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A Survey on Position based Routing Protocol in Vehicular Ad-Hoc Networks

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Abstract

Vehicular ad-hoc networks is designed for Vehicle-to-Vehicle (V2V), Vehicle-to-infrastructure (V2I) communication. One of the noteworthy troubles of VANET application is in directing the bundle in gainful and effective route sine the framework topology is ready. In position based routing protocol geographical position of node is used to select the best path. Hence in position based routing protocol each node determine location of itself as well as destination node. This paper gives a detail description of different position based routing protocol and pros and cons of routing protocol, Position based routing protocol is a large and important categories of vehicular network.

Keywords: VANETS, AD-HOC NETWORKS, GPS, POSITION BASED.

I. INTRODUCTION

Vehicular ad hoc network is a special form of MANET which is a vehicle to vehicle & vehicle roadside wireless communication network. It is autonomous & self-organizing wireless communication network, where nodes in VANET involve themselves as servers and/or clients for exchanging & sharing information.

VANET applications can be categorized as Safety, Traffic efficiency and Infotainment. Similarly the Intelligent Transportation System (ITS) uses periodic or aperiodic message sending strategy depending on the application in use. If neighbour discovery is required then a periodic broadcast message is sent to inform relatives about the availability of neighbour vehicles. Similarly, if an accident, a road obstruction or an ambulance event is detected, then an aperiodic message is sent which needs to be delivered instantly towards the vehicles that are moving towards the scene of emergency.

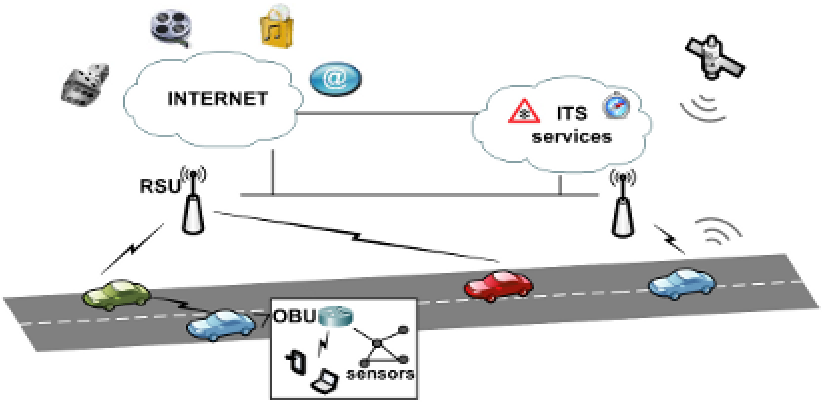

Fig 1: VANET Architecture

Fig. 1 shows the architecture of VANET. Communication takes place between vehicle-to-vehicle as well as vehicle to roadside unit. An On Board Unit (OBU) is setup on every vehicle for signal transmission. Using VANET, vehicles can share music and video files.

1) V2V communication allows sharing information about the traffic environment among moving vehicles. Internet connectivity is required in this type.

2) V2I communication allows vehicles to communicate with fixed units (i.e. roadside unit) deployed on the sides of road at a fixed distance. This type of communication is beneficial for the vehicles that are offline hence no internet connection is required.

The rest of the paper is organized as follows. Section 2 deals with different position based routing protocols, Section 3 on pros and cons of routing protocol, Section 4 on comparison of various position based routing protocols, Section 4 concludes the paper.

2. POSITION BASED ROUTING PROTOCOL

In geographic (position –based) routing, the forwarding by a node is primarily made based on the position of a packets destination and the position of the nodes one-hop neighbors. The position of the destination is stored in the header of the packet. Fig 2 shows the classification of position based routing protocol, divided into DTN, Non-DTN and Hybrid.

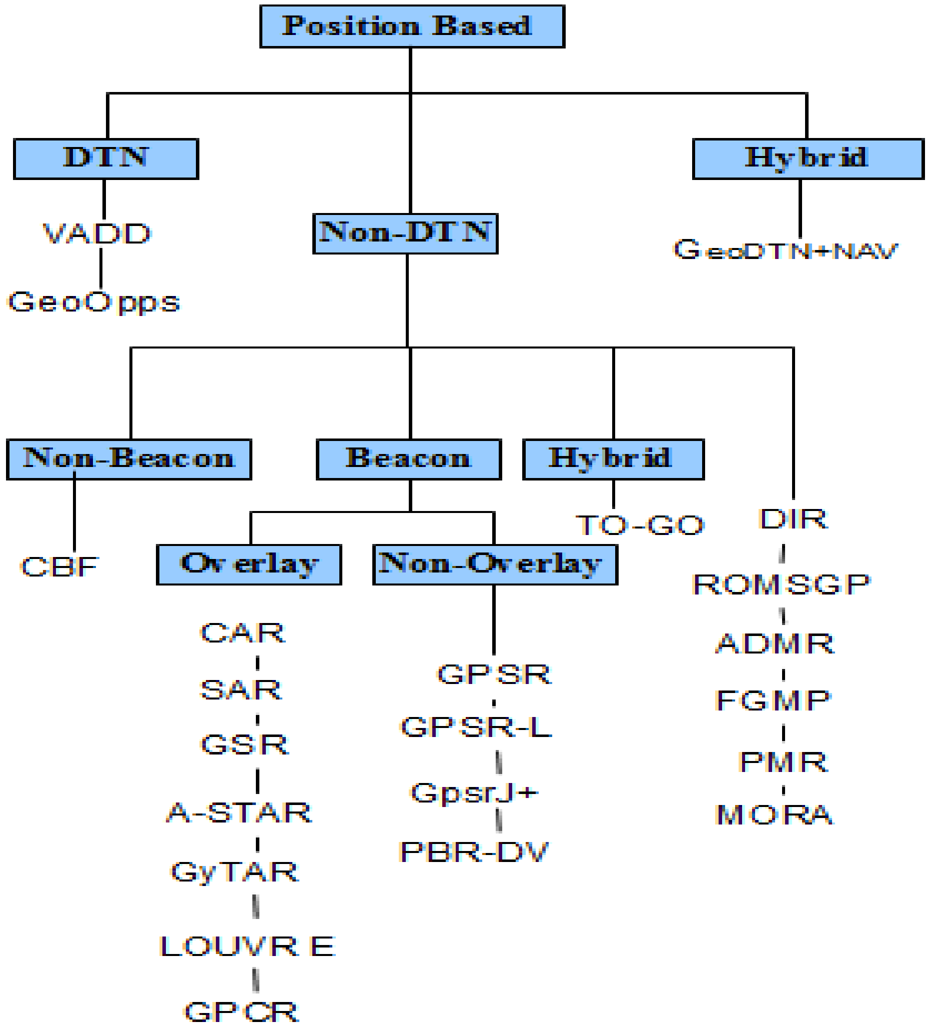

Fig 2: Classification of position based routing

2. Delay Tolerant Network (DTN)

Delay Tolerant Network algorithms take some necessary steps to overcome intermittent connectivity in urban areas. Carry and forward strategy are used to cater for frequent disconnections of nodes in the network. In carry and forward strategy when a node cannot contact with other nodes it stores the packets and forwards them upon connection to a neighboring node. Example of DTN routing algorithm are VADD and GeoOpps.

2.1.1 VADD

The main concept of VADD is based on the query and forward. One of the vital issues is the choice of a forwarding path with limited packet delivery time and it follows some basic principles, which is to transmit maximum routing information through wireless channels and it must select the road with higher speed when the packet has to be carried through certain roads. As vehicular ad-hoc networks have a very high probability of topology change so guaranteed packet delivery along the pre-computed optimal path is not assured, that is why the dynamic path selection should continuously be executed throughout the packet forwarding process. VADD routing algorithm has three modes of operation: Intersection, Straightway and the Destination, where every vehicle takes a choice at a junction and goes for next forwarding path depending on the operations. VADD is applicable in urban VANET scenarios and its operation requires no infrastructure. The data delivery rate as well as control packet overhead is high. The link establishment occurs through beacon messages.

2.1.2 GeoOpps

A delay tolerant network routing algorithm that exploits the availability of information from the GPS in order to opportunistically route a message to a certain geographical location. It takes the advantages of the vehicles' GPS suggested routes to select vehicles that carry the information. The model of selecting next carrier is the neighbor vehicles that chase suggested routes to their driver's destination compute the nearest point that they will get to the destination of the message. Then they use the closet point and their map in a convenience function that expresses the minimum projected time that this message would need in order to reach its destination. The vehicle that can transmit the packet quicker/closer to its destination becomes the next packet carrier.

2.2 Non-Dtn

The non-DTN types of geographic routing protocols do not consider discontinuous connectivity and are only practical in highly congested VANETs. If there is no neighbor of a node in position based routing then forwarding strategy fails to deliver a packet and the situation is called local maximum.In this situation the routing protocol of non-DTN routing protocol performs a recovery strategy to deal with such a failure. The non DTN routing protocol is further divided into a beacon, non-beacon and Hybrid.

2.2.1 Beacon

The routing protocol of this category uses beacon messages to collect information about 1-hop or 2 hop neighbors. Beacons typically play two roles in routing and forwarding process. It is use to trace the closet neighbor to the destination and also identify anchor nodes. There are also two categories of beacon routing protocol i.e. non-Overlay and Overlay.

2.2.1.1 Overlay Routing:

Overlay routing has the attributes that the routing protocol shows on a set of envoy nodes overlay on top of the current network. It is complex to make a decisions at junctions where message need to select different direction in a city scenario. So the overlay routing protocol have some special strategy to select rout at junction. Example of Non-DTN overlay is CAR , GSR, A-STAR, GyTAR and GPCR.

1)CAR: The Connectivity-Aware Routing (CAR) protocol divided into four main parts. They are (1) destination location and path discovery; (2) data packet forwarding along the found path; (3) path maintenance with the help of guards; and (4) error recovery. The protocol combine locating destinations with finding connected paths between source and destination as a substitute of using the popular location service like RLS. Each node regularly broadcasts HELLO message including its velocity vector (moving direction and speed). The beaconing period is dynamically changed according to the number of the registered nearby neighbours so the mechanism can adapt to the changing traffic conditions. The forwarding node evaluates link connectivity by calculating some metrics including hop count and average number of neighbours. The destination selects the path that provides better connectivity and lower delays by computing metrics using anchor point information recorded in the received routing request packet and unicasts reply packet including the collected information as well as its position and velocity vector to the source node. A distinguishing property of CAR is the ability to not only locate the destinations but also find connected paths between source and destination pairs.

2)GSR: Geographic Source Routing (GSR) is position based routing algorithm that is uses location based information of neighboring nodes. In GSR the querying node floods the network with a position request for a particular node. Upon receipt the node replies with a ‗position reply to the querying node. GSR uses extensive flooding and it has several extensions that address to minimize flooding. Such extensions require more processing at the cost of better performance. VANETs however, have superior processing and storage for such algorithms. GSR is a broad position based non-DTN routing protocol and application scenario is urban area. Similar to all position based routing protocol it don‘t need virtual infrastructure. The data delivery rate of GSR is low where as the control packet overhead are moderate. The link type of GSR is beacon and path states with propagation model is road blocking.

3) A-STAR: A-star algorithm is an optimization algorithm for heuristic search, by it we can assure to get the optimal solutions in every step of the search. And the search based on it may be looked as a process to search and find the goal node from the start source node in the state-space graph. In A-STAR anchor is analogous to junctions or intersections as in GSR. Since arterial roads served by a regular fleet of city buses accommodate more vehicle traffic than others, weight is assigned to each street based on the number of bus lines by which it is served. Thus with the digital maps, the anchor path can be computed using Dijkstra algorithm. In a sense, the anchor path is street vehicle traffic aware. Packets are forwarded by intermediate nodes in the manner of greedy forwarding between two successive anchors. The scheme also includes a new recovery strategy that packets are salvaged by traversing a new anchor path which is re-computed at the local optimal node. Besides, to prevent other packets from traversing the same void area, the street at which local optimum occurred is marked ―out of service‖ temporarily and this information is then distributed to the network. That street is not used to compute or re-compute a new anchor path during the ―out of service‖ duration. A-STAR performs better than GPSR and GSR. But its main shortcoming is that most of the network traffic is transferred to the vehicles in main streets, so the bandwidth congestion might be severe. Furthermore, for the vehicles in the secondary streets the chance of being selected to the routing path is less, though the connections among them may be good enough.

2.2.1.2 Non-Overlay Routing

The fundamental principle in the greedy approach is that a node forwards its packet to its neighbour that is closest to the destination. The forwarding strategy can fail if no neighbour is closer to the destination than the node itself. In this case, we say that the packet has reached the local maximum at the node since it has made the maximum local progress at the current node. The routing protocols in this category have their own recovery strategy to deal with such a failure. GPSR, GPSR-L, GpsrJ+ are the example of non-overlay position based routing protocol.

GpsrJ+

Greedy Perimeter Stateless Routing (GPSR) is a responsive and efficient routing protocol for mobile, wireless networks. Unlike established routing algorithms before it, which use graph-theoretic notions of shortest paths and transitive reachability to find routes, GPSR exploits the correspondence between geographic position and connected in a wireless network, by using the positions of nodes to make packet forwarding decisions. GPSR uses greedy forwarding to forward packets to nodes that are always progressively closer to the destination. In regions of the network where such a greedy path does not exist (*i.e.,* the only path requires that one move temporarily farther away from the destination), GPSR recovers by forwarding in perimeter mode, in which a packet traverses successively closer faces of a planar sub graph of the full radio network connectivity graph, until reaching a node closer to the destination, where greedy forwarding resumes.

GpsrJ+

GpsrJ+ is a position based routing protocol which reduces the dependency on junction node. By using digital maps GpsrJ+ recovers from the local maximum. It uses two hop neighbours information for detecting appropriate junction turns and to calculate a good routing path. The packet delivery ratio of GPCR increases which is managed by GpsrJ+. The number of hops in the recovery mode of GPSR is reduced by a number of percentages. An expensive planarization strategy is not required in GpsrJ+. Not appropriate for the delay sensitive applications. It did not apply on realistic city map that are not necessarily grids. It has used simple line trajectory but realistic roads follow a more complex trajectory.GpsrJ+ is a position-based routing protocol which consists of two modes, yet using a special form of greedy forwarding. As obstacles (e.g., buildings) block radio signals, packets may only be greedily forwarded along road segments as close to the destination as possible. Accordingly, the major directional decisions are made at junctions. When packets reach a local maximum, a point at which there is no node closer to the destination, the node switches to GpsrJ+'s recovery mode. In the recovery mode, packets are greedily backtracked along the perimeter of roads. It is not necessary to back forward in small steps through planarazed links, first because the general direction of the right-hand rule always results in the opposite direction of where packets were going before recovery, and second because the objective is to come back as fast as possible to a junction.

2.2.2 Non beacon

Non-Beacon is a geographic routing protocol that does not require proactive transmission of beacon messages. Data packets are broadcast to all direct neighbors and the neighbors decide if they should forward the packet. The actual forwarder is selected by a distributed timer-based contention process which allows the most-suitable node to forward the packet and to suppress other potential forwarders. Receivers of the broadcast data would compare their distance to the destination to the last hop's distance to the destination. The bigger the difference, the larger is the progress and shorter is the timer. Contention-Based Forwarding is a non beacon position based routing algorithm.

CBF performs greedy forwarding without the help of beacons and without the maintenance of information about the direct neighbors of a node. Instead, all suitable neighbors of the forwarding node participate in the next hop selection process and the forwarding decision is based on the actual position of the nodes at the time a packet is forwarded. This is in contrast to existing greedy forwarding algorithms that base their decision on the positions of the neighbors as they are perceived by the forwarding node. In order to escape from local optima, existing recovery strategies, as mentioned in the section on related work, can either be used directly or may be adapted to be used with CBF.

2.2.3 Hybrid

Hybrid no DTN is a geographic routing protocol that exploits topology knowledge acquired via 2-hop beaconing to select the best target forwarder and incorporates opportunistic forwarding with the best chance to reach it. A target node is defined to be the node that greedy algorithm or recovery algorithm would normally pick except at the junction where optimization in choosing the target node either beyond the junction or at the junction is based upon whether the routing is in greedy mode or recovery mode. TO-GO is a non-DTN hybrid routing protocol.

TO-GO Topology-assist Geo-Opportunistic Routing (TO-GO) is a geographic routing protocol. It is different from CBF in three main aspects. First, rather than picking the next forwarding node that makes the best progress to the estimation; it picks the next forwarding node that makes the best progress to a target node. The reason for choosing the target node instead of the destination as the frame of reference is to take care of the city topology where roads intersect and destination usually does not lie on the same street as the source as in the highway. Packets have to make multiple turns into different streets before arriving at the destination. The data is then broadcast to all direct neighbors. Whoever‘s distance is closer to the target node gets picked to be the next forwarding node. The second difference is that unlike CBF, there is still the need of beacons, which are used for nodes to pick the target node. The fact that the data is broadcast and only the node that makes the furthest progress toward the target is chosen is to account for wireless channel errors and low packet delivery rate arising from multi-path fading, shadowing, and mobility – the furthest node (the target node) usually does not receive the data packet. Packets are therefore ―opportunistically‖ making their best progress toward the target node and thus the destination. TO-GO uses a novel way to choose the forwarding set of nodes that are candidates for the next forwarding node. The set is chosen so that all nodes can hear one another (no hidden terminals) and make a progress toward the target node. Lastly, TO-GO differs from CBF by providing routing decision for recovery. CBF on the highway works because the destination is always straight ahead. Thus, local maximum never occurs on the highway. Thus, the selection of the next forwarding node is always one that‘s closest to the destination. However, in city environments, streets cross each other and destination does not lie on the same street as the source. Thus, local Maximum frequently occurs. TO-GO adapts the concept of CBF that packets are opportunistically sent to the target node, calculated by the routing decision in both the greedy and recovery mode.

Hybrid Position Based Routing Hybrid type of geographic routing protocols combines the non-DTN and DTN routing protocols to exploit partial network connectivity. GeoDTN+NAV is a hybrid position base routing protocol.

GeoDTN+NAV : GeoDTN+NAV is a hybridization of non-DTN and DTN routing approaches that combines the greedy mode, the perimeter mode, and the DTN mode. The concept of the GeoDTN+NAV is that nodes belong suspecting with the network is disconnected based on the number of hops packet has travelled in the perimeter. It also measures the distance travelled by the packet so far, delivery rate and neighbor‘s direction with respect to the destination. GeoDTN+NAV is applicable in urban areas as a pure ad-hoc protocol. The data delivery rate and control packet overhead are both moderate. It uses beacon messages for path establishment and can use the road blocking propagation model.

3. PROS & CONS OF POSITION BASED ROUTING PROTOCOLS

Geographic routing that each node knows it’s own & neighbor node geographic position by position determining services like GPS. It doesn’t maintain any routing table or exchange any link state information with neighbor nodes. Information from GPS device is used for routing decision.

Pros

- Route discovery & management is not required.

-Scalability.

-Suitable for high node mobility pattern.

Cons

-It requires position determining services.

-GPS device doesn’t work in tunnel because satellite signal is absent there. We need to know some terms that we have used.

DTN

Delay Tolerant Network (DTN) uses carry & forward strategy to overcome frequent disconnection of nodes in the network. In carry & forward strategy when a node can't contact with other nodes it stores the packet & forwarding is done based on some metric of nodes neighbors.

BEACON

Beacon means transmitting short hello message periodically. It exposes presence and position of a node. An entry will be removed from neighbor table of a receiving node if it fails to receive a beacon after a certain period of time from the corresponding NODE

OVERLAY

Overlay is a network that every node is connected by virtual or logical links which is built on top of an existing network.

VADD (Vehicle-Assisted Data Delivery)

Vehicle-Assisted Data Delivery is based on the idea of carry & forward approach by using predicable vehicle mobility.Among proposed VAAD protocols H-VAAD shows better performance.

Pros

-Comparing with GPSR (with buffer), epidemic routing and DSR, VADD performs high delivery ratio.

-It is suitable for multi-hop data delivery.

Cons

- Due to change of topology & traffic density it causes large delay.

Geographical Opportunistic Routing (GeOpps)

Geographical Opportunistic Routing (GeOpps) protocol utilizes the navigation system suggested routes of vehicles for selecting the forwarding node which is closer to the destination. During this process if there is any node which has minimum arrival time the packet will be forwarded to that node.

Pros

-By comparing with the Location-Based Greedy routing and MoVe routing algorithm GeOpps has high delivery ratio.

-To find a vehicle which is driving towards near the destination GeOpps need few encounters.

- The delivery ratio of GeOpps rely on the mobility patterns & the road topology but not dependent on high density of vehicles.

Cons

-Privacy is an issue because navigation information is disclosed to the network.

Greedy Perimeter Stateless Routing (GPSR)

Greedy Perimeter Stateless Routing selects a node which is closest to the final destination by using beacon. It uses greedy forwarding algorithm if it fails it uses perimeter forwarding for selecting a node through which a packet will travel.

Pros

-To forward the packet a node needs to remember only one hop neighbor location.

-Forwarding packet decisions are made dynamically.

Cons

-For high mobility characteristics of node, stale information of neighbors' position are often contained in the sending nodes' neighbor table.

-Though the destination node is moving its information in the packet header of intermediate node is never updated.

GPSR+AGF

In GPSR we see that stale information of neighbors position are often contained in the sending nodes neighbor table. For this reason an approach which is called Advanced Greedy Forwarding (AGF) is proposed.

Pros

- Though the destination node is moving its information in the packet header of intermediate node is updated.

-Stale nodes of neighbor table can be detected.

Cons

- To find the shortest connected path it may not give desired optimal solution.

Greedy Routing with Abstract Neighbor Table

(GRANT)

To avoid local maximum Greedy Routing with Abstract Neighbor Table (GRANT) applies extended greedy routing algorithm concept. Abstract Neighbor Table of

GRANT divides the plane into areas and includes per area only one representative neighbor.

Pros

-In city scenario with obstacles this extended greedy routing approach works well than as usual greedy approach.

Cons

- VANET has a high mobility characteristics but the performance evaluation of GRANT is done on static traces.

-The overhead of beacon and possible inaccuracy in packet delivery are not measured.

Greedy Perimeter Coordinator Routing

(GPCR)

Greedy Perimeter Coordinator Routing is a position-based routing protocol uses greedy algorithms to forward packet based on a pre-selected path which has been designed to deal with the challenges of city scenarios. No global or external information like static map does not require in GPCR.

Pros

- Does not require any global or external information.

-For representing the planar graph it uses the underlying roads though it is based on the GPSR.

-It has no as usual a planarization problem like unidirectional links, planar sub-graphs & so on.

Cons

- Depends on junction nodes.

-There has a problem in the Junction detection approach in which first approach fails on curve road & second approach fails on a sparse road.

GpsrJ+

GpsrJ+ [18] is a position based routing protocol which reduces the dependency on junction node. By using digital maps GpsrJ+ recovers from the local maximum. It uses two hop neighbors information for detecting appropriate junction turns & to calculate a good routing path.

Pros

-The packet delivery ratio of GPCR increases which is managed by GPSRJ+.

-The number of hops in the recovery mode of GPSR is reduced by 200%.

- An expensive planarization strategy is not required in GPSRJ+.

Cons

- Not appropriate for the delay sensitive applications.

- It did not apply on realistic city map that are not necessarily grids.

- It has used simple line trajectory but realistic roads follow a more complex trajectory.

CAR (Connectivity-Aware Routing)

For city and/or highway environment Connectivity-Aware Routing (CAR) is designed which uses AODV for path discovery and uses PGB for data dissemination mode. It uses guard concept to maintain the path.

Pros

-No digital map is required.

-It has no local maximum problem.

- CAR ensures to find the shortest connected path because CAR has higher packet delivery ratio than GPSR and GPSR+AGF.

Cons

-Unnecessary nodes can be selected as an anchor.

-It cannot adjust with different sub-path when traffic environment changes.

Greedy Traffic Aware Routing protocol

(GyTAR)

Greedy Traffic Aware Routing protocol gives a new concept of intersection-based routing protocol which aims to reduce the control message overhead & end-to-end delay with low packet loss.

Pros

- For high mobility topology changes rapidly and often occurring network fragmentation which is efficiently handle by GyTAR.

-Performance shows that throughput, delay and routing overhead are better than GSR.

Cons

- GyTAR depends on roadside units because it assumes that the number of cars in the road will be given from road side units.

-Gytar cannot avoid void.

GSR(Geographic Source Routing)

GSR routing was proposed for vehicular ad hoc networks in city environments which is the combination of position-based routing with topological knowledge.GSR uses greedy forwarding along a pre-selected shortest path & this path is calculated by using Dijkstra algorithm.

Pros

- Packet delivery ratio of GSR is better than AODV & DSR.

- GSR is scalable than AODV & DSR.

Cons

-This protocol neglects the situation like sparse network where there are not enough nodes for forwarding packets.

-GSR shows higher routing overhead than GyTAR because of using hello messages as control messages.

Anchor-Based Street and Traffic Aware Routing (A-STAR)

Anchor-Based Street and Traffic Aware Routing (A-STAR) is a position based routing protocol which is specially design for city scenarios for inter vehicle communication system. It ensures high connectivity in packet delivery by using vehicular traffic city bus information for an end-to-end connection.

Pros

-In low traffic density, A-STAR ensures for finding an end-to end connection.

-By comparing with the greedy approach of GSR & the perimeter mode of GPSR. A-STAR uses a new local recovery strategy which is more suitable for city environment.

-Path selection of A-STAR ensures high connectivity though its packet delivery ratio is lower than GSR & GPSR.

Cons

-Packet delivery ratio of A-STAR is lower than GSR & GPSR.

- To find a path from source to destination it uses static information based on city bus routes which causes connectivity problem on some portion of streets.

CBF (Contention-Based Forwarding)

Contention-Based Forwarding is a geographic routing protocol that does not make use of beacons. In CBF if there has a data packet to send, the sending node will broadcast the packet to all direct neighbors & these neighbors will find out among themselves the one that will forward the packet.

Pros

-Elimination of beacon message saves bandwidth.

-Reduces the probability of packet collision & inefficient routing by ignoring inaccurate neighbor tables.

-When node mobility is high CBF protocol provides a lower packet forwarding delay.

Cons

- In high way destination is always straight forward so local maximum never occurs as a result CBF works well but in city environment local maximum frequently occurs because source and destination may lie on different path.

TO-GO(Topology-assist Geo-Opportunistic Routing)

TO-GO is a geographic routing protocol which improves packet delivery in greedy & recovery forwarding that can bypass the junction area by using two hop beaconing.

Pros

-No hidden terminal occurs because all nodes can hear one another.

-From simulation result TO-GO, GPCR, GpsrJ+ have similar packet delivery ratio.

- Low S/N ratio is taken care of.

Cons

-Simulation result shows that End-to-End latency in TO-GO is higher than GPCR, GPSR, GpsrJ+.

GeoDTN+Nav

GeoDTN+Nav is a combination of DTN & Non-DTN mode which includes a greedy mode, a perimeter mode and a DTN mode. It can switch from Non-DTN to DTN mode. This approach proposes virtual navigation interface (VNI) which provides necessary information for GeoDTN+Nav to determine its routing mode and forwarder.

Pros

-GeoDTN+Nav can switch from Non-DTN to DTN mode.

-GeoDTN+Nav can recognize partition in the network.

Cons

-The latency increases & the decreases packet delivery ratio in a situation such as sparse network where GeoDTN+Nav trys to fall-back to DTN mode again.

-The result in a partitioned network shows that RandDTN achieves slightly better PDR and lower latency than GeoDTN+Nav

4. COMPARISON OF VARIOUS POSITION-BASED ROUTING PROTOCOLS

Table 1. Comparison among various VANET position-based routing protocols

VANET Position-based routing protocols	Traffic-aware	Forwarding strategy	Buffering	Overlay or Nonoverlay	Predictive	Virtual Infrastructure required	Map-based required	Positioning system-required	Location service	Communication environments required
GpsrJ+	NO	greedy	No	Yes	yes	No	No	Yes	Yes	city
GyTAR,	yes	greedy	no	Yes	Yes	No	yes	Yes	yes	city
VADD	Yes	greedy	Yes	No	Yes	No	Yes	Yes	yes	city
GeOpps,	No	Greedy	yes	No	No	No	yes	No	yes	city
GeoDTN+ Nav	No	Greedy	yes	No	No	No	Yes	No	yes	city

CONCLUSION

The routing of data packets in VANETs is challenging subject of extensive research and routing is the most vital scheme that applications rely upon. For successful implementation of any VANET based application it is required to adapt appropriate routing protocol. A unified routing scheme that fits all VANET scenarios is hard to implement. In this paper we describe the position based routing protocols for further investigation that one can easily simulate, verify and improve a routing protocol. Hence, a survey of position based routing VANET protocols, comparing various features are absolutely essential to come up with new proposals for VANETs. The performance of VANET routing protocols depends on various parameters like packet delivery rate, latency, overhead, mobility model, driving environment and much more.

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