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A Comparative Study on different types of Routing algorithms in VANET Network

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***Abstract*— VANET (Vehicular Ad-hoc Network) is a new technology which has taken enormous attention in the recent years. It is a subclass of Mobile ad hoc networks which provides a unique approach for intelligent transport system (ITS). The design of routing protocols in VANETs application is very important and essential issue for supporting the smart ITS. A Complete understanding of the communications Channel between vehicles is required for realistic modeling of VANETs application and the development of related technologies and applications needs. This proposed paper gives a brief summary of different types of routing protocols which are adapted in various routing algorithms in VANET where it has been divided into four types they are unicast, broadcast, multicast, and geocast, however the multicast and geocast can be merged in one class because geocast usually is a unique type of multicast transmission..**

Index Terms - **VANET, Transmission Strategies, ITS, Routing Protocols, UniCast, Multicast, Geocast**

I. INTRODUCTION

Vehicular networks represent a particularly new class of wireless ad hoc networks that enable vehicles to communicate with each other and/or with roadside infrastructure. VANET is a new standard that integrates Wi-Fi, Bluetooth, IRA, ZIGBEE and other mobile connectivity protocols. In recent years, with the sharp growth of vehicles on roads, driving becomes more challenging and dangerous. Roads are drenched, safety distance and reasonable speeds are hardly respected, and drivers often lack enough attention. In order to help the drivers on the roads to expect about hazardous events or bad traffic areas VANET is used .The essential requirement of VANET is that it should be able to communicate in any environment irrespective of traffic densities and vehicle locations. Through this VANET can provide Safety and comfort for drivers to drive the vehicles.

The main goal for routing protocol is to provide optimal paths between network nodes via minimum overheads. A lot of routing protocols have been developed according to different aspects; it has been classified such as techniques used quality of service, protocol characteristics, network structure. The Chapter II discusses about the routing information, such a Unicast, Multicast and Geocast based on packet transmission which is occurring in various protocols in detail. The Chapter III discusses about the Conclusion mechanism and its parameters of VANET routing protocol in table1, 2 and concludes the best Routing Protocol based on the parameters.

II. ROUTING ALGORITHM.

Based on the packet Delivery, the information from a source to destination can be classified in to four types they are unicast, broadcast, multicast, and geocast, however the multicast and geocast can be merged in one class because geocast usually is a special type of multicast transmission

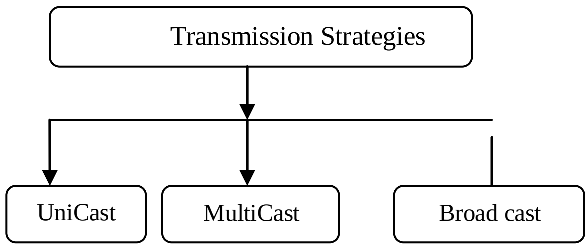

Fig 1

The subdivision is explained below one by one As shown in fig 1. *Unicast* routing is a fundamental operation for vehicle to construct a source-to-destination routing in a VANET .*Multicast* is defined by delivering multicast packets from a

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single source vehicle to all multicast members by multi-hop communication. *Geocast* routing is to delivers a geocast packet to a exact geographic region. Vehicles situated in this particular geographic region should receive and forward the geocast packet; else, the packet is dropped as shown in Fig. 2 (b). *Broadcast* protocol is utilized for a source vehicle sends broadcast message to all other vehicles in the network Fig. 2(c). as shown below

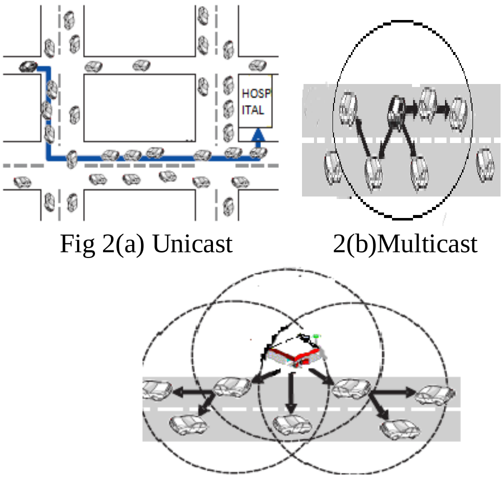

Fig 2(a) Unicast 2(b)Multicast

2(c) Broadcast

3. UniCast Routing Protocol

Unicast routing refers to information delivery from a single source to a single destination using the wireless multi hop scheme; where the intermediate nodes are used to forward data from the source to the destination object, or by using the store and forward scheme. The objective of the carry and forward technique is that, Source vehicles carries data as long as possible to reduce the number of data packets. The delivery delay –time cost by carry and forward technique is normally longer than multi hop transmission technique.

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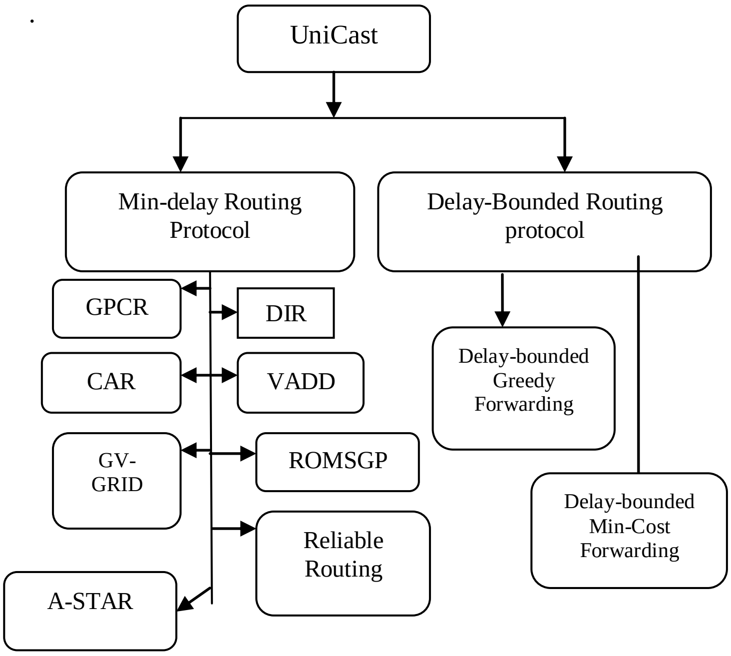

The Unicast protocol is divided into two sub classification and again each classification has its own routing protocol method[1-10].The figure 3 shows the diagram above.

3.1.1 Min-Delay Routing Protocol*:*

This Protocol aims to minimize the delivery delay-time from source to destination. The transmission delay time is the major concern and the shortest routing path is usually selected or adopted. The shortest path may be found in a low density area, packets cannot transmit it by the multi hop forwarding. Since that there is no near by vehicle can forward packets. These packets should be delivered by carry and forward schema. The Min-delay routing protocols are given below

3.1.2 GPCR: **Greedy Perimeter Coordinator Routing Protocol [17]:**

Lochert *et al.* proposed GPCR which is a position-based routing for urban environment. This protocol is very well suited for extremely dynamic environments such as inter-vehicle communication on the city or highway. This Protocol consists of two components: A Restricted Greedy forwarding procedure, A repair strategy for routing algorithm. It follows a destination based greedy forwarding strategy, it routes messages to nodes at crossroads.

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3.1.3 CAR: Connectivity-aware Routing Protocol [4]:

Based on Preferred Group Broadcast (PGB) to minimize broadcast from AODV route discovery and AGF (Advanced Greedy Forwarding) to account for node mobility, Naumov et al. (2007) presented Connectivity-Aware Routing (CAR) in VANETs. This protocol establishes a routing path from source to destination by setting the anchor points at intermediate junctions. This protocol ensures to find the shortest connected path because CAR has higher packet delivery ratio than GPSR and GPSR+AGF.

3.1.4 DIR: Diagonal-Intersection-Based Routing Protocol [16]:

To improve the CAR protocol design, Chen *et al.* developed a DIR (diagonal-intersection-based routing) protocol. This protocol constructs a series of diagonal intersections between the source and destination vehicle .This protocol is a geographic routing protocol, in which source vehicle geographically forwards the data packet towards the first diagonal intersection, and the second diagonal intersection, and so on, until it reaches the last diagonal intersection, and finally geographically it reaches to the destination vehicle.

3.1.5 VADD: Vehicle-Assisted Data Delivery Routing Protocol [3]: VADD (Zhao et al., 2006) is a vehicular routing strategy aimed at improving routing in disconnected vehicular networks It adopted the idea of carry-and-forward for data delivery from a moving vehicle to a static destination. To assist efficient data delivery, it uses predictable traffic pattern and vehicle mobility. A vehicle takes a decision at a junction and selects the next forwarding path with the smallest packet delivery delay. A path is nothing but a simple branched road from an intersection. A set of linear equations can solve the minimum delay.

3.1.6 GVGRID:An QOS Protocol [7]:

Sun *et al*. proposed GVGrid protocol to improve delivery delay-time and routing reliability, which is a QoS routing protocol for VANETs.From source to destination GVGrid constructs a routing path according to grid-based approach, which divides the map into several grids of uniform size. The Route Request (RREQ) and Route Reply (RREP) packets are delivered through different grid to find a routing path through minimum number of grid. A grid is selected based on the route and the distance between vehicle and intersection and is chosen as next grid if the direction of grid is the same as current grid or the grid is closed to the intersection. Then the intermediate grids between source and destination are recorded in the routing table. An correct vehicle which has the fewest number of disconnections in each grid is chosen to forward packets to next grid.

3.1.7 ROMSGP: Receive on Most Stable Group-Path [18]:

Taleb *et al.* proposed ROMSGP, to improve the routing reliability. This routing protocol designed for a city environment. Taleb *et al*. indicate that an unstable routing usually occurred due to the loss of connectivity if one vehicle moves out of the transmission range of a neighboring vehicle. In ROMSGP protocol, all vehicles are split into four groups based on the velocity vector. A routing is said as a stable routing if the two vehicles are categorized in the same group; otherwise, the routing is an unstable routing. A vehicle that belongs to a group if the velocity vector has the maximum projection
vector with this group.

3.1.8 RELIABLE Routing :[8]:

Wan *et al*. specially proposed a reliable routing protocol for the *rural* environment. Wan *et al*. proposed two reliable routing strategies for roadside to vehicle (R2V) communication. The Terrain factor is the challenges of R2V communication in the rural environment. For instance, a moving vehicle in the rural highway occasionally loses the line of sight (LOS) to the neighbor vehicle or to access points (APs) due to the obstacle-property caused by the curve roadway and mountains. In addition, almost no fixed communication infrastructure is available. Multi-hop inter-vehicle communication connecting to AP is the main solution of the R2V communication. The link lifetime is very important issue for designing the reliable routing. The link lifetime is predicted by two conditions.

(1) LOS between a pair of vehicles is lost,

(2) one vehicle moves out of the communication range of the neighboring vehicle.

A link established in a shorter distance usually has longer link lifetime. Long lifetime of a route improves the routing reliability if considered the lifetime-bounded shortest path. In addition to that, the lifetime of a routing path length-bounded maximum lifetime path is considered. To construct a better length-bounded maximum lifetime path, reducing hops can improve the delivery delay-time. A routing path with fewer hops means the links are established in the long distance

3.1.9 A-STAR: Anchor-Based Street and Traffic Aware Routing:

It is very alike to GSR in that packets are routed through anchor points of the overlay. Still, It is a traffic alert: That the

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traffic on the road determines whether the anchor points of the road will be measured in the shortest path. The A-STAR routes based on two kinds of overlaid maps: a dynamically rated map and a statically rated map. A statistically rated map is a graph which displays bus routes that normally imply stable amount of traffic. Dijkstra paths computed over the statistically rated map are in general connected because of the extra knowledge. A dynamically rated map is a map that is generated based on the real-time traffic condition on the roads.

3.2 Delay-Bounded Routing Protocol [19]

Skordylis *et al*. proposed a delay-bounded routing protocol in VANETs, which provides a routing scheme that satisfy user-defined delay requirements while at the same time maintaining a low level of channel utilization. The delay-bounded routing protocol [12] focuses on the development of carry-and-forward schemes that attempts to deliver data from vehicles to static infrastructure access point in an urban environment. Two routing algorithms they are given below
1.D-Greedy (Delay-bounded Greedy Forwarding)
2.D-MinCost (Delay-bounded Min-Cost Forwarding)

To evaluate traffic information and the bounded delay-time to carefully opt between the Data Muling and Multihop Forwarding strategies to minimize communication overhead while satisfying with the delay constraints imposed by the application.

3.2.1 Delay-bounded Greedy Forwarding:

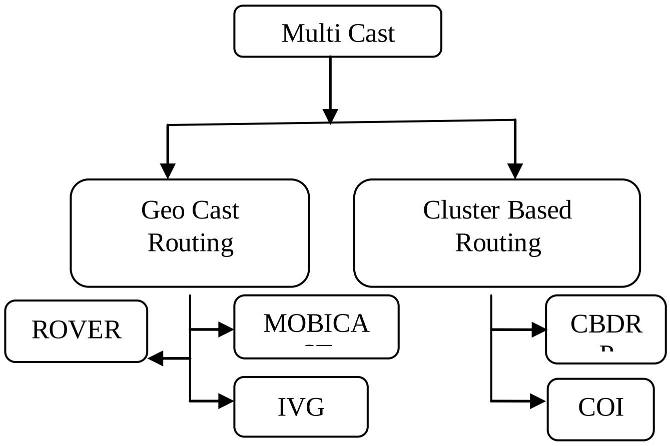
D-Greedy algorithm adopts only local traffic information to make routing decisions. From the map information D-Greedy algorithm selects the shortest path to destined AP and according to the length of the streets , it allocates the constrained delay-time to each street within the shortest path. If packets can be delivered under the constrained delay-time in a street, at that time Data Muling strategy is utilized. The Vehicle will carry the Packets and forwarded at the vehicle's speed to destined AP. Otherwise, Multi hop Forwarding strategy is applied if packets cannot be delivered within the constrained delay-time. Packets are delivered effectively by multi-hop forwarding.

3.2.2 Delay-bounded Min-Cost Forwarding:

D-MinCost algorithm considers the global traffic information in a city to accomplish the minimum channel utilization within the constrained delay-time. The cost and delay of each street can be pre-computed, according to the global traffic information, The cost represents the number of message transmissions in a street. The delay denotes the time required to forward a message in a street. To attain the least cost within the constrained delay, DSA (Delay Scaling Algorithm) is applied to select the best routing path with minimum channel utilization under the constrained delay-time.

3.3 Multi Cast Routing:

Multicast is defined by sending packets from a single source to specific group members by multi hop communication Multicast routing in VANETs can be classified into two categories: geocast and cluster-based routing[1] it shown in fig 3.



3.3.1. Geo Cast Routing [22]

Geocast routing is fundamentally a position based multicast routing. Its objective is to carry the packet from the source node to all other nodes within a particular geographical region (ZOR). To avoid unnecessary hasty reaction, these routing vehicles outside the ZOR are not alerted. A zone of forwarding (ZOF) is explained as the geographic area that vehicles in this area must deliver the packets to other ZOR vehicles. A ZOF aims to accomplish a reliable packet's delivery in extremely dynamic topology. It provides a periodic retransmission, to deal with the network changes .It is considered as a multicast service within a ZOR. It normally defines a forwarding zone where it directs the flooding of packets in order to reduce message overhead and network congestion caused by simply flooding packets everywhere. In the destination zone, unicast routing can be used to forward the packet. A drawback of Geocast is network partitioning and also unfavorable neighbors which may hinder the proper forwarding of messages.

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3.3.2 MOBICAST: Mobile Just In Time Multicasting Protocol [25]:

Mobicast is a multicast geographical protocol, different to traditional geocast routing protocol, It takes into account the time aspect. This protocol is designed to provide a management for spatiotemporal needs in VANETs; that by transmitting a Mobicast packet to Vehicles inside a ZOR at time (ZORt). All the vehicles belong to the ZOR at a time t should keep on connected to preserve the communication of the real-time data among the whole ZOR vehicles. The communication of ZOR is failing if any ZOR vehicle unpredictably speeds up or slows down its speed.Each vehicle can be located by a location provider (GPS) . Vehicle within a ZOR may not efficiently receive Mobicast packets When the network is temporal fragmented.

3.3.3. ROVER: Robust Vehicular Routing [23]:

ROVER is a geographical multicast protocol. Its objective is to send a message to all other vehicles which are available within a specified ZOR (Zone of Relevance); using on-demand routing to find out packets inside a ZOR. The starting node starts discovering a route by flooding its ZOR by RREQ packet, this packet included source ID, its recent ZOR, its location, and a sequence number of the route. When a vehicle received the RREQ packet, if it was almost close to the source and located inside the ZOF and ZOR it accepts the packet;. It doesn't send a reply, If the vehicle was outside of the ZOR. After a vehicle accepts the RREQ packet, it sends back a reply packet which contains its ID to one-hop neighbors, further it will record the RREQt packet information in its routing table. And then retransmit the RREQ packet

3.3.4. IVG: Inter-Vehicle Geocast[24]:

Bachir *et al.* proposed a multicast protocol in ad hoc networks inter-vehicle geocast, called IVG protocol . It is used to inform all the vehicles in a highway if any danger is occurred; such as an accident. The *risk* area is calculated in terms of positioning of vehicles and driving direction . Vehicles located in the risk area form a multicast group. The multicast group is clearly defines temporarily and dynamically by the speed ,location, and driving direction of vehicles. To overcome temporary network fragmentation for delivering messages to multicast members, It uses periodic broadcasts in greater effect

3.4 Cluster Based Routing [21]

This protocol divides the network to clusters, based on the nodes that have the same characteristics, like same velocity or same route, or so on. Every cluster has a cluster head, its work is to supervise communication processes inside, and to outside its cluster. Nodes which are inside the cluster communicate by direct routes, but their communication with other nodes such as outside the cluster is attained by their cluster header, and a virtual infrastructure for networks is created by this concept.

3.4.1CBDRP: Cluster-Based Directional Routing Protocol:

This protocol divides the vehicles into clusters and vehicles which are moving in same direction form a cluster. Every cluster has a cluster head which is responsible for the routing method. These cluster heads communicates with each other via gateway nodes which are the nodes that have more than one cluster head. When a starting node requests a route, it floods the network by request packet information. This clustered structure reduces traffic overhead, because request packet only passes through cluster heads.

3.4.2 COIN: Clustering For Open Ivc Network[35]:

To improve network scalability, COIN clustering mechanism is designed, it also divides the network to clusters; but not like other traditional clustering protocols, According to three parameters ,COIN selects clusters: mobility of nodes, behavior of nodes , and nodes positions . It provides every cluster specific time which is a time to live; in order to minimize control overhead. Inter vehicles communication system (IVC) deals with the unstable distances of inter vehicles. To enable a head of cluster member node and the cluster node keep on continue communicating, their mobility should be low and related to the mobility of all, in this case they can exists in radio contact for a longer time

3.5. Broadcast Routing

Broadcast routing is frequently used in VANET for sharing, weather, traffic and road conditions, emergency, among vehicles and delivering announcements and advertisements. Broadcasting is used when message needs to be disseminated to the vehicle beyond the transmission range i.e multi hops are used. Broadcast sends a packet to all nodes in the network, usually using flooding. This ensures the delivery of the packet but bandwidth is wasted and nodes receive duplicates. In VANET, this performs better for a small number of nodes. The different Broadcast routing protocols given below

III .CONCLUSION

Routing is an vital component in infrastructure-to-vehicle (I2V) and vehicle-to-vehicle (V2V) communication. This

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paper discussed various routing protocols based on their packet transmission of VANET. Designing an proficient routing protocol for all VANET applications is very difficult. Hence a study of different VANET protocols is must, so it will assist to come up with new proposals for VANET applications to transfer data efficiently. The performance of transmission strategies routing protocols depend on various parameters like Routing maintenance, Digital Map, Virtual Infrastructure requirement and several more plays a vital role. Thus this paper has come up with an exhaustive study of different classes of VANET routing protocols using these parameters. From this survey it is clear that, geocast and cluster based protocols within the multicast Protocols are more reliable and effective for most of the applications in VANET.

Parameters / Protocols	Routing Maintenance	Digital MAP	Prior Forwarding Method	Virtual Infrastructure Requirement	Realistic Traffic Flow	Recovery strategy	Control Packet overhead	Scenario	Hierarchical Structure?
GPCR	Reactive	Yes	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
DIR	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
VADD	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
CAR	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
GV-GRID	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
ROMSGP	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
RELIABLE ROUTING	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
A-STAR	Reactive	NO	Greedy Forwarding	NO	YES	Store and forward	Moderate	Urban	NO
ROVER	Reactive	NO	Wireless Multi hop Forwarding	NO	YES	Flooding	HIGH	Urban	NO
MOBICAST		NO	Wireless Multi hop Forwarding	NO	YES	Flooding	-	Highway	NO
IVG	Reactive	NO	Wireless Multi hop Forwarding	NO	YES	Flooding	Low	Highway	NO

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Parameters / Protocols	Routing Maintaince	Digital MAP	Prior Forwarding Method	Virtual Infrastructure Requirement	Realistic Traffic Flow	Recovery strategy	Control Packet overhead	Scenario	Hierarchical Structure?
DTSG	Reactive	NO	Wireless Multi hop Forwarding	NO	YES	Flooding	Moderate	Highway	NO
COIN	Reactive	YES	Wireless Multihop Forwarding	YES	NO	Carry & Forward	Moderate	Urban	YES

REFERENCE

[1]. Marwa Altayeb and Imad Mahgoub" A Survey of Vehicular Ad hoc Networks Routing Protocols" International Journal of Innovation and Applied Studies ISSN 2028-9324 Vol. 3 No. 3 July 2013, pp. 829-846.

[2]. YUN-WEI LIN, YUH-SHYAN CHEN, AND SING-LING LEE "Routing Protocols in Vehicular Ad Hoc Networks: A Survey and Future Perspectives"

[3]. J. Zhao and G.Cao, "VADD: Vehicle-Assisted Data Delivery in Vehicular Ad Hoc Networks," *IEEE Computer Communications*, Apr. 2006, pp.1-12.

[4]. V. Naumov and T. Gross, "Connectivity-Aware Routing (CAR) in Vehicular Ad Hoc Networks," *IEEE International Conference on Computer Communications (INFOCOM)*,May 2007, pp.1919-1927.

[5]. Y. S. Chen, Y.W. Lin, and C. Y. Pan, "A Diagonal-Intersection-Based Routing Protocol for Urban Vehicular Ad Hoc Networks," *Telecommunication System*, 2009 (under revision).

[6]. T. Taleb, E. Sakhaee, A. Jamalipour, K. Hashimoto, N. Kato, and Y. Nemoto, "A Stable Routing Protocol to Support ITS Services in VANET Networks," *IEEE Transactionson Vehicular Technology*, vol. 56, no. 6, 2007, pp. 3337-33347.

[7]. W. Sun, H. Yamaguchi, K. Yukimasa, and S. Kusumoto, "GVGrid: A QoS Routing Protocol for Vehicular Ad Hoc Networks," *IEEE International Workshop on Quality of Service (IWQoS)*, June 2006, pp. 130-139.

[8]. S.Wan, J. Tang, and R. S.Wolff, "Reliable Routing for Roadside to Vehicle Communications in Rural Areas," *IEEE International Conference on Communications (ICC)*, May 2008, pp.3017-3021.

[9]. A. Skordylis and N. Trigoni, "Delay-Bounded Routing in Vehicular Ad-Hoc Networks," *ACM International Symposium on Mobile Ad hoc Networking and Computing*,Nov. 2008, pp.3017-3021.

[10]. S.Sujatha..Soundeswari " Comparative and Behavioral Study on VANET Routing Protocols" *IOSR Journal of Computer*

International Journal of Computer Science
Oddity...Probe...Reviste...
http://www.ijcsjournal.com Volume 2, Issue 2, No 4, 2014. ISSN: 2348-6600
Reference ID: IJCS-066 PAGE NO: 383-390.

Engineering (IOSRJCE) ISSN: 2278-0661, ISBN: 2278-8727 Volume 5, Issue 2 (Sep-Oct. 2012), PP 41-45

[11]. Rakesh Kumar, Mayank Dave" A Comparative Study of Various Routing Protocols in VANET**"** IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 4, No 1, July 2011.

[12]. Hamidreza Rahbar, "DTSG, Dynamic Time-Stable Geocast Routing in Vehicular Ad Hoc Networks", 2001.

[13]. C. Lochert, M. Mauve, H. Fera, and H. Hartenstein, "Geographic routing in city scenarios," *ACMSIGMOBILE Mobile Computing and Communications*, vol. 9, no. 1, 2005, pp.69-72.

[14]. A. Bachir and A. Benslimane, "A Multicast Protocol in Ad hoc Networks Inter-Vehicle Geocast," *IEEE Semiannual Vehicular Technology Conference*, vol. 4, Apr.2003, pp.2456-2460.

[15]. Bijan Paul, Mohammed J. Islam, "Survey over VANET Routing Protocols for Vehicle to Vehicle Communication," *IOSR Journal of Computer Engineering (IOSRJCE)*, ISSN: 2278-0661, ISBN: 2278-8727, vol. 7, Issue 5 (Nov-Dec. 2012), pp. 01-06

[16]. Y. S. Chen, "A diagonal-intersection-based routing protocol for urban vehicular ad hoc networks", 2010.

[17]. Kevin C. Lee," Survey of Routing Protocols in Vehicular Ad Hoc Networks".

[18]. T. Taleb, "A Stable Routing Protocol to Support ITS Services in VANET Networks", 2007.

[19]. Skordylis and N. Trigoni, "Delay-Bounded Routing in Vehicular Ad-Hoc Networks,"*ACM International Symposium on Mobile Ad hoc Networking and Computing*, Nov. 2008, pp.3017-3021.

[20]. Bachir and A. Benslimane, "A Multicast Protocol in Ad hoc Networks Inter-Vehicle Geocast," *IEEE Semiannual Vehicular Technology Conference*, vol. 4, Apr.2003, pp.2456-2460

[21]. Tim Daniel Hollerung, "The Cluster-Based Routing Protocol", *project group Mobile Ad-Hoc Networks Based on Wireless LAN, University of Paderborn*, 2003/2004.

[22]. R. A. Santos, "Performance evaluation of routing protocols in vehicular ad hoc networks," 2005.

[23]. Yuyi Luo, "A New Cluster Based Routing Protocol for VANET", 2010.

[24]. M. Kihl, "Reliable Geographical Multicast Routing in Vehicular Adhoc Networks", 2007.

[25]. Y. Chen, Y. W. Lina, and S. L. Lee, "A Mobicast Routing Protocol for Vehicular Ad Hoc Networks," *ACM/Springer Mobile Networks and Applications (MONET)*, 2009.