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Impact of Node Density and Transmission Range on the Performance of OLSR and DSDV Routing Protocols in VANET City Scenarios

Yassine Meraihi, Dalila Acheli, Rabah Meraihi

Abstract**—**Vehicular Ad hoc Network (VANET) is a special case of Mobile Ad hoc Network (MANET) used to establish communications and exchange information among nearby vehicles and between vehicles and nearby fixed infrastructure. VANET is seen as a promising technology used to provide safety, efficiency, assistance and comfort to the road users. Routing is an important issue in Vehicular Ad Hoc Network to find and maintain communication between vehicles due to the highly dynamic topology, frequently disconnected network and mobility constraints.

This paper evaluates the performance of two most popular proactive routing protocols OLSR and DSDV in real city traffic scenario on the basis of three metrics namely Packet delivery ratio, throughput and average end to end delay by varying vehicles density and transmission range.

Keywords**—**DSDV, OLSR, Quality of service, Routing protocols, VANET**.**

I. Introduction

THE Vehicular Ad hoc Network [1] is a particularity of Mobile Ad hoc Network in which communication nodes are vehicles equipped with calculators, sensors and wireless communication technologies that move at high speed and their movement are constrained to the road layout and traffic rules.

VANET is one of the new technologies that has been an active research area and has attracted considerable attention of governments, industries, academics and research communities [2].

In recent years, the Inter-Vehicle Communications (IVC) has attracted the interests of many automobile manufactures and researchers, several projects are related with VANET such as Car to Car Communication Consortium (C2C – CC) [3], Fleet Net [4], Car Talk 2000 [5] and many more.

VANET applications can be divided into three categories: public safety application, cooperative traffic management and comfort user services [6].

VANET resembles MANET in their self-organization and self-manage information [6], [7], however, VANET possess a few distinguishing characteristics [8], [9] such highly dynamic topology, mobility modeling and prediction, sufficient energy and storage, frequently disconnected network, communication environment and interaction with on-board sensors.

Due to these notable special characteristics, routing protocol has become the main issue for VANET. A variety of research has been done on routing [8], [10] and important number of routing protocols has been proposed with their implementation for Wireless Ad Hoc Network.

The aim of this work is to evaluate the performance of two proactive routing protocols namely OLSR and DSDV under realistic network conditions. These protocols are analyzed based on three important QoS metrics namely packet delivery ratio, throughput and average end to end delay.

The rest of the paper is organized as follows, Section II describes a brief overview of related works, Section III represents the two ad hoc routing protocols that are used in the performances evaluation metric, Section IV describes the simulation setup and performances evaluation metrics of QoS used in the study, section V presents discussions and analysis of results. Finally Section VI concludes the paper and discusses some futures directions of our work.

II. Related Work

Several studies have been made and published for comparing the performance of OLSR and DSDV protocol but most of them have been focused on MANET. There are a few studies that compare OLSR and DSDV protocols in VANET environment.

E. Spaho et al. in [11] compared the performance of OLSR and DSDV routing protocols in a highway VANET city scenario on the basis of throughput and Packet delivery ratio using NS3.14.1 version. They found that OLSR has better throughput and PDR than DSDV protocol.

Performance analysis of DSDV, OLSR and DYMO protocols with varying mobility and scalability in VANET is compared by S. Wasiq et al. [12] in terms of throughput, end to end delay and normalized routing load using NS2.34 simulator. The paper concluded that DSDV performs better.

In [13] U. Nagaraj et al. evaluated the performance of DSDV, OLSR, AODV and DSR in realistic scenario of VANET on basis of packet delivery ratio and end to end delay using NS2 simulator. Their conclusion is that OLSR has better end to end delay and AODV has the better packet delivery ratio.

However to the best of our knowledge, none of these papers has taken transmission range into account under realistic network conditions.

Yassine Meraihi is with the Department of Physics, University of M'Hamed Bougara Boumerdes, Algeria (phone: 0021324816901; fax: 0021324816373; e-mail: y.meraihi@gmail.com).

Dalila Acheli is with Department of Automatisation, University of M'Hamed Bougara Boumerdes, Algeria (e-mail: dacheli2000@yahoo.fr).

Rabah Meraihi is with the Neotilus, DEGETEL GROUP, France (e-mail: meraihi@yahoo.com).

III. Routing Protocols

In the following, we give the overview two proactive ad hoc routing protocols DSDV and OLSR that have been evaluated.

A. DSDV

DSDV [14] for Destination Sequenced Distance Vector Routing is unicast, table driven and proactive routing protocol that maintains route to all the destinations before requirement of the route.

The protocol was developed by C. Perkins and P. Bhagwat in 1994 which was based upon the Bellman Ford algorithm with improved routing mechanisms to obtain good performance, the algorithm used solves the routing loop problems. In this protocol, a mobile node must maintain a routing table that lists all available destinations and the number of hops to reach the destination. DSDV routing table entry contains information about the address identifier of a destination, the next hop to destination, the shortest known distance metric of destination routing path and sequence number. The sequence number is also associated with each route/path to the destination to distinguish stale route from new one and thus avoid the formation of loops so this protocol achieves low routing overhead and low packet delay, the route labeled with the highest sequence number is always used.

DSDV requires a regular update of its routing tables due to the frequent change in the network, the routing table updates can be sent in two ways: the full dump and the incremental dump, the full dump sends the complete routing table to the neighbors infrequently whereas in incremental dump, only those entries from the routing table are sent that has a metric change since the last update. The route labeled with the highest recent sequence number is used, in the case if two routes have the same sequence number; the one with the best/smallest metric is chosen and used.

B. OLSR

OLSR [15] for Optimized Link State Protocol (RFC 3626) is non uniform, table driven and proactive routing protocol where the routes are always available when needed, it present the route immediately before the utilization without any initial delay. OLSR is an optimization version of a pure link state protocol in which the topological changes cause the flooding of the topological information to all available nodes in the network. Its objective is to provide routes to a destination in terms of number of hops with the use of Dijkstra algorithm. The innovation of OLSR is that it minimizes the size of control messages, the loops of retransmissions of packets and rebroadcasting through the use of the concept of MPR (Multipoint Relaying). Each node in the network select a set of neighbor nodes called as MPR which retransmits its packets, the neighbor nodes which are not in its MPR set cannot retransmit the packet, it can only read and process the packet. OLSR makes use of three kinds of the control messages namely HELLO messages, Topology Control messages and Multiple Interface Declaration messages. HELLO messages are exchanged periodically at a certain interval among neighbor nodes to ensure a bidirectional link with the neighbors, to detect the identity of neighbors and to signal MPR selection, OLSR is more suitable for high density network by using MPRs which work well in this context. Topology Control messages are used to disseminate neighbor information throughout the entire network.

Multiple Interface Declaration messages are used to indicate that a node is running OLSR on multiple interfaces.

IV. Simulation Setup Dans Performance Metric

A. Simulation Parameters

In this paper, the performance of DSDV and OLSR routing protocols are studied by the use of the network simulator NS2 in its version 2.34 [16], [17].

Simulations were carried out by taking into account realistic conditions; the vehicular mobility pattern is generated by using VanetMobiSim [18]. It consists of 12 intersections and 20 bi-directional roads with multilane (Fig. 1 shows a snapshot of this simulation area). Intelligent driver model [18] is used for the movement of vehicles on the roads.

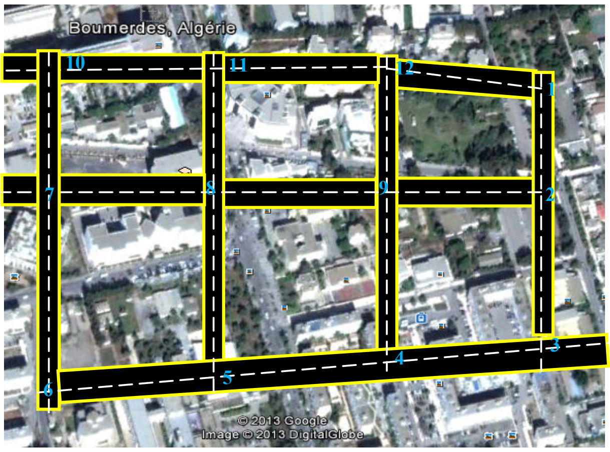

Fig. 1 City simulation area

The following table shows the simulation parameters that we have used in our simulation.

TABLE I
SIMULATION PARAMETERS

Parameter	Value
Platform	Ubuntu
Network simulator	NS 2.34
Routing protocols	DSDV, OLSR
Simulation area	1000x1000
Simulation time	1000s
Traffic type	TCP
Data type	CBR
Radio propagation models	Two ray ground
Mac layer protocol	IEEE 802.11
Antenna type	Omni-directional
Channel type	Wireless channel
Link layer type	LL
Transmission range	250m, 300m,350m,400m,450m
Packet size	512
Number of vehicles	10,20,30,40,50
Speed of vehicles	50 km/h

B. Performance Metrics

The important metrics which are evaluated in this paper are packet delivery ratio, throughput and average end to end delay.

Packet delivery ratio (PDR): it is the ratio of the total number of packets successfully received at the destination node to the total number of packets generated by the source node. It is expressed as:

$$PDR=\sum \text{packets successfully received at the destination node} \div \sum \text{packets generated by source node} \quad (1)$$

Throughput: Throughput is defined as the ratio of the total number of received packets at the destination to the time interval it takes by receiver to receive the last message. It is calculated in bytes/sec or bits/sec.

Average end to end delay (EED): is the total time that is taken to transmit a packet from source to destination. End to end delay value includes all possible delays caused by propagation time (PT), queuing time at the interface queue (QT), transfer time (TT) and processing delay (PD). It is expressed as:

$$EED= PT+QT+TT+PD \quad (2)$$

V. Simulation Results and Discussion

In this section, we discuss and analyze the results of performance of two proactive routing protocols DSDV and OLSR in two scenarios: In the first, the vehicles density is varied by changing the number of vehicles with fixed transmission range and constant speed. In the second, the transmission range is varied with constant speed and constant number of vehicles. The main parameters of Quality of Service (QoS) which are considered are packet delivery ratio, throughput and average end to end delay.

A. Performance Analysis with Varying Vehicles Density

In this analysis, the number of vehicles is varied from 10 to 50 with an increment of 10 vehicles, whereas transmission range is fixed at 250m, results are given in Figs. 2 to 4.

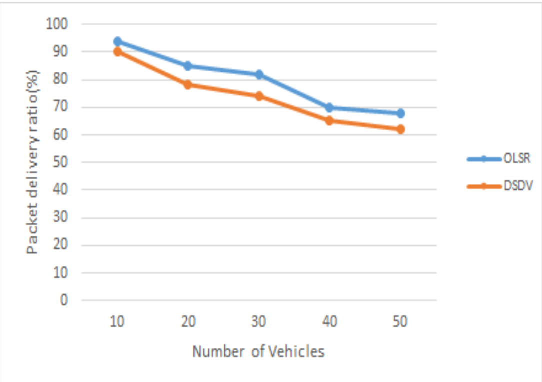

Fig. 2 Packet delivery ratio Vs number of vehicles

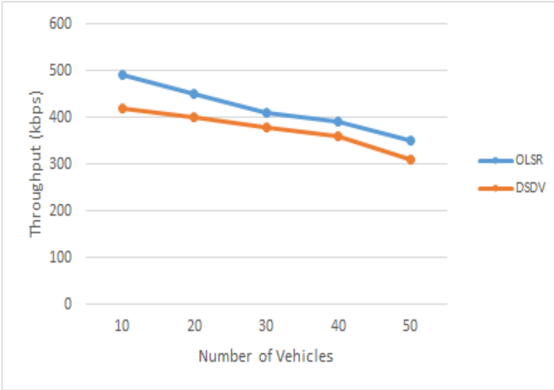

Fig. 3 Throughput Vs number of vehicles

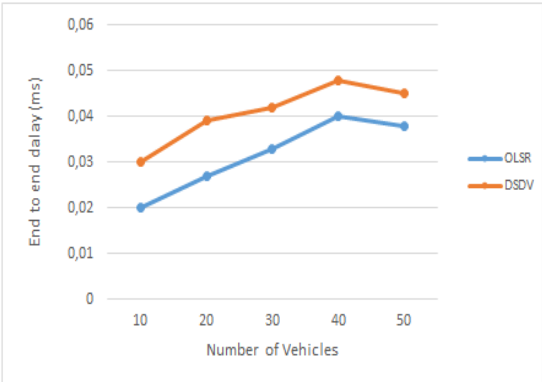

Fig. 4 Average end to end delay Vs number of vehicles

Fig. 2 shows the packet delivery ratio of DSDV and OLSR with varying the number of nodes. It is observed that with the increase in the number of vehicles, the packet delivery ratio decreases for both protocols, this is due to the table driven approach used by almost all proactive protocols. OLSR has the highest packet delivery ratio as compared to DSDV, this happens because of the high optimization of MPRs that reduce overhead and consume low bandwidth. It is seen that change in number of nodes has an impact on packet delivery ratio.

Fig. 3 shows the throughput values of DSDV and OLSR. The results confirm our conclusions of the packets delivery ratio measurements. We observed that OLSR has the highest throughput, it clearly outperforms DSDV.

Fig. 4 shows the average end to end delay values for DSDV and OLSR with varying number of vehicles. It clearly reveals that average end to end delay increases with the increase in number of vehicles for both protocols. OLSR has the lowest average end to end delay as compared to DSDV, this happens because of the use of OLSR' TC message that helps to avoid the stale route problem, whereas in case of DSDV, whenever the topology of network changes, DSDV needs more times to converge before the packets can be sent.

B. Performance Analysis with Varying Transmission Range

In this analysis the transmission range is varied from 250m to 450m with an increment of 50, whereas the number of vehicles is fixed at 40 nodes, results are given in Figs. 5 to 7.

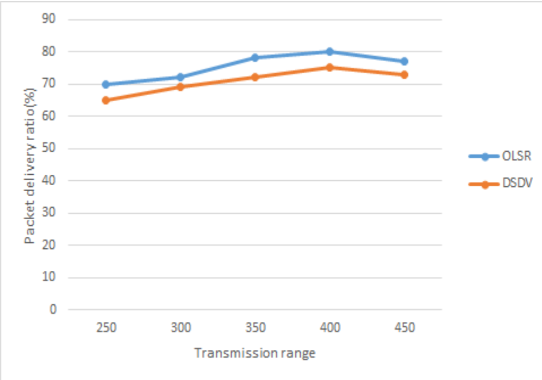

Fig. 5 Packet delivery ratio Vs transmission range

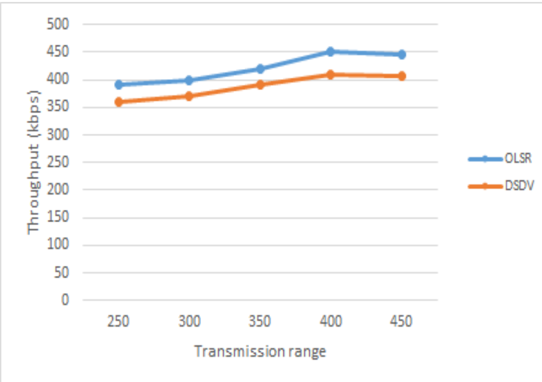

Fig. 6 Throughput Vs transmission range

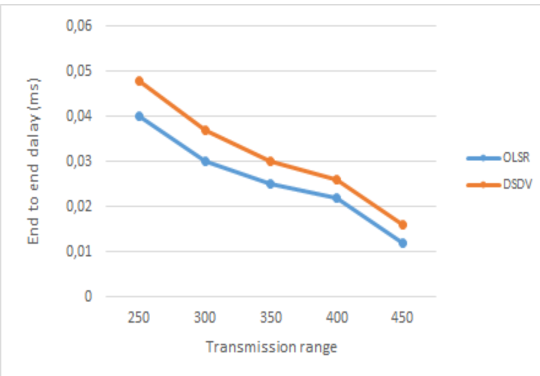

Fig. 7 Average end to end delay Vs transmission range

It is observed from Fig. 5 that the packet delivery ratio increases with increasing the transmission range for both DSDV and OLSR protocols. The reason is that with the increase of the transmission range, there is low possibility for disconnection of the communication network. DSDV has the lowest Packet delivery ratio.

Fig. 6 shows throughput values of DSDV and OLSR, the results basically confirm our conclusion of the packets delivery ratio results. Like packet delivery ratio, throughput increases gradually for both protocols with increasing the transmission range, the OLSR has the highest throughput.

Fig. 7 represents the average end to end delay of DSDV and OLSR, it is observed that the average end to end delay gradually increases for both protocols as transmission range increased, this is due to the decrease in number of hops, it is seen that DSDV has the highest end to end delay.

II. Conclusion

In this paper, performance of DSDV and OLSR routing protocols in realistic city traffic scenario are evaluated and analyzed in terms of packet delivery ratio, throughput and average end to end delay. We have considered the density network and transmission range as the controlled parameters in our experiments to determine the best routing protocol. Based on the results and analysis, this paper concludes that OLSR protocol performs better as compared to DSDV, and that the performance of these protocols is affected while subject to change in number of vehicles and change in transmission range.

Change in number of vehicles decreases QoS whereas increase in transmission range increases QoS.

Future work will be to evaluate the performance of these protocols by varying area size, varying mobility models and varying speed. Performance can also be analyzed for other parameters like jitter, overhead and packet loss.

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