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A Review on Position Based Routing Protocol in Vehicular Adhoc Network

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Abstract: Position based routing protocol is a large and important categories of vehicular ad hoc network. In this routing strategy every node of the participating network knows its own and neighbor node's geographic position. In a position based routing not require to maintenance of routs and so more suitable for highly mobile network. A position based routing protocol consists of multiple major components such beaconing, location service, location server forwarding strategies and recovery strategies. The routing overhead is minimum in this routing protocol. In this survey we present a detail classification is shown and a general review of the position based routing protocol is presented.

Keywords: *Routing protocol, ad-hoc network, DTN, Beacon and VANET.*

I. INTRODUCTION

Vehicular Ad Hoc Networks (VANETs) today show a high interest to the researcher for numerous applications in different sector in saving lives, time, energy and planet. It is one of the most important field of research for Intelligent Transportation Systems (ITS). VANET is a form of Mobile Ad Hoc Networks (MANETs) and are widely based on MANET principals. To make ensure autonomous communication among the vehicles on the road for the purpose of traffic management, safety alerting or infotainment, VANETs provide a large number of routing protocols in the literature. Most of this routing protocol results from the long academic works done in the skeleton of MANETs and need to be classified and subjected to thorough studies, simulations and testing. VANETs are a very specific case of MANETs characterized by a high mobility, frequent changes in topology, high and frequently variable density, long lifetime of nodes and regular moving patterns. In this paper, we give a classification of the existing position based routing protocols for VANETs and briefly describe some of those protocol.

II. ROUTING PROTOCOLS IN VANETS

Routing in VANETs are very complex and challenging task due to the high speed of vehicles making topology of the network highly dynamic and causing frequent links disconnections. As VANETs have a highly dynamic topology, frequent route disconnections occur as vehicles move. Vast numbers of protocols have been developed to cater for VANET specific routing requirements. Different researchers have classified these protocols in different categories. We divide these routing protocols into five broad categories. The classifications of routing protocol are topology based routing, position based routing, cluster based routing[1], geocast routing [2] and broadcast routing [3] .

A. Topology-based routing protocols

In this routing method, the selection of a route from source to destination is based on links information formerly collected by the vehicle (proactive/table-driven) or required when needed (reactive/on-demand) . Here, the step of searching or maintaining a route from source to destination is mandatory before sending data packets. Topology based routing protocols are divided into Proactive, Reactive and Hybrid Protocols. DSDV [4], OLSR [5], FSR [6], AODV [7], DSR [8] , TORA [9] and PGB [10] are the example of topology based routing protocols.

B. Position-based routing protocols

It is the alias of geographic-based routing protocol, this class of routing protocols uses vehicles' geographical information in the communication selection process. In this type each vehicle has the mean to know its geographical position with the help of Geographic Position System (GPS). Here, the knowledge of the whole route is unnecessary to deliver the data packets.

C. Cluster-based routing protocols

In cluster-based routing protocols, the vehicle posses the similar characteristics such as performing in the same direction with more or less the same velocity can form a cluster and chose a cluster-head which manages the cluster and being a leader of inter-clusters communications. We note that intra-cluster communications are cluster-head free and perform using direct links. Every node in the cluster is uniquely identified by a string called Node ID. A host in the cluster maintains a bi-directional link with the head of the cluster. LORA-CBF [11] and COIN [12] are the example of cluster based routing protocol.

D. Geocast-based routing protocols

Geocast refers to the deliverance of information to a group of destinations in a network identified by their geographical location. It is a particular form of multicast addressing used by some routing protocols for ad-hoc networks. All protocols have in common that they enable transmission of a packet to all nodes within a geographic region. In contrast to multicast, which enables a packet to be sent to an arbitrary group of nodes, a geocast group is only defined by a geographic region. Example of geocast routing protocols are IVG [13], DRG [14] and ROVER [15].

E. Broadcast-based routing protocols

For sharing information about traffic, weather and emergency road conditions among vehicles broadcast routing is more suitable. In broadcast routing a node of the network disseminates a message to the vehicle beyond its transmission range through the use of multi hops. Broadcast sends a packet to all nodes in the network, typically using flooding. This ensures that the delivery of such packets consume more bandwidth [41] because of duplicate message reception; also disseminated messages collide due to congestion. It performs better in the sub-urban and highway where a small number of nodes take part in the network. The various Broadcast routing protocols are BROADCOMM [16], UMB [17], V-TRADE [18], DV-CAST [19] and PBSM [20].

III. POSITION BASED ROUTING PROTOCOL

In position based routing algorithm every node of the participating network knows its own and neighbour node's geographic position. There is no need to maintain any routing table or exchange any link state information with its neighborhood node in such routing schemes. The nodes find this location information through the (GPS). Position based routing protocols are more appropriate for VANETs since the vehicular nodes are known to move along established paths. The routing overhead is minimized in these types of protocols because no routing tables are used or created. The position based routing protocols are of three types; Delay Tolerant Network (DTN), non-DTN and Hybrid.

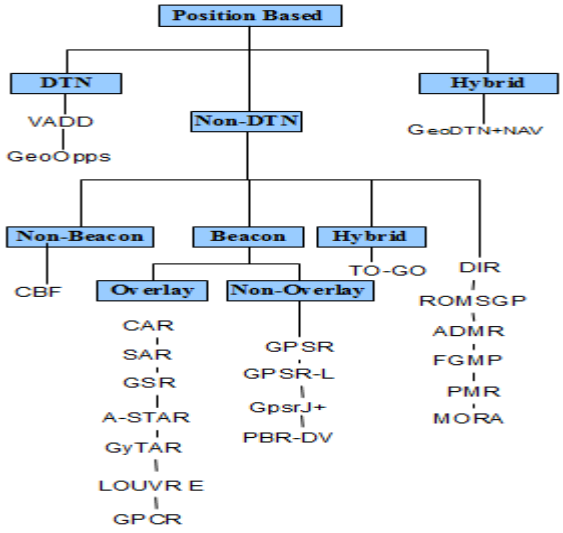

Fig.1. Classification of Position Based Routing

2.1 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 [21] and GeoOpps [22]

Vehicle-Assisted Data Delivery in Vehicular Ad hoc Networks (VADD) [21]

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.

GeoOpps[22]

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 Delay Tolerant Network (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.

A. 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 [23], GSR [24], A-STAR [25], GyTAR [26] and GPCR [27].

CAR[23]:

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.

GSR[24]:

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.

A-STAR[25]:

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.

B. 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 [28], GPSR-L [29], GpsrJ+ [30] are the example of non-overlay position based routing protocol.

GPSR[28]

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+[30]

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.

Contention-Based Forwarding (CBF)[31]

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 Non-DTN Hybrid Routing

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[32]

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.

2.3 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 [33] is a hybrid position base routing protocol.

GeoDTN+NAV [33**]**

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 adhoc 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.

IV. 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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