

Comparison of Position Based Routing Protocols of Vehicular AD HOC Network

Ahmed Nazar Hassan, Abdul Hanan Abdullah, Dalya Khalid Sheet and Kashif Naseer Qureshi

Faculty of Computing, University Teknologi Malaysia, 81310 Skudai, Johor Bahru, Malaysia

Abstract: The vehicular Ad hoc network is a distinguish approach for intelligent transportation system and a sub class of mobile Ad hoc network. The emergence of wireless communication and transportation through inter vehicular communication has promised countless applications enhance the overall driving experience. Vehicular communication would require efficient routing protocols, secure communication, proper coverage and standards. Various routing protocols have been adapted for VANET and particularly using position based routing approach. The paper gives an overview of position based routing protocols and compare them in the context of driving experience and safety.

Key words: VANET · Position · Protocols

INTRODUCTION

The Vehicular Ad hoc networks have received much attention for the development of traffic safety as well as ensuring a pleasant driving experience in transportation sector. VANET can provide a wide range of user services with the use of communication devices without prior infrastructure. The use of Ad hoc in this network was deemed the most suitable method [1]. The vehicles are moving on the roads, equipped with wireless communication devices and interlink with each other. Various routing protocols have been proposed for efficient routing between vehicles and categorized into different types such as topology, position, broadcasting, beaconing, hybrid etc. In position based routing protocols the navigation system GPS is using to perform communication by utilizing position information of vehicle in network. On the contrary, topology based routing protocols alleviate the problems of scalability or control message overhead. Various issues of VANET are being looked into like routing protocols, security, applications and much more.

One of the main challenge is designing efficient routing protocols for data delivery between vehicles because the traditional Ad hoc routing protocols are not suitable for VANET. The vehicles are moving with high range of speed and network topology change more rapidly that causes frequent network fragmentation and packet dropping in network. Therefore, routing protocols

have to be designed with high mobility and ensure the reliability of safety related applications. Traffic lights, road intersections, obstacles and road patterns of specific area restrict the vehicles movement in network. The routing protocols use these information for route decision and forwarding the packet between source to destination.

Position Based Routing Protocols: The distinctive features of VANET a different and efficient routing protocol required for communication. The position based approach in protocols proposed for different projects such as FleetNet [2], CarTALK2000 and NoW [3-4]. Position based routing protocols requires physical position of vehicles in network for perform data routing. Global positioning system (GPS) use for position information in network. Some other strategies are used in these protocols such as beaconing, location services, forwarding and recovery strategies. The first beaconing strategy is use for contain the neighbor vehicle node position and location services obtain the destination location. In forwarding and recovery, strategies are used for packet forwarding between source and destination nodes. The position based routing protocols have many advantages such as no need route maintenance and routing path determined when packets are required to be forwarded. These protocols only need position information of destination, node identifiers, forwarding nodes and their neighbors.

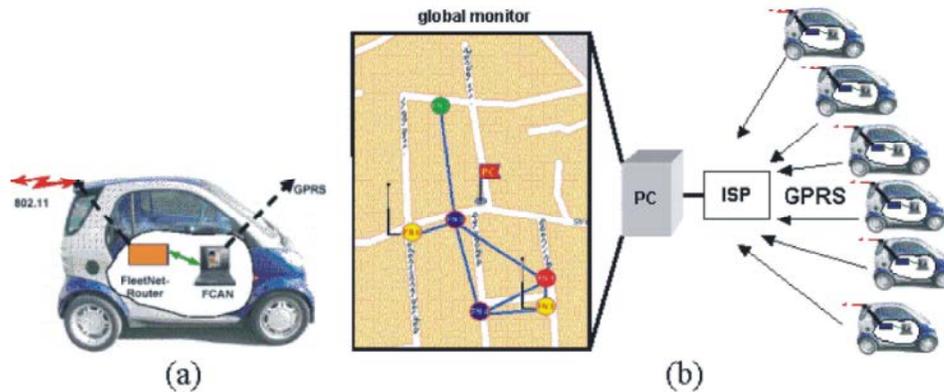


Fig. 1(a): GPS system placed in car (b) GPRS service providers

Many researchers proposed different strategies and replace location services with topology based routing. Schwingschlogl and Kosch [5] introduced an AODV protocol enhanced with Geocast-based capability for vehicular networks. The geocast routing protocols also using geographical location but focuses on sending messages or packets to a selective geographic region [6]. Another position based strategy called reactive location service (RLS) used route discovery procedure, which is used in reactive non-position protocol such as AODV and DSR [7]. The geographic source routing (GSR) proposed with vehicular movement patterns [8].

A new position based routing protocol proposed called A-STAR for urban areas [9]. The protocol adopts anchor-based routing approach like GSR with spatial awareness and the term used street awareness. The streetawareness means using street map information in their routing scheme. For identification of certain paths protocol use city bus route, the advantage of this strategy is the packet delivery ratio and high connectivity noticed. Further author suggested some future work using bus schedule as an enhancement of A-STAR.

In CarNet project geographical forwarding method used to achieve scalability in high mobility networks. The protocol worked without infrastructure and adjust its radio spectrum and power levels based on node densities in the network. In sparse network, finding the next hop is difficult so grid uses in order to solve this problem. GPSR uses greedy forwarding method for forwarding the packets. In greedy forwarding, next hop are chosen based on nodes, which are geographical closer to the destination node. However, if node is not in range with destination than forwarding is fail. In this case, protocol switches in perimeter routing algorithm. The network topology is seen as a planar graph and packets are forwarded by traversing the graph using the right hand rule.

Grid location service (GLS) as a scalable distributed location service is an equal distribution of maintaining location service among the nodes. It reduced network load on any single node and avoid a single point of failure. The repair strategy in GPSR relies on planarizing graph and unsuitable for city environment.

The Greedy perimeter coordinator routing (GPCR) is used for improve GPSR problem [10]. In this protocol the restricted greedy forwarding strategy and repair strategy used. In this protocol the map and graph planarization algorithm are not required because it used street and junctions for forwarding decision. The node present in junctions called coordinator nodes and they decide which next street for packet reached to destination.

Beacon message is a short hello message to find the neighbor node and usually many position-based protocols use this beaconing. On the other hand, the beaconless approach is also used in these protocols. The author proposed urban multi hop broadcast (UMB) routing protocol with beaconless strategy for broadcasting purposes [11]. The protocol has two phases directional broadcast and intersection broadcast. The directional broadcast use for find a node furthest away in broadcast direction and without beaconing information forward the packet. In intersection broadcasting propagate packets in different directions of an intersection using repeaters or fixed infrastructures. The UMB performance well in dense areas.

Another position based protocol greedy traffic aware routing (GyTAR) proposed for vehicles movement prediction and similar to anchor-based routing with spatial awareness [12]. The process of packet forwarding in this protocol is through road junctions toward the destination. The junctions are chosen on the fly and calculate number of vehicles between junction and next junction radio range. The vehicles contain navigation system with real time traffic data. The greedy forwarding approach is use

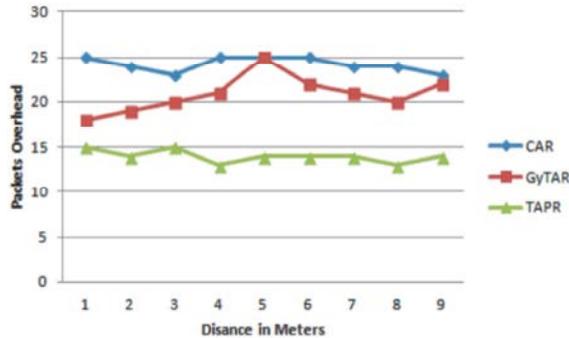


Fig. 2: Packet Overhead Comparison of CAR, GyTAR and TAPR

for forward the data and selects the next hop based on predicted node location. GyTAR protocol calculation based on vehicle direction, speed and last known position like recovery strategy. The performance of this protocol was shown outperform GSR in terms of packet latency, packet delivery and overhead.

In another adaptive data dissemination protocol (SADV) [13] proposed a store and forward strategy for VANET. The protocol requires fixed infrastructure at each junction. The static node assisted routing (SNAR) is a module of SADV and using for hold the packet when next hop is not found in it opposite direction. The best route measured through delay matrix and some metrics take in account such as vehicle density and position information. The second module is link delay update (LDU) use for measure the delay matrix with real time data from a static node and distributesthese information to other static nodes. The overall performance of this protocol is better in packet delivery in medium and sparse networks.

Predictive directional greedy routing (PDGR) [14] proposedto handle the unique VANET characteristics. The protocol is basedon direction and position of vehicle node and next hop is select with highest score. If the next hop, is not find then carry and forward approach used in protocol. The protocol overall performance is better with GPSR and GSR in term of packet delivery ratio.

Adaptive packet relaying (TAPR) [15] proposed for VANET and used vehicle direction and position during forwarding method. The VANET environment is seen as a disconnected network wherein vehicles forms clusters that are separated by many broken links and beacon messages are use for maintain the clusters. The protocol contains two mode connected and disconnected mode, in disconnected mode vehicles are not able to communicate with other clusters. The packet is forwarded toward the destination through direction until it reaches the vehicle that is at the edge of current cluster. The cluster chooses to mute until clusters are connected.

The above mentioned position based routing protocols assumed location service available and nodes are able to contain destination location. Another routing protocol connectivity-aware routing (CAR) [16] proposed to integrates a location service into its route selection process. The new beaconing approach and recovery strategy proposed in protocol. The optimized broadcasting method is used to locate the position of the destination. The anchor points are constructed at the same time from source to destination. The CAR protocol similar to other anchor-based protocols, data packets are then greedily routed between anchor and destination. When link is break protocol, avoid rediscover routes frequently. The CAR protocol proposed Guards concept for maintain the routes and repair them on-the-fly as they break. The protocol also implemented an adaptive beaconing method and varies to the network density. The overall performance of CAR is better compared to GPSR in terms of packet delivery, average latency and overhead.

Comparison of Position Based Routing Protocols:

The basic objective of efficient routing protocols are to ensure packet delivery in time and without any error. The protocols are evaluated based on packet delivery ratio, end-to-end delay and overhead rate. However, protocols have their features and requirements and depend on situation. We selected most used position based routing protocols out of many reviewed and already we explained above section. We evaluated these protocols in the context of safety applications for VANET urban area.

Table 1 describe the features and requirements of selected protocols. Usually these protocols are used beaconing approach for gathering the position information of neighbor nodes. Some protocols use beaconing for gathering latency information such as SADV protocol. CBF and UMB are not using beaconing approach because they gathered stale due to vehicle mobility.

Most of protocols assumed the position of destination, Grid and CAR implemented a location service with diverse features. In Grid protocol, the location service is implemented as a separate modules and the work load is distributed among the nodes. The CAR location service is for not only position information of target node but also use for forming route between source and destination. The location service mechanism overcome the complexity of protocol but have impact on overhead.

Table 1: Requirements and features of protocols

Features	Position based routing protocols
Vehicle Movment	CAR, TAPR, GyTAR, GVGrid
Broadcast	CBF,UMB,CAR
Beaconing	Grid, GVGrid, GyTAR, SADV, TAPR,CAR
Location Service	Grid,CAR
Recovery Approach	Grid,CAR
Fixed Infrastructure	UMB, GVGrid,SADV

Table 2: Performance comparison of protocols

Metric	Low	Medium	High
Latency	GyTAR	Grid,CBF	GVGrid, TAPR
Delivery Ratio	-	Grid	CBF,UMB,GVGrid,GyTAR, SADV,TAPR,CAR
Packet Overhead	TAPR	CBF, GyTAR,SADV	Grid,UMB,GVGrid,CAR

The UMB, GVGrid and SADV protocols are using fixed infrastructure in order to perform routing in network. SADV requires fixed infrastructure at junctions for store and forward packets. The fixed infrastructure enhanced the performance of routing protocols. However, due to cost and roads structure it is not easy to install the towers in some areas.

CAR and Grid implements a recovery strategy in the case when the forwarding strategy fails. GyTAR and TAPR uses the carry and forward method use for forwarding packet if next hop is not available. While not giving the packet delivery guarantee. The global flooding is not required in position based routing, some protocols uses the broadcasting approach such as CBF, UMB and CAR. CBF uses an enhanced broadcasting; CAR uses broadcasting for its position service and assist to creating routes for forward packets.

Density of path mean number of nodes available in a path such as GyTAR, AADV and CAR includes this information in their routing algorithm. The node position information and vehicle speed travel direction are assumed in GVGrid, GyTAR, TAPR and CAR. These protocols are best in packet delivery ratio.

Simulation Setup: We select NS2 simulation to test position based routing protocols here we show the popular position based protocols. Below graphs shows the overall performance of three protocols. The CAR protocol suffer from packet overhead and GyTAR is medium and TAPR protocol is low.

The Figure 3. Shows the packet delivery ration of two position-based protocols CAR and Grid. The CAR protocol delivery ratio is better than Grid.

The performance comparisons of position-based protocols are grouped in three regions low, medium and high packet delivery ratio and show in below table.

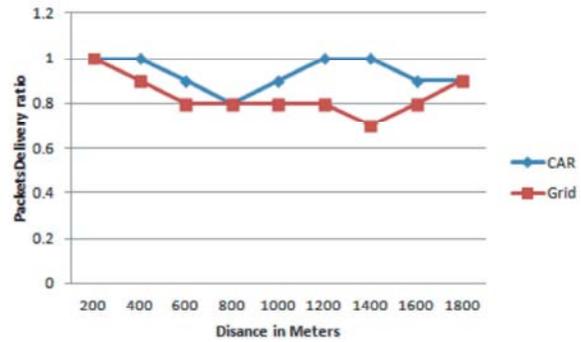


Fig. 3: Packet Delivery Ratio of CAR and Grid

Above Table, 2 shows the performance based on simulation results of position based routing protocols. The results shows on the base of three metrics and grouped the protocols in region of high, medium and low. The most of position base protocols have high packet deliveryrate in the presence of infrastructure and recovery approaches. The Grid protocol is less suitable for urban environment due to its recovery strategy.

The GVGrid protocol has high latency because of QoS. On the contrary, the TAPR select to mule when forwarding cluster is not available and cause of higher latency. SADV belong to medium region because it is used store and forward strategy. When packets are arrive than a little latency while determine the best path. The CAR and GyTAR have low latency because these protocols contain path and vehicle movement [17].

UMB,Grid,CAR and GVGrid have overhead in packets delivery. CAR and Grid protocol includes location services and overall overhead packets increase. The CBR protocol use-broadcasting approach and belong to medium region, because it is not using beaconing approach and cause of lowpacket overhead. In TAPR the beaconing use for maintain its clusters in the network.

CONCLUSION

The high packet delivery rate at a minimal latency is one of the significant requirements of vehicular Ad hoc network environment. Most high critical safety application the packet delivery in time is another important factor. Still VANET environment has been faced these problems and many researchers proposed different approaches to overcome these issues from the network. The forwarding strategies and infrastructure are depends on the delivery of packets in network. If routing protocol contain density possible route, vehicle direction and movement, latency of packet delivery will improve. The presence of location service in protocol

affected the overhead of network and beaconing, broadcasting approach also greatly affects the performance of protocols.

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