

Performance Analysis of AODV, DSDV and OLSR in a VANETs Safety Application Scenario

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Abstract— Vehicular Ad Hoc Networks (VANETs) is derived from Mobile Ad Hoc Networks (MANETs) that recently attracts attention of research community. Active road safety application is one of the types of VANETs applications that is very important. It reduces the probability of traffic accident on the road and save human life. Besides that, it has a specific characteristic such as hard delay constraint compared to another type of VANETs applications. Therefore, performance simulation and analysis for this application are critical and require an unique approach also. In this paper, we compared and evaluated the performance of AODV, DSDV and OLSR in a safety application scenario using NS-3. Simulation result show that despite DSDV is originally a MANETs protocol, but it could adapt to the requirement of safety application consistently, whilst OLSR and AODV failed to achieve the expected performance.

Keywords— VANETs, AODV, OLSR, DSDV, Safety Application

I. INTRODUCTION

A Mobile Ad-hoc Networks (MANETs) consists of a group of mobile nodes which have the ability to self-configuring the network with or without the fixed network infrastructure[1]. Vehicular Ad-hoc Networks (VANETs) is a rapidly emerging class from MANETs where the node is the vehicle. Given the number of cars today, VANETs will be the most widely distributed and largest scale ad hoc networks[2]. Communications between cars without the need of fixed infrastructure open up new possibilities and application for the research and industry communities. New studies and projects are emerged from this fields as it can be seen as the fundamental part to improve road safety, to increase comfort and to reduce congestion. Therefore, in Intelligent Transportation System (ITS) architecture, VANETs is a crucial technology.

In a routing protocol evaluation of safety application, one of the critical aspects to consider is the mobility model that mimic the real world scenario of safety applications. Mobility models such as manhattan city model, graph-constrained model or even more random waypoint model definitely not suitable in simulating the safety application as the position and

speed of cars in the safety application's scenario is specific and unique.

II. RELATED WORKS

There were some studies carried out in the performance analysis of various routing protocols in VANETs. In [3], AODV, DSDV and AOMDV are simulated and compared in a realistic environment. While evaluation on AODV, DSR and Swarm are analysed in [4]. The performance of AODV, DSR and DSDV in freeway environment are discussed in [5]. OLSR and AODV are compared in an urban realistic environment in [6] and in a highly fading environment in [7]. In a city traffic scenario, a study in [8] evaluate FSR, AODV, DSR, and TORA. This survey paper differs from the mentioned above since in this paper the simulation is done in a safety application scenario And this paper evaluates and compares AODV, DSDV and OLSR routing protocols. The remainder of this paper is organised as follows. Safety application is introduced and explained in section III. Section IV presents the routing protocols that is evaluated. Section V explains the simulation mobility model, scenario, and result. The performance analysis is given in section VI. Finally, the conclusion of this paper is presented in section VII.

III. SAFETY APPLICATIONS

Applications that can be extracted from the power of VANETs are (i) active road safety application, (ii) traffic efficiency and management application, and (iii) infotainment application [2].

Active road safety applications are mainly use to decrease the risk of traffic accidents and the death of the drivers and passengers of the vehicles. If information of vehicle position, intersection position, distance heading and velocity are known to other vehicle despite the visibility of the driver, it can decrease the number of road accident significantly. Intersection, head, rear-end and lateral vehicle collisions are taking a significant percentage around the world. If a driver were given a warning half a second before the moment of

accident, more than a half number of accidents would not occur[9]. Therefore, giving the information about the collision faster will give manifold effects in reducing the probability of accident. Furthermore, the vehicle and the road side units could exchange information to determine dangerous locations on roads. Vehicle Safety Communications (VSC) consortium mention the type of applications in this field[10]: (i) traffic signal violation warning, (ii) curve speed warning, (iii) emergency electronic brake light, (iv) pre-crash sensing, (v) cooperative forward collision warning, (vi) left turn assistant, (vii) lane change warning, and (viii) stop sign movement. One of the sample of cooperative forward collision warning is in a situation when a car is overtaking a slower car without knowing there is another car in another side of the road as explained in figure 1. For example in figure 1, the silver car try to overtake the red car without knowing there is a black car coming from the opposite of the road. The red car as the intermediate car will try to inform the silver car to stop overtaking as the a collision is possible in this case. Performance of the routing protocols will compared and evaluated for this scenario.



Figure 1. An example scenario of cooperative forward collision warning.

IV. ROUTING PROTOCOLS

In this performance analysis, we pick the famous routing protocols: AODV[11,12], DSDV[13] and OLSR[14]. These protocols are optimized for MANETs but also used for VANETs in many occasions. In term of the underlying routing information update mechanism, routing protocols are divided into two major types; reactive (on-demand) or proactive (table-driven). DSDV and OLSR are the examples from the proactive type. While AODV represents the reactive type. For interested readers to the available routing protocols in VANETs could refer to [1].

A. AODV

In AODV's route discovery process, a source node sets up a route to the destination by sending a Route Request (RREQ) packet. Intermediate nodes forward the packet to other nodes until an active route is found or the maximum number of hops is reached. When an active route has been known, the intermediate nodes will transmit Route Reply (RREP) packet back to the source node. Finally, the source node opens the route after receive the RREP packet.

The use of a destination sequence number (DesSeqNum) to find the latest route to the destination in AODV is a main

difference compared to another protocol. If the DesSeqNum of the current packet received is greater than the last stored DesSeqNum, then the node will update the path destination. However, intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries.

B. OLSR

OLSR utilizes a technique called multipoint relaying for optimized message flooding. Each node build and maintains the set of neighbors that can be reached in 1-hop and 2-hops periodically. The dedicated Multi-Point Relays (MPR) algorithm minimizes the number of active relays that is necessary for covering all 2 hops neighbors. OLSR's advantage is as a proactive protocol, the routes to all destinations is known and maintained before the utilization. Nevertheless, it has a strong disadvantage as the nodes in VANETs are moving really fast, calculating the optimal node may be impossible for most cases.

C. DSDV

DSDV can solve routing loop problem effectively and it is applying the Bellman-Ford algorithm. But it has a weak point that it needs to update the routing table regularly, so it drains more power and more bandwidth.

V. SIMULATION

In this simulation, we simulate a safety application in VANETs. We develop a simulation with traffic condition similar to the situation in figure 1. In our Ubuntu 11[15] Linux machine, we have installed the newest version of NS-3[16], the successor of popular network simulation NS-2.

A. MOBILITY MODEL

Safety application simulation requires the node's trajectory to be able to be altered by the application. Such mobility models using that approach is called as the application-centric mobility model[17]. In this simulation, to capture the realistic movement of the vehicles, we develop a mobility model with that approach. Therefore, each nodes in our mobility models will also react if they receive a message about their surrounding. Another approach where the nodes in mobility model don't react to the application is called as the network centric approach.

B. SIMULATION SCENARIO

For the explanation of the scenario, please observe figure 2 as the transformation from figure 1. In this case, A overtakes an M number of car while in another side of the road, there is B moving in opposite direction. In here, B informs its location to the intermediate cars. The intermediate cars try to inform B and A about the possible collision between A and B. Once A receive the warning, A will react and cancel the overtaking action. The alteration in A's trajectory is possible with the help of application-centric approach. In the simulation we vary the number of intermediate cars to calculate the effects of car

density in routing protocol performance. The transmission range for each car is 250 m. For the details of the simulation environment please refer to table 1.

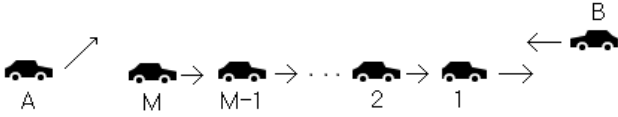


Figure 2. Simulation Map Scenario.

Table 1. Simulation Environment Setup.

Parameters	Specifications
OS	Ubuntu Linux 11[15]
Network simulator	ns-3.12[16]
Simulation time	10 seconds
Simulation area	100 m x 1000 m
Number of vehicles	3 – 12 cars
Transmission range	250 m
Speed	car A & B: 30 m/s, other : 20 m/s
MAC Protocol	IEEE 802.11b
Data Rate	1 mbps
Propagation Loss	Friis Model

C. SIMULATION PERFORMANCE METRICS

The following metrics are calculated in the evaluation of AODV, DSDV and OLSR for various number of intermediate cars.

(1) MAXIMUM PACKET DELAY

In a safety application scenario, the network does not require high data rates but it requires a hard delay constraint[1]. If the warning is late, then it is as useless as no information. So in this simulation, we calculate and compare the maximum delay achieved by each protocols in corresponding way

$$d = \max_{i=n}^n |t_{ri} - t_{ti}|$$

where d denotes the maximum delay, n is the number of transmitted packet, t_r is time when the packet is received and t_t denotes when the packet is transmitted.

(2) AVERAGE PACKET TRAVEL SPEED

Another metric that we use is the average packet travel speed. The distribution of location of a vehicle to the neighbour is important. The average travel speed of the packet comparison will tell us which routing protocol has done the better jobs in disseminating the warning information. We are going to calculate it in the following way

$$v = \frac{1}{n} \sum_{i=n}^n \frac{s}{t_r - t_t}$$

where n is the number of received packet, and s is the distance when the packet is transmitted.

D. SIMULATION RESULT

The maximum delay and average packet travel speed metrics in this simulation for all protocols are presented in figure 3 and figure 4 respectively.

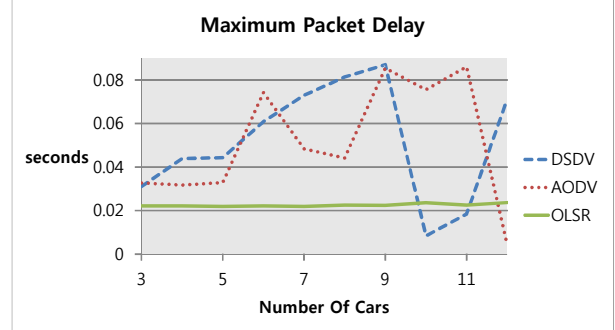


Figure 3. Maximum Delay vs Number of Cars

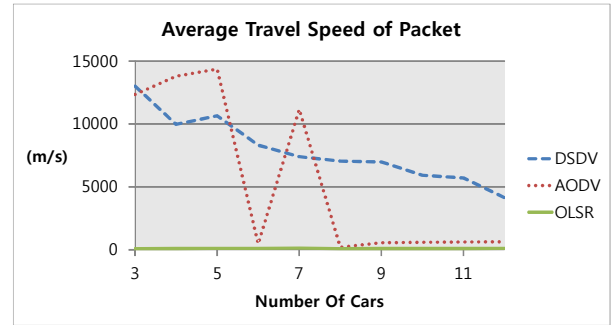


Figure 4. Average Packet Travel Speed vs Number of Cars

VI. RESULT ANALYSIS

From figure 3 and figure 4, we can see that OLSR despite having the lowest maximum delay, it has a trouble to distribute the packets to the neighbours nodes in a timely fashion. AODV performed really well when the number of car is not high, but it is proved to be not consistent in the intermediate density and performed disastrously in a high density situation. DSDV on the other hand, in spite of the maximum delay is relatively higher compare to another protocol, the consistency and high performance in the average travel speed cancel it out. For all protocols, the maximum delay proved to be not an alarming concern, as the maximum packet delay can perform below 0.09 seconds in any density.

VII. CONCLUSION

This paper compared AODV, DSDV and OLSR routing protocol in a VANETs safety application scenario. Analysis of the performance has also been given. An important observation was the performance of DSDV surpass the performance of AODV and OLSR. As a conclusion, when deploying an application that is related to the safety application, employment of DSDV is more encouraged than

AODV. Whilst the usage of OLSR is not recommended for any situation in safety application.

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