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GPS Based Routing for Urban Vehicular Ad-Hoc Networks

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ABSTRACT

Vehicle-to-Vehicle communication is evolving as a major area of research since the services provided by internet are numerous and vehicular applications like vehicle to vehicle communication for road safety, vehicle coordination and entertainment applications are not an exception. There have been a lot of ideas which were proposed in this context for effective routing in vehicular Ad-Hoc Networks. Until now the existing proactive routing protocols use only the static geographical information for determining the best possible route to reach the destination. But these approaches are not effective for frequently changing network topology which is predominant in Vehicular Ad Hoc Networks (VANET). Even though the reactive routing protocols determine the route whenever it is needed, it does not reduce the complexity in route determination.
In this paper, we present an alternative to the existing routing protocols used in VANETs. We propose that with the use of Global Positioning System (GPS) as an assistive tool to the current routing protocols improves the route discovery process; until now very few protocols implement routing only based on GPS.Nonetheless, GPS has been used partly to determine the location of a node from which other nodes would get help.We assume that, in the near future every vehicle will have its own GPS hardware capable of formatting the dynamic GPS data available.

Keywords: VANETs, Ad-Hoc Networks, Routing, Grids and GPS.

INTRODUCTION

Three kinds of protocols are mainly used for routing in VANETs - Proactive Routing Protocols, Reactive Routing Protocols, and Hybrid Routing Protocols. In proactive routing, structure of entire network is stored in a table and forwarding is done according to the information available in the table. These tables are updated by periodically exchanging the routing information among the nodes. These kind of protocols are not feasible for VANETs since VANETs have high mobility and non-static network topology. The proactive protocols are best suited for static network topologies. Since all the routing information is stored, large amount of memory is required for proactive routing. Examples for these kind of protocols include Destination-Sequenced Distance-Vector routing (DSDV)[1], Optimized Link State Routing (OLSR)[2], and Topology Broadcast Based on Reverse-Path Forwarding (TBRPF)[3].

If we consider reactive protocols, they do not store any routing information in memory. They implement an algorithm called route discovery procedure to know the route, only when there is a demand for packet forwarding. They require a lot of processing power which is non-feasible and highly ineffective. The examples for reactive routing protocols are Ad hoc On-demand Distance Vector Routing (AODV) [4] and Dynamic Source Routing (DSR)Protocol [5].

To have the advantage of both the types, hybrid routing protocols use tables for a short perimeter of network and use route discovery procedure for communication with other nodes outside the known perimeter. Zone Routing Protocol (ZRP)[6] is an example for hybrid routing protocols.

Location Based Geographic Routing Protocols fall under this category since they use location information for route discovery procedure and also save the information available. Examples are Greedy Perimeter Stateless Routing (GPSR)[7], Location-Aided Routing [8], LACBER [9], Energy Efficient Location Aided Routing(EELAR)[10], etc. Also grids are an efficient means for power distribution algorithms and maintenance. In this paper, we propose an algorithm for routing in VANETs using grid architecture and GPS based location information.

In the rest of the paper, Related Work is presented under Section 2, Preliminaries in Section 3, Proposed Algorithm in Section 4 followed by Conclusion under Section 5 and References.

2. Related Work

Location Aided Routing (LAR) protocol is one of the basic location based protocols. LAR Scheme 1 uses “expected zones” based on GPS information of destination. LAR Scheme 2 allows intermediate carrier nodes to control the routing. But it is not as efficient as other proposed protocols.

DSR, which is a reactive routing protocol used for routing in multi-hop wireless mobile ad-hoc networks. It searches its cache to know if destination path is already known. It implements route discovery and route maintenance for determining the route. Since it does not make the use of location based information, it is not as efficient as location based protocols.

LACBER is Location Aided Routing Protocol for GPS Scarce MANETs, is improved in terms of economical use of energy and number of hops compared to LAR. It divides nodes into three categories: G-Nodes, CG-Nodes and N-Nodes. G-Nodes know their location. CG-Nodes can calculate their location with the help of G-

Nodes. N-Nodes do not have any location information. Lower communication overhead, low cost of implementation and energy efficiency are the features of this protocol. But there was no discussion on throughput. Energy efficiency is given a little importance in most of the routine applications. But throughput is mainly considered as metric for evaluation of performance.

EELAR is a location based protocol based on LAR. It uses Base Stations and divides its range into different sectors and assigns them an area ID each. Nodes in same area communicate by flooding and those in different areas communicate through Base Station which routes between them. Forwarding nodes compare distance between themselves and destination to that of source and destination and decide on whether to forward the packet or not. Beckoning is used to determine range of the nodes from the Base Station. The control overhead and data delivery ratio are better than those of DSR, LAR and AODV. But, this approach is not efficient if there is high node mobility and increase in the number of network areas.

By implementing the routing in GPS layer itself, the control overhead is reduced since there is no need of beaconing or regular exchange of packets.

3. Preliminaries

Every node has GPS hardware. . Each node has a unique MAC ID and GPS ID. The region of traffic susceptibility is divided into grids of $100m^2$ each and is assigned an IPv6 address (Nodes are not assigned a permanent IP address. Every node in a grid has the IP address of the grid). Hence any packet with IP address of the grid is multicast to the nodes in the grid. MAC address is used to identify the destination in the grid. Node to node communication may not be possible for distant areas if there is scarcity of mobile nodes. To overcome this problem Base Stations are necessary. Intermediate servers have database which has information of nodes GPS ID and MAC ID.

4. Proposed Routing Algorithm

4.1 Node-to-Node Communication

When a node needs to communicate with another node, it needs to provide the GPS_ID of the destination node. Then, the location information i.e., latitude, longitude and velocity direction of the destination node is obtained from a GPS tracking server like Google Navigation, gps-trace.com, instamapper.com, gps-gate.com, opengpstracking.com, etc., or directly from the satellite. MAC address of the destination can be retrieved from the server database.

Then the source node searches for the IPv6 address of the obtained location in the local IP distribution table stored in its memory. The source node now attempts to send the packet with the IPv6 address and MAC address in the destination field along with destination node velocity direction by multicasting the packet to its present grid's address. Then any of the nodes present near the source node, which has the same velocity direction as of destination node may respond with their MAC address and location information. If it fails to receive any response, it makes another attempt until the number of attempts does not exceed the maximum number of attempts (MaxAttempts).

The source node checks the direction of the responded node by comparing location information of the node (LATi, LONi) with its location information (LATs, LONs). As shown in figure 1, if that node is in the desired direction, (LON – LONi) < (LON – LONs) will be true if the node is in between the source and destination in the horizontal direction and (LAT – LATi) < (LAT – LATs) will be true if the node is in between the source and destination in the vertical direction. If the node's position is in the desired direction, the source node acknowledges the responded node. Hence the packet will be forwarded to the node in the desired direction, which responds first. If the number of attempts become more than the maximum number of attempts, the source node buffers the data and reinitializes the above procedure after a specified time.

The intermediate nodes have the IP address information and each node follows the same procedure for forwarding except for the location information fetching. The acknowledgement form the destination follows the same procedure.

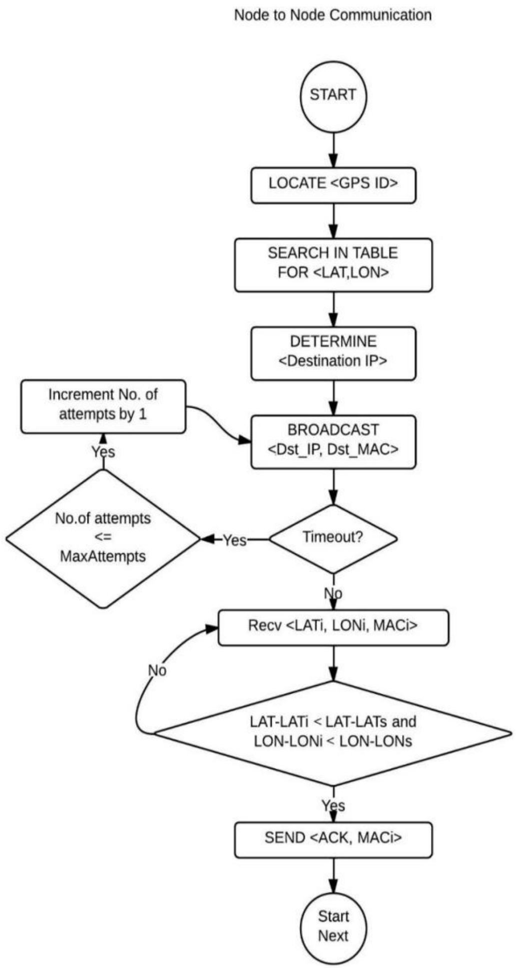

Fig 1 Flowchart for node-to-node communication

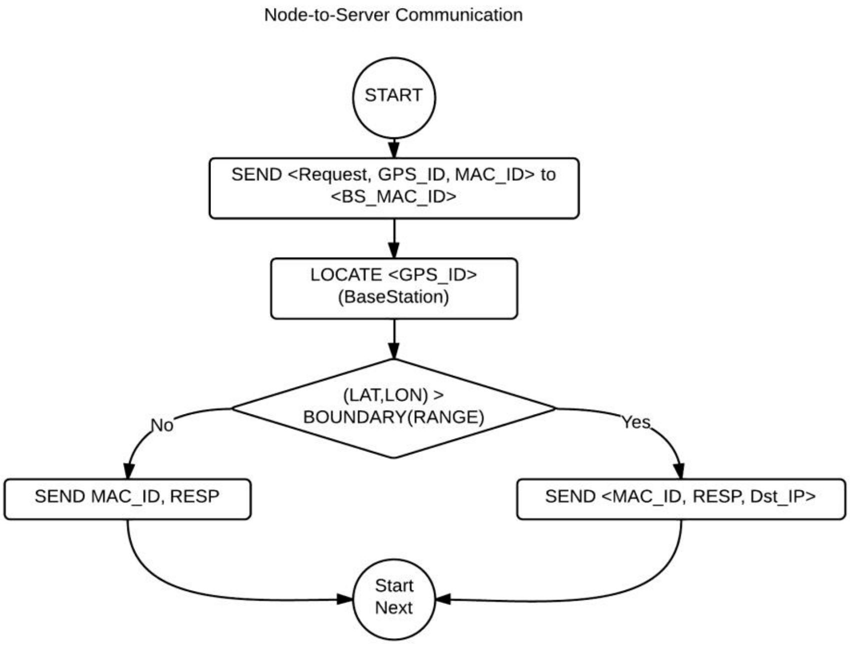

Fig 2 Flowchart for Node-to-Server

4.1.1 Algorithm

begin
while (DstMAC != MACi){
(LATs, LONs MACs) ← Coordinates and MAC Address of Source node
LOCATE <Dst_GPS_ID> // GPS_ID is used to get destination location information
LAT ← Latitude of Destination
LON ← Longitude of Destination // Response from Server
Speed ← Speed of Destination
DstMAC ← MAC Address of Destination Node
LOOKUP Dst_IP in IP distribution table// Search the Table for IP address of the received location
while (attempt <= Max_Attempts){
SEND <Dst_IP, Dst_MAC> //Multicast
if (timeout)
{attempt = attempt + 1;}
while (1){
RECV <LATi, LONi, MACi> // Receive Location information and MAC address of an adjacent node
LATi ← Latitude of intermediate node responded
LONi ← Longitude of intermediate node responded
MACi ← MAC address of the responded node
if ((LAT – LATi) <= (LAT – LATs) && (LON – LONi) <= (LON - LONs){

// if the node is in between the source and destination
SEND <ACK, MACi> // Send Acknowledgement to the responded node.
break;
}}
}}
end

4.2 Node-to-Server Communication

Node-to-server communication is one of the areas which is not researched upon much. But, there are some aspects which are required to be improved. The client node initiates a request, for example: GET http://www.google.com along with its GPS_ID and MAC address which is multicast to the nearest base station with BS_MAC_ID (Base Station's MAC address), as shown in figure 4. The base station gets response from the GPS tracking server and the location information of the client node using the GPS_ID.

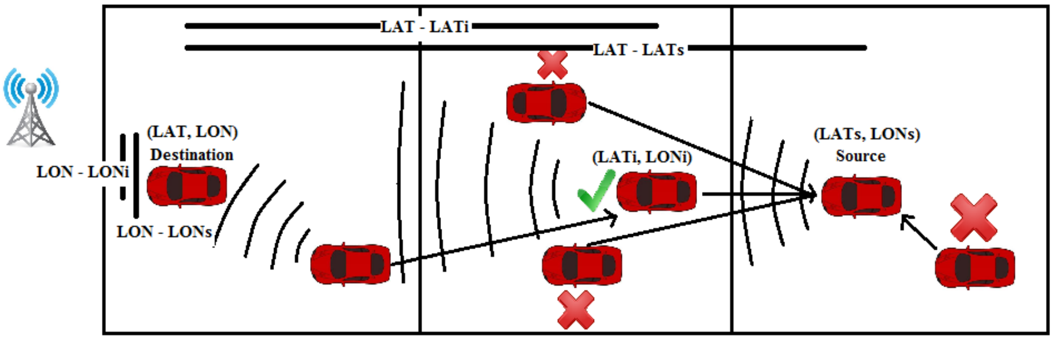

Fig 3 Node-to-Node communication

4.2.1 Algorithm

begin
SEND <Request, GPS_ID, MAC_ID> to Broadcast address
BS{ RECV <Response>
LOCATE <GPS_ID>
LATc ← Latitude of the Client
LONc ← Longitude of the Client
if (LATc, LONc) in range (Base Station Grid){
SEND <MACc, Response>
While (attempt <= Max_Attempts){
SEND <Response, Client_IP, Client_MAC> //Multicast
if (timeout){
attempt = attempt + 1;
}else
{ LOOKUP <Client_IP>
IPn ← IP address of the next Base Station towards the Client

SEND <Client_MAC, Response, IPn>
}}}}
end

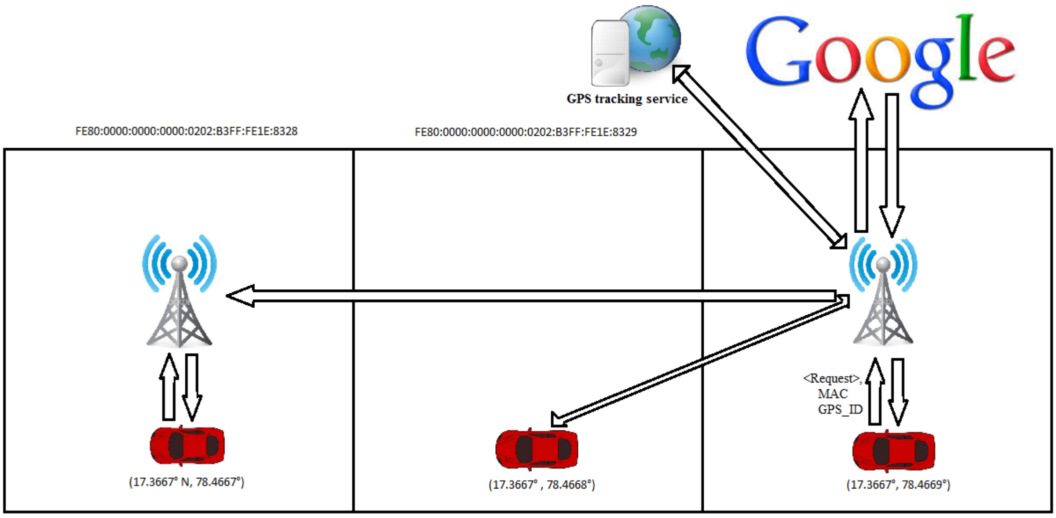

Fig 4 Node-to-Server Communication

If the client node is in the range of the base station, it forwards directly to the IP address of the client's grid and MAC address of the client. Else, it forwards to the nearest base station, which in turn forwards to the client. As illustrated in figure 4, when the car is the first grid, it gets the response directly from the base station in its grid. When it moves to the second grid, it gets the response with the IP address of the second grid and when it moves to the third grid, the response has been forwarded to the base station in third grid by the base station in the first grid. Whenever the server terminates the connection, a new connection has to be made through the base station near the car's grid.

5. CONCLUSION

In this paper we have proposed that the use of GPS can reduce amount of overhead present in the reactive and hybrid routing protocols. The grid system has been introduced to have the support of IP. It gives the advantage of having a static scenario at an instant of time and makes the protocol stack for mobile nodes backward compatible. All the changes to be made for mobile node needs to be done only in the extra networking layer, which may be called as mobile layer. Since GPS is sought to be an improving technology, we look forward for the implementation of GPS based protocols for VANETs.

REFERENCES

[1] C.E. Perkins and P. Bhagwat, Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers, in: Proc. of ACM SIGCOMM ’94 Symposium on Communication, Architectures and Protocols (1994) pp. 234–244.

[2] T. Clausen, P. Jacquet, A. Laouiti, P. Muhlethaler, A. Qayyum and L. Viennot. Optimized Link State Routing Protocol. IEEE INMIC Pakistan 2001.

[3] R. G. Ogier, F. L. Templin, B. Bellur, and M. G. Lewis, Topology Broadcast Based on Reverse-Path Forwarding (TBRPF), Internet Engineering Task Force (IETF) draft, November 2002. http://www.ietf.org/internet-drafts/draft-ietf-manettbrpf-06.txt.

[4] C. Perkins, E. Belding-Royer, and S. Das, Ad hoc On-demand Distance Vector (AODV) routing, University of Cincinnati, Internet draft, July 2003.

[5] J. Broch, D. B. Johnson, and D. A. Maltz, The dynamic source routing protocol for mobile ad hoc networks, draft-IETF-manet-dsr-03.txt, Internet Draft, Oct. 1999.

[6] Z.J. Haas and M.R. Pearlman, The zone routing protocol (ZRP) for ad hoc networks (Internet-draft), in: Mobile Ad-hoc Network (MANET) Working Group, IETF (1998).

[7] B. Karp, and H. T. Kung, GPSR: Greedy perimeter stateless routing for wireless networks, in Proc. IEEE/ACM MOBICOM, Boston, MA, Aug. 2000. p. 243–254.

[8] Ko, Young-Bae, Vaidya N.H., Location-Aided Routing (LAR) in mobile ad hoc network, Wireless

[9] Dipankar Deb, Srijita Barman Roy, and Nabendu Chaki, LACBER: A NEW LOCATION AIDED ROUTING PROTOCOL FOR GPS SCARCE MANET, International Journal of Wireless & Mobile Networks (IJWMN), Vol 1, No 1, August 2009

[10] Mohammad A. Mikki, Energy Efficient Location Aided Routing Protocol for Wireless MANETs, (IJCSIS) International Journal of Computer Science and Information Security Vol. 4, No. 1 & 2, 2009.