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Design of Reactive Routing Protocols to Improve the Performance of VANET

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Abstract— Vehicular Ad-Hoc Networks (VANET) is a subclass of Mobile ad-hoc networks which gives as an eminent method for Intelligent Transport System (ITS). The analysis of routing protocols in VANET is essential and basic for intelligent ITS. In this paper discussed the pros/cons and the applications of a typical routing protocol used for vehicular ad-hoc networks. It evaluates the backward designed purpose, and tracks the progression of routing protocols. In this paper, an effort has been made to evaluate the performance of vehicular networks by using two reactive routing protocols namely Ad-hoc On demand Distance Vector (AODV) and Dynamic Source Routing (DSR) are the detection algorithms which works as gateway and a geographical routing protocol namely Greedy Perimeter Stateless Routing (GPSR) which is used to update network topology information available to all nodes in VANETs for different scenarios. Comparisons of protocols are made on the basis of different parameters such as throughput, packet loss, packet delivery ratio and end-to-end delay using NS2 simulator.

Index Terms— VANET, routing protocols, AODV, DSR, GPSR, QoS, Vehicle-to-Vehicle, Vehicle-to-Infrastructure.

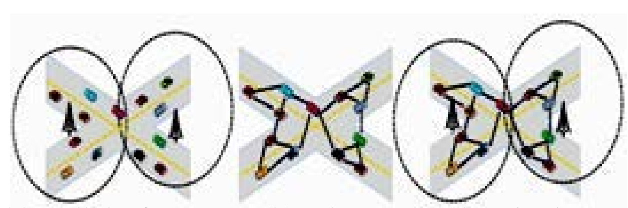
1 INTRODUCTION

The recent technology of Vehicular networks represents a predominant novel category of wireless ad hoc networks that facilitate vehicles to exchange the information with each other on the roadside communications. Previously, drivers share their communication by means of voice, gestures, horns, and also with the examination of every one routes to control their activities. When the distance of the vehicle gets increase, then the analysis of vehicle communication is difficult to manage. Hence the hand signals, semaphores and colored lights have been implemented by the traffic police for controlling and supervision of the traffic.

For providing the safety communication “[13], [14]”, the mechanization of traffic signals and automobile indicators was deployed. Now a day, the drivers can able to share their traffic information and guidelines by using the car phones or civilian propagation. Wireless communications are more suitable for exchanging the personalized and absolute information. VANET concentrate on all the issues which are interrelated to the connections and communications between vehicles. VANET also concentrates on the Wireless Access for the Vehicular Environment (WAVE) principle based on the emerging IEEE 802.11p specification. VANET fundamentally enables Infrastructure-to-Vehicle (I2V), Vehicle-to-Infrastructure (V2I), and Vehicle-to-Vehicle (V2V) infrastructure.

2 NETWORK ARCHITECTURES

Wireless ad-hoc networks are usually in the motion of mobility nature hence it do not rely on permanent infrastructure and propagation of information for communication. As like Wireless ad-hoc networks VANETs also uses the same standard for highly self-motivated situation for exterior transportation. As shown in Figure. 1, the design network of VANETs is differentiated as three categories: pure cellular /WLAN, pure ad hoc, and hybrid. The permanent cellular gateways and the WLAN/WiMax access points at traffic intersections are used by VANETs. The permanent cellular gateways and the WLAN/WiMax access points are used to connect the vehicles with the Internet and also to gather traffic information during the process of routing. The pure cellular or Wireless LAN structure is shown in Figure 1 (a). While combining both cellular network and WLAN in the VANETs the access point is presented as well as 3G connection is also established.



(a) Cellular/WLAN (b) Ad Hoc (c) Hybrid

Fig 1. Architectures for Vehicular Network

In Figure 1 (b) shows Vehicle to Vehicle communication for obtaining the defined goals, like blind crossing. In Figure.1 (c) the Hybrid architecture combines both the infrastructure networks and an ad-hoc network jointly for providing the probable solution for VANETs. By using WLAN and cellular capabilities as the gateways and mobile network routers “[1]”the vehicles with only WLAN capacity can able to communicate with the other vehicles through multi-hop links connected to the network. The hybrid architecture can offers improved coverage, but with some problems of faultless transition of the communication between dissimilar wireless systems.

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3 Outline of Routing Protocols

In VANET, the protocol for routing is classified as five categories “[2],[4]”,

3.1 Topology based routing protocol
3.2 Position based routing protocol
3.3 Cluster based routing protocol
3.4 Geo cast routing protocol
3.5 Broadcast routing protocol

3.1 Topology Based Routing Protocol

Topology based routing protocols uses linsk for linking the information to carry out packet forwarding.

3.2 Position Based Routing Protocol

Position based routing protocols consists of a group of routing algorithms. Based on the routing algorithm it shares the property of geographic positioning information to select the best subsequent forwarding hops. This protocol does not require any global route for transmitting the packets from source node to the destination node.

3.3 Cluster Based Routing Protocol

Cluster based routing protocols is preferred only when the area is divided into clusters. A group of nodes present in the cluster identifies them as which cluster it belongs to, then a node in a cluster is selected as cluster head for broadcasting the packets to all other nodes present in the cluster. Excellent scalability can be provided for huge networks but in high movable VANET the network delays and overhead may occur when forming clusters. Hence for providing scalability on the cluster nodes the cluster based routing of virtual network infrastructure has been created.

3.4 Broad cast Routing Protocol

Broad cast routing protocol is frequently used for sharing, traffic, weather and emergency road conditions between vehicles. Broadcast routing is also used for delivering advertisements and announcements.

3.5 Geo cast Routing Protocol

Goe cast routing protocol is also a location based multicast routing. The process of Geo cast routing is within the specified geographical region i.e., within the Zone of Relevance (ZOR) to deliver the packet from source vehicle node to all other vehicle nodes.

4 Vehicular Adhoc Network Protocol

An Adhoc routing protocol is a standard “[14], [15]” that controls how vehicle nodes decide in which way to route the packets between computing device in vehicular ad-hoc network. Existing unicast routing protocols of VANET is not capable to meet every traffic on highway road scenarios. They have also had some advantages and disadvantages. Hence two reactive routing protocols AODV and DSR and one position-based routing protocol GPSR has been chosen for simulation analysis.

4.1 Adhoc On-demand Distance Vector Routing Protocol (AODV)

It is an On-demand route acquirement routing protocol. It is better routing protocol than Destination Sequenced Distance Vector (DSDV). It is used to increase the size of network dynamically when there is an increase of vehicle nodes “[5], [6], [7]”.

4.2 Dynamic Source Routing Protocol (DSR)

It is also an On-demand route routing protocol in which the sequence of nodes is calculated and maintained as an information in packet header. For caching the source routes every mobile node in the network wants to maintain a route cache. When a packet is transmitted, the route-cache of the node is compared with the actual route. If the route cache is successfully compared, then the packet is forwarded or else route discovery process is initiated once again “[6],[7]”.

4.3 Greedy Perimeter Stateless Routing (GPSR)

Greedy Perimeter Stateless Routing (GPSR) “[9]” is a type of position based routing. GPSR uses the nearest neighbor information of destination in order to transmit packet. GPSR is also known as greedy forwarding. In GPSR each node contains the information of its current physical location and also the information of neighboring nodes. The knowledge about node positions provides better routing and also knowledge about the destination. By using Global Positioning System (GPS) devices all the information about nodes position has been gathered.

5 Performance Analysis

5.1 Packet Delivery Ratio (PDR)

Packet Delivery Ratio is an essential factor in any network to evaluate the performance of routing protocol. The major parameters to analyze performance are packet size, number of nodes, transmission range and the structure of the network. When packet delivery ratio is high then the performance analysis is considered as better one. The mathematical formula for calculating the performance is shown in equation (i)

$$\text{PDR} = \sum \frac{\text{total packets received by all destination node}}{\text{total packets send by source node}} \qquad \text{(i)}$$

5.2 Average End-to-End Delay (E2E Delay)

Average End-to-End Delay is the factor in which the time taken by a packet to route throughout the network from a source to its destination. The average end-to-end delay can be calculated by the mean of end-to-end delay of all successfully delivered messages. Hence end–to-end delay partially depends on the packet delivery ratio. When the distance of source and destination gets increase, then there is an increase of packet drop. The average end-to-end delay includes all possible delays in the network such as buffering route discovery latency, retransmission delays at the MAC, and propagation and transmission delay. The mathematical formula for calculating the average end-to-end delay is shown in equation (ii).

$$\text{D} = \frac{1}{n}\sum_{i=1}^{n}\left(Tr_i - Tr_s\right)*1000\,(\text{ms}) \qquad \text{(ii)}$$

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Where,
D = Average E2E Delay
i = packet identifier
Tr_i = Reception time
Ts_i = Send time
n = Number of packets delivered successfully

5.3 Packet Loss (PL)

Packet Loss is the proportion of the number of packets that not at all reached the destination to the number of packets originated by the source. The mathematical formula for calculating the packet loss is shown in equation (iii).

$$PL = \frac{(nSent\ \text{Packets} - \text{nReceived Packets})}{nSentPackets} \quad \text{(iii)}$$

Where,
nReceivedPackets = Number of packets received
nSentPackets = Number of packets sent

5.4 Packet Loss Ratio (PLR)

Packet Loss Ratio is the proportion of the number of packets that not all reached the destination to the number of packets originated by the source. The mathematical formula for calculating the packet loss ratio is shown in equation (iv).

$$PL = \frac{(nSent\ \text{Packets} - \text{nReceived Packets})}{nSentPackets} * 100 \quad \text{(iv)}$$

Where,
nReceivedPackets = Number of packets received
nSentPackets = Number of packets sent

5.5 Average Throughtput (AT)

Average throughput is the average of the total throughput. It is also calculated in packets per unit Time Interval Length (TIL). The mathematical formula for calculating the packet loss ratio is shown in equation (v).

$$AT = \frac{\text{Re}\,ceived\ \text{Packet Size}}{Stop\ \text{time} - \text{Start time}} * \frac{8}{1000}\ \text{(ms)} \quad \text{(v)}$$

Where,
Start Time - Simulation start Time
Stop Time - Simulation Stop Time

6 Simulation Results

The two types of Reactive (On-demand) routing protocols namely Ad-hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) and one Position-Based (Geographical) routing protocols namely Greedy Perimeter Stateless Routing (GPSR) protocols is used for the performance analysis.

6.1 Scenario

In this scenario, number of nodes linked in a network when the time is varied and also the number of connections is varied for comparing the AODV, DSR, and GPSR protocols.

TABLE 1
VARIOUS PARAMETERS USED WHILE VARYING NUMBER OF CONNECTIONS

Parameter	Value
Protocols	AODV, DSR, GPSR
Number of Nodes/Varying Traffic (VT)	20, 40, 120, 250
Simulation Time	500 sec
Traffic Type	CBR
Routing protocol	AODV, DSR, GPSR
Transmission Range	250 m
Mobility Model	Random Waypoint
Simulation area	750 * 750 m
Node Speed	15 m/s
Pause Time	00 sec
Interface Type	Queue
Mac Protocol	802.11Ext
Packet Size	512 MB
Queue length	50
Radio Propagation Model	Two Ray Ground

TABLE 2
PERFORMANCE OF AODV, DSR AND GPSR WITH VARYING NUMBER OF CONNECTIONS

VT	PL	E2E Delay	PDR	AT	PLR
20	240	115.442	90.4028	230.7	2.390
40	638	125.145	95.5757	250.97	3.981
120	770	120.306	96.1747	235.58	5.010
250	1110	120.425	91.3664	243.87	6.472

TABLE 2.1 AODV

VT	PL	E2E Delay	PDR	AT	PLR
20	240	120.574	68.4883	205.76	1.290
40	165	70.705	40.7186	240.57	1.761
120	330	185.110	9.4177	170.38	1.810
250	290	135.254	1.3466	180.55	1.552

TABLE 2.2 DSR

VT	PL	E2E Delay	PDR	AT	PLR
20	220	100.475	60.8090	195.46	1.090
40	135	65.405	30.5426	205.37	1.561
120	250	105.90	8.0990	125.18	1.410
250	250	85.010	1.5446	115.44	1.090

TABLE 2.3 GPSR

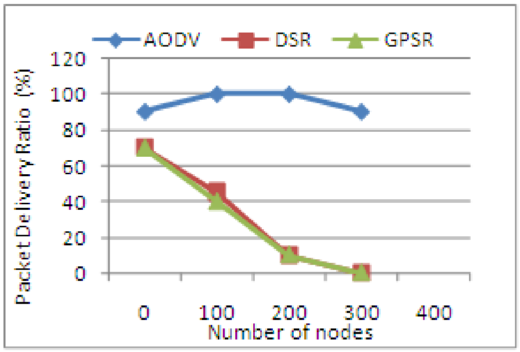

Fig. 2 shows packet delivery ratio of AODV, DSR and GPSR. The result shows that AODV packet provides the higher packet delivery ratio than DSR and GPSR.

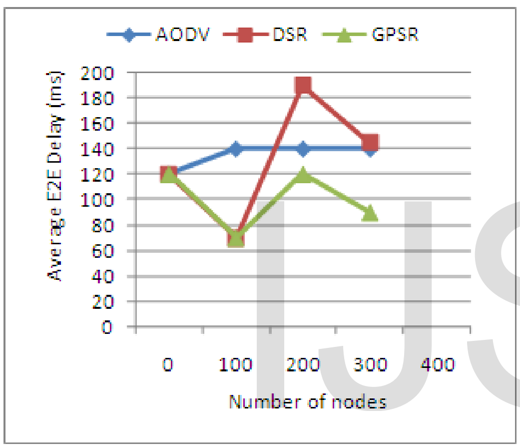

Fig. 3 shows the Average E2E Delay of AODV is constant, when the number of nodes (vehicles) gets increases. Whereas, when the number of vehicles increases the protocols of DSR and GPSR have some deviation.

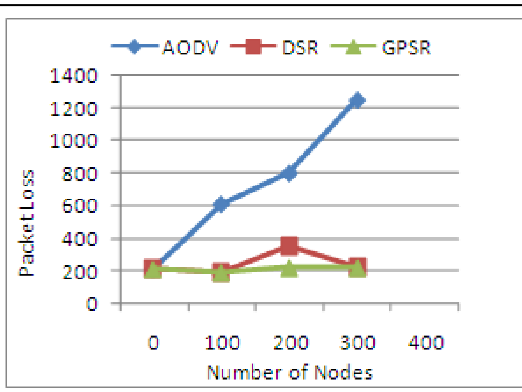

Fig. 4 shows the data packet loss of AODV, DSR and GPSR. The result clearly shows that when number of nodes (vehicles) increases the data packet loss of AODV is also increase than the DSR and GPSR.

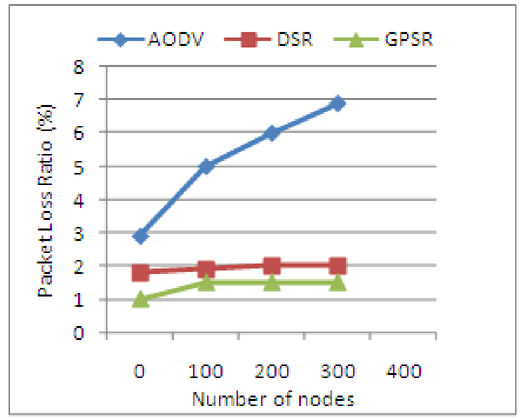

Fig. 5.shows the packet loss ratio for AODV, DSR and GPSR. The AODV results show that when the number of nodes (vehicles) increases the packet loss ratio is also gets increase.

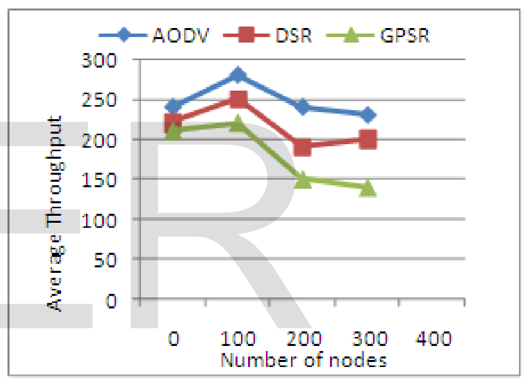

Fig. 6. shows the Average Throughput analysis for AODV, DSR and GPSR. The protocol of AODV shows the better throughput than DSR and GPSR when the number of vehicles.

7 Conclusion

These subdivisions have reviewed existing routing protocols "[10]". For forwarding the packets the first routing decision has been described by the Prior forwarding method. In the prior forwarding method the multi-hop method used in case of Delay Bounded protocols. Digital map visualization provides the street level map and traffic statistics for analyzing traffic density and vehicle speed on the road. Digital map is a compulsory one in case of Cluster Based Routing Protocols, since for analyzing the cluster node. Therefore to provide scalability "[12]" for clustering of nodes Virtual Infrastructure is created. The cluster head on the each cluster provides secure communication among inter-cluster and intra-cluster synchronization. Recovery strategy is a criterion which is used to recover from critical situations and also to evaluate the performance of the protocol "[15]". Finally the performance analysis reactive routing protocols of AODV shows the best performance with the ability of maintaining connection by continuous exchange of information necessary for TCP network.

AODV performs best on packet delivery ratio where as in case of throughput GPSR performs well. When considering at higher node mobility, AODV is performed worst in case of packet loss and throughput but it performs best for packet delivery ratio, whereas while considering GPSR, for higher node mobility in case of E2E delay and throughput it performs better than AODV, but DSR shows the better results than GPSR in case of packet loss.

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