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Routing protocols for Vehicular Sensor Networks: A Survey

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Abstract — **Vehicular Sensor Network (VSN) is an emerging architecture used to sense the physical word. In VSN's the vehicular sensors are placed in moving vehicles like cars, buses etc. Because of the highly dynamic environment, frequent disconnection and patterned mobility, it is necessary and important to provide routing protocols which adapt to these environments. Since, vehicles moves fast the battery power and the processing capability will not be a constraint. This paper provides with the characteristics of the VSN environment, which should be considered while designing the routing algorithm. The Routing in Vehicular networks are broadly classified into five categories Topology based, Position based, Cluster based, Geocast and Broadcast. Based on these categories, the recent routing protocols are classified and compared with others.**

Key Words: VSN,VANET,Routing,V2V,V2I

I. INTRODUCTION

Vehicular Sensor Networks(VSN)is the new emerging architecture for monitoring the physical world. Consider the urban areas where the density of the vehicles on the road will be high due to which accidents may occur frequently. The current generation of vehicles is equipped with latest wireless technologies to give security to the people who are riding and to access the network resources on-the-fly. VSN's are the combination of wireless sensor networks (WSN) and Vehicular Ad-hoc Network (VANET). To improve the detection performance generally sensors are equipped in vehicles to detect or to estimate some events and it is not just used for communication. To collect dynamic set of information and to sense the physical environment with low cost and higher accuracy VSN is used. Since there is a challenging deployment scenario in VSN's, with high mobility and limited lifetime there should be innovative solutions for data routing compared to WSN and MANET. Other factors such as road layout and varying environments such as highways, city and simple layout make the routing scenario more difficult [1]-[3].

Every participating vehicle is considered as the nodes. Since the movements of vehicles are restricted by roads and traffic regulations fixed infrastructure should be deployed.When vehicles fall out of the signal range, it is dropped out from the network and the other vehicles can join in when they fall under the signal range. The various applications of VSN's include urban monitoring, to improve safety of the environment and the humans, to give driving assistance, traffic and distributed surveillance and for entertainment purposes. Routing protocols of VSN's focus on mobile nodes where routing protocol of other sensor networks concentrate on stationary nodes. The routing protocol should be designed to adapt to the changing topology which should make the routing decisions quickly and should attain maximum throughput and minimum delay. Communication can happen based on V2V (Vehicle to Vehicle) communication where information is shared between vehicles, V2I (Vehicle to Infrastructure) communication where messages are initially sent to the Road side Unit (RSU) and then broadcast to the vehicles in range, V2I/V2V a hybrid model where vehicles receive message via vehicles and it is passed to the RSU's. This paper gives the extensive survey on routing protocols which discusses the pros and cons based on the parameter metrics. Fig1 gives the simple environment of the vehicular networks [1][3].

II. KEY CHARACTERISTICS OF VSN

A. Highly Dynamic Topology

In the various sensor networks the node can sense the environment constantly, since the sensors will be stationary and fixed in a particular place. In VSN's the sensors will be placed in the vehicles which will be movingin the high speed, hence the mobility should be supported. Routing messages passed between the vehicles will be more challenging, because of the rapid. changing topology the routing paths and the neighboring tables cannot be maintained [1][2].

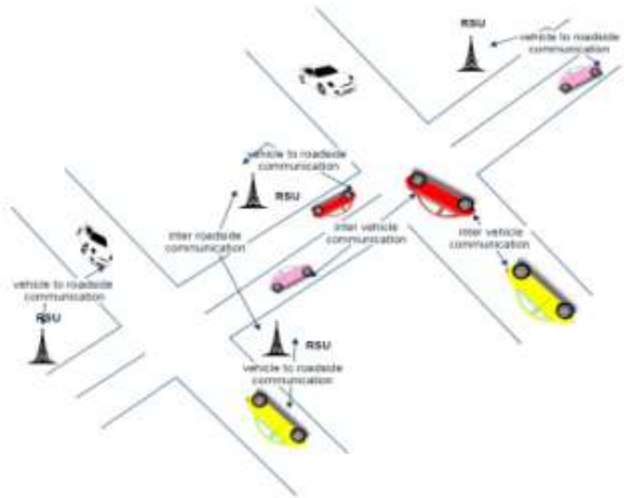

Fig 1 Simple scenario of Vehicular networks

B. Frequent Disconnection Of Network

Because of the dynamic changing topology, the link between the two connected vehicles may be broken in few minutes which cause disconnection of the network. Another problem is the heterogeneous node density, which is the frequently used roads will have many vehicles and non-frequently travelled roads will have less vehicles. Even in the frequently used roads, in non-rush hours roads will have less density of vehicles than the rush hours, which causes frequent disconnectivity [1][2].

C. Battery Power And Storage Capabilities

In VSN's the nodes will be having quite large amount of energy since they are placed in the vehicles rather than small handheld devices. Also when compared to the other sensor networks in which nodes are static, VSN's will have good amount of energy and processing capabilities [1][2].

D. Propagation Model

In most of the ad-hoc networks the environment will be of free space, whereas in the vehicular networks there will be a presence of buildings, trees and other vehicles. The vehicular environment should be able to find the difference between the physical objects, the vehicles which are transmitting the information and the access point which is the Road Side Units (RSU) [2].

E. Patterned Mobility

Vehicles follow a certain mobility pattern that is a function of the underlying roads, the traffic lights,the speed limit, traffic condition, and the drivers' driving behaviors. Because of the particular mobility pattern, evaluation of vehicular routing protocols only makes sense from traces obtained from the pattern. There are many vehicle mobility trace generators developed for the purpose of testing vehicular routing protocols in simulation [2].

F. Sensing Environment

Vehicles can be driven in the varying environments such as highways, rural areas, urban areas and battle fields. Routing protocols should be able to adapt to these varying environments which will be the challenging task [1].

III. CLASSIFICATION OF ROUTING PROTOCOLS

Routing protocols for VSN's are classified as Topology Based, Position Based, Cluster Based Geocast and Broadcast on the basis of application or area where it is used. Fig 2 provides the detail classification of the routing protocols

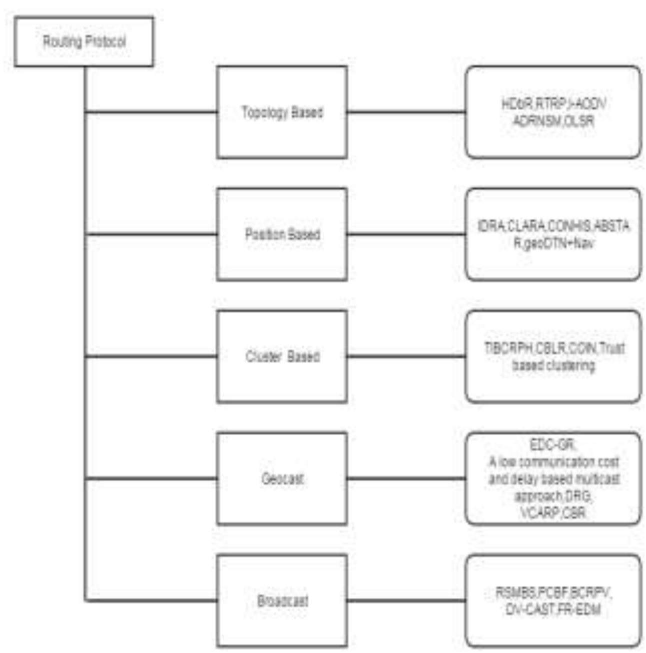

Fig 2 Routing protocols classification

A. Topology Based Routing

Topology based routing protocol uses link's information to send data from source to destination within the network. Before sending the data the source discovers the route and maintains it in the routing table. Performance gets decreased since it requires additional information on node topology during routing decision process. They are further divided into Proactive, Reactive and Hybrid Routing protocols [2][4]-[6].

i. *Proactive Routing Protocols*

Proactive Routing Protocols are generally based on shortest path algorithms. A table is constructed and maintained at every node in the network without the consideration of communication requests. Packets are constantly broadcasted and forwarded between the nodes to maintain link states or path, although some paths are never used. Therefore the each value in the table indicates the next hop to certain destination. Two types of update are possible Proactive update and Triggered update. While new destinations are added in the network, the table size increaseswhich in turn causes increase in load.

ii. *Reactive Routing protocols*

In Reactive routing protocols the route is found only if a node wants to communicate with other node. It reduces the burden of the network by maintaining the routes of the network that are currently in use. Reactive routing consists of route discovery phase in which the query packet is flooded in the network.It reduces network traffic because flooding is on-demand.Overhead is lesser than proactive routing protocols.Disruption of nodes is caused when there is excessive flooding in the network.Latency will be high because of route discovery.

iii. *Hybrid Routing Protocols*

Hybrid Routing protocols are a combination of reactive and proactive routing protocols. It is introduced to reduce the control overhead of proactive protocols and to minimize the initial delay of route discovery phase in reactive. Hybrid routing is zone based, where nodes are divided into different zones for route discovery and route maintenance phases. It reduces the overhead of the network but not suitable for highly dynamic environment.

B. *Position Based Routing*

In position based routing, nodes make the forwarding decision based on the position of the destination packet and the one-hop neighbors position. Source node knows its location and destination's location by using Global Positioning System (GPS).The source packet stores the position of the destination packet in the header of the packet. There will not be a global route created and maintained in position based routing. It is more robust and promising to highly dynamic environment. Position based routing is also known as geographic routing. It is classified into DTN, NON-DTN and Hybrid [8].

C. *Cluster Based Routing*

In cluster based routing, the nodes are preferred to form as clusters/groups based upon some parameters. Nodes in the network will identify themselves to form as a group, where a node is assigned as a cluster head which will broadcast the packet to the cluster. It provides better scalability for large networks, but forming clusters in highly mobile environment causes network delay and increase in overhead [8].

D. *Geocast Routing*

Geocast based routing protocol is location based multicast routing, where multicast service is provided within a geographical region. The packet from the source node is transmitted to all other nodes (multicast) within a geographical region. Overhead of the network is reduced since the vehicles outside the region are not alerted. One of the pitfall in Geocast routing is network is partitioned and the proper forwarding of packets may be disturbed by the unfavorable neighbors[2][8].

E. *Broadcast Routing*

In broadcast routing the important or emergency information will be disseminated as a broadcast message to all other vehicles. If the message needs to be sent beyond the transmission range, then multi-hop delivery is used. Generally broadcast routing is used in the situations of intimating the road conditions like frozen surface, captured traffic jam, weather and emergency information [2][6].

IV. DISCUSSION ON VARIOUS ROUTING PROTOCOLS

A. *Topology Based Routing*

1. *HDbR* [10]
A New Hop-Count and Node-Degree Based Routing proposes a new routing protocol that is based on the hop-count and node-degree metrics to determine route strength. The hop-count is derived by identifying the next-hop node that has the minimum distance to the sink node. Meanwhile, the node-degree is obtained through the vehicle ID of each neighboring nodes in its radius. All the nodes or vehicles in VANETs context were assumed to be equipped with an On-Board Unit (OBU) that will periodically send beacon messages to other nodes around the transmission range area.

2. *RTRP*[11]
In this paper, an efficient Road and Traffic-aware Routing Protocol (RTRP) is presented, in which the best path to transmit data packets is calculated based on distance and density factor in the 1st phase. This best path includes

intersection sequent numbers that data packets would be transmitted along. By using the best path information, a greedy data forwarding algorithm is deployed in the 2nd phase on each road segment, based on a Reaching Intersection Time (RIT) and a Turning Direction Probability (TDP). We develop a mobility model that includes road intersection, traffic light at intersection, various density areas, obstacles, etc. to validate proposed routing protocol.

3. *I-AODV* [12]

Infrastructure based Ad Hoc On-Demand Distance Vector Routing Protocol, performance of AdHoc On-demand Distance Vector (AODV) routing protocol has been optimized by introducing fixed roadside wireless nodes for data transmission in a VANET environment. The concept is based on the presence of such wireless nodes along the road sides in major cities in the world. The word infrastructure is used because these fixed nodes contribute in providing paths available most of the time; thereby a way of tackling the dynamic network topologies and link failures. Additional directional antennas are employed at the fixed wireless nodes to achieve Line Of Sight (LOS) communication between them. Significant improvements are shown based on key performance metrics of hop count, route discovery time, network control traffic, end to end delay, media access delay, data dropped and throughput.

4. *ADRNSM* [13]

Acute direction Route Node Selection Multipath routing is proposed which is multipath protocol and adapt to 16 different directions of movement. This protocol is basically introduced to be aware of movement direction and engage nodes moving only in specific direction for routing to destination node. This protocol finds multiple paths to destination node and avoids engaging the nodes moving in other directions to increase the performance in urban scenario.

5. *OLSR*[2]

Optimized Link State Routing Protocols(OLSR) is a proactive and point-to-point routing protocol based on the traditional link-state algorithm. It is using a technique called multipoint relaying for optimized message and flooding process for route setup or route maintenance. The algorithm minimize the number of active relays for covering the neighbors and it is called Multi-Point Relays(MPR). The protocol introduced for accuracy and stability for routing the data in network .Optimized Link State Routing protocol (OLSR) has two key concepts, Multipoint Relays(MPRS) algorithm and Optimized State is among one-hop neighbors and cover two-hop neighbors or sending link state information for maintenance of routing. Every node receives updates only once and unselected packets cannot retransmit updates. The major advantage of this protocol is that all routes and destinations are known and maintained before the operation. On the other hand, the nodes are moving fast, due to calculation of optimal node may be impossible in some cases.

B. Postion Based Routing

1. *CLARA* [14]

Collaborative Learning Automata Based Routing for Dense urban Regions using Vehicular sensor Networks- The algorithm is designed for sending information to the intended destination with minimum delay and maximum throughput. The learning automata (LA) stationed at the nearest access points (APs) in the network learn from their past experience and make routing decisions quickly. The proposed strategy consists of dividing the whole region into different clusters, based on which an optimized path is selected using collaborative LA having input parameters as vehicle density, distance from the nearest service unit, and delay. A theoretical expression for density estimation is derived, which is used for the selection of the “best” path by LA. Proposed Approach consists of two phases Route establishment and Route Selection using a learning automata based approach. Here the road is divided into clusters in a single cluster where the V2V communication takes place.

2. *CONHIS* [15]

Contact History Based Routing for Vehicular Delay Tolerant Networks- Proposed an algorithm that exploits the history of a node to find the best candidate relay to take a decision to forward a message to the destination. This contact history contains every node’s past encounters with relay nodes that had come in contact with this node in the past. Every node creates and stores the history with it and forwards a message to a candidate node that has highest count of encounters with various relay nodes in the network. Because of maintaining history at every node increases the overhead.

3. *ABSTAR* [16]

Anchor bus based street and traffic aware routing designed specifically for performance improvement in highly mobile environment of VANETs. This inherits the characters of geographic routing and also contains additional features such as choose a route with the smallest number of buses as possible between various source and destination. It uses real time traffic density information and Street aware along with the number of buses through route and selects the route with lower number of buses, in order to increase the efficiency of routing. It also has the ability to sense the type of vehicle which becomes advantage over other protocols.

4. ***IDRA* [17]**

Intersection-based Delay sensitive Routing using Ant colony optimization proposes- Based on proposed terminal intersection concept, IDRA makes use of Ant colony optimization (ACO) to find robust and optimal route with min-delay. The forward ants are in charge of exploring routes consisting of a succession of intersections, which are selected considering local road segment delay and global delay from current intersection to the terminal intersection of the destination. The backward ants take charge of collecting global delay and updating ant pheromone along the explored routes. Data packets are forwarded by dynamically choosing the next intersection utilizing updated ant pheromone. Greedy carry-and- forward mechanism is adopted by IDRA to forward data packets between two adjacent intersections, reducing the effects of individual vehicle movement on routing paths.

***5. GeoDTN+Nav* [1][2]**

GeoDTN+Nav (Cheng et al., 2008) is a hybrid of non-DTN and DTN approach that includes the greedy mode, the perimeter mode, and the DTN mode. It switches from non-DTN mode to DTN mode by estimating the connectivity of the network based on the number of hops a packet has travelled so far, neighbor's delivery quality, and neighbor's direction with respect to the destination.

C. Cluster Based Routing

1. *LORA_CBF* [1][2][9]

In Location Routing Algorithm with Cluster based Flooding, each node can become the cluster-head, gateway or cluster member. For each cluster, there is one cluster-head. The node which connects two clusters are called gateway. The cluster-head maintains information about its members and gateways. The packet forwarding is same as the greedy routing. Only cluster head and gateways can send out the location request (LREQ) packets, when the location of the destination is not available as well as the phase of the Location Reply (LREP) messages. The proposed LORA-CBF shows highly heterogeneous performance results.

2. CBLR [1][2][9]

Cluster Based Location Routing assumes all vehicles can gather their positions via GPS. The algorithm divides the network into multiple clusters. Each cluster has a cluster-head and a group of members within the transmission range of the cluster-head. The cluster-head and members are formed as follow: A new vehicle transmits a Hello Message. If the vehicle gets a reply from the cluster-head vehicle, the new vehicle would become a member of the cluster. If not, the new vehicle becomes the cluster head.

3. *COIN* [2,9]

Cluster head selection in COIN is based on vehicular dynamics and driver intentions instead of ID or relative mobility as in conventional clustering methods. IVC (Inter Vehicle Communication) also accommodates the oscillatory nature of inter-vehicle distances. Ideally, the relative mobility between a cluster head and a member node should be low, so they remain in radio contact for as long as possible.

4. *Trust based clustering* [18]

Trust based clustering creates clusters by considering direction, position and relative speed of the vehicle for managing the scalability issue. Moreover, we have proposed a new algorithm for selecting the most appropriate cluster head (CH) by considering the real time updated position and trust value of vehicles. Whenever the message is generated by the source node, it will transfer the message to its cluster-head provided the cluster-head is present within the transmission range of the source node. The cluster-head will send a beacon message to all the members within its transmission range present inside the cluster except source node for calculating indirect trust value on source node. Indirect trust is calculated to find whether it is a malicious node or not.

5. *DCH*[19]

In Energy Efficient Double Cluster Head Routing Scheme While utilizing the ad hoc mode, we show that it is important to put the maximum proportion of vehicles' transceivers to the sleeping mode in order to save energy. To achieve this, we propose a new double cluster head (DCH) scheme in which only cluster heads (CHs) can undertake inter cluster communication. If the source vehicle is in the vicinity of any base station, it forwards its packets to that base station otherwise; the source vehicle transmits its packets to the two cluster heads in its cluster. Both CHs carry the packets and as soon as one of the CHs gets into the range of any base station it transmits the packets to the base station. By keeping two cluster heads improves the communication of the network, but keeping two cluster heads consumes energy.

D. Geocast Routing

1. ***VCARP* [20]**

Vehicular Networks Context-Aware Routing Protocol a Geocast routing protocol for Vehicular Networks that takes into account context information of the network (such as nodes location and destination) to make routing decisions. It consists of a shared cache mechanism used to avoid packets loss due to full caches, and a flow- based routing to reduce network overhead caused by unnecessary packet retransmissions. It uses hop-to-hop approach to send packets to the destination. At this stage, VCARPuses the carry-and-forward and two new techniques, shared cache and flow-based routing, in order to increase the packets delivery rate and reduce the network overhead caused by unnecessary packets retransmissions.

2. ***DRG*[2][9]**

Distributed Routed Geocast protocol improves the reliability of message forwarding by defining the zone of orwarding (ZOF) which surrounds the region of interest. Vehicles in the ZOF region forward the message to other vehicles in the ROI.

3.A ***Low communication cost and delay based multicast approach*[21]**

This paper considers the delay-bound guaranteed multicast service where a vehicle aims to send a message to a group of vehicles using minimal bandwidth within a guaranteed delay bound. The source and multicast destinations are location-aware and trip-aware. Therefore the multicast approach developed for VANETs is totally different to the one in ad hoc networks. The proposed approach forwards the multicast message to the vehicles in the multicast group along the road segment with the least time cost, reserving as much as possible the remaining time for carry-and-forward transmissions which helps to reduce the bandwidth consumption for packet transmissions. It reduces the communication cost by constructing the sharing path for message transmission from source to all members based on the planning path information of each vehicle.

4. *EDC-GR*[22]

Efficient Dynamic caching for Geocast Routing proposes neighbor selection scheme based on overlapping area threshold and efficient caching based on threshold time beaconing system to incorporate caching for geospatial packet dissemination which enhances data packet delivery ratio significantly. Due to this the messages that could not be forwarded because of local maximum problem in greedy forwarding are stored in cache which enhances Geocast message delivery success ratio. Caching technique in Geocast routing has been enhanced using dynamic cache. Further, an improved next-hop neighbor selection mechanism based on overlapping area threshold has been designed considering the especially characteristics of VANETs. Caching has no perceptible effect on network load due to threshold time based beaconing system. The scheme chooses only those neighborhood nodes which are not close to the transmission range. Hence, next hop will not leave the transmission range before receiving the data packet which is intended to the node.

5. ***CBR*[23]**

Content Based Routing using Multicasting proposes an approach that accumulates content-based subscriptions in a compressed structure using Binary Decision Diagrams (BDDs) encoding and extends VANET's Spatio-temporal Multicast Routing Protocol (SMRP) to use the framework from middleware tier to build a most favorable dissemination mesh. The proposed system makes the best use of bandwidth by accumulating subscriptions, supporting subscription changes and minimizing the size of routing tables. The vital contribution is to integrate the middleware tier and network components to obtain a dissemination structure. Hence achieves efficient group communication for a dynamic environment like VANETs.

E. Broadcast Routing

1. ***FR-EDM [24]***

Fast and Reliable Emergency message Dissemination Mechanism (FR-EDM) to disseminate emergency messages. FR-EDM resolves the broadcast storm problem. Here the message is fast forwarded to the hot spot area, and is delivered to all vehicles in the area reliably. Emergency messages are disseminated in a freeway. Where the freeway is divided into three segments. This mechanism let's all vehicles in the hot spot area(one of the segment) can receive the emergency messages as soon as possible such that they can change their way to the gateway in time and avoid the heavy traffic jam caused by the accident. The first segment should also receive the message to avoid accident from the abnormal vehicle (AV). But in the center segment should be forwarded as fast as possible to reduce the delay to hot spot area.

2. ***DV-CAST* [25]**

It uses local topology information by using the periodic hello messages for broadcasting the information. Each vehicle uses a flag variable to check whether the packet is redundant or not. This protocol divides the vehicles into three types depending on the local connectivity as well connected, sparsely connected, totally disconnected neighborhood.

3. *BCRPV*[26]

In Broadcast control based Routing Protocol for Vanet the routes are established on-demand. When a source needs to send packets to a destination located in the Internet it first checks its routing table. If it finds a route to the destination, it starts sending data packets; otherwise, the source starts route discovery process by executing the following steps: (1) select forwarder(s) to rebroadcast RREQ (Route Request to maximum of 2 forwarders); (2) encapsulates this information in RREQ; and (3) broadcast the RREQ.

4. ***PCBF*[27]**

Preferred and Contention Based Forwarding is an efficient geographical broadcast protocol. PCBF uses a combination of contention-based forwarding and protocols like Emergency Message Dissemination for Vehicular Environments (EMDV). While the preferred forwarder is allowed to immediately forward the packet by reducing end-to-end delays. PCBF uses direct negative acknowledgements in case of unnecessary rebroadcasts and the use of forwarders outside the target region.

5. ***Road Side Unit Assisted Stochastic Multi-hop Broadcast Scheme*[28]**

It proposes a broadcast scheme that is not likely to cause broadcast storm problem with a reasonable delay and selecting preferred forwarders, also found in other high delivery rate. Here multi-hop broadcast scheme is proposed that makes use of RSU and V2I (Vehicle to Infrastructure) communication. In conventional broadcast schemes, the RSU's will not participate in broadcast schemes. The proposed scheme consists of two parts; in the first part RSU should use a maximum transmission range to rebroadcast a message when it receives the one. For the second part, to mitigate the broadcast storm, it should suppress a further rebroadcast in the inner region of its broadcast range.

Table I COMPARISON OF ROUTING PROTOCOLS

PROTOCOL	TYPE	FORWARDING MECHANISM	RECOVERY STRATEGY	SCENARIO	GPS REQT	MAP REQT	BENEFITS	LIMITATIONS	SIMULATION PERFORMANCE
HDbR	Topology based (Reactive)	Contention based forwarding	Node Awareness	Simple straight road	Yes	No	Delivery rate is not affected, when there is increase in no.of nodes	When there is increase in scalability, overhead increases	Because of the hop counts, delay increases when there is increase in no.of nodes.
RTRP	Topology based (Reactive)	Greedy based forwarding	Flooding	City	Yes	Yes	Forwarding node based on RIT(Reach Intersection Time) is good.	Choosing forwarding node in each road segment causes end-to-end delay	Throughput decreases drastically when there is increase in no.of nodes. Delay will be high in dense regions
I-AODV	Topology based (Reactive)	Greedy based forwarding	Flooding	Urban City	Yes	No	Link Failure is considered	Network delay is enormous because of broadcasting hello packets	Fixed road side nodes cause improvements in route discovery process. Delay is average while increase in no of nodes
ADRNSM	Topology based (Reactive)	Trajectory	Flooding	Urban regions	No	No	Makes the node aware of 16 different directions of movement.	If no.of nodes increase due to variations in traffic no.of retransmissions also increases	Only constant distance is taken between the nodes.
OLSR	Topology based (proactive)	Flooding	Flooding	General	No	No	Improve the QoS Reducing Network Load Reduce Contention	Optimization Problem Calculating the optimal node	Accuracy and Stability for routing the data is good

CLARA	Position based (DTN)	Opportunistic Forwarding	Node Awareness	Dense urban regions	Yes	Yes	Route is selected adaptively based upon learning automata approach	Cache consistency should be done because of history based routing.	Packet delay ratio and delay is good even when there is increase in no.of vehicles.
CONHIS	Position based (DTN)	Opportunistic Forwarding	Random Selection	Dense urban regions	No	No	History based Approach	Because of maintaining history at every node increases the overhead.	Delivery ratio is good and delay is average
ABSTAR	Position based (DTN)	Greedy based forwarding	Carry and forward	City	Yes	Yes	Ability to sense about the type of vehicles.	Maintenance of junction creates overhead	Routes with smaller no.of buses
IDRA	Position based (Non-DTN)	Greedy based forwarding	Carry and forward	Urban regions	Yes	No	Dynamically selects optimal routing paths depending on the delay	Lower delivery ratio with the increasing vehicle speed	With the increase of vehicle speed, the packet delivery is more stable and higher
GeoDTN+Nav	Position based (Hybrid)	Hybrid	Perimeter Forwarding	Highway	Yes	Yes	Switches from Non-DTN to DTN mode. Recognizes partition in the network	RandDTN achieves slightly better PDR and lower latency than GeoDTN+Nav	The latency increases & the decreases packet delivery ratio in a situation such as sparse network where GeoDTN+Navtrys to fall-back to DTN mode again
CBLR	Cluster based	Multi-hop forwarding	Flooding	City	Yes	Yes	Since, only the header needs to find the destination path, the routing overhead is less and it is proportional to the number of clusters.	The link will be maintained only if there is at least one header in the intermediate cluster.	Delay is less and packet delivery ratio is good
COIN	Cluster based	Greedy based	Flooding	Highway	Yes	Yes	Stable structure	Little overhead is there	Delay is low.
Trust based clustering	Cluster based	Multi-hop forwarding	Flooding	Highway	Yes	No	Malicious node is detected	The average speed of a vehicle within a network has great influence for determining the size of cluster.	Routing overhead is good.

DCH	Cluster based	Multi-hop forwarding	Flooding	City	No	No	By keeping two cluster heads improves the communication of the network	By keeping two cluster heads consumes energy	Packet loss ratio is low and packet delivery ratio is average
LORA-CBF	Cluster based	Multi-hop forwarding	Flooding	Highway	Yes	Yes	Shows highly heterogeneous results	Mobility and Size should not be a constraint	Delay is low
CBR	Geocast	Contention based forwarding	Flooding	Highway	Yes	Yes	Achieves efficient group communication for dynamic environment	Scalability cannot be extended Required fixed interval flooding of messages	Bandwidth use is good and delay is average
VCARP	Geocast	Multi-hop	Carry and forward	City	Yes	Yes	Uses shared cache mechanism	Maintaining cache is difficult	Increase in delivery rate by reducing no.of retransmission and delay is low
DRG	Geocast	Greedy based forwarding	Store and forward	Highway	Yes	Yes	Supports scalability	Delay will be high	Packet delivery ratio is good
A Low communication cost and delay based multicast approach	Geocast	Opportunistic forwarding	Carry and forward	City	Yes	Yes	Reduces communication cost by constructing the sharing path for message transmission	No guarantee for delay	Communication cost is reduced
EDC-GR	Geocast	Greedy based forwarding	Cache based forwarding	General	Yes	No	Size is not limited because of dynamic cache	Delivery ratio is average	Minimizes packet loss
FR-EDM	Broadcast	Multi-hop forwarding	Fast forwarding	Freeway	Yes	No	Deliveries emergency message as soon as possible	Propagation delay is average	Achieves low disseminating delay
DV-CAST	Broadcast	Opportunistic forwarding	Store and Forward	Highway	Yes	No	Temporary network fragmentation problem is considered	High overhead	End-to-end delay is average and robust against extreme traffic conditions

BCRPV	Broadcast	Opportunistic forwarding	Beacon	Freeway	Yes	No	Reduces communication overhead and number of control messages Smaller number of route failures	Packet delivery ratio is average compared to others	Reduces number of dropped packets
PCBF	Broadcast	Contention based forwarding	Beacon	Highway	Yes	No	Duplicate packets are eliminated efficiently	Waiting time of the vehicles causes overhead	End-to-end delay is good
RSMBS	Broadcast	Multi-hop forwarding	Beacon	City and highway	Yes	No	Compared to pure flooding proposed mechanism is good	Using beacon is not ideal solution	Delay and network usage is average

IV. COMPARISON AND CONCLUSION

Table I gives the comparison of various routing protocols. In this paper, the different characteristics of vehicular environment are discussed, which will play a critical role in designing a routing algorithm. Existing routing protocols are categorized into five broad types, in which for each category the recent routing protocols are compared with the parameters. For VSN's the routing protocols should be designed with the high flexibility to meet the different sensing requirements. Every routing protocol will have its own pros and cons of bandwidth utilization, delay, overhead, throughput and so on. The routing performance of a protocol depends heavily on sensing environments. Hence the survey of routing protocols for VSN's and by comparing its features, will be absolutely essential to bring up new routing protocols for vehicular networks

REFERENCES

[1] Xin Su, "A Comparative Survey of Routing Protocol for Vehicular Sensor Networks" IEEE conference 2010.

[2] Uma Nagaraj, Dr M.U. Kharat, PoonamDhamal, " The study of various routing protocols in VANETS" IJCST Vol. 2, Issue 4,Dec. 2011.

[3] Mohammad JalilPiran, G. Rama Murthy, G. Praveen Babu, "VEHICULAR AD HOC AND SENSOR NETWORKS;PRINCIPLES AND CHALLENGES" International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC) Vol.2, No.2, June 2011.

[4] KASHIF NASEER QURESHI, ABDUL HANAN ABDULLAH, "TOPOLOGY BASED ROUTING PROTOCOLS FOR VANET AND THEIR COMPARISON WITH MANET" Journal of Theoretical and Applied Information Technology Vol. 58, No.3, Dec 2013.

[5] 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

[6] Kevin C. Lee, Uichin Lee, Mario Gerla, "Survey of Routing Protocols in Vehicular Ad Hoc Networks"

[7] Bijan Paul, Md. Ibrahim, Md. Abu NaserBikas," VANET Routing Protocols: Pros and Cons" International Journal of Computer Applications Volume 20– No.3, April 2011

[8] GhanishthaNarang, YogeshJuneja, "Review on classification of different VANET Protocols based on routing information" International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 5, May 2015

[9] Venkatesh, A Indra, R Murali," Routing Protocols for Vehicular Adhoc Networks (VANETs): A Review" Journal of Emerging Trends in Computing and Information Sciences Vol. 5, No. 1 January 2014

[10] W.N.WahidahHashim, A.R.MohdShariff, S.IryantiFadilah, “A New Hop-Count and Node-Degree Based Routing Protocol for Vehicular Ad-Hoc Networks (VANETs)” IEEE 11th Malaysia International Conference on Communications November 2013.

[11] Pham Thi Hong, Hyunhee Park, and Chul-Hee Kang, “A Road and Traffic-aware Routing Protocol in Vehicular Ad hoc Networks” ICACT Feb 2011

[12] Faisal Iqbal, Mohammad Inayatullah Khan Babar, Mohammad HaseebZafar, MegatFarezZuhairi, “I-AODV: Infrastructure based Ad Hoc On-Demand Distance Vector Routing Protocol for Vehicular Ad Hoc Networks” Proc. of the IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA) 26-27 November 2013

[13] Harish Laxmichand Sharma, PankajAgrawal, R V Kshirsagar, “Acute direction Route Node Selection Multipath Routing for VANET: Design Approach” International Conference on Signal Processing and Integrated Networks (SPIN) 2014

[14] Neeraj Kumar, SudipMisra, Mohammad S. Obaidat, “Collaborative Learning Automata-Based Routing for Rescue Operations in Dense Urban Regions Using Vehicular Sensor Networks” IEEE SYSTEMS JOURNAL, VOL. 9, NO. 3, September 2015

[15] Milind R. Penurkar, Umesh A. Deshpande, “CONHIS: Contact History-based Routing Algorithm for a Vehicular Delay Tolerant Network” Annual IEEE India Conference (INDICON) 2014

[16] AnchalaArneenaMoharnrnadi, Raj G.S, VirnalKarthick.R, “ABSTAR: Improves Qos for City Environment in VANET” Fifth International Conference on Advanced Computing (ICoAC) 2013

[17] Guangyu LI, Lila BOUKHATEM, “An Intersection-based Delay Sensitive Routing for VANETs Using ACO Algorithm” IEEE conf 2014

[18] RashmiRanjanSahoo, Rameswar Panda, Dhiren Kumar Beherab, MrinalKantiNaskarc, “A TRUST BASED CLUSTERING WITH ANT COLONY ROUTING IN V ANET” IEEE Conf 2012

[19] HamdiIdjmayyel, Bilal R. Qazi, Jaafar M. H. Elmirghani, “Energy Efficient Double Cluster Head Routing Scheme in a City Vehicular Networks” 27th International Conference on Advanced Information Networking and Applications Workshops 2013

[20] Rodrigo B. Soares, Eduardo F. Nakamuray, Carlos M. S. Figueiredoy and Antonio A. F. Loureiro, “VCARP: Vehicular Ad-hoc Networks Context-Aware Routing Protocol” IEEE 2012

[21] Chengchao J, Zhengkun M, Wennai Wang, Shenghui Zhao, “A Low Communication Cost and Delay Guaranteed

[22] Multicast Approach for Next Generation Vehicular Ad Hoc Networks” ICCE-Taiwan 2014

[23] DurgaPrasada Dora, Sushil Kumar, OmprakashKaiwartya, “Efficient Dynamic Caching for Geocast Routing in VANETs” 2nd International Conference on Signal Processing and Integrated Networks (SPIN) 2015

[24] SmithaShivshankar and Abbas Jamalipour, “Content-based Routing Using Multicasting for Vehicular Networks” IEEE 23rd International Symposium on Personal, Indoor and Mobile Radio Communications - (PIMRC) 2012

[25] Jeng-Farn Lee, Chang-Sheng Wang and Ming-Chin Chunag, “Fast and Reliable Emergency Message Dissemination Mechanism in Vehicular Ad Hoc Networks” IEEE Communications 2010.

[26] OZAN K. TONGUZ, NAWAPORN WISITPONGPHAN, FAN BAI, “DV-CAST: A DISTRIBUTED VEHICULAR BROADCAST PROTOCOL FOR VEHICULAR AD HOC NETWORKS” IEEE Wireless Communications 2010

[27] AmadouAdama Ba, AbdelhakimHafid, JawadDrissi, “Broadcast Control-Based Routing Protocol for Internet Access in VANETS”IEEE Communications 2011

[28] RajapandiyanRajendran, Jan de Jongh, An Efficient and Reliable Multi-Hop Geographical Broadcast Protocol in Vehicular Ad-Hoc Networks” 13th International Conference on ITS Telecommunications (ITST) 2013

[29] Xing Fan, Bo Yang, Ryo Yamamoto, Yoshiaki Tanaka, “Road Side Unit Assisted Stochastic Multi-hop Broadcast Scheme for Instant Emergency Message Propagation” ICACT 2014