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Comparative Performance Evaluation of VANET Protocols in Hills Based Topology

Comparison of AODV, DSDV and DSR using ESTINET Simulator

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***Abstract*- VANET or Vehicular Adhoc Networks have gained an immense popularity among the research community in the past few years. VANET enables intelligent transportation system thus, enabling better safety. Some authors have compared AODV, DSR and DSDV in VANET, but most of them focus on city or highway scenario. In this paper, we have considered a case of hilly/curved roads. Such regions can greatly benefit from deployment of VANET. In this paper, we have compared AODV, DSR and DSDV in a hilly topology in adhoc and infrastructure modes using ESTINET simulator.**

***Keywords*- AODV, DSR, DSDV, Estinet, Hill Topology**

I. Introduction

There have been a number of problems due to ever increasing number of vehicles. Traffic jams and increasing accidents are the two most prominent problems due to it. These problems have raised a demand for an intelligent transportation system. An intelligent transportation system can be achieved by enabling communication among the vehicles moving on the road. This can be made possible with VANET (Vehicular Adhoc Networks) [1], a field of wireless networks suited to vehicular environments.

AODV [2], DSR [3] and DSDV [4] are routing protocols for MANET, but can be applied to VANET as well. VANETs can be of great importance in hilly areas. Hilly areas are generally characterized with narrow, curvy and dangerous roads.

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Figure 1. Hilly roads as seen on google maps.

VANETs can find a number of applications in such a scenario. For example, if a vehicle is overtaking another vehicle on a blind curve, a road side unit placed on the curve can warn the overtaking vehicle about a vehicle coming from the opposite direction, thus preventing a crash. As an another example, steep curves, narrow points and accident prone points can be identified and fed into the road side units. Vehicles reaching such points can be warned in advance so that they are extra cautious at such points. Hilly areas could benefit heavily from deployment of VANET, thus reducing mishaps in such risky driving areas. In this paper, we have compared overall performance of AODV and DSR in adhoc mode and AODV, DSR and DSDV in infrastructure mode (with road side units).

II. Related Work

There are some papers that have compared VANET routing protocols. Pooja Rani et al. [5] have compared AODV, DSR and DSDV in a flat 500m X 500m topology under condition with varying number, speed and distances between vehicles. Ganis Zulfa Santoso and Moonsoo Kang [6] have compared AODV, OLSR and DSDV in a particular safety scenario where an overtaking vehicle is at a risk of collision with a vehicle coming from other direction. They have used a 100m X 1000m scenario and varied the density of vehicles. Shaikhul Islam Chowdhury et al. [7] have compared AODV, DSR and AOMDV under various mobility scenarios – varying speed and number of vehicles. Niansheng Liu et al. [8] have compared AODV, DSR and DSDV in a 30m X 500m freeway scenario. S. S. Manvi et al. [9] have compared AODV, DSR and Swarm Intelligence routing protocol in a 1000m X 1000m topology at varying speeds and number of vehicles.

But most of these are focused on topologies like cities, highways and freeways. None of them have taken into consideration hills/curves based topologies. Our main aim in this paper is to study these protocols in such a terrain and come to appropriate conclusion.

III. Background

A. *AODV*

AODV [2] uses a route discovery phase to find a route to the destination. The source sends a broadcast RREQ (Route Request) message to all its neighbour nodes. On receiving the node each node records the previous hop (called backward learning) and broadcasts it further. This is repeated until the destination is reached. The recorded nodes are used by the destination to send back RREP (Request Reply) back to the source. This phase also involves recording the previous hops. The recording of previous hops in first phase helps destination to send data back to the source, whereas recording of previous hops in this phase helps the source to establish a forward path to the destination. A path breaks leads to a new RREQ broadcast.

B. *DSR*

In DSR [3], the source decides the route to be followed by the packets. Each packet carries the complete path for routing. Route discovery phase starts with broadcasting a RREQ (Route Request) packet. A receiving node checks if it has a route to destination in its cache. If it exits, that route is used, otherwise the node adds itself to the recorded hop sequence and broadcasts RREQ further. This process goes on until the destination is reached.

C. *DSDV*

DSDV [4] is a distance vector routing protocol that uses routing tables at each node. On receiving a packet, the node can check its routing table to see the next hop and number of hops to the destination. Routing updates are exchanged periodically between the nodes. It uses the concept of sequence numbers for marking the routes. A fresh route has a higher sequence number than an old one. For two routes having the same sequence number, the one with less number of hops is preferred. Connected paths use even sequence numbers whereas broken paths use odd sequence numbers.

IV. Simulation Setup

Simulations were carried using ESTINET [10] simulator on Fedora 14 [11] keeping in view a hill /curvy roads based scenario. The given figure shows the topology design for the simulation.

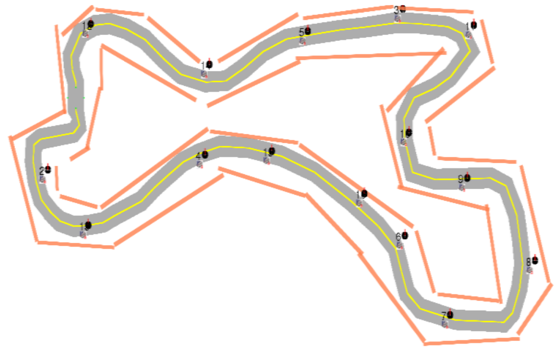

Figure 2. A hilly road scenario without RSUs

In this simulation, we have blocked signals towards both sides of the roads. In a hill based environment, generally one side is blocked due to hills and the other may not be. However, we have assumed that the signals towards the other side might be blocked or may be very weak due to trees or variation in elevation at different points.

The simulation has been divided into two parts. The first part simulates AODV, DSR and No Protocol scenarios in ad-hoc mode, that is, without using any road side units (RSUs). The second part simulates AODV, DSR and DSDV protocols using road side units (RSUs).

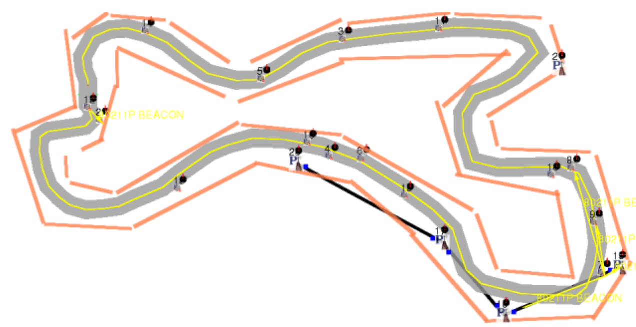

Figure 3. A hilly road scenario with RSU

The following table shows the parameters for simulation.

TABLE I. SIMULATION PARAMETERS

Traffic Scenario	Hills / Curves based; Blocked
Vehicle Count	15
Vehicle Speeds	0 – 20 mph
Simulation Time	100 seconds
Vehicle Types	802.11p (agent-controlled)
Simulator	ESTINET

V. Simulation Results

The protocols AODV, DSR and DSDV have been compared here in relation to three parameters – average throughput, drop packets and number of collisions. In addition to this one more case called "without" has been considered. No protocol has been used in the protocol stack of nodes in this case. "Without" case has been studied only for non-RSU environment whereas DSDV has been studied only for with-RSU environment.

A. *Average Throughput*

The average throughput of AODV, DSR and DSDV protocols has been studied over a period of 100 seconds. The following table gives the average throughput of the four cases in RSU and non-RSU environments.

TABLE II. AVERAGE THROUGHPUT

Protocol	Avg. Throughput without RSU	Avg. Throughput with RSU
AODV	209.18	170.41
DSR	142.89	147.72
Without Protocol	124.08	-
DSDV	-	108.75

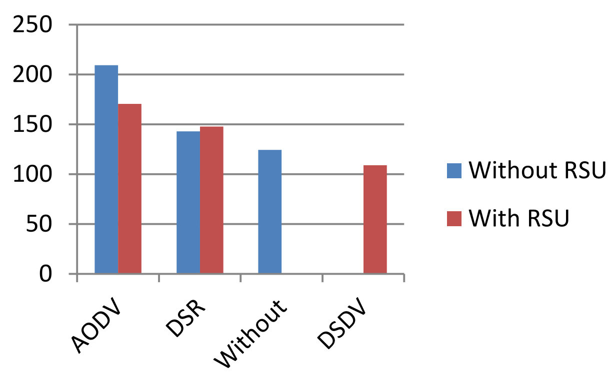

Figure 4. Comparison of average throughput

This clearly shows that AODV has the best throughput followed by DSR protocol in RSU as well as non RSU environments. DSDV performs the worst. However, a notable thing is that the average throughput of AODV has decreased on using RSUs whereas DSR has shown some improvement in throughput on using RSUs.

B. *Drop Packets*

The following table shows the number of packets dropped by different protocols during a simulation time of 100 seconds.

TABLE III. NUMBER OF DROP PACKETS

Protocol	Number of drop packets without RSU	Number of drop packets with RSU
AODV	929	996
DSR	80	53
Without Protocol	635	Not Applicable
DSDV	Not applicable	848

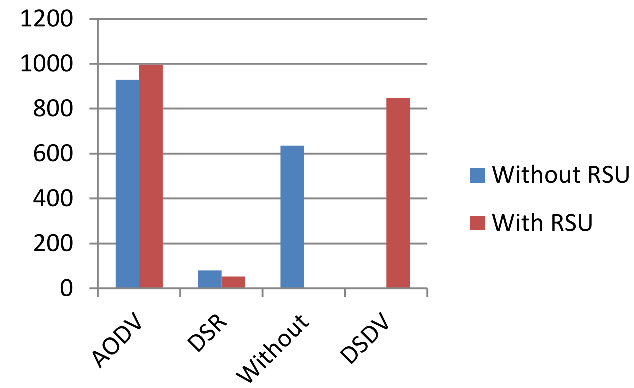

Figure 5. Comparison of packets dropped

AODV performs poorly as far as the number of drop packets is concerned followed by DSDV. On the other hand DSR shows a very good performance as compared to the other protocols. On using RSU the drop packets increases in AODV whereas they considerably drop in case of DSR.

C. *Number of Collisions*

The following table shows the number of collisions for ADOV, DSR and DSDV during the 100 seconds simulation time.

TABLE IV. NUMBER OF COLLISIONS

Protocol	Number of collisions without RSU	Number of collisions with RSU
AODV	592	643
DSR	41	48
Without Protocol	339	Not Applicable
DSDV	Not applicable	462

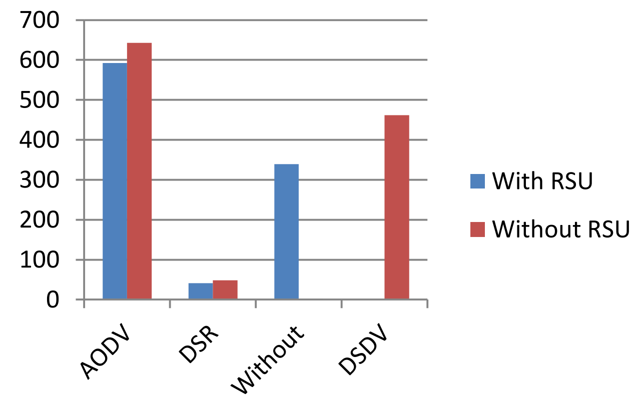

Figure 6. Comparison of collisions

Here again, DSR performs the best with the least number of collisions. AODV proves to be the worst with the maximum number of collisions.

VI. Conclusion

Although AODV shows the highest average throughput in hilly/curvy roads scenario, but it performs poorly as far a other factors i.e. drop packets and number of collisions are concerned. DSR has a lower average throughput as compared to AODV, but it's much better than DSDV. Moreover, it's drop rate and collision rate is excellent when compared to AODV and DSDV.

Keeping all parameters in view DSR comes out to be the best for hilly/curvy road scenario. And its performance is generally better when RSUs are used as compared to non-RSU environment.

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