COMPARATIVE ANALYSIS OF VANET ROUTING PROTOCOLS ON REAL CITY MAP

A Dissertation Proposal submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

By

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TOPIC APPROVAL PERFORMA

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PROPOSED TOPIC : Comparative Analysis of VANET Routing Protocols on real city map

Qualitative Assessment of Proposed Topic by PAC		
Sr.No.	**Parameter**	**Rating (out of 10)**
1	Project Novelty: Potential of the project to create new knowledge	7.00
2	Project Feasibility: Project can be timely carried out in-house with low-cost and available resources in the University by the students.	7.20
3	Project Academic Inputs: Project topic is relevant and makes extensive use of academic inputs in UG program and serves as a culminating effort for core study area of the degree program.	7.20
4	Project Supervision: Project supervisor's is technically competent to guide students, resolve any issues, and impart necessary skills.	6.80
5	Social Applicability: Project work intends to solve a practical problem.	6.60
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ABSTRACT

Intelligent Transportation System (ITS) is a tried course to lessen the congested movement issues. ITS is a rising use of Vehicular Ad-hoc Network (VANET). VANET is a Mobile Ad-hoc Network (MANET) in which vehicles are dynamic in nature. VANET directing conventions has been considered and examined in the previous couple of years. The point of VANET is to assemble an information framework among moving vehicles on the streets, which empowers the vehicular correspondence for wellbeing concerns. In this study, an examination has been made to think about directing conventions on the premise of topology based, position based, geo-cast based, group based, communicate based.

DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation proposal entitled "COMPARATIVE ANALYSIS OF VANET ROUTING PROTOCOL ON REAL CITY MAP" in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Ms. Harinder Kaur. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

Sheetal Prabha Pal

11611909

SUPERVISOR’S CERTIFICATE

This is to certify that the work reported in the M.Tech dissertation proposal entitled **“Comparative Analysis of VANET Routing Protocol On Real City Map”**, submitted by **Sheetal Prabha Pal** at **Lovely Professional University, Phagwara, India** is a bonafide record of her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

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SHEETAL PRABHA PAL

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VANET	VEHICULAR ADHOC NETWORK
ITS	INTELLIGENT TRANSPORTATION SYSTEM
RSU	ROAD SIDE UNIT
MANET	MOBILE ADHOC NETWORK
WSN	WIRELESS SENSOR NETWORK
DSDV	DESTINATION SEQUENCED DISTANCE VECTOR
OLSR	OPTIMIZED LINK STATE ROUTING
STAR	SOURCE TREE ADAPTIVE ROUTING
AODV	AD-HOC ON-DEMAND DISTANCE VECTOR
QOS	QUALITY OF SERVICE
GPSR	GREEDY PERIMETER STATELESS ROUTING

LIST OF FIGURES

Chapter 1
INTRODUCTION

1.1 Vehicular Ad-hoc Network(VANET)

In the present scenario, effective communication between nodes within the network is one of the challenges. The network used for communication is wired network or wireless network. Remote Network is of two sorts one is framework based and other is foundation less. Specially appointed system is a foundation less system. Ad-hoc network is a network consisted of number of devices communicating each other directly without having connection with access point or router. Wireless Ad-hoc network is a decentralized network. Each node participating in communication to other node and which node can transfer information dynamically is based on network connectivity. Wireless Ad-hoc devices can be of forms such as palmtop, laptop, internet mobile phones, etc. There computation power, storage space, communication capabilities and interoperability will varies tremendously. Due to dynamic topology of nodes, routing information of each node changes continuously.

Intelligent Transportation System is a tested route communication to reduce the congested traffic problems. To improve the transportation system ITS technology has been used. The objective of ITS is to assess, expand, study and incorporate new concepts and technologies to achieve traffic efficiency, enhance environmental quality, conserve energy, preserve time and enrich safety concerns.

ITS is one of the emerging application of vehicular ad-hoc network. In VANET, each vehicle is dynamic in nature. The communication between nodes is important aspect. The communication between the nodes is depends on various routing protocols. The idea behind the VANET protocol is to bring (1) overall connection of all mobile users to the outside world or the other network, (2) reliable vehicle to vehicle communication that enables the Intelligent Transportation System (ITS). The correspondence design of vehicular specially appointed system classified as Inter-Vehicle Communications (IVC) or Vehicle-to-vehicle (V2V) interchanges. There are some routing protocols has been used to do effective communication within the network. Classification of routing protocol are on different basis are as follows-

- Topology based routing Protocols- AODV, DSR, DSDV, OLSR, STAR
- Position based routing protocols-MFR, B-MFR, GPSR, LAR

- Geo-cast based routing protocols- IVG, Cached Geocast, Abiding Geocast, DRG, ROVER, DG-CastoR, Mobicast, DTSG, Constrained Geocast, Geocache
- Cluster based routing protocols- FTLocVSDP, SRD, LORA_CBR, VWCA
- Broad-cast based routing protocols- BROADCOMM, UMB, V-TRADE

1.1 Architecture And Communication

This section explains the architecture of vehicular ad-hoc network. VANET comprises of various components that falls in various domains and discussion of all these domains are done under domain view. All components communicate among each other that form various communication types and that are also discussed with reference to VANET architecture.

1.1.1 COMPONENTS OF VANET ARCHITECTURE

The design of VANET made out of keen vehicles i.e vehicles joined with handsets and on board application, Road Side Units (RSU), brought together administration framework and correspondence connect. An essential VANET engineering contains the moving hub conveying inside the scope of other moving hub and in addition with the RSU [1]. The VANET architecture is of three possible categories: (a) Vehicular infrastructure networks, (b) Vehicular ad hoc networks, (c) Hybrid Vehicular Networks as shown in Fig 1 [2].Vehicular infrastructure network [3] composed of fixed cellular gateways and Wireless Local Area Network (WLAN) access points. They are used as traffic intersections to connect to the internet such as 3G for collecting information for routing scenarios. The architecture under this is shown in Fig 1(a). In Vehicular Ad-hoc network [3], all fixed or stationary road side units are providing connectivity to the moving vehicles to perform vehicle-to-vehicle communication (Fig 1(b)). Hybrid Vehicular Network [3] comprises the cellular Network, WLAN access points and the Ad-hoc networks (Fig 1 (c)). Mixture design [29] which utilizes a few vehicles with both WLAN and cell abilities as the portals and versatile system switches so vehicles with just WLAN capacity can speak with them through multi-bounce connects to stay associated with the system.

According to the IEEE1471-2000 [30, 31] and ISO/IEC42010 [32] architecture standard guidelines, we are able to find that the system of VANET architecture can further be classified as follows: mobile domain, infrastructure domain and generic domain is shown in Fig 2 [33].

- Mobile space: Mobile area made out of vehicle space and cell phone space. The portable space contains a wide range of vehicles, for example, transports and autos. The cell phone space comprises of every single versatile gadget, for example, cell phones and individual route gadgets [4].
- Infrastructure space: In this area, there are two classes of area one is roadside framework space and focal foundation space. The roadside foundation area comprises of the RSU, for example, movement lights and focal framework space comprises of administration unit, for example, activity administration focuses (TMCs) and vehicle administration focus [4].
- Generic domain: In generic domain, there are two types of domain one is internet infrastructure domain and other is private infrastructure domain. In this one or more nodes as well as servers working directly or indirectly for VANET.

The versatile space trades [5] directing data and conveys to Infrastructure area which forms information and does its own balances. At that point in second step, foundation space thusly conveys to unspecific area and trades data with it. The information among the stationary and moving assets result in productive and successfully implemented by the clients.

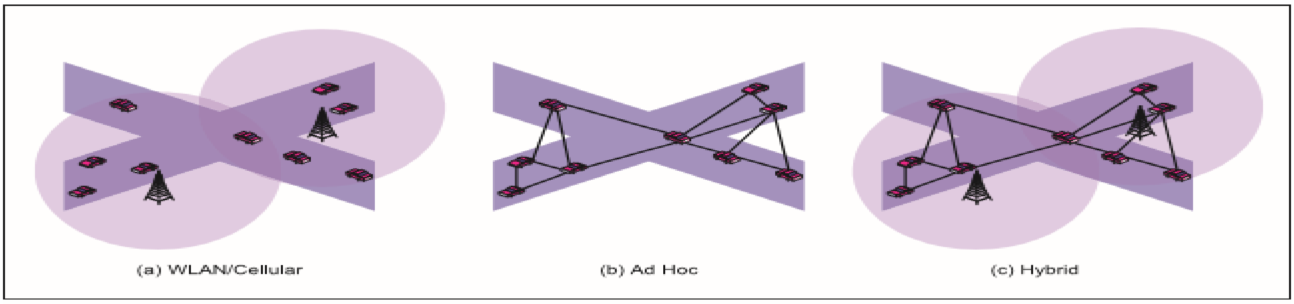

Figure 1 Network Architectures of VANET

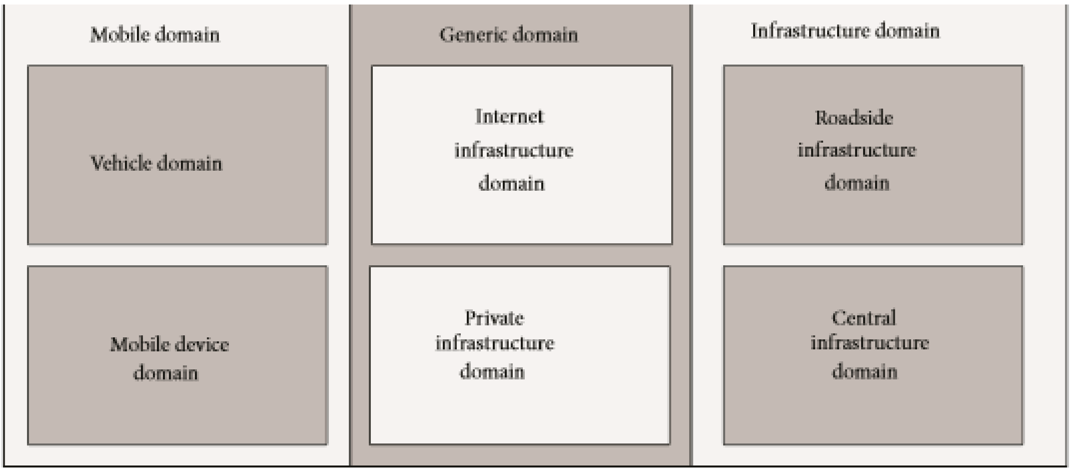

Figure 2 VANET system domains

1.1.2 COMMUNICATION ARCHITETURE

The communication architecture of VANET [5] are broadly categorised on four communication types which are briefed as follows:

- *Inter vehicle communication (IVC):* The vehicle communication detects the inner information system and detects factors affecting the communication. Factors may be driver fatigue and drowsiness. These factors are recorded and used in concern of driver as well as public safety [1] is shown in Fig 3.
- *Vehicle to Vehicle Communication (V2V):* This gives information trade among vehicles in order to help drivers by advising about the basic data and cautioning messages. In V2V correspondence, it doesn't rely upon settled framework for sharing of data and it help the wellbeing and security arrangements (Fig 3).
- *Vehicle to road Infrastructure (V2I):* In this, correspondence happens among moving vehicles and stationary RSUs for information accumulation. It permits ongoing activity and climate refreshes for drivers and gives natural detecting and checking (Fig 3).
- *Vehicle to broadband cloud communication (V2B):* This permits the vehicular communication using wireless broadband connections such as 3G or 4G. This upgrading the assistance of drivers as well as tracking of vehicles over internet that might contain more traffic information (Fig 3).

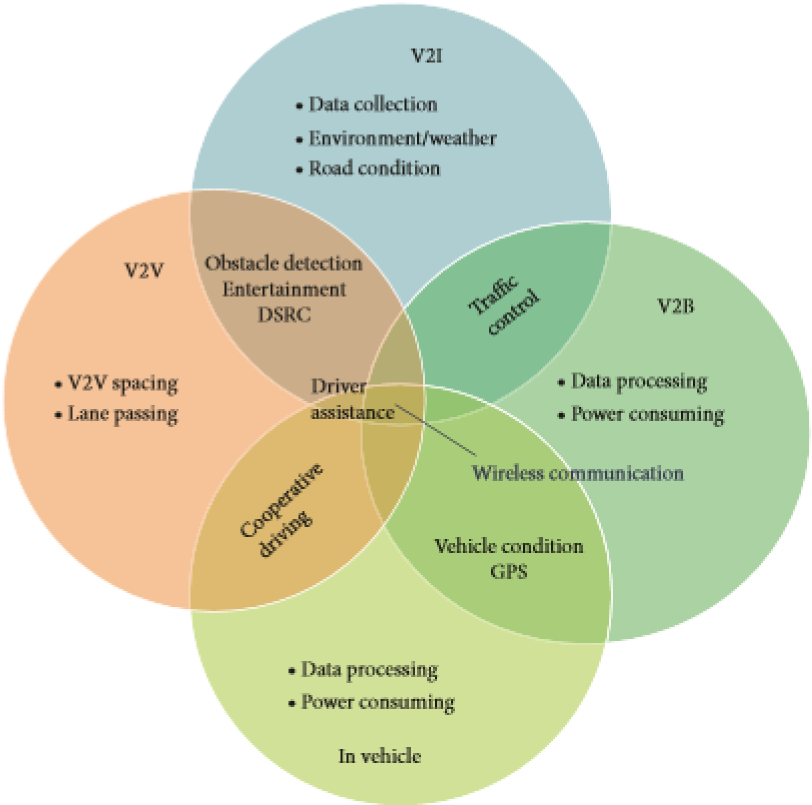

Figure 3 Functions of communication architecture

1.2 VANET CHARACTERISTICS

VANET has its isolated characteristics from other kind of Ad-hoc networks such as MANET. These unique characteristics are discussed as follows [3,6]:

- *High dynamic topology:* Due to mobility of vehicles, the topology of VANET changes continuously.
- *Frequent disconnected network:* Due to high mobility of node, frequent link failures occur between vehicles when they share information.
- *Enough battery power and storage capacity:* Intelligent vehicles carry sufficient battery power and storage capacity. So, it has sufficient storage to perform all communication and computation tasks.
- *Mobility modelling and prediction:* To plan the system convention for VANET, the versatility model and expectation assumes an imperative part. In addition, vehicular hubs are typically compelled by prebuilt thruways, streets and lanes, so given the speed and the road outline, final position of the vehicle can be anticipated [6].
- *Communication environment:* There are two typical communication environments one is highway scenario and other is city scenario. In highway scenario, the traffic flows

in unidirectional, simple and straight forward. In city, the streets are usually separated by building, trees and other barriers.

- *Hard delay constraints:* The information passing to the neighbour vehicles on time, there is no delay. The aim of this is that safety messages having high priority and are communicated within time.
- *Localization:* The positions of the vehicles within the network are detected by the Global Positioning System (GPS).

The above special aspects will generate new challenges that need to be solved in Vehicular Ad-hoc environment. The main challenges of VANET are as follows [6]:

- Due to high mobility, the neighbour vehicles changes continuously.
- Load on channel increasing constantly.
- Due to distinguished received signal power, the connectivity between vehicles is irregular.
- Loss of information due to exposed and hidden terminal problems.

Chapter 2

REVIEW OF LITERATURE

2.1 PROTOCOL TAXONOMY

The vehicles can exchange the routing information among the network to ensure the connectivity of network. To maintain the routing information of the network, we require the protocols suite. The routing protocols are classified as follows in Fig 4:

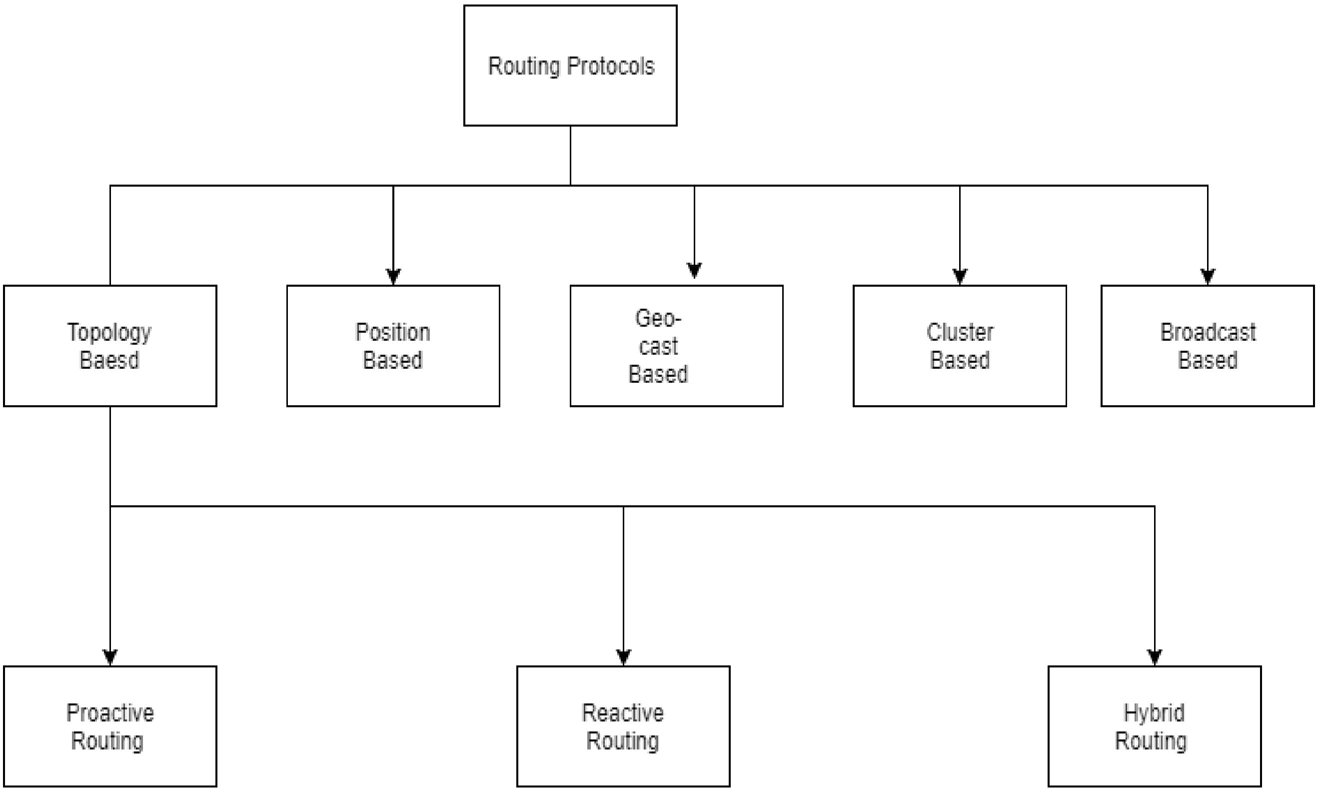

Figure 4 Routing Protocol Taxonomy

2.1.1 Topology based routing protocol:

In topology based steering convention, it utilizes the worldwide data of system topology and data about the correspondence connect to settle on directing choices [7]. This protocol uses link information to forward the packets within the network. They determine the routes and preserve it in the table to do further processing [9]. The category of topology routing protocols are as follows: Reactive or on request convention, Proactive or table driven convention and Hybrid convention [8].

2.1.1.1 Proactive routing protocol or table driven:

This category uses the shortest path algorithms such as Bellman ford's to calculate the shortest distance between two nodes [10]. It maintains the routing information and list of hops periodically and further circulate the routing information throughout the network. Proactive routing doesn't deal with route discovery as it already preserves the destination route and maintained within table [11]. Proactive protocols perform better in those applications that require low latency [11]. Since nodes are mobile in nature, they keep on changing the topology of network so maintaining the routing information is main concern [8].

There are some proactive protocols named as Destination Sequenced Distance Vector (DSDV), Optimised Link State Routing (OLSR) and Source Tree Adaptive Routing (STAR).

Pros:

- Discovering of route is not needed.
- Deal with real applications with low latency.

Cons:

- Unused paths have significant space in bandwidth.

2.1.1.2 Reactive routing protocol or on-demand:

Receptive directing convention opens the course revelation just when a hub needs to speak with the other hub [11]. It keeps up just those courses that are presently are being used, so it lessens the system overhead by taking out the support of courses [9]. Route discovery is done by flooding a query message throughout the network and this phase is complete when the connection is established.

The examples of On demand routing protocols are Ad-hoc On-demand Distance Vector (AODV) [28], Dynamic State Routing (DSR).

Pros:

- Updating the routing table has no more concern.
- It saves the bandwidth by Beaconless.

Cons:

- Latency is high for searching a route.

2.1.1.3 Hybrid routing:

Half and half steering consolidates the highlights of Proactive directing convention and additionally receptive directing convention. It diminishes the control overhead of proactive directing and limits the postponement of introductory course revelation of responsive steering convention [34]. Half and half directing conventions are utilized to accomplish the elite in thickly populated systems (substantial number of hubs). Key thought of Hybrid Routing Protocols is to utilize a responsive directing at the worldwide system level and to utilize a proactive in a hub's nearby neighbourhood [8].The examples of hybrid routing protocol are Zone Routing Protocol (ZBR) and Zone-based Hierarchical Link State (ZHLS).

2.1.2 Position based routing protocol:

As the topology of VANET changes as a rule with no earlier notice, so directing in such systems is basic assignment. Position based directing uses the position data to find the precise data of source and goal hubs and neighbour hubs. The correct area of hub is controlled by utilizing GPS (Global Positioning System) or some other area administrations [12].Routing is done in bounce to jump mold to send the information bundle. The position data of every hub is found by area administrations and sending procedures which are utilized to forward the parcel to whole system.

Location services [13] can be any of (a) Some for some (b) some for all (c) All for some (d) All for all. Forwarding strategies can be of (a) Greedy forwarding (b) Hierarchical routing (c) Restricted directed flooding [13].

Some of Position based protocols are Location-aided Routing Protocol (LAR), Greedy Perimeter Stateless Routing Protocol (GPSR), Secure Position Aided Ad-Hoc Routing (SPAAR) and Sociological Orbit Aware Location Approximation Routing (SOLAR).

Pros:

- High scalability
- Robustness against frequent topology changes

- There is no requirement of route discovery and maintenance.

Cons:

- It requires resources like Global Positioning System (GPS) for location information.

2.1.3 Geo-cast Based Routing Protocol:

Geo-cast Routing is produces multi-jump remote correspondence over self-governing versatile condition. The idea behind the Geo-cast is it send the data packets from a single source vehicle to all other vehicles using a special geographical area called zone of relevance (ZOR) [13].Flooding of message is from source to ZOR and path followed by flooding message is called as zone of forwarding (ZOF).

Examples of geo-cast routing protocols are Inter-Vehicular Geo-cast (IVG), Cached Geo-cast, Abiding Geo-cast.

2.1.4 Cluster Based Routing Protocol:

Cluster based routing [15] works with three modules cluster formation, inter-cluster routing and Intra –cluster routing. These working of these modules are as follows:

1) **Cluster Formation**: Hundreds or thousands of sensors are deployed in Wireless Sensor Network (WSN). Clustering is a technique to manage the working of all the nodes. Formation of cluster includes deploying the nodes in 250*250m square region. Then compute the residual energy of all the sensor nodes. Each cluster having a cluster head (CH). Cluster head can do computation of routes when two of the cluster communicates. The hub having remaining vitality more prominent than normal lingering vitality of the considerable number of hubs can be chosen as CH. The probability of each node become CH are equal. All the nodes closest to the CH form a group called as cluster is shown in fig 5.
2) **Inter-clustering Routing**: On the off chance that the hub of one group needs to speak with the hub of another bunch. The sender hub sent the parcel hub to the outskirt hub of same group. At that point the fringe hub checks whether the goal hub is in a similar group or on the other bunch, if the goal hub is in the other bunch the parcel is sent by outskirt hubs to neighbouring outskirt

hubs. The procedure rehashes until the point that the bundle is gotten by the goal through most limited way.

3) **Intra-clustering Routing**: This routing is done when the nodes of same cluster wants to communicate. The source communicates the question bundle to every one of the hubs of the group until the neighbouring outskirt hub of other bunch got it. If the communicating nodes are of same cluster then it uses routing table and shortest path is used to deliver the query packet.

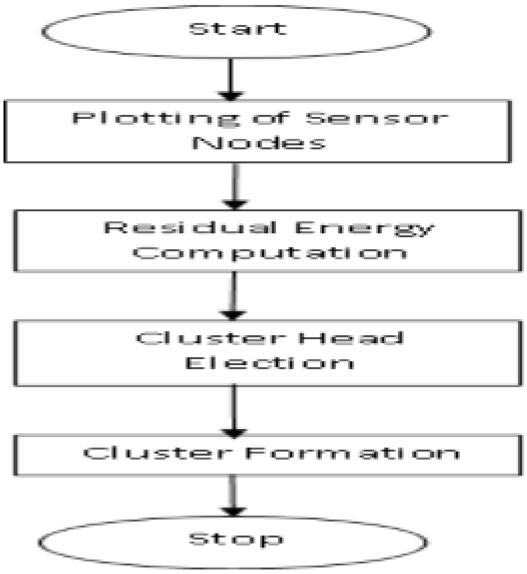

Figure 5 Cluster Formation

Pros: Grouping of specially appointed system has many points of interest over different systems [16]. The points of interest are as per the following:

- It overhauls steering at the system layer by limiting the span of directing tables.
- It monitors the vitality and data transmission in specially appointed systems.
- Upgrading versatility, throughput and power utilization will permit the better execution of the convention for Medium Access Control (MAC).

Example of this routing protocol is Cluster Switched Gateway Protocol (CSGR).

2.1.5 Broadcast based Routing Protocols:

Broadcast routing [3] is generally used for traffic sharing, weather and emergency, road congestion information between the vehicles, in VANET. Unicast routing is utilized as a part of communicate to decide the course to the goal, if goal isn't in scope of source then multi-jump is utilized. Broadcast routing used the simplest technique of flooding. All the nodes re-broadcast the message to all the neighbouring nodes except to the node it got the message. Flooding ensures that the message reached to all nodes of the network.

Examples [17] of broadcast routing protocols are BROADCOMM, Urban multi-hop broadcast (UMB) protocol, Vector Based Tracing Detection (V – TRADE), Distributed Broadcast Vehicular Protocol (DV-CAST), Preferred Group Broadcast (PGB), Position aware reliable broadcasting protocol (POCA) and Density aware reliable broadcasting protocol (DECA).

2.2 TOPOLOGY BASED ROUTING PROTOCOLS

2.2.1 PROACTIVE ROUTING PROTOCOL

2.2.1.1 Destination Sequenced Distance Vector (DSDV)

Destination sequenced distance vector [18] uses the Distributed Bellman Fords algorithm. In this protocol, each node keeps routing table information of all the other nodes within the network and counts the hops to reach the target node is recorded as shown in Fig 6. Every node have a distinguish sequence number, which is given by the target node. Sequence number distinguishes between new routes to the stale routes. To maintain consistency of network routing tables are updated periodically as shown in Fig 7. To lower down the routing updates variable sized update packets are used depending on topological changes.

Each broadcast update can contain following information: (1). Destination address (2). Number of Hops to reach the destination (3). Sequence number. There are two category of route update packets:

(a). Full dump update packet: In full dump, a node sends all the routing tables to other nodes in the network.

(b). Incremental update packet: A node transmits the changed entries from the last Full dump.

The advantages [19] of this protocol are: (1). It avoids the routing loops in mobile network. (2). There is no delay in route setup process as the routes are previously defined. The disadvantages are: (1). Generate a lot of control traffic causes inefficient utilization of network resources. (2). Bandwidth of network is blocked when we deal with large network with less mobility and small network with more mobility.

ARM-DSDV [20], it controls to diminish the directing overhead. The refresh period control keeps up the portability grids, it depends on rate of progress of neighbours and modify it powerfully. The refresh content control keeps up the course request grid and updates it powerfully.

Randomized-DSDV [21] utilizes the irregular steering interims according to the likelihood dissemination to take out the communicate tempests of directing updates.

DSDV with different channels [22], it partitions the system layer into control and information planes. Control planes are used to send routing updates packets and data planes are used to deliver the data packets.

Destination	NextHop	Metric	Sequence number	Install	Stable_data
MH_1	MH_2	2	S406_MH_1	T001_MH_4	Ptr1_MH_1
MH_2	MH_2	1	S128_MH_2	T001_MH_4	Ptr1_MH_2
MH_3	MH_2	2	S564_MH_3	T001_MH_4	Ptr1_MH_3
MH_4	MH_4	0	S710_MH_4	T001_MH_4	Ptr1_MH_4
MH_5	MH_6	2	S392_MH_5	T002_MH_4	Ptr1_MH_5
MH_6	MH_6	1	S076_MH_6	T001_MH_4	Ptr1_MH_6
MH_7	MH_6	2	S128_MH_7	T002_MH_4	Ptr1_MH_7
MH_8	MH_6	3	S050_MH_8	T002_MH_4	Ptr1_MH_8

Table 1: Structure of the MH_4 forwarding table

Destination	Metric	Sequence number
MH_1	2	S406_MH_1
MH_2	1	S128_MH_2
MH_3	2	S564_MH_3
MH_4	0	S710_MH_4
MH_5	2	S392_MH_5
MH_6	1	S076_MH_6
MH_7	2	S128_MH_7
MH_8	3	S050_MH_8

Table 2: Advertised route table by MH_4

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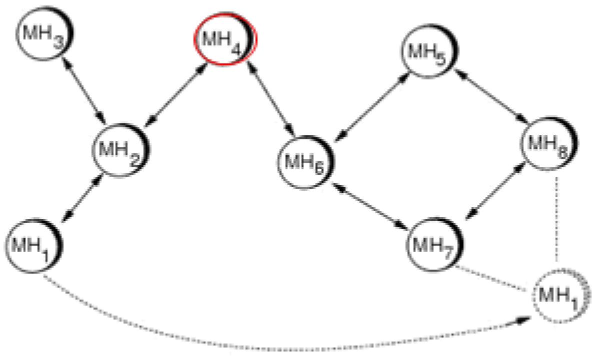

Figure 1: Movement in an ad-hoc network

Fig 6 Movement of node and routing table information

Destination	NextHop	Metric	Sequence number	Install	Stable_data
MH_1	**MH_6**	**3**	**S516**_MH_1	**T810**_MH_4	Ptrl_MH_1
MH_2	MH_2	1	S238_MH_2	T001_MH_4	Ptrl_MH_2
MH_3	MH_2	2	S674_MH_3	T001_MH_4	Ptrl_MH_3
MH_4	MH_4	0	S820_MH_4	T001_MH_4	Ptrl_MH_4
MH_5	MH_6	2	S502_MH_5	T002_MH_4	Ptrl_MH_5
MH_6	MH_6	1	S186_MH_6	T001_MH_4	Ptrl_MH_6
MH_7	MH_6	2	S238_MH_7	T002_MH_4	Ptrl_MH_7
MH_8	MH_6	3	S160_MH_8	T002_MH_4	Ptrl_MH_8

Table 3: MH_4 forwarding table (updated)

Destination	Metric	Sequence number
MH_4	0	S820_MH_4
MH_1	3	S516_MH_1
MH_2	1	S238_MH_2
MH_3	2	S674_MH_3
MH_5	2	S502_MH_5
MH_6	1	S186_MH_6
MH_7	2	S238_MH_7
MH_8	3	S160_MH_8

Table 4: MH_4 advertised table (updated)

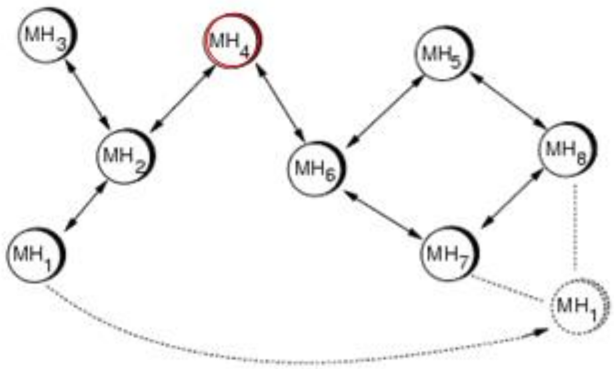

Figure 7 Routing update with node movement

2.2.1.2 Optimized Link State Protocol (OLSR)

OLSR protocol [23] enhances the link state protocol of MANET. In link state protocol all the information of routes with the neighbouring nodes are broadcasted throughout the network. OLSR minimizes the size of control information**:** acknowledges the subset of control packets to its neighbours rather than all packets which are in the multipoint relay selectors. It reduces the broadcasting of control information by selected nodes, called multipoint relays (MPR) as shown in Fig 8, to broadcast the message in the network. It performs intermediate routing among the nodes in the network.

There are two categories of control messages one is hello and other is topology control [8]. Hello messages are used to check the status of link information and their neighbours. Topology message is used for diffuse the information with the next intermediate nodes, which are the part of least MPR selector lists.

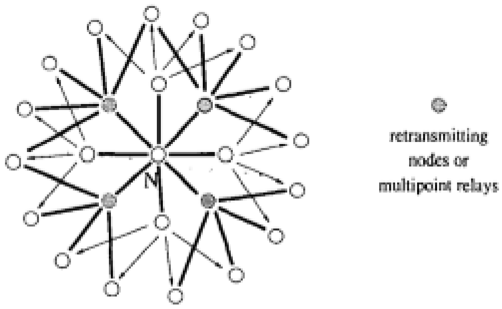

Figure 8 Multipoint Relays

2.2.1.3 Source Tree Adaptive Routing Protocols (STAR)

STAR [24] is a proactive routing protocol. Each node determines and preserves the topology of network, builds the shortest path tree to the target node. The main idea of protocol is to determine the neighbouring nodes and exchange the information among nodes.

This protocol uses two mechanisms to determine the neighbours:

(1). ***Hello message***: Hello message is used by all the nodes periodically to update about its existence. Such messages doesn't contain any routing information, it only have small packets. When the node receive a hello packet from previously unknown node, then it update neighbours list. If a node doesn't get any message from neighbour node from a certain amount of time then updates the information of link broken or neighbour is not in the range.

(2). ***Neighbour protocol***: In this no hello message is needed to support and is implemented at link layer. It declares about the new neighbours and loss of connectivity to the existing neighbours.

This protocol [25] adopts two approaches: least overhead routing approach (LORA) and optimum routing approach (ORA). It works only one approach at a time. It reduces the control overhead of packets and gives shortest routes using LORA. ORA modify the routing tables to update the information.

This protocol is effectively applicable to large scale networks to reduce the overhead and bandwidth consumption and not good enough for the highly mobile networks.

Anchor based street and traffic aware routing protocol (A-STAR) [26], in this protocol to update the routing information street map is used, for anchor path calculations to the destination node. This protocol uses an efficient recovery technique. Packets are serviced by new anchor paths. To avoid other packets to go by the used coverage area, this area is declared temporarily as "out of service". A threshold value is represented as to count times packet to retrieve the sending of stale packets.

This protocol dynamically sensed and assigned the weight to street based on the current traffic information, which provides more quality with anchor computations.

2.2.2 REACTIVE ROUTING PROTOCOLS

2.2.2.1 Ad-hoc On-demand Distance Vector (AODV)

AODV [27] is source initiated routing protocol. It is an improvement over DSDV and DSR. It minimizes the broadcast as it doesn't preserve routes from every node to other node as it only contains those routes that are currently in use. It mainly focuses on link breakage and change in network topology.

There are four message formats [28] of AODV:

(1). Route Requests (RREQs): This request is sent to the destination node via intermediate nodes to inform that source is ready for transmission as shown in Fig9.

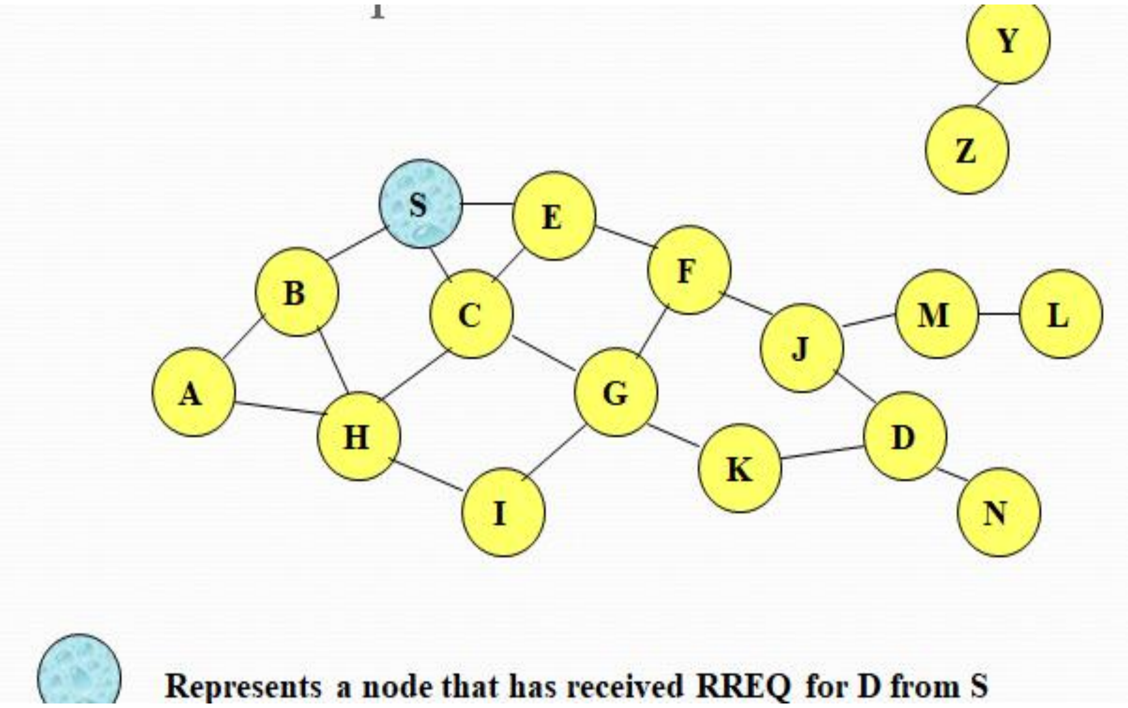

Figure 9 Route Requests in AODV

(2). Route Replies (RREPs): As the node receive RREQs message, the target node transmits RREPs packet back to the origin node.

(3). Route Errors (RERRs): When there is any link failure in active route is detected, this message is flooded in the network to inform all the active nodes about the link failure.

(4). Route Reply Acknowledgement (RREP-ACK): This message is sent back to the sender to acknowledge the receipt of RREP.

AODV [29] includes:

(1). **Path Discovery**: This process is started when the source node needs to connect with the newly found node. Each node has unique sequence number and broadcast identifier. Source node starts discovery process by transmitting RREQ message to the next intermediate node. The RREQ message contain following entries such as source address, source sequence number, destination address, destination sequence number, broadcast id and hop count. Broadcast id is incremented with new RREQ issued by the source node. If the node gets multiple replicas of RREQ from next immediate nodes, it simply drops redundant RREQ and doesn't re-broadcast it.

If an intermediate node doesn't entertain the RREQ, then it keeps track through reverse path setup and forward path setup.

(a). Reverse path setup: RREQ moving from source to destination node, it automatically updates the reverse path by which all the nodes gets the RREQ request to source. In this each node conserve address of neighbour who sends first copy of RREQ as shown in Fig 10.

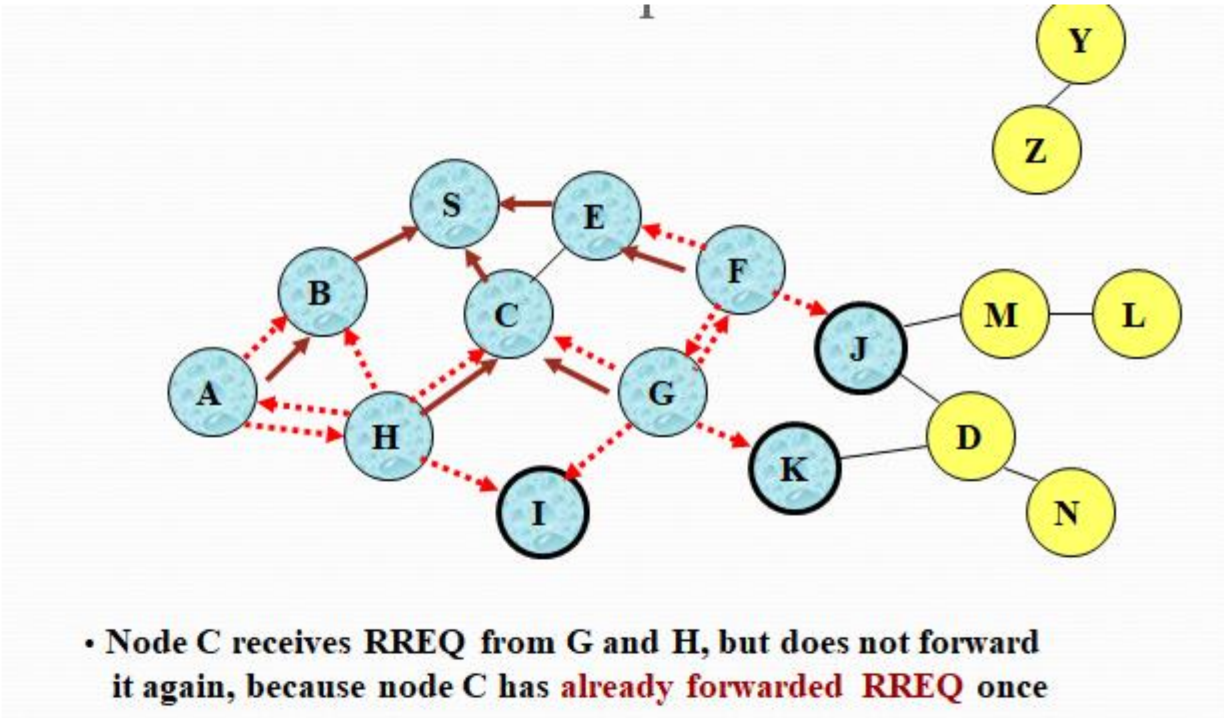

Fig 10 Reverse path setup

(b). Forward path setup: Each node ahead sets the forward pointer to that hub from which it has been gotten the RREPs, invigorate the timeout data for courses as shown in Fig 11.

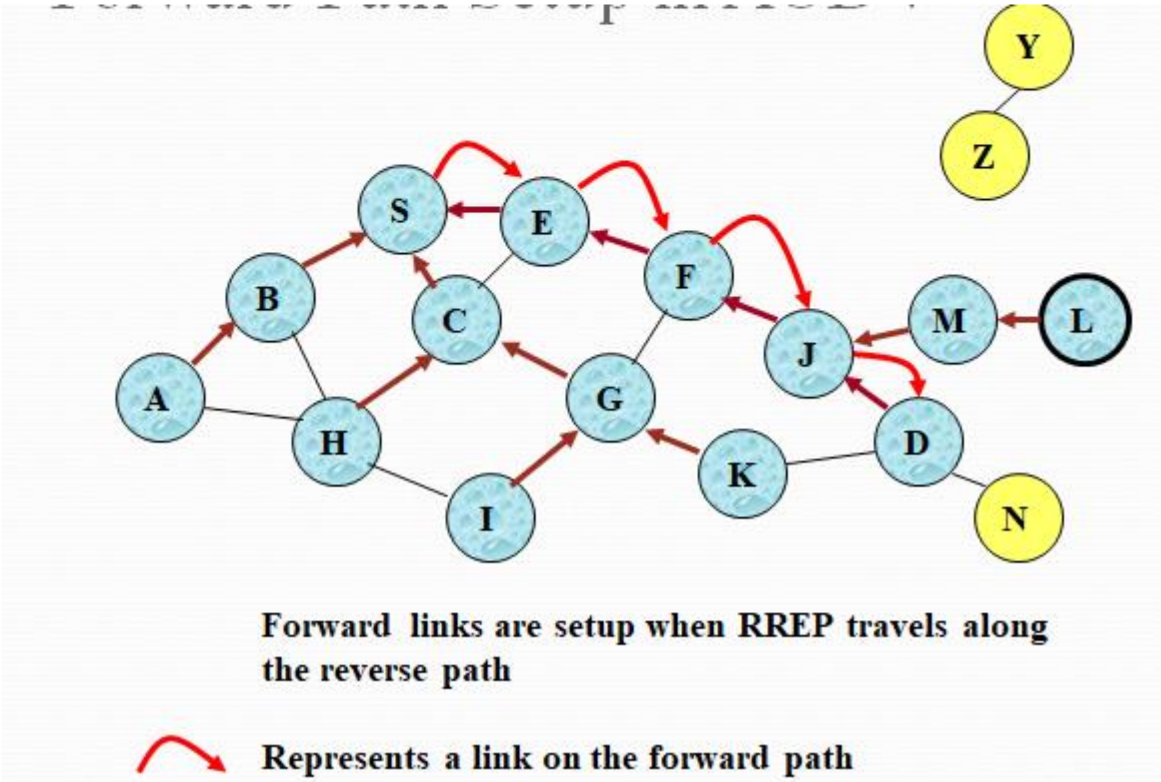

Figure 10 Forward path setup

(2). **Route table management**: Route is maintained at that time as it is used by any of its active neighbour. The routing entries having following entries such as:
(a). Route request expiration timer: This timer removes the entries of reverse path routing from the inactive nodes. It depends on the size of network.
(b). Route caching timeout: The time period after which the routes are declared as inactive.
(c). Active timeout period: This entry is entertained to inform all the nodes between source to destination about the link failure.
(3). **Path maintenance**: Path among the nodes is maintained due to high mobility of nodes. When the source changes it location from previous place then the route discovery procedure will be re-initializes and find the new path. If any other or destination node changes its position, a special RREQ is sent back to source node. Hello message is sent periodically to ensure the symmetric link as well as link failures.
(4). **Local connectivity management**: The updation of local connectivity information is done when a node broadcast the message to its neighbours. It ensures that the neighbour is considered. Inactive nodes in an active path required to send "hello" messages. If message is not received from next hop, then the neighbour using the next hop sent the notification of link failure.

2.3. Literature Review Analysis:

In this literature review section VANET routing protocols has been discussed. Routing protocols are classified on different basis of topology, position, geo-cast, broadcast and cluster. Topology based protocols are categorised as reactive, proactive and hybrid. Topology based routing protocols. In Proactive protocol, routes that are not used currently are also the part of routing table. In reactive routing table it reduces the overhead created by unused routed. In hybrid, it combines the features of both proactive and on demand routing protocol.

Position based routing protocol may not concern about the discovery and maintenance of routes. In geo-cast category it provides multi-hop communication between different autonomous systems. Working of cluster based routing protocol is firstly it form the cluster. After the cluster has been formed the cluster head is selected. Cluster head is selected on different basis such as average distance from all the nodes in the network. Cluster head behave as the gateways in the network to communicate with other clusters. Broadcast routing aims to share the routing information among the network by flooding of message. Every node broadcast the message to every other node except it receives from.

The behaviour of routing protocols is different on real world problems. To check the performance of routing protocol for real world environment, it has to be implemented on the real city map. The performance of the routing protocols is measured by different parameters. These parameters are throughput, delay, overhead routing and packet delivery ratio.

Chapter 3

PROBLEM STATEMENT

VANET is a network in which vehicles are highly dynamic in nature. Due to high mobility of vehicles, communication among them is the main concern to focus. To preserve the communication we need to study how the sharing of information between the nodes. Communication among the nodes is done by different routing protocols. The behaviour of routing protocols is different when it has to be implemented in real world environment. To check the performance of routing protocols in real environment, it has to be implemented in on the real city map. Ludhiana city road is a one way road. In the early hours of the day, late evening and on weekends the traffic is more in comparison of normal hours of day. The road is congested at peak hours of the day. So, it has to be implemented on Ludhiana city map. The performance of routing protocols is measured by different parameters. Routing protocols which has to be implemented are DSDV, AODV and GPSR. The main aim of the study is to do the comparative analysis of VANET routing protocols on real city map of Ludhiana. Analysis of routing protocols is done by checking the effect of network density and effect of speed on real environment.

Chapter 4
SCOPE OF THE STUDY

The main aim of doing this study is safety concerns. Car collision is one of the sudden dead causes, in next few years it is expected to be one cause. It leads the business opportunities such as traffic advisory services and car assistance.

Safety applications may reduce the number of accidents over an amount of time, the idea behind this is to avoid the accidents from the beginning. Some of the pre-existing technologies such as StreetSmart[30] and TrafficView[31] update the drivers through communication of road conditions. Traffic condition is being communicated among the vehicles will degrade the vehicle crashes due to human error.

Another application of this study is **traffic management**. Getting the information about the congestion at road, then all the vehicles approaching towards it will change the route to avoid the delay. As vehicles get the information from other vehicles about the congestion or it may told from the RSUs.

Chapter 5

OBJECTIVE OF THE STUDY

The main aim of study is to perform the comparative analysis of VANET routing protocol on real city map are as follows:

- To analyse the traffic conditions in case of dynamic vehicles.
- Implement various routing protocols with more number of vehicles.
- To reduces the accidents cases and improve the road safety.
- To improve Quality of Service (QoS) by improving delay, throughput, packet delivery ratio and overhead routing.
- To solve real city problems.

Chapter 6

RESEARCH METHODOLOGY

6.1 TOOLS USED

The tools used for comparative analysis of VANET routing protocol on real city map are:

(1). NS-2 (Network Simulator tool): This tool is use to analyse the network traffic. Since the communication among the vehicles is too complex, to provide the best results we use NS-2. It checks the network behaviour and parameters affecting the performance. The analysis of performance is done using this tool.

(2). SUMO (Simulation of Urban Mobility): SUMO is used to create the live network. It is used to create the mobility of network flow as running environment. The live network is passed to the NS-2 to analyse the conditions.

(3). MOVE and Java Development Kit (JDK-7): MOVE is used generate the traffic on road. The move files are stored in move.jar files. To run .jar files java toolkit is needed. It is implemented using two models: Traffic Models and Mobility model.

6.2 METHODOLOGY

VANET is a network in which nodes are highly dynamic in nature. Due to mobility of nodes communication among the nodes is an important aspect. Communication among the nodes in different situations is based on which protocol is to be implemented. There are various routing protocols on different basis such as on topology and position based. Performance of protocols is depends upon parameters. In order to check the performance in real world, we have to implement it on real city map. There are few steps need to be implemented as follows:

1. In order to extract map, OpenStreetMap (OSM) is used. It uses the geographical database for extracting the real city area. There are few steps used to extract the map are as follows in Fig 12:

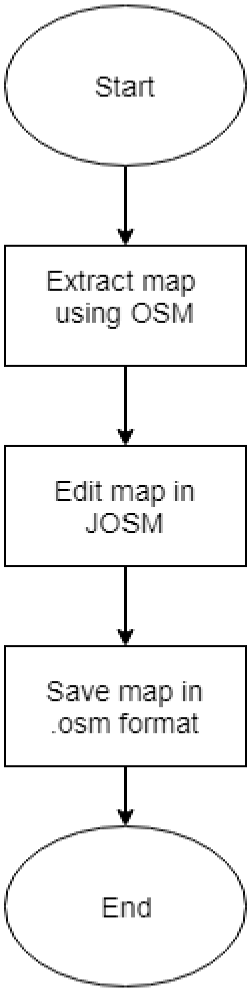

Figure 12 Extract the real city map

2. To check the effect on network density we have to increase number of vehicles. To check the effect on speed for example if a car is moving 45 kmph and another car is moving with speed of 60 kmph. The data dissemination for car having more speed 60kmph is more in comparison of other car.

   Ludhiana city road is a one way road. In the early hours of the day, late evening and on weekends the traffic is more in comparison of normal hours of day. The road is congested at peak hours. The reason to take this road in study is that this is small city road and traffic is more, this will degrade the performance of road.
3. MOVE and SUMO will generate the real time traffic condition. MOVE and SUMO will generate the TracI file that contains the change vehicle state from one position to another. Now this file is forwarded to NS-2 for analysis.

4. Implement the routing protocols such as AODV, DSDV and GPSR. Implement these routing protocols in real time traffic condition generated by MOVE and SUMO.
5. Obtain the trace files generated by NS-2 for further processing.
6. Analyse these routing protocols on the basis of performance parameters. Performance parameters include packet delivery ratio, throughput, delay and overhead of routing.

    Various performance parameters are as follows:

    - **Throughput**: Number of bits or information transmitted from source to target over per unit time. It doesn't contain overhead information.
    - **Packet Delivery Ratio**: Number of Packets received by the receiver to the total number of packets sent.
    - **Delay**: Difference in time that a packet is transmitted by a source to the time it has been received by the target.
    - **Routing Overhead**: It is defined as the ratio of number of data packets sent as control information or routing information to that of total data sent from source to target node.

6.3. FLOW CHART

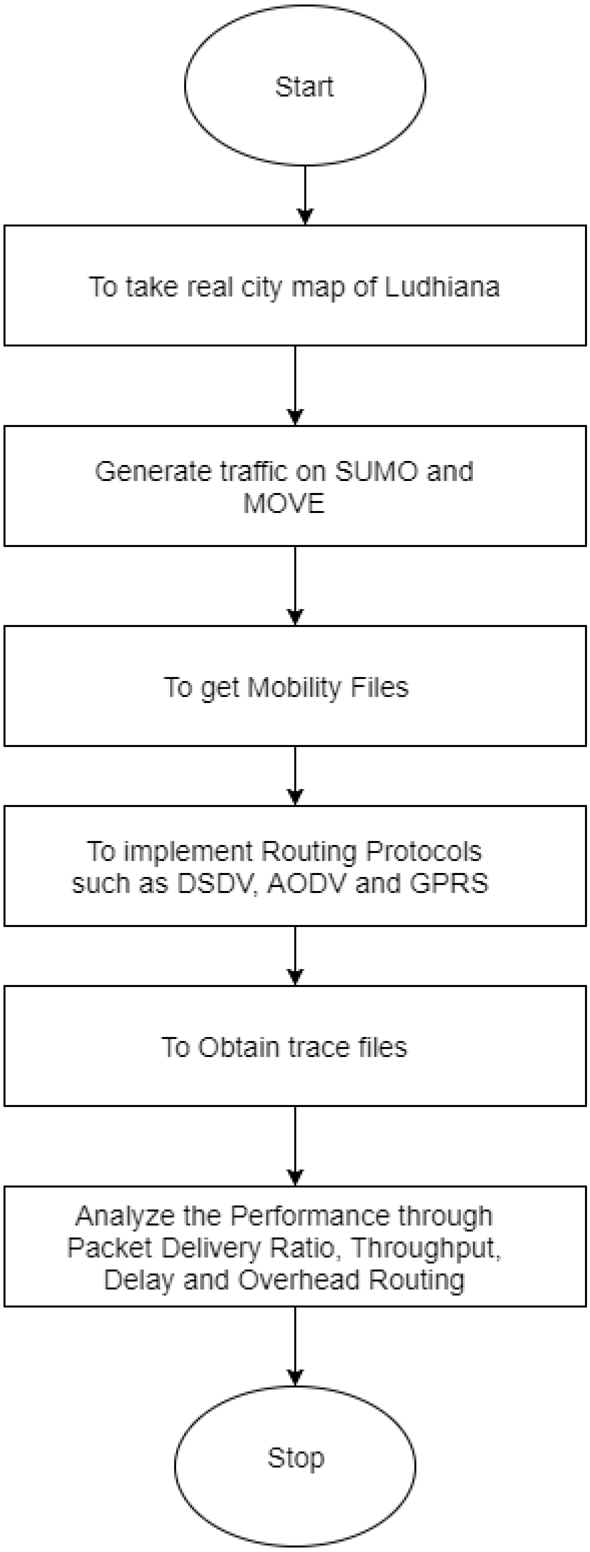

Figure 13 Implementations of VANET routing protocols on real city map

Chapter 7

CONCLUSIONS AND EXPECTED OUTCOMES

In this study, VANET routing protocols has been discussed. Routing protocols are classified on different basis of topology, position, geo-cast, broadcast and cluster. The behaviour of routing protocols is different on real world problems. To check the performance of routing protocol for real world environment, it has to be implemented on the real city map.

The expected outcome of the research is to enhance the working of routing protocols such as DSDV, AODV and GPSR. The performance of the routing protocols is measured by different parameters. These parameters are throughput, delay, overhead routing and packet delivery ratio. The main aim of the study is to do the comparative analysis of VANET routing protocols on real city map of Ludhiana. Analysis of routing protocols is done by checking the effect of network density and effect of speed on real environment.

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