CHAPTER - 1

INTRODUCTION

Vehicular Ad hoc Network (VANET) is a kind of Mobile Ad-hoc Network (MANET) where vehicles act as a node in the network. A VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 metres of each other to connect and in turn, create a network with a wide range network [1]. Vehicular Ad-hoc Networks (VANETs) is not a new technology but still there is lot of research issues.

Generally, VANET is used for avoiding the traffic and driving problem. Driving means, changing location constantly. More than 60% accidents happen due to the delay of less than half second. We can avoid these types of problem by introducing the VANET. It is also helpful for sharing documents, music and videos etc. To implement VANET we must know about some simulation tools like NS-2, SUMO, and GlomoSIM etc. These tools are used to analyze the performance of the proposed by system. These tools give the practical implementation

Aims and Objectives

Aim of our study is to identify which ad hoc routing method has better performance in VANET. The main purpose of our thesis is to study different routing methods of a network which is applicable in VANET and to find protocols that more suitable in various scenarios (City & Highway). We will use these parameters i.e. throughput and packet drop for comparison with already is suitable protocol for VANET. On the basis of comparison we will be able to suggest which routing protocol is suitable for which scenario of VANET. To achieve this aim we have set the following objectives:

- Finding problems with traditional MANET routing protocols used in VANET.
- Finding problems with various proposed routing protocols & techniques for VANET.
• Comparing performance results of the suggested protocols with the traditional MANET routing protocols.

**Overview**

A Vehicular Ad-hoc Network or VANET is a technology that uses moving vehicles as nodes in a network to create mobile network.

As vehicles fall out of the signal range and drop out of the network, other vehicles can join in, connecting vehicles to one another so that a mobile Internet is created.

VANET is a subgroup of MANET where the nodes refer to vehicles. Since the movement of vehicles is restricted by roads, traffic regulations we can deploy fixed infrastructure at critical locations.

The primary goal of VANET is to provide road safety measures where information about vehicle’s current speed, location coordinates are passed with or without deployment of infrastructure. VANET belongs to wireless communication network area. VANET is the emerging area of MANETs in which vehicle act as the mobile nodes within the network. The basic target of VANET is to increase Safety on road users and comfort of passenger.

VANET is the wireless network in which communication takes place through wireless link mounted on each node (vehicle) [1]. Each node within VANET acts as both, the participant and router of the network as the nodes communication through other intermediate node that lies within their own transmission range. VANET are self organizing network. It does not rely on any fixed network infrastructure. Although some fixed nodes act as a roadside units to facilitate the vehicular networks for serving geographical data or a gateway to internet etc [2]. Higher node mobility speed and rapid pattern movement and characteristics of VANET, these cause rapid changes in network topology [3].
1.2.1 COMMUNICATION TYPES

The communication types are Vehicle to Vehicle (V2V), Vehicle to Roadside (V2R) and Vehicle to Infrastructure (V2I).

1. Vehicle to Vehicle (V2V) - It is suitable for short range Vehicular network. It provides real time safety, fast and reliable. It does not need any roadside infrastructure. In V2V warning messages are broadcasted from vehicle to vehicle.

2. Vehicle to Roadside (V2R) - It provides communication between vehicles and the roadside units. It makes use of pre-existing network infrastructure such as wireless access points. In V2R warning messages are send to roadside units and then from that roadside units warning messages are send to vehicles.

3. Vehicle to Infrastructure (V2I) - This communication provides longer – range vehicular networks.
Figure 1.2 Communication in VANETS

Characteristics of VANET

VANET is application of MANET but it has its own distinct characteristics which can be summarized as [3]:

1. **High Mobility**

   The nodes in VANETs usually are moving a high speed. This makes harder to predict a node’s position and making protection of node privacy.

2. **Rapidly changing network topology**

   Due to high speed mobility and random speed of vehicles, the position of node changes frequently. As a result of this, network topology in VANETs tends to change frequently.

3. **Unbounded network size**

   VANET can be implemented for one city, several cities or for countries. This means that network size in VANETs is geographically unbounded.
4. Frequent exchange of information

The ad hoc nature of VANET motivates the nodes to gather information from the other vehicles and road side units. Hence the information exchange among node becomes frequent.

5. Wireless Communication

VANET is designed for the wireless environment. Nodes are connected and exchange their information via wireless. Therefore some security measures must be considered in communication.

APPLICATIONS OF VANET

Efficiency and safety are two important requirements that can be used to classify VANET applications based on their primary purpose. However, efficiency and safety are not completely separated from each other. On the contrary, those and other aspects should be considered together in the design of VANET applications. For instance, an engine failure or an accident involving two or more vehicles can lead to a traffic jam. A message reporting this event conveys a safety warning for nearby drivers who use it to increase their awareness. The same message may trigger the computation of an alternative route for a vehicle that planned to pass through the accident location, but it is not close to that point yet. In this case, the goal is to increase the transport efficiency for individual vehicles. Furthermore, depending on different factors such as the importance of the accident location, the transport system may compute and suggest alternative routes to a large set of vehicles considering a broader view of the traffic demands in order to diminish the impact of this event to regions not close to the accident. In this case, the goal is to increase the overall transport efficiency. Note that in both cases, an early event notification can help a driver or a passenger to decide to take a different route, use a different means of transport or even stay at the current location in case of a serious traffic
problem. In this case, an additional goal is to provide a person with useful information in the planning of an activity related to the transport system.

VANET applications will monitor different types of data such as the vehicle conditions, surrounding roads, approaching vehicles, surface of the road and weather conditions to make the infrastructure more secure and more efficient. Once this data is available, vehicles will communicate via wireless communication networks among the other vehicles exchanging the relevant information for different purposes.

**Safety Applications**

The ultimate goal of safety applications in VANETs is to avoid and decrease the number of road accidents. This is an application category sensitive to the delay. Thus, in order to reduce the delay, in this category applications use vehicle-to-vehicle communication. Other requirement is the reliability; all vehicles close to the hazard have to alert about it. In case a collision occurs, there are two issues to deal with: the approaching vehicles and the accident location itself. Simple applications like sending emergency notifications to a call center that transfers the notification to emergency responders already exist, such as the GM’s On Star system [18]. Whenever an accident happens, an event (e.g., the release of an airbag) triggers a notification system to send emergency messages to nearby emergency responders. These notifications may carry the position provided by a GPS-enabled device. For future applications, depending on the distance to the accident that occurred further along the road, this application must warn the driver or even automatically break the vehicle (e.g. emergency breaking) when the distance decreases under a certain limit. It is also highly desirable to obtain emergency video streaming to help emergency responders (paramedics, fire fighters, and other rescue personnel). They could know before arriving on the scene the geographic location of the vehicle and traffic conditions at the site in order to respond more strategically to the incident. This video information can be obtained from vehicles equipped with video cameras, and with capabilities to store and forward images. The application could also monitor the post-collision
scenario, taking appropriate actions and executing them promptly. Once an accident has occurred, the application should manage vehicle flows and identify alternative routes to either individual or a large set of vehicles, according to the accident location, time of the day and other factors. Of course, a safety application should be designed to act proactively providing drivers with early warnings and prevent an accident from happening in the first place.

**Efficiency Applications**

This is a category where the applications are aware of the vehicle location aiming to improve their mobility within the public roads. In this category, most of the applications require a high availability, because the drivers need of the provided information to make decisions during the trip, becoming the voyage more secure. In general, the communication pattern occurs among the vehicles and from vehicles to road side units. We can classify these applications in two ways: applications to control the crossroads and intersections, and applications to reduce and avoid traffic jams.

1. **Crossroads and intersections**

Traffic control and management is an important research area that can benefit VANETs. For instance, vehicles passing near and through intersections should drive carefully since two or more traffic flows converge, and the possibility of collision increases. In this scenario, virtual traffic lights could control and manage the traffic flow at intersections. Another safety application is to warn the driver of an impending collision, who can take proper actions to prevent it. In both applications, i.e., virtual traffic lights and safety, there are stringent requirements to be attended, mainly related to real-time constraints and distributed processing.

2. **Road congestion management**

A road congestion application can provide drivers with the best routes to their destinations and also determine the best time schedules for traffic lights along the overall routes. The goal is to decrease congestion on the involved roads and maintain a smooth traffic flow. This can potentially increase the road capacity and prevent traffic jams.
3. Comfort Applications

In this category, drivers can receive information from vehicular services that may help the driver during the trip making it more comfortable and enjoyable. Normally, the typical application requirements are reliability and availability providing the information in the right moment that the driver needs. Such application type comprises: weather information, gas station or restaurant location, city leisure information, tourist information, information on the available parking lot at a parking place, international service handover, road charging, route navigation (e.g., estimated journey time, recommended information based on the user’s context, automatic road map update, civilian surveillance) and advertisements or announcements of location-based sales information. In many cases, the communication will happen between vehicles and road side units, with no demand for a large bandwidth.

4. Interactive Entertainment

Aiming to distribute and to deliver entertainment-related information to drivers and passengers, this application category has as main features the connectivity and the availability. Thus, communication patterns can happen directly among vehicles or between vehicles and road sides. Ideally, the information should be tailored to the users’ context. The challenge here is how to keep this context information up-to-date, considering the dynamics and mobility of vehicles and people in a VANET. After all, the synchronization among vehicles and central servers becomes a great challenge in this context. Examples of applications in this category are: Internet access, distributed games, micro blogs, chats, music downloads, web browsing, file sharing, home control, etc. In future generation applications, passengers will have the opportunity to interact with passengers in nearby vehicles or with people anywhere in the world through instant messaging services, games, and even videoconference.

5. Urban Sensing

A vehicular network can be seen as a network paradigm for urban monitoring and for sharing data of common interest. This is particularly true in urban areas, where we can expect to have a
high concentration of vehicles equipped with onboard sensors. Vehicular networks can be used for effective monitoring of environmental conditions and social activities in urban areas, playing an important role in urban sensing [12, 71]. Urban sensing applications can be further potentialized when Smartphone capabilities taken onboard can be used complementarily with VANET sensors [36, 40]. In this context, the design of a Vehicular Sensor Network (VSN) introduces novel and challenging issues, which are considerably different from traditional wireless sensor networks, thus requiring innovative solutions. This is a promising research area since vehicles are not affected by energy constraints and other restrictions. Vehicles can be equipped with powerful processing units, different wireless communication devices, navigation systems, and a plethora of sensing devices such as chemical detectors, vibration/acoustic sensors, and still/video cameras. The combination of vehicular and sensor networks presents a tremendous opportunity for different large-scale applications in VANETs ranging from traffic routing and relief to environmental monitoring, distributed surveillance and mobile social networks.

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**ROUTING PROTOCOLS**

The similarity between MANETs and VANETs enables protocols in MANETs to be applied in VANETs. Yet, performance of these protocols can be affected, due to features listed in the section which distinguish VANETs from MANETs. The routing protocols in VANETs can be categorized into several types [8]: broadcast routing, position based routing (geographic routing), cluster based routing, Geocast routing, and topology based routing. Notice that in the current literature, the features and the advantages of different types of protocols are often
combined in one protocol to deal with network mobility, e.g. the combination of position based routing and broadcast routing or a topology based protocol.

![Routing Protocols in VANETs](image)

**Figure 1.3 Routing Protocols in VANETs**

### 1.5.1 Broadcasting protocols

Flooding broadcast is a simple and straightforward method of message dissemination. In a flooding scheme, every node receiving the message forwards the message. Yet, the problems caused by flooding, e.g. waste of bandwidth and frequent collisions, and make it an inefficient method especially in the case of dense network. Broadcast storm in VANETs is quantified, which indicates that in the flooding scheme, with the increase of vehicle density, the transmission performance is significantly affected, in terms of the number of hops, total delay and packet loss ratio.

**There are four strategies in broadcast routing protocols:-**

Different broadcasting strategies to select the forwarding nodes are mentioned as under.

- **Probability-based**

A given broadcast routing determines the decision for example depending on the number of copies a node has received. The strategy is often dynamic .probability distribution function.
Broadcast Routing

★ Probability-based

The selection criterion is the amount of additional area that would be covered by enabling a node to forward. Some proposal also computes position as useful input information.

Broadcast Routing

★ Location-based

The selection criterion is the amount of additional area that would be covered by enabling a node to forward. Some proposal also computes position as useful input information.

★ Neighbor-based

A node is selected depending on its neighbor’s status (for instance, the status concerns how a neighbor is connected to the network).
 Figure 1.6 Broadcast routing in Neighbor-based

- Cluster-based

Cluster-heads forward packets. Nodes in the same cluster share some features (e.g., relative speed in VANETs). Re-clustering takes place either on-demand or periodically. Nodes are grouped in clusters represented by an elected cluster-head only.

 Figure 1.7 Broadcast routing in Cluster-based

A. Cluster-based protocols

In this category, message propagation is conducted by a virtual chain of networks. Vehicles are grouped geographically as clusters as Radio range of wireless devices decides the cluster size to be adopted in the network. Each cluster has a cluster head
(CH) and takes charge of inter-cluster communication. Cluster members in same cluster communicate with each other directly and via cluster head (CH) with vehicles in other clusters. The reliable communication between the cluster heads affects the performance of system. In cross layer protocol, predefined backbone members (BM) are selected to forward messages prior to the propagation and are referred as Dynamic Backbone Assistance MAC (DBA-MAC). If a vehicle has not received any messages from nearby BMs for a specific time period, it upgrades itself as a BM and broadcasts a inspiration to create BM network. The suitability as a BM is measured by the relative distance between the BM candidates and the BM at the end of the predefined period, the one with the longest distance winning contention with the highest probability. While message propagation is on, only BMs forward messages from preceding BM. If at some time, BM fails to forward a message; all other vehicles start argument to forward message.

B. Adhoc (Topology based) Routing Protocols

In AODV, the source node broadcasts a route request (RREQ) before the message is actually transmitted. The nearby node responds to this message with a route reply (RREP), if it stores a route to the destination and if not, the node rebroadcasts the RREQ. At some time, when the destination receives RREQ, it responds with RREP and RREP is propagated back to the source. The message transmission begins as soon as RREP is received. In case if a RREP with less hop count to the destination is received, the route is updated by the source and a new route is adopted for message propagation. In case if a link failure occurs, the upstream node of the break point reports to the source and source re-initiates finding a route if necessary. DAODV further improves AODV by introducing mobility information in route selection. It is supposed that every vehicle in the network is fortified with Global Positioning System (GPS) and the mobility information. During route discovery, the direction of candidates needs to be
checked. All the candidates moving in same direction as source and destination are referred as potential candidates. The potential candidates within the source and destination are only responsible for responding to the source. If there is no potential candidate between source and destination, all potential candidates respond to the source to build the route.

C. Location Based Routing Protocols

Global Positioning System (GPS) and route map provide location of vehicles in VANETs. Location information can be used to find a route from source to the destination for propagating message. The traffic related information is often used to forecast the location of possible relays for the stability of the route.

Greedy Perimeter Stateless Routing (GPSR) is the most popular location-based protocol. In this, it is expected that the position of every node and destination within the network is known by all others. As the message is transmitted, it finds the node closest to the destination to forward the message. If in case, transmitter fails to find the greedy path, the perimeter mode is used to forward the packet in which it traverses along the closer faces of a planar graph of the network and greedy forwarding restarts if the node closer to the destination is found as compared to the current node. This procedure comes to a halt when a node closer to the destination is found and greedy forwarding procedure continues. In VANETs GPSR has to handle the mobility of the nodes. When the node is about to transmit a message, it calculates the geographic location of each neighbor after a specific time T, based on current location, direction of movement and current velocity. Among the left behind nodes, the one closest to the destination implements forwarding the message.

D. GeoCast Routing Protocols

Geocast routing protocols set a Region of Interest (ROI) which is determined by the location of the message source. Packets are send to all the vehicles within ROI, for example, information on accidents and congestion. Vehicles travelling in opposite direction may be used to relay the
message through the ROI. On the other hand, the vehicles travelling in same direction are grouped based on transmission range and a group head (GH) is selected for every individual group. Once an incident begins, the vehicle which is part of the incident, broadcasts a message to notify other vehicles about the incident. In case if network condition fails to guarantee that the message is transmitted throughout the ROI, as in disconnected case, GHs travelling in opposite direction take charge of forwarding the message. Once a GH receives the message and rebroadcasts it, the source stops periodical broadcast upon sensing the rebroadcasting. The GH travelling in the opposite direction rebroadcasts the message before it moves out of the region of interest.

Summary

The chapter discussed the working of VANETs, its applications, types of communication involved, characteristics of VANETs, different routing protocols involved in VANETs. The chapter elaborated the positive aspects of VANETs.