AN IMPROVED HARMONY SEARCH ALGORITHM FOR OPTIMIZED LINK STATE ROUTING PROTOCOL IN VEHICULAR AD HOC NETWORK

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PENINGKATAN CARIAN HARMONI YANG DIOPTIMUMKAN UNTUK PROTOKOL PENGHALAAN KEADAAN PAUTAN DALAM VANET

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DISERTASI YANG DIKEMUKAKAN UNTUK MEMENUHI SEBAHAGIAN
DARIPADA SYARAT MEMPEROLEH IJAZAH
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2018

DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

18 APRIL 2018

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ABSTRACT

Vehicle Ad-hoc Network (VANET) is the direct application of Mobile Ad-hoc Network (MANET) in which the nodes are represented by vehicles moving in city or highway scenario environment. The main goal of such networks is to create a network where the vehicles can exchange data by communicating with other vehicles or with Road Side Unit. These types of communications have led to the emergence of Intelligent Transportation System, using this to apply various applications that can provide a safer driving and more efficient one. Deployment of VANETs relies on routing protocols to transmit the information between the nodes. Different routing protocols that have been designed for MANET have been proposed to be applied in VANETs. However, there are many challenges when it comes to deploying these routing protocols in VANET due to its unique characteristics. In this work we deal with the well-known MANET proactive Optimized Link State Routing protocol (OLSR). The deployment of OLSR in VANET gives moderate performance, this is due to its necessity of maintaining an updated routing table for all possible routes. The performance of OLSR is highly dependent on its parameter, thus finding optimal parameters configurations that best fits VANETs features and improves the network's quality of services is essential before its deployment. Therefore, we aim at OLSR parameters configurations by coupling two stages, a procedure for optimization which is carried out by a Modified Harmony Search Algorithm based on embedding two popular selection methods in its memory; roulette wheel selection and tournament selection and a simulation stage represented by MATLAB simulator (based on a highway scenario). The experimental analysis shows that the optimized OLSR parameters obtained by our proposed approach has achieved promising results when compared with original OLSR, basic Harmony Search Algorithm and Particle Swarm optimization in terms of global network quality of services performance.

ABSTRAK

Rangkaian Ad Hoc Kenderaan (VANET) adalah aplikasi langsung Rangkaian Mudah Alih Ad hoc (MANET) di mana nod-nod diwakili oleh kenderaan yang sedang bergerak di persekitaran senario bandar atau lebuh raya. Matlamat utama jaringan tersebut adalah untuk mewujudkan suatu jaringan di mana kenderaan boleh menukar data secara berkomunikasi dengan kenderaan lain atau dengan Unit Jalan Raya. Jenis komunikasi ini telah membawa kepada kemunculan Sistem Pengangkutan Pintar, yang digunakan untuk pelbagai aplikasi yang dapat menyediakan pemanduan yang lebih selamat dan cekap. Penggunaan VANET bergantung kepada protokol penghalaan untuk menghantar maklumat antara nod. Protokol penghalaan yang berbeza yang telah direka untuk MANET telah dicadangkan untuk digunakan dalam VANET. Walau bagaimanapun, terdapat banyak cabaran berkenaan dengan pelaksanaan protokol penghalaan dalam VANET disebabkan oleh ciri-ciri uniknya. Dalam kajian ini, kami mengendalikan protokol Keadaan Penghalaan Optimum MANET proaktif yang terkenal. Pelaksanaan OLSR dalam VANET memberi prestasi yang sederhana disebabkan oleh keperluan mengekalkan jadual penghalaan yang dikemas kini untuk semua laluan yang berkemungkinan. Prestasi OLSR amat bergantung pada parameternya, maka mencari konfigurasi parameter optimum yang paling sesuai dengan ciri-ciri VANET dan yang boleh meningkatkan kualiti perkhidmatan jaringan adalah penting sebelum pelaksanaannya. Oleh itu, kami mensasarkan parameter OLSR yang disesuaikan secara dengan menggabungkan dua peringkat, iaitu satu prosedur pengoptimuman yang dilakukan oleh Algoritma Carian Harmoni yang Dipertingkatkan dengan menggunakan dua cara; pemilihan tayar rolet dan pemilihan pertandingan dan satu tahap simulasi yang diwakili oleh simulator MATLAB (berdasarkan senario jalan raya). Analisis eksperimen menunjukkan bahawa keputusan penggunaan optimum parameter OLSR yang didapati dari pendekatan proposal akan dicapai berbanding dengan OLSR asal, Carian Harmoni Algoritma asas dan pengoptimuman kawanan zarah kualiti prestasi perkidmatan rangkaian dari segi global.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

VANET	Vehicular Ad Hoc Network
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
MANET	Mobile Ad Hoc Network
OLSR	Optimized Link State Routing Protocol
ITS	Intelligent Transportation System
HS	Harmony Search Algorithm
GA	Gentic Algorithm
SA	Simulated Annealing Algorithm
ACO	Ant Colony Optimization
PSO	Practical Swarm Optimization
DSR	Dynamic Source Routing
DE	Differntial Evaluation
HSO	Harmony Search Optimization
RSU	Road Side Unit
R2R	Road Side Unit To Road Side Unit
CAMs	Cooperative Awarness Messages
DGPS	Differntial Global Postioning Systems
GPS	Global Positoning Systems
CAML	Continuous Air Interface Medium And Long-Range
DSRC	Dedicated Short-Range Communications
AITS	Assossiation For Intelligent Transportation System

GPSR	Greedy Perimeter Stateless Routing
DYMO	Dynamic MANET On Demand protocol
DREAM	Distance Routing Effect Algorithm for Mobility
FSR	Fisheye State Routing
STAR	Source Tree Adaptive Routing
GSR	Global State Routing
DSDV	Destination Sequenced Distance Vector
ZRP	Zone Routing Protocol
CGSR	Cluster-Head Gateway Switch routing
GEOCAST	Geographic Addressing And Routing
HSR	Hierachically Segmented Routing
LAR	Location Aided Routing Protocol
AODV	Ad Hoc On-Demand Distance vector
DSR	Dynamic Source Routing
MFR	Most Forward With Radius
NFP	Nearest Forward progress
WSN	Wireless Sensor Network
IWSN	Industrial Wireless Sensor Network
MOPR	Movement Prediction Routing
QoS	Quality Of Service
RREQ	Route Error Packet
NS2	Network Simulator
SAM	Simple Ad Hoc SiMulator
OPNET	Optimized Network Engineering Tool
NFA	Necessity First Algorithm
EA	Evaluation Annealing
MPR	Mutli Point Relay
B&B	Branch And Bound
CSA	Colonal Selection Algorithm

SQP	Sequntial Quadratic Programming
DOPs	Dynamic Optimization Problems
BMSD	Bounded Shortest Multicast Algorithm
NPI	Node Parent Index
DBHS	Discrete Binary Harmony Search Algorithm
MBDE	Modified Binary Differential Evaluation Algorithm
GHS	Global Harmony Search Algorithm
BMSD	Bounded Shortest Mulitcast Algorithm
IWD	Intelligent Water Drop Algorithm
SP	Shortest Path
TC	Topology Control
HMCR	Harmony Memory Consideration Rate
PAR	Pitch Adjusment Rate
HM	Harmony Memory
NI	Nubmer Of Iterations
MATLAB	Matrix Labortory
PDR	Packet Delivery Ratio
E2E	E2E Delay

CHAPTER I

INTRODUCTION

1.1 RESEARCH BACKGROUND

Vehicular Ad Hoc Network (VANET) is considered as an emerged class of the well-known Mobile Ad Hoc Network (MANET). The idea of vehicles communicating between them and forming a network to support different kind of applications has attracted many researchers in both of the academic and manufacturers communities. Nodes in VANET are vehicles and they communicate between each other using vehicle to vehicle (V2V) or vehicle to infrastructure (V2I), where the first one enables vehicles to communicate with each other to share their information and the second one enables the vehicles communicate with Road Side Units (RSU) that gather and broadcast information. These types of communications has led to the emergence of intelligent transportation systems (ITS), using this to apply applications that uses this technology to transmit different kind of information which can make a safer driving and more efficient one. For instance, in case of an accident has occurred it is useful to broadcast a message indicating the accident and warning the drivers to slow down or take another routes before reaching the accident area, for this reason it's an interesting field of study for the researchers to work on and develop these kind of applications which can save humans lives. Figure 1.1 demonstrates A VANET network.

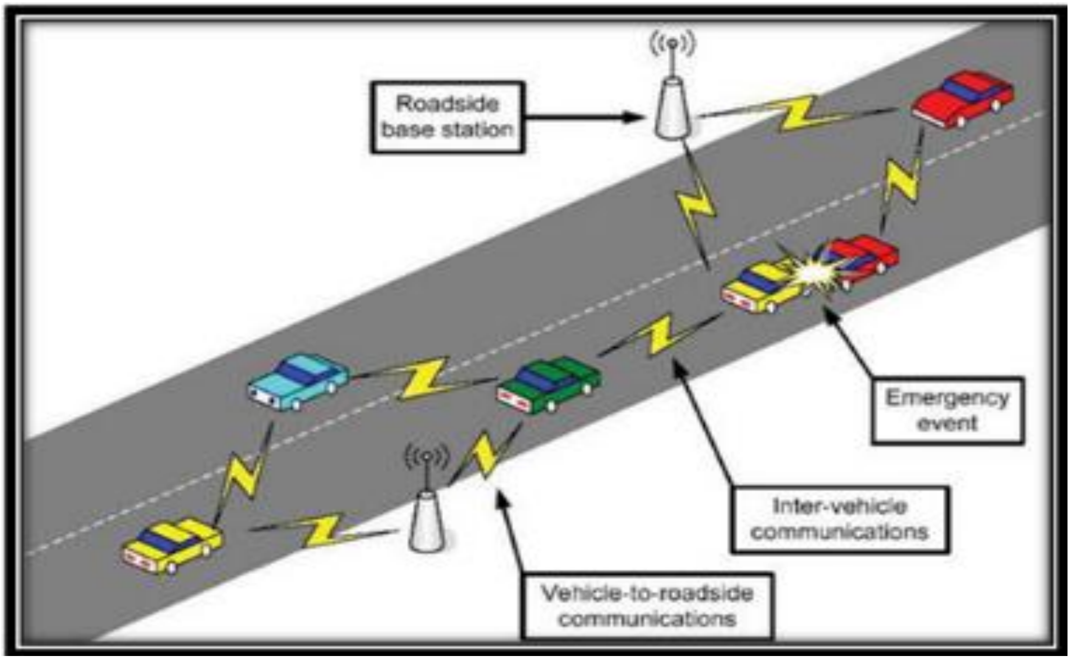

Figure 1.1Typical VANET scenario

The term VANETs reflects to the ad hoc nature of these highly dynamic networks. The fact that the nodes in this kind of network are moving vehicles, VANET's characteristics are unique when comparing to other kinds of ad hoc networks. These features have important implications for designing decisions. The main features of the VANET are presented as following:

- The rapid changing of the network topology is hard to manage. Due to the high speed of the vehicles in VANET and the different velocities of the nodes depending on the scenario, the network's topology is highly dynamic.
- Frequent fragmentation of the network, which leads the messages to have troubles reaching the required destination.
- Small diameter, mainly due to the speed of the nodes and the existence of the obstacles on the roads such as, trees and surrounding buildings and the height of antennas that are used. Therefore, links between the nodes are disconnected frequently.
- The scenarios of VANET are three, namely, urban, highway and rural. Each scenario has its features, for instance, the density of nodes are higher in urban scenarios (cities entrance

and jam hours) than it is in rural scenarios, hence the nodes can join or leave the network which leads to frequent changes to the network's topology.

- The devices used in these kind of networks do not suffer from power constraints, unlike mobile ad hoc networks and wireless sensor networks (WSN) as the vehicles can be equipped with sufficient energy suppliers.
- The content of the messages can change the network topology as the drivers' response affect the network.

In VANET, routing protocols plays an important role in the deployment of applications. It is necessary to send packet through several vehicles to reach the required node destination. Due to the features of VANET, it is essential to design an efficient and reliable routing strategy that is one of the most challenging problem in the field of this kind of network. A strategy for adaptable routing is required since the dynamic nature of VANET. Such as: network topology, density of the nodes and high speed of the nodes. Additionally, the routing protocols need to provide different kind levels of quality of services (QoS) to different types of applications and services. Different types of routing protocols that have been designed for MANET have been proposed to be applied in VANETs directly or after modifying them.

However, there are many challenges when it comes to deploying these routing protocols in VANET, as the frequent changes, the high speed and the high density of velocities are present in this network. The rapid exchange of messages between the vehicles to broadcast information leads to consume the network's resources.

The focus of this research is to propose a modified meta-heuristic method which is Harmony Search algorithm (HS) and apply it on the proactive Optimized Link State Routing protocol (OLSR). This protocol was selected primarily because it has a set of features that makes it suitable for VANETs. It presents very competitive delays during data packet transmission in large networks (a vital feature for VANET applications), it can adapt greatly to constant topology changes, and its simple operation makes it easy to integrate into various types of systems. Furthermore, it has a high implication on increasing the rates of the network data and lowering the network load. As such, all these characteristics make OLSR a good candidate for optimal tuning.

1.2 PROBLEM STATEMENT

Vehicular Ad hoc Network (VANET) is one type of wireless node networks in which nodes are represented by cars or vehicles moving in urban or highway environment. The usefulness of VANET is to provide instant messages or data transmission between vehicles from one side and between vehicles and roadside unit from another side. This is applicable in various features of intelligent transportation systems in order to provide safety and comfort to travelers. Furthermore, the multi-hop capacities of VANETs will enable varied implementations and services that are uniquely suited to mobile situations. These would include safety-related functions for accident avoidance, comforting applications to enable chatting between vehicles as well as files sharing, gaming, and automobile infotainment. Such nascent uses cannot yet be implemented through current vehicular communications. Towards their effective implementation, effective protocol sets that are well-optimized are essential. Numerous protocols have been developed in order to deal with data transmission in VANETs. Settings that involve vehicles can represent unique challenges for roadway communications, including heterogeneously distributed traffic patterns that range from light to heavy, as well as operational issues related to high vehicular mobility. Thus, even in the enabling presence of huge amounts of vehicular traffic, mobility constraints in the roadways and their intersections can result in spatial topology holes emerging between vehicular groups. As a result of these exceptional issues, the development of protocol sets can be a challenge. Many studies have applied the OLSR protocol for VANET deployment. This is a unicast proactive protocol with a simple operation; however, allows a constant exchange of the control packets, which could lead to network congestion. This indirectly affects the performance of the VANETs that are dependent on the selected parameters of the OLSR routing protocol. The OLSR protocol makes use of the hop-by-hop routing, where every node uses the local information for routing the data packets. Though there are a less number of configurable parameters governing the OLSR protocol, the probable combinations within these values could make the task difficult to be configured using manual configurations. Because of the complex nature of this problem, automatic intelligent tools have to be used for solving them. Hence, researchers have used the meta-heuristic algorithms as an effective technique for solving various optimization problems. However, the application of the meta-heuristic techniques in optimising the OLSR protocol (and indirectly in the VANETs) is still limited. Four different optimization techniques including Particle Swarm

Optimization (PSO), Differential Evolution (DE), Genetic Algorithm (GA), and Simulated Annealing (SA) were introduced in (Toutouh et al. 2012) to enhance OLSR in VANET. The simulation was done on realistic scenarios of the city of Malaga. The simulation results revealed that the proposed tuned OLSR configurations result in better QoS than the standard, in terms of packet delivery ratio (PDR), end to end delay (E2E Delay) and network overhead. However, the optimized OLSR parameters based on these optimization methods is not suitable for network with higher number of nodes and velocity, since it causes insufficiency in the network's quality of services.

1.3 RESEARCH OBJECTIVES

The main goal of this research is to develop an optimized proactive OLSR protocol for VANET.

- To propose an auto-tuned optimized link state routing protocol based on a modified harmony search algorithm.
- To evaluate the performance of obtained OLSR parameters configuration by the proposed method using MATLAB in a highway scenario.

1.4 RESEARCH SCOPE

This research deals with VANET based on the proactive protocol OLSR which is a widely known routing protocol that has been proposed for MANET. This research presents a modified intelligent algorithm as HS to deal with the optimization problem of OLSR in order to find the optimal or near optimal parameters configurations of OLSR in VANET. The proposed methodology is evaluated on 70 numbers of nodes that move in non-random way following the restrictions set by a highway scenario and moving at speeds ranging between 70km/h to 100km/h. The dimensions of the network is set to be $500\times 500\ m^2$. The nodes radius coverage area is 150m. The routing table of each node is 100. The scope of this study considers improving the routing protocol OLSR performance in VANET in order to enhance the network's quality of services by using a modified harmony search algorithm.

1.5 SIGNIFICANCE OF RESEARCH

In order to improve the performance of the OLSR routing protocol, a modified harmony search is applied with OLSR in a VANET highway seario in order to auto-tune the parameters of OLSR that governes its performance and find the optimal parameters set that can enhance the OLSR functionality in a network with features of high density and velocity.

The scenario of this research will be evaluted and the imapct of the obtained OLSR's new parameters configurations will be demonstarated as applied on highway scenario where the nodes are moving at high speeds and how the routing protocol can adapt to the constant topology change in order to deliver the packets between the nodes without consumin the network's resurces.

1.6 ORGANIZATION OF THE THESIS

This thesis comprises six chapters. Chapter I provides an introduction of the topic and produces background study about the state of art of VANET. It also presents the problem statement, research objectives, significant of research study including the scope and methodology of this research.

Chapter II provides a brief description on different variations of VANET. It also provides VANET characteristics, applications, challenges, and communication types. Furthermore, it presents the types of routing protocols in ad hoc networks. Furthermore, it presents a description about optimization methods and harmony search algorithm. Finally, it includes a comprehensive review on the related work to this study.

Chapter III provides a discussion on the used methodology to accomplish the objectives of this study. It also describes the MATLAB simulation software to create the scenario in details. This chapter also includes a brief description on routing protocol and meta-heuristic method that are used in this study.

Chapter IV provides a detailed explanation on developing and evaluating the performance of Harmony Search Algorithm based on selection methods as an optimization technique for creating and implementing VANET to automatically find a solution vector in order to obtain efficient OLSR parameter configurations. IHS is used to improve the performance of OLSR in VANET.

Chapter V analysis the simulation results using different performance metrics; PDR, E2E Delay, overhead and Variance of Energy Consumption. The simulation results are obtained from various simulation runs. This chapter concludes with a discussion of the simulation results.

Chapter VI provides a summary on the concluded results of this study. At also evaluates and discuss the results based on different performance metrics, namely, PDR, E2E Delay, overhead and variance of energy, and draws conclusion based on these metrics. Finally, it suggests further work regarding this study.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter aims to establish the foundations needed to understand the state of art of Vehicular Ad Hoc networks.VANET has been gaining the attention of researchers' community, especially in the area of routing protocols. The ultimate goal of routing protocols is to deliver the data packet from the source node to the destination node in a correct way. Therefore, the following issues such as, packet size, number of nodes, path cost and the nodes mobility must be taken under account to decide what is the best routing protocol to be chosen in order to forward the packets from the resource node to the destination node. In this chapter, a detailed discussion of VANET and its aspects, namely, its characteristics, applications, challenges and types of communications will be presented. Also, this chapter provides a brief discussion about the Intelligent Transportation Systems. Furthermore, types of routing protocols will be discussed in details such as proactive, reactive and hybrid protocols. This chapter also contains a description on the basic HS algorithm and optimization methods. Besides that, this chapter includes summary on the related literature review to this study that have been conducted by researchers.

2.2 VEHICULAR AD HOC NETWORK

Vehicle Ad-hoc Network (VANET) is the direct application of Mobile Ad-hoc Network (MANET). MANET creates spontaneous wireless networks among the mobile nodes for data exchange. VANET can be deployed in places where it is very impractical to install the necessary infrastructure to form a network between the nodes.

In VANETs, the nodes are vehicles. The main goal of VANETs is to create a network where vehicles can communicate with each other and exchange messages to provide road safety. By using multi hop routing, nodes can forward date packets to other nodes in the network even if they are not within the same radio range. The facts that the vehicles can travel at high speed and communicate with the absence of any fixed infrastructure represents several challenges. As VANET is considered as sub-class of MANET. However, VANET nodes mobility is nonrandom as the nodes have to follow the topology and rules of the roads(Yousefi et al. 2010).

The vehicular ad hoc network plays an important role in Intelligent Transportation Systems (ITS). As the number of the vehicle is increasing, it also increased the possibility of road accidents and traffic jam in a city with relatively higher number of population. This hinders the productivity of individual and company. With the proper application of VANET, it is possible to reduce the accidents and traffic jam on highways and roads. Development of VANETs and its applications are becoming very popular now a-days to so as to eradicate the daily problems of traffic jam and road accidents(Kumar et al. 2013).

There are three types of communications available in VANETs. The first type is vehicle to vehicle communication (V2V), second is vehicle to roadside communication (V2R) and the third is roadside to roadside communication (R2R). Each vehicle is equipped with a transceiver known as On-board Unit (OBU)(Sharma & Preetsingh 2016). These transceivers help the vehicles in the network to send or receive a message with other vehicles or with Road Side Unit (RSU). This can be shown in figure 2.1, where the scenarios of the communications can be highway, urban or rural. Each one of these scenarios has its own challenges, hence, it’s important to understand the nature of the network in order to deploy it in different environments.

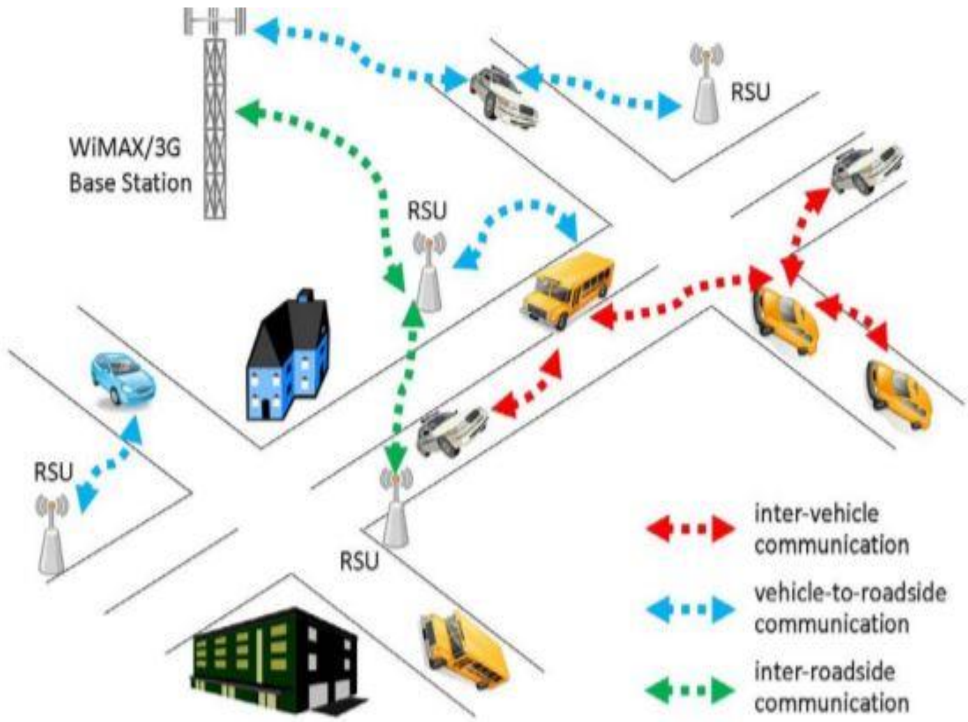

Figure 2.1 Type of VANET (Sharma & Preetsingh 2016)

2.2.1 Characteristics Of Vanet

The characteristics of VANET make it recognized as a special type of ad hoc networks. These features considered as a challenge for its establishment(Al-Sultan et al. 2014).

- Dynamic topology: The topology of VANET network is in frequent changing. This is due to the nodes can move at high speeds especially in urban environments, where vehicles can exceed the speed of 100 Km/h on highways roads. The nodes may also move in different directions. Thus, nodes in the network can shortly join or leave the communication range, leading to quickly changing topology. This dynamic nature of network presents constraints in the connectivity between nodes since the link between two nodes can be disconnected easily while transmitting information.

- Nonrandom mobility: The mobility of nodes in VANET differs from other types of ad hoc networks, as the nodes mobility patterns are predictable. Since the speed limits, road and streets topology in which the nodes are required to obey the traffic lights and road signs. Hence, the mobility of the nodes is constrained by these topologies and layouts, leading to predictable moving patterns.
- High number of message: The rapid exchange of messages either between the vehicles or between vehicles and road side units to communicate with each other and create a network that covers all kinds of applications (safety and comfort) leads to high numbers of messages within the network.
- Large network size: The network size of VANET is large. The network scale can consist a high number of nodes such as in rush hours and jam hours (city centers or entrance of big cities) where many vehicles are sharing the same roads, leading to high network density.
- Sufficient energy: The energy limitations is not a critical challenge in VANET. Unlike in other ad hoc networks such as MANET and WSN. The nodes in VANET which are vehicles can be equipped with large batteries that provide the required energy power for long time.
- High power processers: The computational ability is high in VANET as computing and communication resources to help the nodes with obtaining higher communication capabilities can be available and equipped on vehicles; such as on board navigator, memories with large capacities and high speed processors. All these resources can make the nodes obtain accurate information about their directions, positions and speed since the nodes highly depend on locations.

All these characteristics and features make the VANET a unique and different type of ad hoc network even though it is considered as a sub-class of MANET. Table 1 summarizes the properties of VANET and illustrates how it differs from MANET.

Table 2.1 Summary of VANET and MANET features

Property	VANET	MANET
Node’s mobility	High, nonrandom	Random
Network size	Large	Medium
Energy limitations	Low	Very high
Node’s computation power	High	Low
Location dependency	Very high	Low

2.2.2 Applications Of Vanet

VANET has emerged as an ad hoc network to provide safety and comfort to vehicles drivers and travelers. As the number of the vehicle is increasing, it also increased the possibility of road accidents and traffic jam in a city with relatively higher number of population. This hinders the productivity of individual and company. The potentials of VANETs are huge when one considers the monumental amount of vehicular traffic that is present. The potential for robust solutions can only increase recognition by governmental, research, and industrial agencies of the need to develop effectively networked vehicles. Accordingly, these technologies have a bright future that is full of promise for the enhancement of transport schemes. Furthermore, the multi-hop capacities of VANETS will enable varied implementations and services that are uniquely suited to mobile situations. These would include safety-related functions for accident avoidance, comforting applications to enable chatting between vehicles as well as files sharing, gaming, and automobile infotainment.Communications between vehicles where they exchange and collect information about their environment can provide different of types of applications. Depending on the nature of application, there are two types of VANET applications(Eze et al. 2014):

- Comfort / entertainment applications
- Safety applications

Comfort applications or non-safety applications is a category that aims mainly to provide both drivers and passengers with comfortable and pleasant journeys. Also, they can provide information about roads traffics, location of the nearest shops or restaurants and their prices and promotions. Video streaming, exchange instant messages, online games and internet access can be available for passengers comfort in an infrastructure network.

Safety applications aims to increase road safety. In these type of applications vehicles are required to communicate with each other in order to collect and process messages. Safety applications exchange two types of safety messages to disseminate them across the network. First type is periodic messages, this type of messages is frequently broadcasted containing information for other vehicles. To prevent unsafe situations from happening, the information about sender vehicle's including their speed, location and other comfort application data needs to be processed by the received vehicle in order to avoid any unsafe situation. Second type is Event-driven messages. These types of messages are high priority messages. Whenever an unsafe situation or a hazard condition has been detected, Event- driven messages are sent containing sender's location, time and type of the condition.

One of the most common and simple application being the cooperative awareness messages (CAMs) among the vehicles in wide range by transmitting through many vehicles. Unlike MANET where the networks formed between the nodes can be random, VANET can be strategically arranged to provide constant and organized networks among the nodes (in this case vehicles). For example, on a highway, most of the times the vehicles are restricted to limited range of motion and they follow the predictable path instead of moving randomly. Some other application of VANET includes, digital braking systems where the drivers can react to vehicles braking or stopping suddenly even though the cars are not discovered by the other cars.

Another application of the VANET can be team forming (platooning). This application allows the drivers to follow the leading cars maneuver information such as steering and acceleration information. One of the useful application of the VANET can be Traffic Information Systems. This can help provide the up to minute information about the traffic to the vehicles. The biggest importance of this application is that the broadcast is done in real time unlike many available services which tends to arrive after long delay to the drivers on the road. This application would play an important role in minimizing the problems such as traffic jam and in traffic accident alerts.

2.2.3 Challenges Of Vanet

The nature and characteristics of VANET forces some challenges for its deployment. It's important to address these challenges for the VANET to be installed. These challenges can be categorized into(Boukerche et al. 2008):

a. TECHNICAL CHALLENGES

The technical problems that raise the technical issues which should be removed before the deployment of the network. These challenges are:

- Network management: the high nodes mobility in the network leads to frequent changing in its topology and channel condition. Therefore, a structure of the network like a tree is hard to be made. Due to this feature of the network, challenges in network management arise.
- Collision and congestion: the constant changing of network density crates technical issues. For example, the number of nodes in urban region in mornings and the end of a working hours is higher than when it's night which there occurs collision and congestion in the network.
- Impact of the environment: the fact that VANET communicate using electromagnetic waves the obstacles in the environment can affect these waves which it considered as a technical issue.

- Security: VANET’s safety applications are important to save humans lives therefore, it is critical challenge to ensure the messages shared within the network are secured.
- Variable routing protocol: it is difficult to design a routing protocol for a network with such challenging features where the high mobility and the constant changing topology make exchanging messages a critical issue.

b. SOCIAL AND ECONOMIC CHALLENGES

For the deployment of VANET, there is another issue apart from the technical issues which is the economic and social issues. The fact that purchaser information about location and movement can be known in such a network, it can be rejected by the purchaser due privacy concerns. Therefore, it is difficult to persuade manufactures to invest in such network.

2.2.4 Types Of Communication In Vanet

Within VANETs, all nodes communicate with others via either voice or messaging. Communications in a VANET are necessary for providing current reports to every vehicle in the VANET’s area that are shared between vehicles. To supply precise data, such schemes need seamless communications delivered through positioning protocols and devices. Efficient protocol suites are required, due to the unreliability of shared communications media as well as bandwidth constraints in the provision of effective and secure messaging between vehicles(Zeadally et al. 2012). The three main classes of communications deployed in VANETs are:

a. VEHICLE-TO-VEHICLE COMMUNICATIONS (V2V)

These comprise multi-hop, multicast methods that are utilised for sending reports associated with roadway traffic situations through multiple series of hops. With ITS, every vehicle requires critical data for upcoming directions, such as emergency messaging associated with collisions, massive traffic jams, or environmental hazards. Forwarded messaging in V2V comprises two classes: naive and intelligent broadcasting.

Naive-based broadcasts are involved when vehicles are broadcasting messages at regular intervals. Other vehicles that receive these broadcasts will ignore them if the messages come from behind, while accepting messages coming from their front, for further relay to automobiles after them. The constraint of naive-based broadcasting is in its huge messaging broadcasts, wherein messaging collisions increase, delivery ratios decrease, and delivery times conversely increase.

Intelligent broadcasts resolve the problems of naive-based broadcasting by implementing advantageous acknowledgement methods, wherein the quantity of messages can be restricted during emergencies. Vehicles that detect emergency events and receive the same message from either front or after vehicles will not re-broadcast the message on the presumption that the vehicle coming after it will re-broadcast the messages and so on, given that the vehicles behind are assigned the responsibility for re-broadcasting the message.

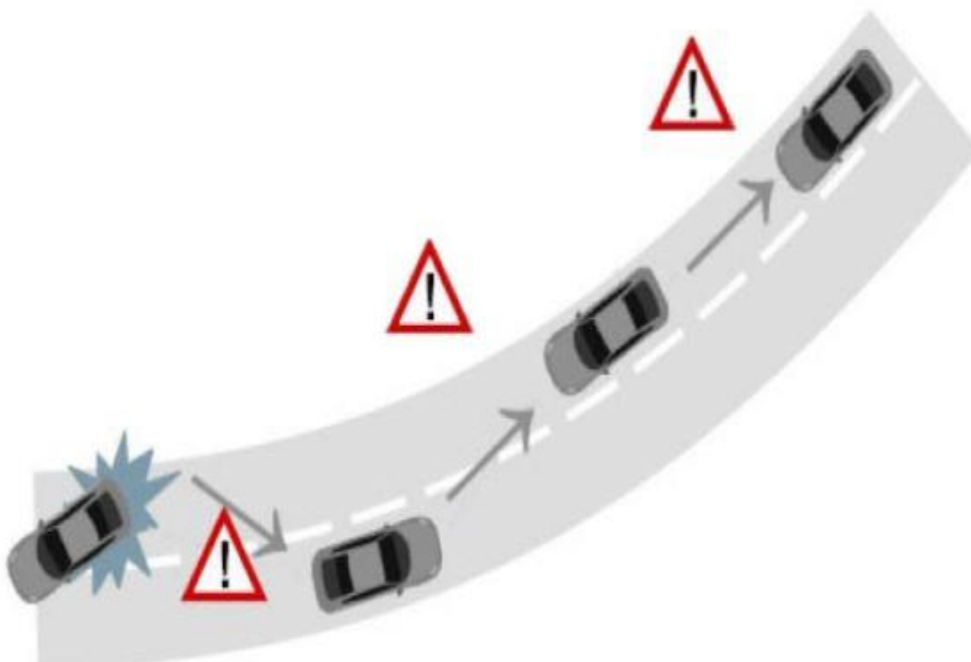

Figure 2.2 V2V communications(Zeadally et al. 2012)

b. VEHICLE-TO-ROADSIDE COMMUNICATIONS (V2R)

Communications that occur between a vehicle and RSUs through single-hop broadcasts are termed V2R communications. As such, RSUs forward message broadcasts to every vehicle that can network through them, provisioning high-bandwidth connections between RSUs and each vehicle. The RSUs can be sited anywhere, i.e. for every kilometre or so, but these can provide high-bit-rate data in heavier traffic as well. Using the broadcast of speed limits as an example, RSUs will determine the applicable limit via their internal traffic condition and time tables. Occasionally, an RSU will broadcast messages that involve those limits, comparing the directional or geographical limits of a vehicle to evaluate if it is going beyond the given limits, and then transmit vehicular alert messages to it along with requests to lower speed.

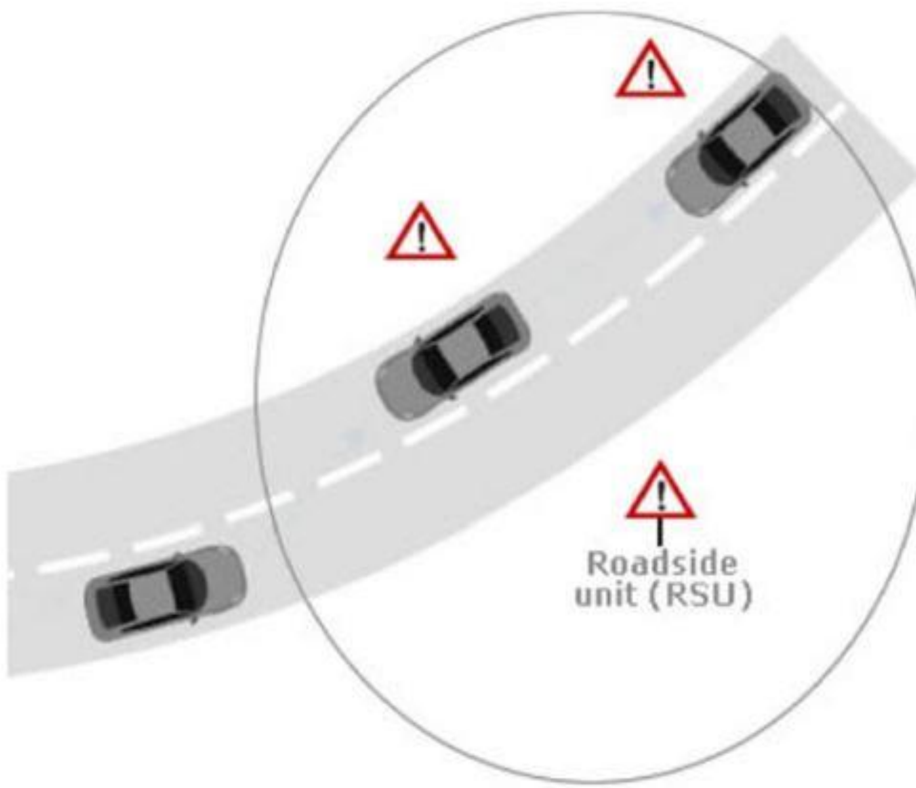

Figure 2.3 V2R communications(Zeadally et al. 2012)

c. INTER-ROADSIDE COMMUNICATIONS

Communications that occur between local RSUs and to the main RSUs are termed inter-roadside communications. Depending on retrieval requirements with the RSUs, vehicles will send their respective mobile information to their local RSUs, which then forward the information to the main RSU via multi-hop routes. When vehicles need to send their information to others via end-to-end deliveries along these inter-roadside routes, the RSUs that are in range of the transmitting vehicles will quickly forward the information to other RSUs until the information reaches a final RSU that is within range of the target vehicle. Such information is typically sent via routes representing minimums of hops and costs. The final RSUs then forward the information to the destination vehicles.

2.2.5 Intelligent Transportation System

This is a term that generally characterises the techniques used in transport frameworks for effectively regulating traffic composed of all types of transport, such as road, rail, water, and air. The ITS system coordinates intra-modal and inter-modal transmissions of necessarily critical information between every vehicle, thus expanding overall the degree of mobile security as well as upgrading vehicular productivity and lowering environmental impacts. This directly reduces the overall cost of roadway and vehicular maintenance and also general fuel consumption. Intra-modal transmissions involve streams of information between every vehicle of the same transport type, i.e. roadway-to-roadway, aviation-to-aviation courses, and the like(Zeadally et al. 2012).

Inter-modal transmissions involve streams of information among different types of transport, such as roadway-to-aviation, roadway-to-railroads, aviation routes-to-conduits, and so on. The system manages telemetry and communications that can comprise either vehicle-to-vehicle communications or some other modified system. Vehicles serving as ITS nodes work as receivers, senders, or switches at different times, sending various messages to a variety of vehicular types within the system or else to a centralised transport office that is accountable for handling safe and trouble-free traffic. For communications between each vehicle or among vehicles and the RSUs that alternate along both sides of the road, there will be coordinating radiofrequency transceivers in each vehicle that can enable hub vehicles to establish short-range remote ad hoc networks. Differential Global Positioning Systems (DGPS) and Global Positioning Systems (GPS) should be similarly installed in each vehicle to determine the positions of every vehicle.

Regarding present developments in ITS, projects that are being deployed globally are as follows:

- Continuous Air Interface Medium and Long-Range (CAML): This method attempts RSU and vehicular communications using disparate media types, such as cellular and infrared links as well as certain dedicated remote links. Implementations include vehicular and driver security, information streams among automobiles, and applications recognised as providing live on-road entertainment for drivers and other travellers(Msadaa et al. 2010).
- Dedicated Short-Range Communications (DSRC): The technique implements communications among vehicular nodes as well as certain fixed locations along roadways, such as the collection of electronic fees at tool booths or prepaid parking facilities at restaurants(Yin et al. 2004).

The Association for Intelligent Transportation System (AITS) of India is a non-profit organisation that aims to save time, money, lives, and the environment. Since 2001, it has been engaged in million-dollar projects to develop ITS in Indian cities with foreign assistance. Industrial and institutional research has joined with government initiatives to advance the project, according to a regulatory framework established by the government of India, in pursuit of its vision of deploying the most suitable as well as safest transport systems. Accordingly, every RSU must be sensibly sited to foster communications. The quantity, program, and budgeting of RSUs are strongly dependent on the kinds of roadways and protocols involved. For example, one role of the protocols may be to allocate every RSU evenly throughout the full length of a road. Some cases may require RSUs to be accessible at the borders of their transmission areas, while others may necessitate that certain RSUs be made available just for convergence.

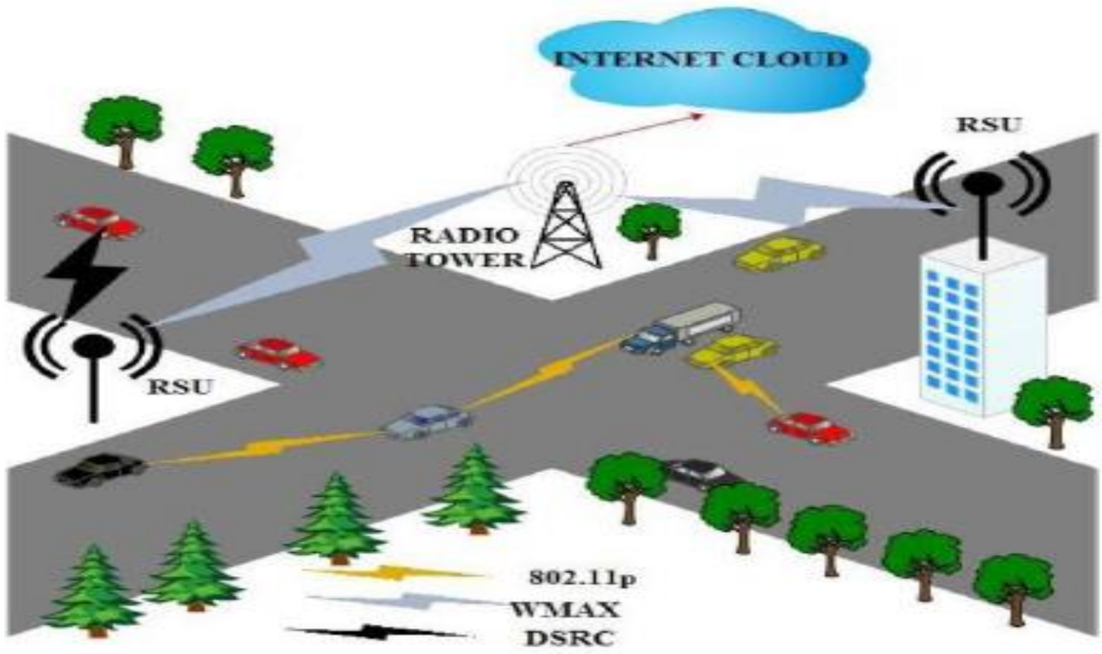

Figure 2.4 ITS scenario

2.3 TYPES OF ROUTING PROTOCOLS

Packet Routing schemes evaluate paths whereby data packets can be most efficiently forwarded so as to enhance bandwidth and delivery ratios as well as reduce latencies. This section examines vehicle-to-vehicle (V2V) packet routing. Various strategies for networking vehicles that are utilised in the propagation of information collected from vehicular traffic are subject to examination. Vehicle-to-vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Infrastructure-to-Vehicle (I2V) communications are anticipated to have a primary role in the evolution of smart city traffic management systems. The effectiveness of these types of communications is typically reliant on data propagation (routing) protocols. V2V routing of messages can enable numerous sources of data in order to enhance message handling. Figure 2.6 shows the classification of the routing protocols. They are classified into three major vertical and two horizontal categories. The vertical categories include: Flat, Hierarchical, and Geographic Position Assisted Routing, while the Horizontal categories include: Reactive, Proactive and Hybrid(Bae & Lee 2014).

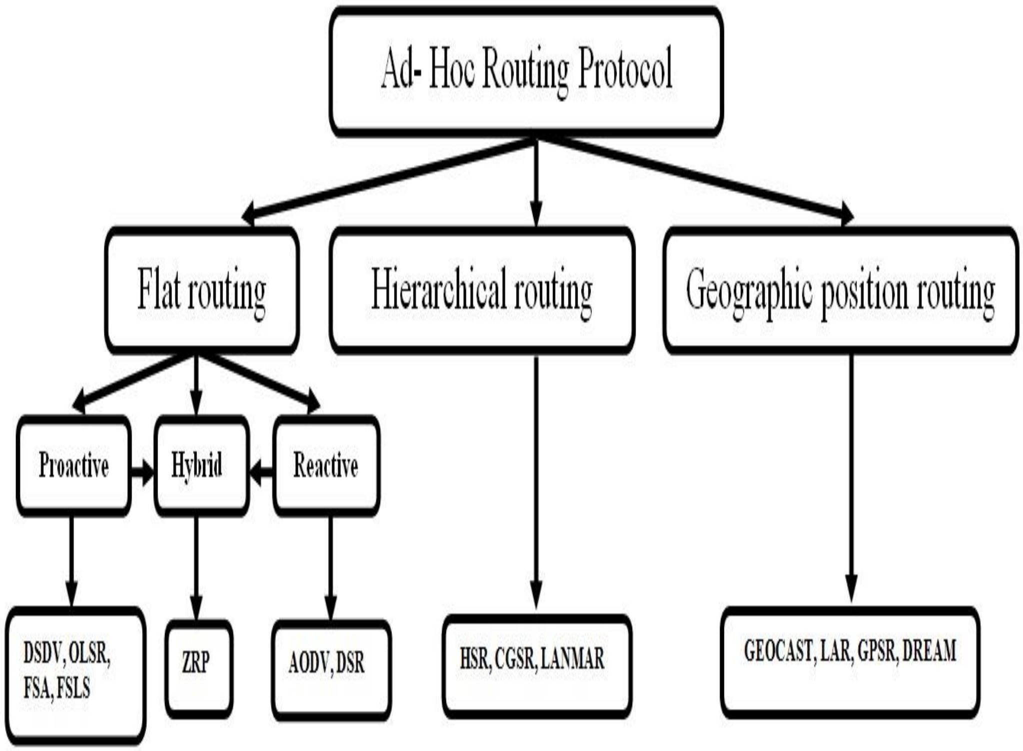

Figure 2.5 Classification of routing protocols

2.3.1 Flat Routing Protocol

Flat routing implies that every ad hoc and route element is to be evaluated in terms of the same analytic level, wherein every node is assigned similarly to tiers. Segregated networks that are split into levels or tiers are not allowed and, generally, there is no clustering of nodes groups. Consequently, flat routing protocol methods treat ad hoc networks as nodal groups that are not partitioned into subnets. Such protocols may be additionally categorised according to Proactive, Reactive, and Hybrid types.

a. PROACTIVE ROUTING PROTOCOL

Proactive-type routing protocols register paths for every network destination and are derived from conventional wire-line protocol methods. With proactive routing, the routes to every destination are calculated ahead in order for the protocols to be supplied with full data regarding the topology,