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Review Article

A Comparative Survey on Vehicular Ad-hoc Network (VANET) Routing Protocol using Heuristic and Optimistic Techniques

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Abstract: The aim for conducting this study is to bring optimistic and heuristic techniques of routing protocol at one place as a survey. In vehicular ad-hoc network (VANET), a routing protocol has some significant challenges. In literature a variety of techniques have been used to tackle these issues. This study provides the comparative analysis of the more optimistic and heuristic techniques: Ant colony optimization, greedy forwarding, fuzzy logic, delay tolerance and clustering techniques. These are compared to find which technique is better, discusses advantages and disadvantages of routing protocols. Finally, we concludes the paper by pointing out some open issues and possible directions of future research related to VANET routing.

Keywords: Geographic routing, routing protocol, topology based routing, heuristic techniques, optimistic techniques, VANET

INTRODUCTION

A new kind of network, VANET, is hitting the streets. With the strident growth of vehicles on roads in the recent years, driving is becoming more challenging and dangerous day by day. Finding routes towards the chosen destination in such disengaged and topologically dynamic environment is regarded as the most compelling challenge. To create solutions aimed at helping drivers on the roads by expecting risky events or avoiding bad traffic areas (Nithya Darisini and Kumari, 2013). Vehicles are equipped with communication equipment that allows them to exchange messages with each other in Vehicle-to-Vehicle communication (V2V) and also to exchange messages with a roadside network infrastructure Vehicle-to-Roadside Communication (V2R). The major objective has clearly been to increase the general safety of vehicular traffic, favorable traffic management results.

VANET is a special kind of mobile ad-hoc network (MANET) (Al-Sultan *et al*., 2014). Even though uncountable numbers of routing protocols have been developed in MANET, many do not apply well to VANET. VANET represent a particularly challenging class of MANET. They are dispersed and self-organizing communication networks made by moving vehicles, that's why they are categorized by very high node mobility and limited degrees of freedom in mobility patterns. There are two categories of routing protocol in VANET: *Topology based routing* uses the information about links that exist in network to perform packet forwarding (Lee *et al*., 2010). *Geographic basedrouting* uses neighboring location information to perform packet forwarding. Since link information changes in a regular basis, topology-based routing suffers from routing route breaks (Lee *et al*., 2010).

Despite many surveys already published on routing protocols in VANET (Chaqfeh *et al*., 2014) yet there is still deficiency. In order to resolve the routing protocols issues in VANET, a comparative study of techniques is conducted. It is challenging to design efficient routing protocol. These issues are resolved by using optimistic and heuristic techniques: clustering, position based routing, greedy forwarding, ant Colony optimization, fuzzy logic, genetic algorithm and these all techniques are brought together in this study for the convenience of the researchers to find them in one paper.

LITERATUR REVIEW

In order to help the drivers to correspond efficiently with the other vehicles in the network, this study tells about heuristic and optimistic techniques and issues are discussed, greedy forwarding technique has been analyzed in the given research.

Greedy forwarding is a query related technique based on the combination of Greedy Perimeter Stateless Routing (GPSR) and face routing; face routing works when GPSR gets fail. This technique works on scenario: a source node sends information to destination node which is geographically close to it.

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The information like road safety conditions, traffic situations on road and parking lot information can be exchanged from one vehicle to another, greedy forwarding is a position and network based protocol; in any case one node must be there in a network; in case of more than one node, distance of source node between other nodes would be calculated and source node would go for closest node.

Handoff problem is somewhat tricky to eliminate in mobile ad-hoc networks, but according to the given study, handoff problem can be resolved in VANET. In order to hold traffic infrastructure, researchers have suggested cluster based routing technique; using two routing protocols namely Ad-hoc On-Demand Distance Vector (AODV), AODV+ and network simulator (NS2), unpredictable movements within the network can also be reduced. Researchers have implemented this procedure on Fedora and Windows, vehicles are taken as nodes; whole scenario represents clustered vehicles.

In cluster based technique there is a head node (source node) and a receiving node (destination node) and each node is connected to another node. Preliminary from the source node, each node sends data packets to next node until packets reach destination node; such procedure helps nodes (vehicles) to remain connected at every instant and they get reply if any trouble occurs. Hence, cluster technique reduces and removes problem of dropping down the network and it keeps vehicles connected within network.

Comparing the position based and non position based routing approaches, the current research has been conducted. For the position based routing approach, forwarding decisions bases on position information: first of all, position-based routing requires position-awareness of all participating nodes. When a packet has been sent to destination node, the sending node is also acknowledged with the current geographic location of the destination to be included in packet header and to make the routing decision; for this purpose, a Global Positioning System (GPS) received on each node is used. It has been said that besides the header, each node is also aware of the position of its direct neighbor located at the shortest distance. Although, the Dynamic source routing has also been used to configure and determine the location but its performance is not up to the mark because of different scalability and mobility issues.

Determining the best solution in order to establish a vehicular network in city environment, the researchers have performed an experiment. They have used both position based and non-position based routing approaches. The results have shown that AODV Routing and position based routing approach is far better than Geographic Source Routing (GSR) (Zhu *et al*., 2014) and non-position based routing approach. The researchers have concluded that combining the position based approach with the topological knowledge give rise to an ultimate solution named as GSR; this approach leads to good performance in order to establish vehicular network in a city environment.

Combination of Wireless Mesh Network (WMN) and ad-hoc as communication basis to develop a Geographic Load Balancing Routing in Hybrid Vehicular ad-hoc Networks (GLRV) for data delivery and load balancing purposes. GLRV utilizes benefits of hybrid VANET, in which Area Roles (ARs) serve as backbone nodes. AR not only provides Internet services, but also can support communication between nodes. GLRV has advantages of geographic routing, while provides network load balancing mechanism such as congestion detection on ARs and bypassing mechanism of vehicle users. It effectively avoids increase of transmission delay when load is heavy (Wu *et al*., 2011).

Ant Colony Optimization (ACO) is an algorithm that is completely related to the behavior of real ants while finding the shortest paths and from a source to the destination (i.e., food for ants). It has been observed that ants are used to place certain amount of pheromone while traveling from their source (nest) to destination (food); these pheromones helps them returning earlier to their source. Considering this phenomenon, the ACO algorithm is designed that can be helpful to resolve the network routing problems and find the shortest paths: Dynamic MANET On-demand (DYMO) and MAR-DYMO protocols are also used (Correia *et al*., 2011).

Delay Tolerant Networks (DTN) is considered as a growing issue; in order to solve such a crucial problem an intelligent routing protocol is designed. Genetic Algorithm (GA) is used as the learning method for selecting the best vehicle that carry packets from one partition to another in an efficient manner. The reason to use GA which is a subclass of Evolutionary Algorithm (EA) is its quality to optimize the problems using numerous techniques based on natural evolution including mutation, inheritance, crossover and selection. In order to design the protocol, first the evolution has been started from a population of randomly generated chromosomes or individuals where each individual is a set of genomes. All chromosomes are evaluated by a fitness function and it has been determined that how each of these chromosomes can be chosen for the next generation in an efficient way (Bitaghsir and Hendessi, 2011).

Hybrid Bee swarm Routing (HyBR) protocol is designed for VANET, this protocol is based on constant learning paradigm to consider the dynamic environmental changes in real time that sets up a ley property of VANET. Combining the features of geographic routing with those of topology routing, HyBR plays a role of multipath and unicast routing protocol that does not only guarantee the road safety services by transmitting packet with minimum delays but it also makes sure of the high packet delivery feature (Bitam *et al*., 2013).

One of the dangerous tasks in VANET is designing an efficient and effective routing protocol with the ability to send more packets in least span of with less dropped packets; it is considered difficult due to frequent changes of topology and high mobility of nodes in routing protocol. Keeping the same issue in mind, various researchers have designed the routing protocol suitable for the dense environments having a large amount of vehicles with close reserves between them. It has been observed that an effective routing protocol can have a significant impact on enhancing various factors including improving the system reliability by influencing the percentage of packets delivery, reducing the range of interruption caused by large buildings in city environment and taking scalability into apprehension in order to avoid conflict. In addition, one of the most crucial factors is delivering a packet in the shortest possible span of time, more specifically in the emergency situations (Wang *et al*., 2009).

VANET ROUTING TECHNIQUES

Geographic load balancing routing in Hybrid VANET: There is an attempt to develop a more effective geographic routing protocol in hybrid VANET for data delivery and load balancing purposes. Load balancing mechanism is an efficient way to eliminate network bottlenecks, increase network throughput and improve network flexibility. We consider the combination of Wireless Mesh Network (WMN)) and Ad Hoc as the communication basis and develop a geographic routing protocol, namely Geographic Load Balancing Routing in Hybrid Vehicular Ad Hoc Networks (GLRV), for data delivery and load balancing purposes.

GLRV uses benefits of hybrid VANET, in which ARs serve as backbone nodes. AR not only provides internet services, but also can support communication between nodes. GLRV has the benefits of geographic routing, while provides network load balancing mechanism such as congestion detection on ARs and bypassing mechanism of vehicle users. It effectively avoids the increase of transmission delay when the load is heavy.

When AR is under congestion and network connectivity is reduced, by shifting to the adaptable routing, the mobility of vehicles can be used to achieve the date with less delay. At the same time, forwarding set provides some forwarding candidates and uses node ID to avoid the hidden terminal problem, which further increases the reliability of the algorithm.

Hybrid VANET not only enhances constancy of the network logical topology also reduces amount of redundant data and increases network scalability but also expands scope of network services. Adopt location information of vehicles, forwarding set based on two-hop neighbor table, multiple routing strategies and switching schemes to better deal with highly dynamic topology. Algorithm overcomes network load imbalance by node congestion detection on ARs and bypassing mechanism of vehicle users. Simulation results show that GLRV has better performance in routing reliability, load balancing and hybrid network structure (Wu *et al*., 2011).

Multi-metric routing decisions in VANET: Using the method of fuzzy control and fuzzy logic, the routing decisions can be made better under the multiple selection criteria. A new routing protocol is developed named Fuzzy control based AODV routing (Fcar), that is based on the classical AODV. In Fcar, route period and percentage of similar directional vehicles as two routing metric to evaluate a route. When a source need to set of connections to a destination, it first broadcast a Route Request (RREQ) which holds some information (direction, speed) of the source (Singh, 2014).

If an intermediary node receives RREQ, it Fig. 1 out how long it can communicate with last hop vehicle, then compare result with route lifetime which stored in

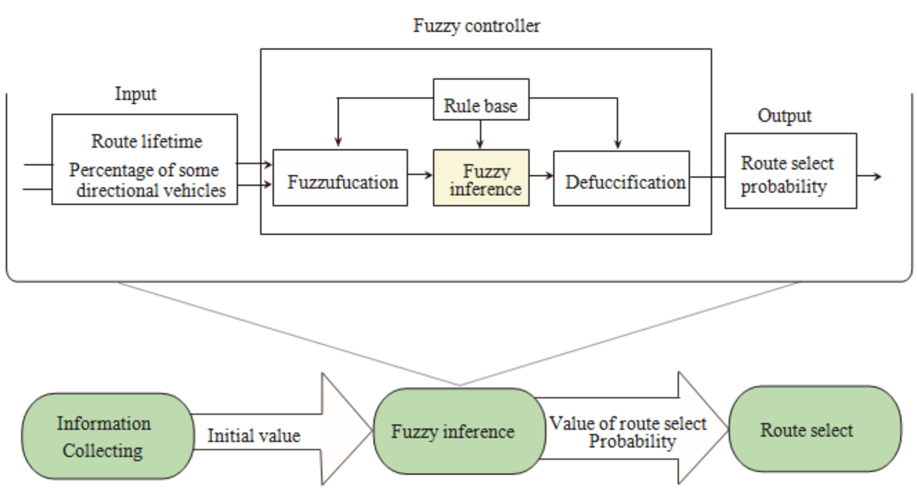

Fig. 1: Structure of fuzzy controller (Wang *et al*., 2009)

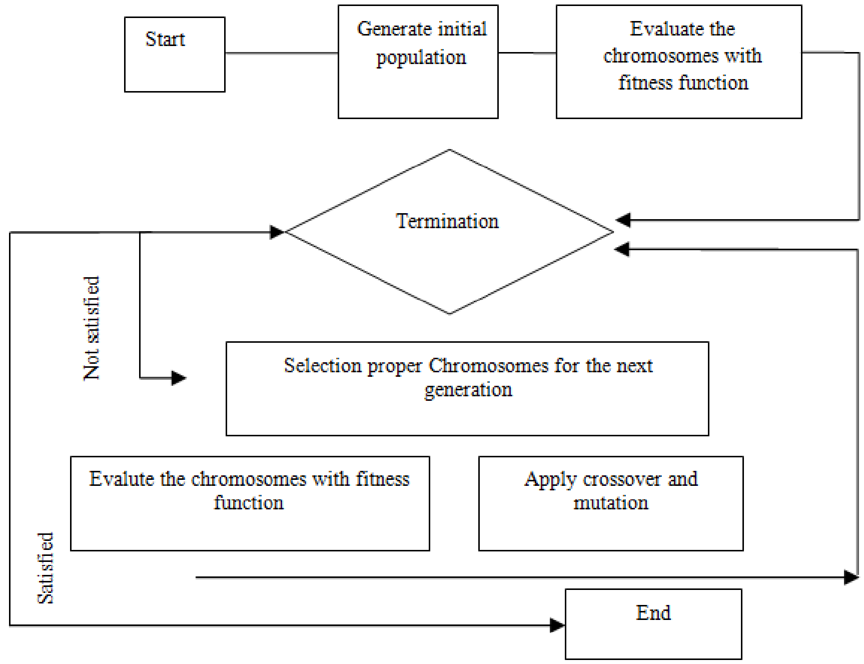

Fig. 2: Flow chart of genetic algorithm (Bitaghsir and Hendessi, 2011)

RREQ and switch lifespan in RREQ with smaller one; intermediary vehicle also need to understand angle between the current intermediate vehicle and last hop vehicle, if angle is smaller than a predefined value, then plus one to number of same directional vehicles stored in RREQ and number of same directional nodes divided by hop count was defined as percentage of same directional vehicles. When prior works completed, intermediary vehicle refresh the information kept in RREQ with its own information.

The route lifespan and percentage of same directional vehicles kept in RREQ are two inputs of fuzzy controller which are planned. Once the intermediary vehicle received a RREQ it will use fuzzy controller to calculate route select possibility as output of fuzzy controller. With the output result, the intermediate vehicle can make a routing decision. In Fcar, once find out a better route it start route revive instantly, keep the route in routing table is best one and it also make use of RREQ received repetitive as a replacement of discard it straight forward. The simulation result specify that Fcar has been upgraded in each of evaluating criteria and it proved that Fcar has its flexibility in VANET.

It has been analyzed that when the network compactness reaches a definite level, the greater effect is supported by speed as compared to the network density. Key point of routing protocol used in VANET is how to deal with the variety of network density. Character of VANET and growth in reliability of routes. In addition, a movement of the future ad-hoc network and VANET is to deliver multimedia facility and data facility through 3G cellular network, so need to add QoS support in future routing protocol. The Fcar can modify routing strategy vigorously and fulfill the necessities of QoS to some range through adding or altering the routing criteria which related to QoS (Wang *et al*., 2009).

An intelligent routing protocol for delay tolerant networks using genetic algorithm: An intelligent routing protocol for Delay Tolerant Networks (DTN) is making use of genetic algorithm as the learning method for selecting best vehicle to transmit packets from one partition to another. It happens when compactness of vehicles in streets declines or when enforcement of law, military and financial reinforced vehicles may each wish to interchange data secretly within their own vehicular network, due to the sensitivity of information replaced. Even in densely populated urban scenarios, sparse sub-networks can be prevalent. In these situations, DTN (Benamar *et al*., 2014) routing algorithms are needed. GA create solutions to optimization problems using techniques encouraged by natural evolution such as selection, crossover, mutation and inheritance (Fig. 2):

- First stage is initialization in which the evolution usually starts from a population of randomly generated individuals.
- Each individual or chromosome is a set of genomes.
- In each generation, we want to gauge the chromosomes by a fitness function and conclude how appropriate each of them is to be selected for the afterward generation.

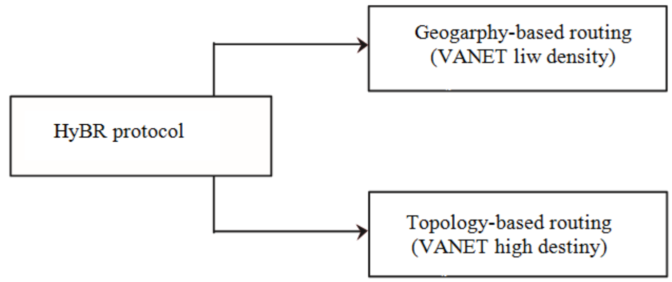

Fig. 3: HyBR routing protocol procedures based on VANET density (Bitam *et al*., 2013)

- The population of following generations is formed by choosing and amending the proper previous chromosomes.
- These amendments are based on crossover and mutation, Crossover is a way to combine two chromosomes to produce new offspring.
- The notion behind crossover is that the novel chromosome may be better than both of the parents if it takes the best characteristics from each of the parents.
- In mutation we alter one or more genome values in a specific chromosome.
- Mutation is done in order to avoid the population from deteriorating at any local optima.
- The process of breeding offspring from prior generation will remain until a termination situation has been reached.
- This situation may be also finding a clarification that satisfies minimum criteria or reaching a fixed number of generations (Bitaghsir and Hendessi, 2011).

HyBR: A Hybrid Bio-inspired Bee swarm Routing protocol for safety applications in VANET: The bee (Apis mellifera) is a social and domestic insect innate to Europe and Africa. The bee nourish on nectar as a basis of energy in their lives and use pollen as a source of protein in the nurturing larvae. The bee colony contains only breeding female known as the Queen, a few thousands of males called Drones, several thousands of sterile females called Workers and many young bee larvae called Broods.

The bees share a communication language of extreme correctness, based on the dances which are done by the workers (called "scouts"). After finding food and returning to the hive, the scout tells others about the distance, direction, quantity and quality of food found. With their visual, tactile and olfactory perception, the other bees observe the transmitted information.

There are two types of dances: the round dance when food is very close. This dance indicates only the direction; the second type of dance is the waggle dance in which the bee effects are repeated movement that forms a drawing like the number eight. The distance between the food source and the hive is transmitted depending on the speed of the dance. If the dance is faster, then the food distance is smaller. The food nature is specified by the odor of the bee when it is scrubbed. The food amount depends on the wriggling of the bee. The more the wriggling, the higher is the quantity.

Motivated by communication between bees when they explore their food source, the VANET environment can be seen as a bee environment. The end-point sender which could be either a vehicle or roadside base station corresponds to the beehive and the destination which may be a vehicle or a roadside base station called from now a node links to the bee food source. Intermediate vehicles or roadside base stations are represented by workers.

Figure 3, HyBR is a hybrid protocol which applies a topology based routing approach when network density is high (e.g., city-based VANET) and applies a geography-based routing approach when the network is not dense (e.g., highways). Using GPS devices, outdoors or through other means, each node saves the location information of all VANET nodes. Only succeeding hop toward the destination is specified. Network density is used to conclude type of routing method to use in VANET situation.

Using its position table, source node checks network between source and destination after dividing it on a set of sub-networks where each one has a limit equal to transmission range. After source node computes sub routes using topological routing of its routing table and also finds the sub routes used to spread packets using geography based routing using its positions table. Packet header is used to put the sub routes in a sorted manner; the sub routes are arranged in such a way that contains all information of the entire route from source to destination; in this way all data packets can be sent in an efficient manner. Two consecutive sub paths have been selected; topology-based procedure and geography-based procedure are defined at the header of each data packet; these paths are located by the source node and sent to the destination node. A border node is defined between two consecutive sub networks when the network is divided into sub-networks. The border node is the destination of first sub network and the source for the second sub network. Consequently, in order to provide safety for

VANET the high class information is required between the network nodes. Through a realistic propagation model and a set of simulation tests, it has been proved that HyBR overtakes the GPSR and AODV topology based routing protocol with reference to the packet delivery ratio and end to end delay. Moreover, it arranges for an efficient standardized overhead load measure. With regards to the future work, it has been said that HyBR protocol can be used across hybrid networks in order to provide cloud computing connections and internet access transportation system ITS application (Bitam *et al*., 2013).

Information dissemination in VANETs based upon a tree topology: In this study, an upgraded type of the implementation of Dynamicity Aware Graph Relabelling System (DAGRS) that clue to a better performance of Broadcasting Over Dynamic Forest (BODYF), a broadcasting protocol over a tree-based topology specifically designed for highly fluctuant topology that does not have any parameter and we compare its performance versus Delayed Flooding with Cumulative Neighborhood (DFCN), Speed Adaptive Probabilistic Flooding (SAPF), Weighted p-Persistent Broadcasting (WPB) and Simple Flooding (SF).

DFCN is a neighbor based topology protocol, designed to minimize the resources required and generally accepted by the community (Liang *et al*., 2014). SAPF is a dissemination protocol that dynamically adapts the rebroadcasting probability in terms of the speed of the device. WPB is a distance based protocol that considers forwarding the message in terms of the distance between the source and the receiver nodes. Finally, SF is one of the bases of broadcasting protocols, which simply floods the network. These protocols are compared in three very realistic environments, dealing with MANET and VANET and using three different densities in each scenario. Thus, the protocols are finally compared in nine different environments.

As BODYF works over a tree topology, first check that the implementation of a tree topology in a vehicular ad-hoc network is not affected by the high speed of the devices and hence, it is reasonable to use it. A tree in a graph is, by definition, a connected cycled free sub graph and a forest is defined as a set of trees.

The objective of DAGRS is to build a spanning tree on the graph, but this is typically not feasible due to network partitioning and devices mobility, so DAGRS will be used to build a forest topology. This is operated by locally applying some simple rules in every node. T represents a node with token, N is a device without token and any means it can be any of them. The numbers on the edges are labels representing the route to the token. A token does not have any information related to the tree, it just provides a status to a node that will allow the tree merging process. By using a single token per tree mechanism, the formation of cycles is not possible, as only the node possessing the token is able to merge its tree with another one. The four possible rules defined in DAGRS are:

Rule 1: A tree link breaks and the node belongs to sub-tree which does not possess token (indicated by the label on the edge). In this case the node must regenerate token, otherwise there will exist a tree without a token (which is an undesirable situation).

Rule 2: A tree link breaks and broken link occurs at a node which currently belongs the sub-tree which possesses token. In this case, node does nothing regarding maintenance of token.

Rule 3: When a node with token meets another device possessing a token; both nodes will try to merge their trees in order to obtain a bigger tree from the two existing ones. The trees merging process starts. As result of this rule, a bigger tree and only one token remain (the merging process discards one token automatically in order to have one and only one token within each tree).

Rule 4: Token traversal in general case: the token visits nodes of tree following a given strategy.

Primarily, all devices are considered T, which means they all create one-node trees. The algorithm then, performs on basis of the four rules defined above to produce spanning forest topology in the dynamic network. It is important to highlight that DAGRS model itself does not model applications; it simply models the mechanisms to handle with topology changes and communication between devices. This model uses only one-hop neighbor's information, so it is a localized algorithm (Fig. 4).

For measuring the performance of the tree topology, consider the nine different test cases. The results show that the resources needed for creating a spanning tree in a vehicular ad-hoc network are not far from the ones a MANET requires and therefore, it is

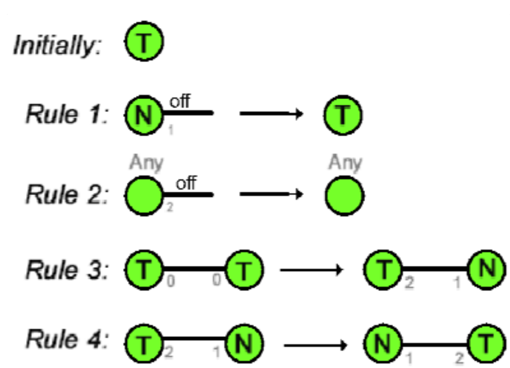

Fig. 4: DAGRS rule for creating spanning forest topologies (Ruiz *et al*., 2012)

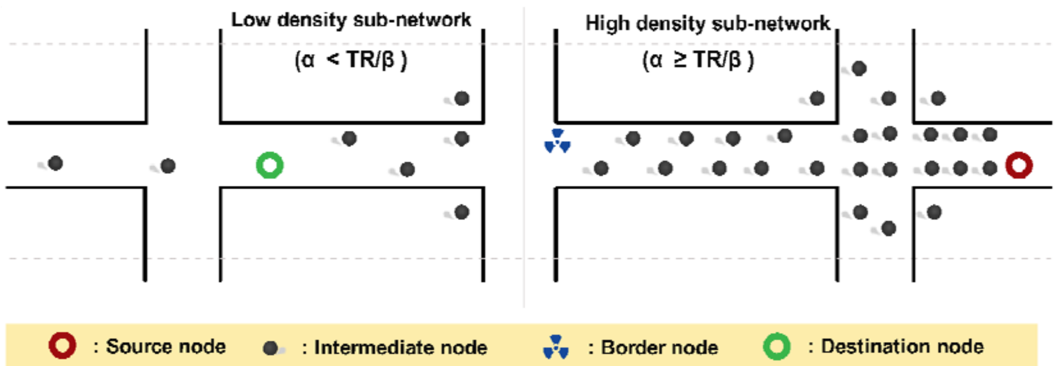

Fig. 5: HyBR transmission based on the network density (Correia *et al*., 2011)

feasible to apply this topology over a vehicular network. The five different protocols have been compared in the nine different scenarios mentioned before. Results show that the coverage achieved by BODYF is, in general, higher or does not have statistical differences with the others, except SF that is considered the upper bound. This is a very good performance since as networks are connected SF achieves the best possible coverage.

Additionally, BODYF makes reasonable use of network resources, considering that, for example, DFCN was specifically created for reducing the number of forwarding messages. BODYF was specifically designed for dealing with highly fluctuant networks and the results show that the coverage it achieves when dealing with VANET is really good making at the same time very efficient use of the network resources. Even when BODYF was not developed for MANET, our experiments state that it is outperforming DFCN which was specifically tuned to work over MANET and also makes less use of the network resources than DFCN. WPB also shows a very good performance in terms of the network resources, situated in the first position of the ranking done. It also achieves a very competitive coverage in all the scenarios (Ruiz *et al*., 2012).

Mobility-aware ant colony optimization routing for VANET: An intellectual routing protocol for Calculating, choosing and selecting the shortest path for transferring the data from source to the destination efficiently in network is using Ant Colony Optimization (ACO) routing protocols. It is no secret that, VANET is a significant step to get closer to the Intelligent Transportation System (ITS) (Khekare and Sakhare, 2013). It used when VANET work with the help of vehicle communicating devices placed in the borders of highways and roads, the vehicles can transmit the packets from one node to another. ACO procedure helps accessing the information, including speed and position available in the vehicular networks. This information is required to design an ant based algorithm in order to show acceptable performance in dynamics of networks.

Main aim of this protocol is to create and assess bio-inspired procedures implement in vehicular networks for vehicles position and speed. The suggestion is to use this information to help routing decisions. Having, in the end procedures that adapt well to VANET:

- ACO is an algorithm based on actions of the real ants in finding shortest path from a source to the food.
- Ants deposit a certain amount of pheromone in its path while traveling from its nest to the food.
- In this way ants following the shorter path are expected to return earlier.
- ACO algorithms can be applied in the network routing problems to find the shortest path.
- Route discovery procedure is performed when a node in the network wants to send data to another node for which it does not know a route.
- The RREQ messages keep a list of visited nodes.
- After receiving an RREQ message, the node checks whether it has a route to its destination.
- The destination reply Route Reply (RREP) message back to the source of the RREQ, telling it about this route.
- When a route is successfully used in the forwarding of data packets, the lifetime connected with that route is extensive.
- DYMO protocol keeps routes that are being used (Correia *et al*., 2011) (Fig. 5).

Use of clustering approach to optimize the performance of VANET: VANET is a remarkable technology used for the vehicular communication. In this network moving cars act as notes and create a mobile network. Handoff in mobile cellular communication is a common problem that can be solved through various ways. Similarly, this issue may also occur in vehicular ad-hoc networks; when a vehicle enters one base station and leaves the previous one, with which it was connected before, at that signals can become either weak or get dropped. In case of vehicular network, week or no signal can create serious problems; so, there is a need to implement a technique that keeps the connection string between the vehicles so that they can communicate effectively.

Clustering approach creates solutions to handoff problems in mobile cellular network using techniques encouraged by handle the traffic infrastructure:

- Various unpredictable movements that may occur in the network can also be condensed or decrease using this cluster based technique in VANET.
- A network that requires routing protocol that enables nodes or vehicles to remain connected to each other.
- If one vehicle wants to send data packets to the next node.
- A node fall out of signal range and drop out of network.
- In order to use Cluster technique every participating car into a wireless router or node, allowing cars approximately 100300m of each other to connect.
- As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another network.
- There is a head node (source node) and a receiving node (destination node) and each node is connected to another node.
- Starting from source node, each node sends data packets to next node until packets reach the destination node.
- Such arrangement helps the nodes (vehicles) to remain connected.
- At every moment and they get acknowledge if any problem occurs.
- The cluster technique reduces and removes problem of dropping down the network and it keeps vehicles connected within the network (Anand and Singh, 2013).

Analysis of greedy forwarding in VANETS: In VANET, the vehicles are equipped with wireless communication devices i.e. Wireless LAN. These networks are selfconfiguring network composed of mobile nodes communicating through wireless links in an environment without any fixed infrastructure support. Greedy forwarding routing protocol use to deliver the information to a specific destination (Singh and Agrawal, 2014). It's similar to mobile ad-hoc networks: short radio transmission range, self-organization, self-management and low bandwidth if one vehicle wants to get the parking lot information then the driver should contact to the next nearest node:

- A routing protocol is an essential attribute of any network, which helps distribute or send the information to a particular destination.
- Greedy Perimeter Stateless Routing (GPSR) protocol is used to implement a query related technique which is none other than greedy forwarding.
- One of the most important features is that by contacting to the adjacent or next nearest node (vehicle) the driver can easily get the parking lot information.
- Greedy Forwarding technique allows the drivers to effectively communicate with the other vehicles (nodes) in the network. 5) The GPSR protocol allows the vehicles send the data packet to the closer neighbor node in the network.
- After the packet is sent and the packet reaches a local maximum then a recovery mode is used to forward a packet to the node, closer to the actual destination, where the packet meets local maximum.
- The packet continues traveling in greedy mode as it reaches the node which is closer to the destination.
- The nodes are evenly distributed in the free open space scenario which is best to be used in GPSP protocol.
- GPSP is open to exchange the important information, such as traffic situations on the road, parking lot information and road safety conditions, from one vehicle to the other.
- One of the considerable network and position based protocol is greedy forwarding 11) A good network required at least one node that remains active.
- In case of more than one node, the distance between source and other nodes would be calculated; on the basis of which the source node would prefer to go to the nearest node (Li *et al.*, 2011).

Routing strategy for VANET in City environments: High dynamics of VANET make the routing of data a quite challenging task, highway traffic is based on position-based routing approaches that require high mobility of network nodes. It is difficult to manage two-dimensional scenarios baseline position routing approach. Here the point arises, which routing strategy should be adopted for VANET (Abbasi *et al.*, 2014). For the position based routing approach, forwarding decisions bases on position information: first of all, position-based routing requires position-awareness of all participating nodes:

- In order to send a packet to a destination node a sending node. They requires information on the current geographic position of the destination in order to include it in the packet header and to make the routing decision. e.g., through a GPS receiver on each node.
- Such protocols very effective in highway scenarios, deal with problems associated to a two-

dimensional system area as well as with problems like radio obstacles due to buildings.

- Position-based routing bases forwarding decisions on position information.
- The sender computes a sequence of junctions the packet has to pass through in order to reach the destination.
- The sequence of junctions can either be put into the packet header.
- The path between source and destination is determined by a Dijkstra shortest path calculation based on the street map (Lochert *et al*., 2003).

COMPARATIVE ANALYSIS

Comparing various heuristic and optimistic techniques including Ant colony optimization, Greedy Forwarding, Tree topology, Genetic Algorithm, Position based routing, Hybrid bio inspired bee swam, Multi metric in VANETS, Geographic load balancing and Cluster techniques, the given section has been designed. Going through the realistic reliability model, routing stability, VANET environment, simulator and routing protocol of each of these techniques; it has been analyzed that Ant colony optimization is less appropriate under the urban scenario, while its reliability model is more realistic using Ant-DYMO routing protocol. On the other hand, analyzing reliability model of cluster technique, it comes to know that its model can become realistic when using AODV+ protocol while this technique is medium suitable under the wireless environment.

The wireless environment makes greedy forwarding less suitable when using GPSR routing protocol. Position based routing technique is less suitable under the highway and city environment whereas the hybrid bee swam technique is medium suitable under the same scenario; though the model of former technique is realistic on proposed GSR and AODV routing protocol while the later technique is realistic using the HyBR protocol. Last but not the least, genetic algorithm is considered less suitable under the urban scenario while its model is stated as realistic based on the delay tolerance protocol.

In this section there is a comparison between different optimistic and heuristic techniques as shown in Table 1.

Table in which advantages and disadvantages of techniques have been discussed which is as follows:

Delivery ratio refers to the numbers of data packets delivered to the destination; it is not wrong to state that the greater is the value of deliver ratio the better will be the performance of the protocol. Comparing delivery

Table 1: Comparative study of techniques

Techniques	Routing protocol	VANET environment	Realistic mobility model	Routing stability	Simulator
Ant colony optimization	AODV, DYMO, Ant-DYMO and MARDYMO	Urban scenario	Yes	Low Suitable	NS-2
Cluster Technique	AODV, AODV+	Wireless access in vehicles	Yes	Low Suitable	NS-2
Greedy Forwarding	GPSR, Face Routing	Wireless Environment	Yes	Low Suitable	NS-2
Position-based routing technique	GSR,AODV	City environ-ments, highway traffic	Yes	Low Suitable	NS-2
Hybrid Bio inspired Bee swam	Proposed routing protocol (HyBR)	Urban/Highway	Yes	Medium suitable	NS-2
Genetic algorithm	Delay tolerance protocol	Urban	Yes	Low Suitable	NS-2
Geographic load balancing	GLRV protocol	Simulated real-world road map	No	Low Suitable	NCTUns
Tree topology	DAGRS, BODYF	Highway, vehicular city center	Yes	High suitable	JANE simulator
Multimetric in VANETS	Fuzzy control based, AODV	Urban scenario	Yes	High suitable	SUMO

Table 2: Advantages and disadvantages of techniques

Technique	Advantages	Disadvantages
Ant colony optimization	Take vehicular position and speed information	End-to-end delay
Cluster Technique	Reduce unpredictable movements	Delay in packet delivery
Greedy Forwarding	accident alerts that warn drivers	Frequently disconnected network due to high speed movement
Position-based Routing Technique	Handle nvo dimensional scenarios with obstacles	Required high mobility of network nodes and Performance Limitation due to scalability and mobility
Hybrid Bio inspired Bee swam	It provides an acceptable normalized overhead load measure	end-to-end delay issue and unstability of packet delivery ratio
Genetic Algorithm	Increase packet delivery ratio in sparse or partitioned network	Greedy perimeter forwarding fails to forward the packet towards destination where the network is sparse or is disconnected
Geographic load balancing	Better performance in the routing reliability load balancing	Network load imbalance by node congestion detection
Tree topology	DAGRS that leads to a better performance of BODYF	Due to high speed there is unstability of using tree in VANETS
Multi metric in VANETS	Deals with the variety of network density	end-to-end delay

Table 3: Average delivery ratio of different techniques

Type	Routing protocol	Delivery ratio (%)
Topology based	GLRV	85
	GSR	70
	GPSR	79
Geographic based	BODYF	87
	Fcar	86
	Cluster based	62
	Ant-DYMO	92
Hybrid based	GeoDTN+Nav	77
	HyBR	64

ratio of different techniques, it has been analyzed that Topology based technique performs much better when using GLRV routing protocol while it shows lower value of delivery ratio using the GSR and GPSR routing protocol (as shown in the Table 2). Coming to the geographic based technique, it is said that it performs remarkably using the Ant-DYMO protocol while the performance of BODYF, Fcar and Cluster based is comparatively less appropriate. Comparing the value of packet delivery ratio of hybrid based technique, it has been analyzed that the performance of GeoDTN+Nav is better than the results obtained from HyBR protocol.

Another table in which its type, routing protocol and delivery ratio is categorized and compared as shown (Table 3):

CONCLUSION

This study provides a comprehensive survey of optimization and heuristic techniques with the issues faced by VANET, in particular with routing protocol challenges and requirements. This study provides the comparative analysis of multiple parameters of VANET. The open issue in VANET routing is the need of any standard tool for evaluating these protocols. As VANET routing is advancing and becoming mature, many of the underlying assumptions and technologies will need to become mature as well so that much validity can be given to the benefits of these routing protocols.

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