the future works.

2. RELATED WORK

Research work is still going on in the field of vehicular ad hoc network such as designing new VANET routing protocols for a particular application, analyzing and improving the existing ones. Routing protocols are classified on the basis of routing information and transmission strategy by Altayeb et al. [3]. Lin et al. [4] surveyed and classified VANET routing protocols as unicast protocols, multicast protocols, geocast protocols, mobicast protocols, and broadcast protocols. Cabrera et al. [5] presented a set of issues and their solutions which are common to many VANET routing protocols such as ideal transmission range assumption problem, use of stale information in geographic protocols as time of exchange of information depends on beacon interval and criterion to optimize trajectory-based protocols. Kim et al. [6] proposed a protocol for VANET that identifies more reliable paths by predicting the existence of candidate relay nodes when the link expiration time (LET) passes which reduces the frequency of route failures and data loss. If the node finds no candidate relay node then the data is rerouted to a different block.

Spaho et al. [7] describes the various existing mobility models such as Random Waypoint Model, Manhattan Model etc. used in ad hoc networks as well as compare the various mobility simulators, network simulators and integrated simulators for VANET. SUMO [8] is a powerful open source mobility simulator. It is written in C++. It is intended for traffic simulation close to the real scenario. VanetMobiSim [9], an extension to Canu-MobiSim, is also a traffic simulator capable of producing realistic vehicular mobility traces for several network simulators. Ana et al. [10] presents a novel mobility model in which movement patterns are generated by considering the social relationship between individual drivers. The basic idea is that each vehicle's initial and final points are known. The vehicles have same destination has high degree of social relation and there is more probability that they remain geographically collocated.

There are several papers that analyze the effect of different road scenarios on the VANET routing protocols. The one related to this is presented in [11]. In this paper, AODV, Bellman Ford and DSR routing protocols for V2V communication in urban scenario are implemented using QualNet VANET scenario. The performance of the Bellman ford routing protocol is concluded better than AODV and DSR as it has lowest end to end delay. Nidhi et al. [12] deployed a real world fragment for studying the impact of mobility using AODV protocol in the VANET. From paper it is concluded that traffic lights become an obstacle since nodes drops the packets at intersections due to the large number of transmission at the same time which can be avoided by using roadside units.

The routing protocols AODV, DSDV and OLSR are used in our simulation. AODV is a reactive routing protocol [13] works purely on demand basis. AODV builds routes using a route request / route reply cycle along with sequence numbers.

The destination sequenced distance vector routing protocol (DSDV) [14] is a table driven or proactive routing protocol. In DSDV each node maintains routes to all destinations well in advance. Each entry in the routing table is marked with a sequence number initiated by the destination node to distinguish stale routes from the new ones which help in avoiding loops in routes.

OLSR [15] is a table driven, proactive protocol based on the concept of Multi point Relays (MPR). Each node selects a set of its neighbor nodes as "multipoint relays" (MPR). In OLSR, only nodes, selected as MPR, are responsible for forwarding control traffic, intended for diffusion into the entire network.

3. PROPOSED WORK & METHODOLOGY

To generate mobility model, SUMO (Simulation of Urban Mobility) traffic simulator [17] is used. The steps to implement a VANET mobility model, traffic simulation will be as generation of road map and then vehicular traffic on the map.

For mobility model, a network of size (1700m x 1000m) is considered. In the investigated area five vehicle types (Cars A, B, C and D and Bus) are considered for the flow of traffic of different speed (20 to 50 Km/hr) and different length. All drivers are 50% perfect in driving is assumed. Each vehicle samples a target destination and path to reach that destination. Right-of-way rule is used to resolve conflict at intersection.

To evaluate the performance of routing protocols a network simulator NS-3.19 [16] is used. For simulation purpose a realistic mobility model is generated using SUMO tool and used. In simulations, the node density as 12, 24, 36, 48 and 60 with constant pause time of 10s is varied. The different network parameters used for network simulation for routing protocols are given in the Table I.

Table I: Various parameters used in the simulation of routing protocols.

Simulation Parameters	**Value**
Network Simulator	NS-3.19
Traffic Simulator	SUMO- 0.15.0
Routing Protocols	AODV, DSDV, OLSR
Simulation Area	1700m x 1000m
Number of Nodes	12, 24, 36, 48, 60
MAC Protocol	IEEE802.11
Propagation Loss Model	Friis
Simulation Time	300 sec.
Connection Type	CBR or UDP
Packet Size	512
Data Rate	1 Mbps
CBR Interval	10 sec.
Nodes Speed	20-50 Km/hr.

In this paper, the performance of routing protocols has been analyzed using metrics such as throughput, Packet Delivery Ratio (PDR), end-to-end delay and Packet Loss Ratio (PLR) defined below.

Throughput: It is the number of successfully delivered data bits per second over a network to the destination node. It is represented in kilo bits per second. Throughput,

$$\frac{\sum Number\,of\;Bytes\,\mathrm{Re}\,cieved\;at\,Destination * 8}{1024}(Kbps)$$

Packet Delivery Ratio (PDR): It is the ratio of the number of data packets received at the destination to the total number of packets sent.

$$\text{PDR} = \frac{Number\,of\;Packets\,\mathrm{Re}\,cieved}{Number\,of\;Packets\,Sent}$$

End-to-End Delay: The average time taken by a data packet to be transmitted across a network from source to destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations are counted. The lower the value of end to end delay means the better performance of protocol.

Packet Loss Ratio (PLR): Packet loss is the ratio of the number of packets lost during transmission to the total number of packets sent to the destination.

$$PLR = \frac{Number\ of\ Packets\ Lost}{Number\ of\ Packets\ Sent}$$

4. SIMULATION RESULTS AND PERFORMANCE ANALYSIS

In this work the performance analysis is carried out for a vehicular ad hoc network by varying parameter i.e. number of nodes as 12, 24, 36, 48 and 60 while keeping other network parameters constant. Three protocols i.e. AODV, DSDV and OLSR are taken for comparison of performance for UDP connection with CBR applications. As the connection is UDP so each packet travels independently of the other. The performance metrics defined above are used for analysis.

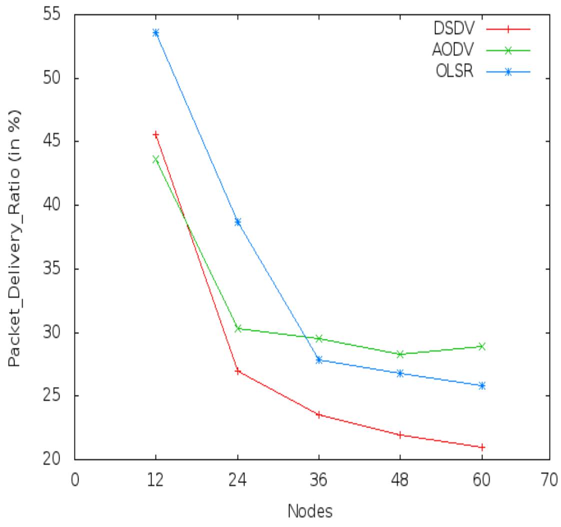

Fig. 1: Effect of node density on Packet Delivery Ratio.

In Figure 1, the packet delivery ratio (in %) which is the ratio of the number of packets received by the CBR sink to the number of packets sent by the CBR source, both at the application layer during simulations time versus the number of nodes changes is shown. The OLSR outperforms AODV and DSDV protocols when there are small number of nodes but AODV performance is best as node density increases. DSDV consistently has lowest Packet Delivery Ratio.

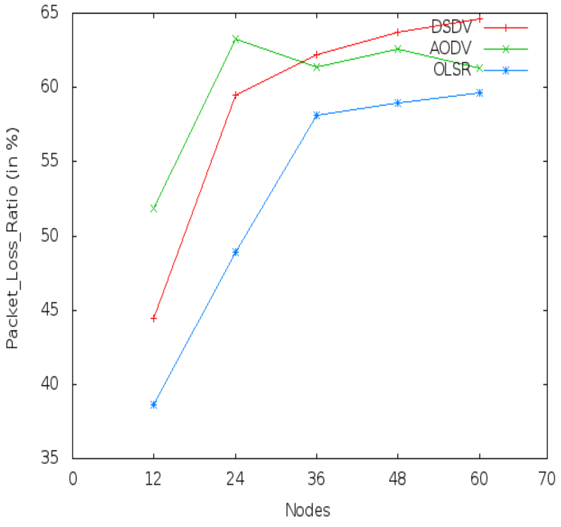

Fig. 2: Effect of node density on Packet Loss Ratio.

The packet delivery ratio decreases for all the protocols as the node density increases. However, increase in node density results in the increases of number of collisions and packet loss (in %) as shown in Figure 2. Packet loss ratio firstly increases speedily due to increase in the number of nodes and then gradually. DSDV has lowest packet loss ratio at higher node density.

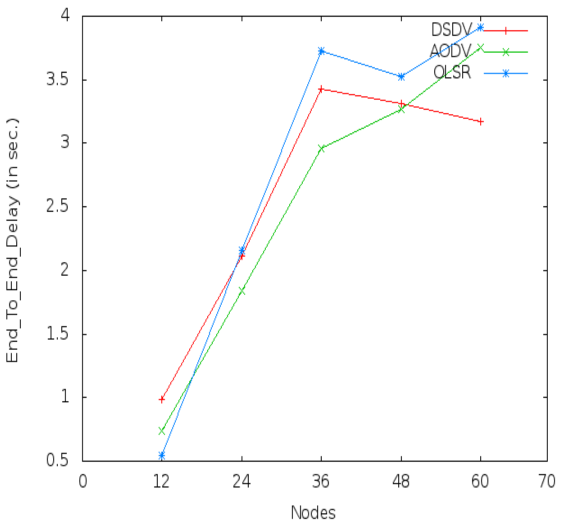

Fig. 3: Effect of node density on End to End Delay.

Figure 3 shows the variation of the average end to end delay (in sec.) by varying node density as 12, 24, 36, 48 and 60. Average end to end delay increases with increasing the number of nodes for all protocols. AODV performs best in terms of end to end delay in results. End to end delay of OLSR and DSDV is comparable throughout the simulation.

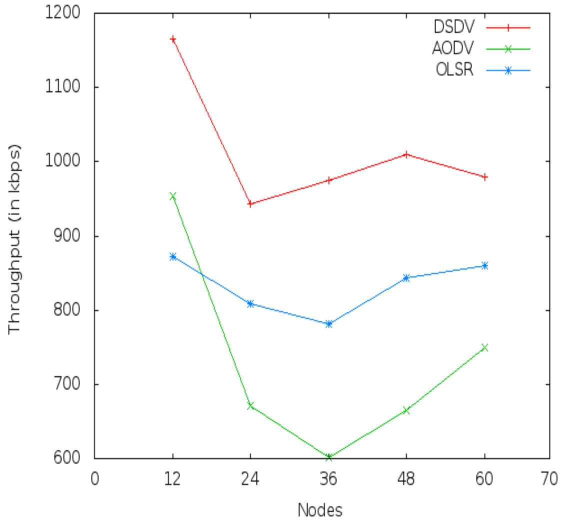

Fig. 4: Effect of node density on Throughput.

Figure 4 shows Throughput (in Kbps) of protocols by varying number of nodes from 12, 24, 36, 48 and 60. The AODV has lowest throughput in comparison with all the other two protocols considered. However throughput of all nodes first decreases and then increases with increase in node density. At 12 nodes throughput of AODV is more than OLSR but after that OLSR has higher throughput. DSDV shows higher throughput than AODV and DSDV since its routing overhead is more than others but the packet delivery ratio of AODV and OLSR is better than the DSDV.

5. CONCLUSIONS

In this paper, performance of three routing protocols AODV, DSDV and OLSR was evaluated for vehicular ad hoc networks by varying node density over UDP connection for CBR application against various metrics. The results shows that on demand routing protocol (AODV) performs slightly better than table driven routing protocols (DSDV and OLSR) in terms of packet delivery ratio and end-to-end delay. OLSR has highest packet delivery ratio at low node density and at high node density AODV has best packet delivery ratio. But AODV has lower throughput. So, AODV is best to be used in vehicular ad hoc network with high mobility.

For future work, we can study the effect of other network parameters on the performance of these routing protocols for vehicular ad hoc networks. Future work will also include the evaluation of position based routing protocols as they are more suitable in vehicular traffic environment.

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