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Effect of Speed on the Performance of VANET Routing Protocol

Mohammed Sami Noori
Northern Technical University, Mosul, Iraq.

Osama A. Qasim
Northern Technical University, Mosul, Iraq.

Emad A. Mohammed
Northern Technical University, Mosul, Iraq.

Abstract

The vehicular ad-hoc network (VANET) is one of the modern communication models and is divided into two types: (1) vehicle-to-infrastructure (V2I) communication, (2) vehicle-to-vehicle (V2V) communication. This model enables easy communication between vehicles on the roads. VANET helped open the door to the development of various applications such as emergency information dissemination, traffic management, and traffic engineering, to reduce dangerous situations faced by drivers and passengers on the roads. Besides, VANET helped achieve an efficient and safe transportation system by adopting various methods to disseminate data and inform vehicles on roads of traffic status. Some characteristics of VANET make it difficult to publish data such as vehicle traffic speed and network density. To assess routing protocol performance in a city scenario and study the effect of speed on protocol performance. We simulated the AODV protocol in a city scenario with the change in vehicle speed to see how speed affects protocol performance. The performance was evaluated in metrics: end-to-end delay (E2ED), overhead, and packet delivery ratio (PDR).

Keywords: VANET; V2V; AODV; PDR; E2ED.

1 Introduction

Recently, new technologies have appeared that have contributed to providing facilities for passengers with an increase in the number of vehicles on the roads. Among these applications are emergency warnings, assistance to the drivers, safety application, etc. An ad hoc network is one of the types of wireless communication networks. This network is established from wireless transcribing equipment with a set of mobile nodes [1]. A mobile ad hoc network (MANET) is a mobile that does not require or requires little infrastructure, it has many characteristics such as limited energy, limited bandwidth, dynamic topology, and random node movement [2]. The vehicular ad-hoc network (VANET) is a type of MANET but differs from it in some characteristics. VANET is a network that has recently appeared due to the increased need to support wireless equipment such as laptops, mobile phones, and the Global Positioning System (GPS) that can be used in vehicles [3]. The demand for communications, whether from vehicle to infrastructure (V2I) or from vehicle to vehicle (V2V), will continue due to the increasing importance of mobile wireless networks and equipment [3]. VANET possesses several characteristics that have made it difficult to develop effective routing protocols. Examples of these characteristics are mobility models, dynamic topology, no restriction on road pattern, and network size. One of the main characteristics that contributed to the difficulty in developing protocols is the movement of vehicles at high speed. The routing protocols in VANET are divided into Cluster, Geocast, Position, Topology, and Broadcast-based routing protocol as shown in figure 1 [4][5]. Topology-based routing protocols are divided into Hybrid, proactive, and interactive. An interactive routing protocol is an on-demand routing protocol. Examples of interactive routing protocols are AODV [6], TORA [7], and DSR [8]. The focus of this research is on the AODV protocol and studying the effect of speed on the performance of the protocol.

The research is divided into five sections: Section 2 presents the AODV protocol. Section 3 describes the simulation environment. Section 4 consists of results analysis. Finally, Section 5 is the conclusion.

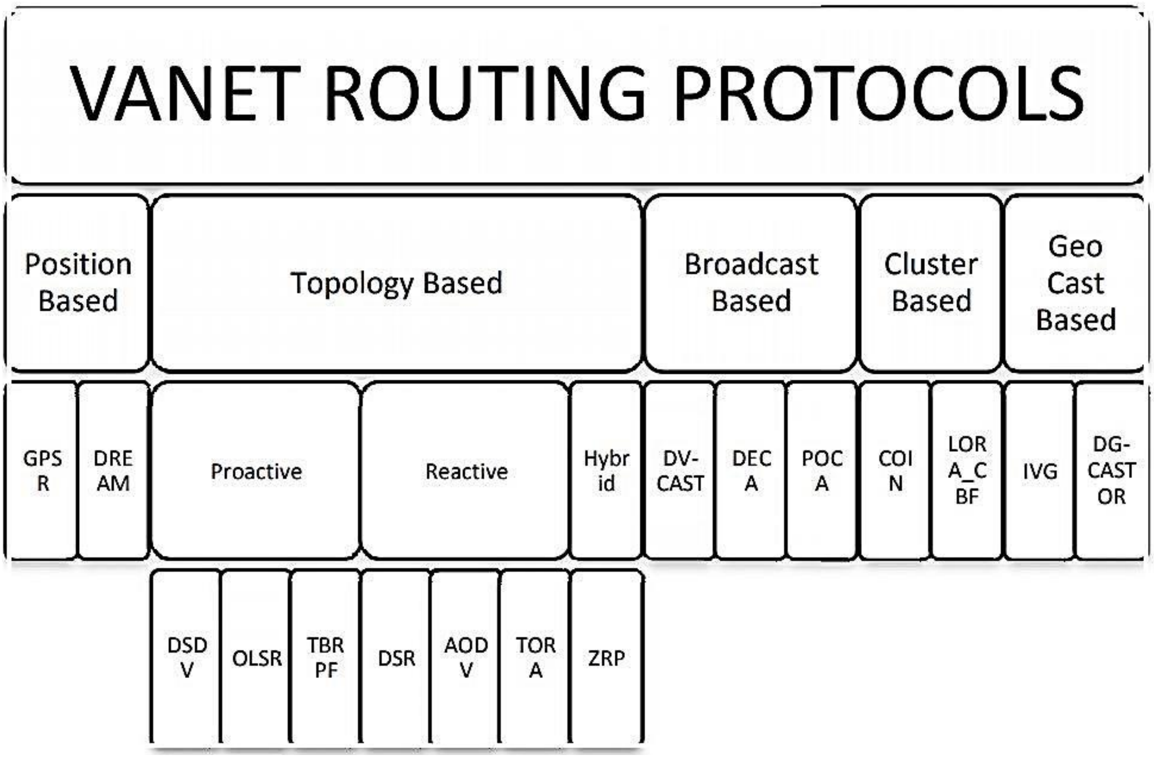

Figure 1 Routing protocol.

2 Ad-hoc On-demand Distance Vector

AODV is an interactive routing protocol. This protocol supports multicast and unicast routing. Before sending the data packets, the source vehicle sends a route request message (RREQ) to the neighboring vehicles [9]. If the neighboring vehicles store route to the interface vehicle, then it sends a route reply message (RREP) to the source vehicle. If it did not have a route to the interface vehicle, it sends (RREQ) to the other neighboring vehicles. The interface vehicle responds (RREP) to the source vehicle when the interface vehicle receives (RREQ) [10]. When the source vehicle receives (RREP) it starts sending data to the interface vehicle. Figure 2 shows how to create the path between the interface and the source vehicle.

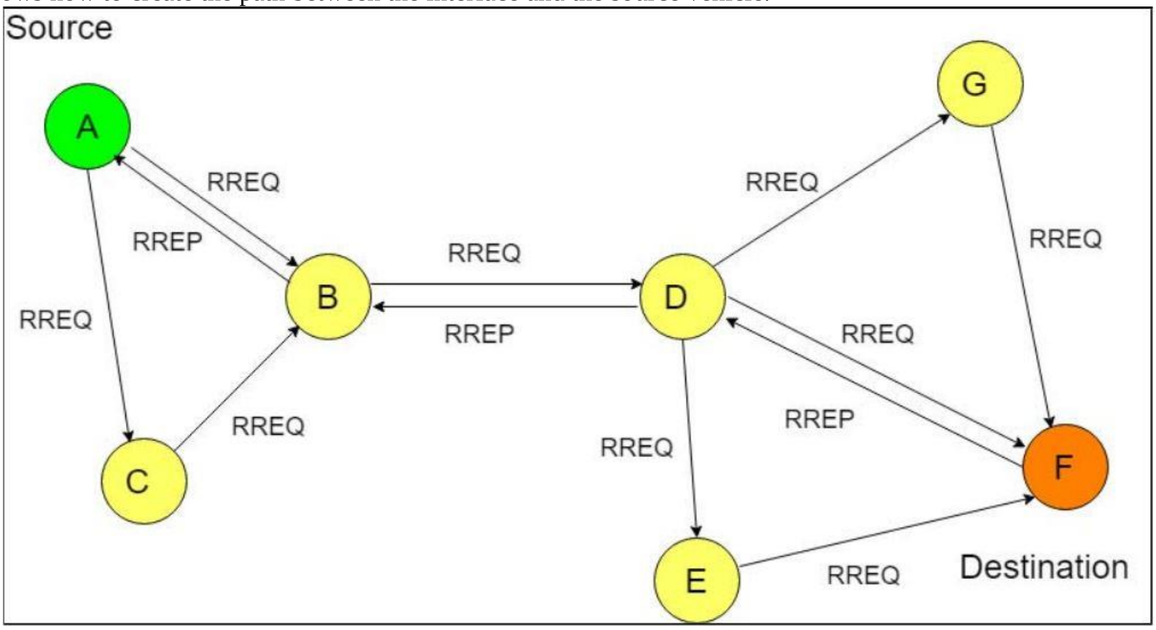

Figure 2 AODV Route Discovery.

3 Simulation Environment

The AODV protocol was simulated in the city scenario. The simulation environment consists of 50 vehicles randomly distributed in a city scenario with changing vehicle speed; this simulation focuses on the vehicle-to-vehicle connection. Table 1 present the parameters adopted in this simulation.

Table 1 Simulation Parameters

Parameter	**Value**
Protocol	25
Simulation area	5*5 km
Number of vehicles	50
Speed	60, 80 km/h
The size of packet	512 Bytes
The size of control message	64 ytes

4 Results and Discussion

In this paper, a city scenario was used to simulate the AODV protocol and study the effect of speed change on protocol performance. The protocol performance was evaluated in two cases, the first case being vehicle movement at 60km/h speed and the second case, the movement of vehicles at 80km/h speed during 200 s simulation times. In this simulation, the performance was compared via three parameters: E2ED, PDR, and overhead.

A. End to End Delay

It is the time difference between sending packets from the source and delivering them to the interface [11]. Equation 1 illustrates the method for calculating the E2ED.

$$\text{Average E2ED} = \text{Average time taken to delivered packets}/\text{Total number of packets delivered} \quad (1)$$

B. Overhead

It is the number of messages sent to discover and maintain routes [12]. Equation 2 explains the method for calculating overheads.

$$\text{OH} = \text{Total number of overhead messages} \;/\; \text{Total transmitted data packets} \quad (2)$$

C. Packet Delivery Ratio

It is the difference between the numbers of packets sent by the source to the number of packets delivered to the interface [13]. Equation 3 explains the method for calculating the PDR.

$$\text{PDR} = \text{Total successful packet received} \;/\text{Total transmitted packet} \quad (3)$$

a. Effect of Changing Vehicle Speed

i.Vehicle Movement at 60 km/h

In this case, the AODV protocol was simulated at 60km/h speed during 200 s simulation times. Figure 3, 4 and 5 shows the E2ED, PDR, and overhead.

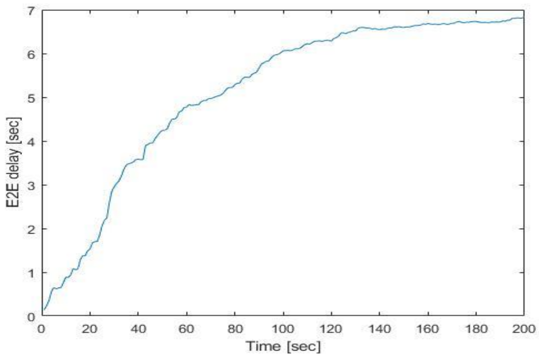

Figure 3 E2ED at 60 km/h speed.

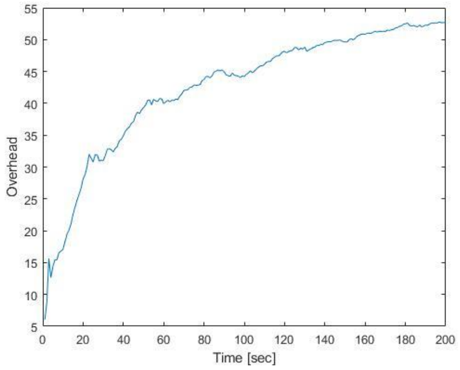

Figure 4 Overhead at 60 km/h speed.

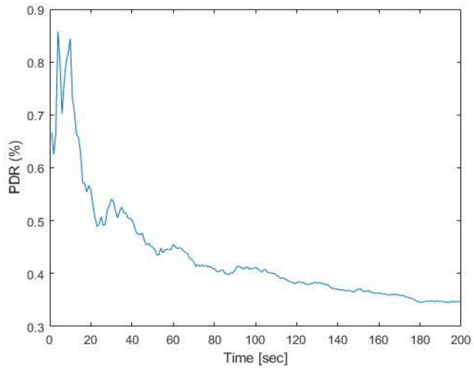

Figure 5 PDR at 60 km/h speed.

4.1.2 Vehicle Movement at 80 km/h

In this case, the AODV protocol was simulated at 80km/h speed during 200 s simulation times. Figure 6, 7 and 8 show the E2ED, PDR, and overhead.

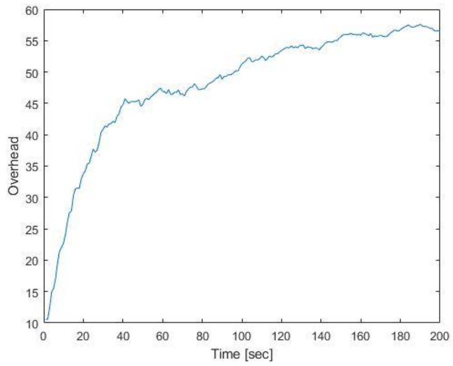

Figure 6 Overhead at 80 km/h speed.

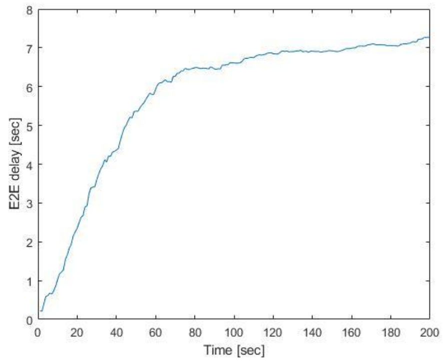

Figure 7 E2ED at 80 km/h speed.

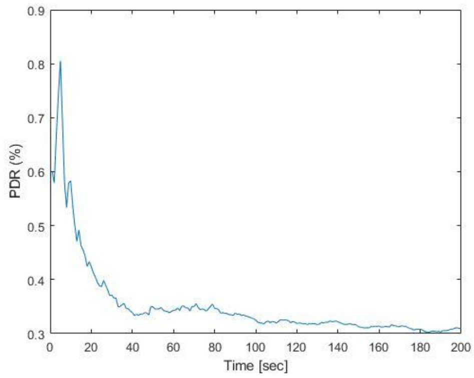

Figure 8 PDR at 80 km/h speed.

4.1.3 Performance Comparison

The performance of the AODV protocol was compared in the case of vehicle movement at 60, 80 km/h speed during 200 s simulation time.

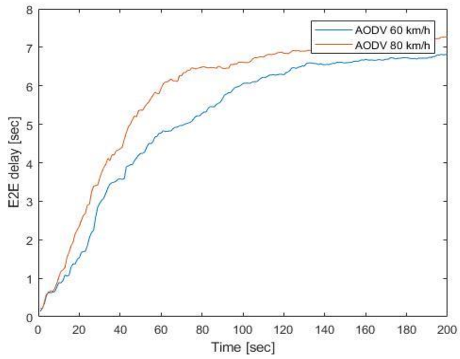

Figure 9 E2ED between 60 and 80 km/h speed.

Figure 9 illustrates the delay, the comparison result showed that the delay rate is high in the case of vehicles moving at high speed, this result can be interpreted that when the vehicles are moving at high speeds, the network degradation increases due to failure of the links, which leads to a delay in delivery of packets between the source and the interface.

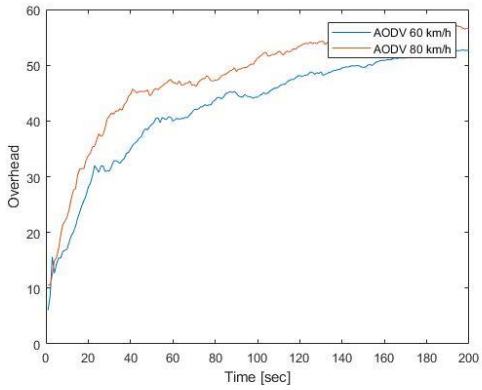

Figure 10 Overhead between 60 and 80 km/h speed.

Figure 10 illustrates the overhead; the comparison result showed that the overhead ratio is high in the case of vehicles movement at high speed. This is since the number of control messages increases with the increase in speed because the increase in speed leads to an increase in the number of failed links, and thus the number of control messages increases to discover alternative routes.

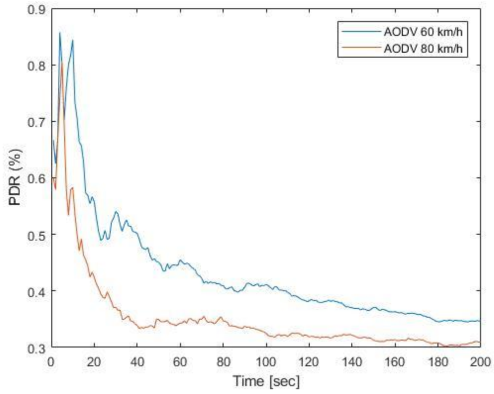

Figure 11 PDR between 60 and 80 km/h speed.

Figure 11 illustrates the PDR, the comparison result showed that the PDR is low in the case of vehicles movement at high speed. This result can be interpreted that when vehicles are moving at high speeds, the chances of failure of the links between vehicles increase, and thus the number of lost packets increases.

65 Conclusion

The effect of speed on the AODV protocol was studied. The simulation was carried out in two cases; the first case was vehicle movement at 60km/h speed and the second case at 80km/h speed during 200 s simulation time. Protocol performance was compared in the two cases through three measures of E2ED, overhead, and PDR. The comparison result showed that the protocol's performance in the case of the vehicle movement at low speed is better than at high speed. The reason for this is that when the speed increases the percentage of failure of the links increases and thus leads to a decrease in the rate of packet delivery due to the increase in the loss of packets, and an increase in the delay in delivering packages to the interface. Finally, overhead increases due to the increase in the number of control messages to discover paths instead of failed paths.

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