CHAPTER ONE

INTRODUCTION

1-1 Preface

Vehicular networks are part of mobile adhoc networks, which enables vehicles to communicate with each other to exchange information required by providing a network of self-organizing environment without needing a fixed infrastructure or centralized management. In the future it is expected will use VANET networks across the compounds in a wide range due to the increasing number of vehicles equipped with communications technology. One of the important applications in VANET is safety, in case of occurrence of a collision between two vehicles with each other on the highway it is necessary to notify the cars coming in this way ,the occurrence of this incident at the earliest so as to avoid the collision and congestion .

 The main performance goal in the deployment of warning messages is high reliability, rapid spread. It is difficult to achieve these goals due to the different traffic density.

" the traffic information generally has a broadcast-oriented nature"[11],Prefers to use the broadcast protocol instead of using unicast protocol Guidance in disseminating information on traffic, Because the benefits of a group of users, rather than a single user, and feature core protocol broadcast that is the vehicle does not need to know the vehicle address they want to send a particular piece of information and this leads to the cancellation of the complexity of Topology in mobile networks, such as VANET[11]

.

A major contrast between these two types of protocols is in the way that the information packets are spread in the network. In multi-hop broadcasting, a packet propagates through the network by way of flooding. In single-hop broadcasting, vehicles do not flood the information packets. Instead, when a vehicle receives a packet, it keeps the information in its on-board database. Periodically, each vehicle selects some of the records in its database to broadcast. The the single-hop broadcasting protocols is divide into two categories, which are the fixed broadcast interval protocols and the adaptive broadcast interval protocols. While the main focus of the fixed broadcast interval protocols is only on the selection and aggregation of information, an adjustment of broadcast intervals is also taken into consideration in the adaptive broadcast interval protocols.

1-2 Problem Statement

One of the most determinant factors in the dissemination process is the topology of the road map that affects the average distance between the sender and the receiver, as well as the different obstacles .

Another critical factor is packet collisions caused by simultaneous forwarding, usually known as broadcast storm (packet collisions caused by simultaneous forwarding) .

Also high delay problem is a major problem facing vanet network

1-3 Proposed Solutions

This project presents reliable and optimal message Dissemination protocol. In order to ensure high reliability and optimal Dissemination a combination of two broadcast mechanism are proposed the first one is a

Geocast mechanism to carry out the solution of broadcast storm problem and Over head problem by using adaptive broadcast , and the second is to reduce the delay by using clustering flooding mechanism .

1-4 Objectives

The main objectives of this research is that the dissemination protocol proposed should be able to :

1- Send many safety messages simultaneously with low delay .

 2- Achieve optimal and reliable message Dissemination.

This is objective can be achieved by divided the vehicles in the road in subgroups (cluster), by Implement new protocol called optimizing cluster protocol (OCG) using MATLAB as tool to simulate and carryout the result.

1-5 Methodology

 In order to implement vehicular Networks parameters, equations and relations to get results, MATLAB environment is used as a simulation tool.

 The methodology implemented in this thesis is the vehicles in road divide in subgroup (cluster) each group have coordinator vehicle ,head vehicle, tail vehicle, and slave vehicle. the coordinator vehicle is accountable to make cluster ,the cluster contain all vehicles in transmission range of coordinator vehicle (R). The first step in create the cluster is the process of selection coordinator, this process doing according to it is speed ,location and position. The Speed of coordinator vehicle must be medium ,location at middle of all vehicles and the direction in direction of traffic flow ,that means the coordinator vehicle is the vehicle that has smallest value of d_i

,where the d_i is minimum distance of summation (summation of distance between the vehicle in the position j and vehicle in the position i for all values of n) ,where n is the number of vehicles in the transmission range of coordinator , after the process of selecting a coordinator vehicle is complete ;the coordinator vehicle select the head and tail vehicles according to the distance between it and each vehicles(head ,tail),the coordinator vehicle is check if the distance is maximum distance (T_i, H_i) respectively to head and tail distance, then check if the vehicle is in the same direction of flow ,if yes this is vehicle is becoming a head vehicle ,else is becoming a tail vehicle. After determine the head and tail vehicles the all other vehicles is becoming slave vehicles(the vehicles is not coordinator, head or tail).

1-6 Thesis Outlines

The structure of this Master Thesis will be written as follows:

Chapter two : is on some basic background of vehicular ad hoc networks ,technologies of VANETs, application of VANETs ,and standers of VANETs.

Chapter three :is on main scenarios to be tested and metric to be used in the research

Chapter four: is provides results from a metric that adjusted and discussion about the results.

Chapter five: is summarized the idea of this thesis and recommendation for future work.

CHAPTER TWO

LITERATURE REVIEW

CHAPTER TWO
LITERATURE REVIEW

2-1 Vehicular Ad Hoc Networks

Vehicular Ad hoc Networks (VANETs) belong to a subcategory of traditional Mobile Ad hoc Networks (MANETs). The main feature of VANETs is that mobile nodes are vehicles with sophisticated "on-board" equipment, traveling on constrained paths (i.e., roads and lanes), and communicating with each other via Vehicle-to-Vehicle (V2V) communication protocols, and between vehicles and fixed road-side Access Points (i.e., wireless and cellular network infrastructure), or Vehicle-to-Infrastructure (V2I) communications [13].

"Future networked vehicles represent the future convergence of computers, communications infrastructure, and automobiles .Vehicular communication is considered as an enabler for driverless cars of the future".

"VANETS are considered as one of the most prominent technologies for improving the efficiency and safety of modern transportation systems. For example, vehicles can communicate detour, traffic accident, and congestion information with nearby vehicles early to reduce traffic jam near the affected areas. VANETs applications enable vehicles to connect to the Internet to obtain real time news, traffic, and weather reports. VANETs also fuel the vast opportunities in online vehicle entertainments such as gaming and file sharing via the Internet or the local ad hoc networks"[15].

"Applications such as safety messaging are near-space applications, where vehicles in close proximity, typically of the order of few meters, exchange status information to increase safety awareness"[13],and traffic and

congestion monitoring require collecting information from vehicles that span multiple kilometers. The aim is to enhance safety by alerting of emergency conditions. Applications for VANETs are mainly oriented to safety issues (e.g., traffic services, alarm and warning messaging, audio / video streaming and generalized infotainment, in order to improve the quality of transportation through time-critical safety and traffic management applications, [14]). At the same time, also entertainment applications are increasing (e.g., video streaming and video-on-demand, web browsing and Internet access to passengers to enjoy the trip)[13].

"Non-safety applications are expected to create new commercial opportunities by increasing market penetration of the technology and making it more cost effective. Moreover, comfort and infotainment applications aim to provide road travelers with needed information support and entertainment to make the journey more pleasant. They are so varied and ranges from traditional IP-based applications (e.g., media streaming, voice over IP, web browsing, etc.) to applications unique to the vehicular environment (e.g., point of interest advertisements, maps download, parking payments, automatic tolling services, etc.)"[13].

 In general, we can distinguish between intra and inter-vehicle communications. we can used the term of intra to describe communications within a vehicle, while inter vehicle communication is used to describe the second one represents communications between vehicles, or vehicles and sensors, placed on any different locations, such as roadways, signs, parking areas, …etc. Inter-vehicle communications can be considered to be more technically challenging because vehicle communications need to be supported   when vehicles are stopping or moving. a small electronic

transmitter can be used to provide a prepaid or automatic billing system when a vehicle slow down instead of stopping at atoll booth. the integration of cameras and speed sensors are another example used for determining the speed of the vehicle [17].

Quality of service provided in a VANET is strongly affected by mobility of vehicles, and then dynamic changes of network topology. Different classes of vehicles can move in VANETs, depending on: traffic conditions (i.e., dense and sparse traffic), speed limits in different and also type of vehicles. in general vehicles in VANET move at higher speeds when compared to traditional mobile nodes in MANETs[18].

"All these unique features let VANETs well fit into the class of opportunistic networks that means the network behavior is changing and connectivity availability is not always satisfied. As a typical example, in order to maintain network connectivity in VANETs, it is a common technique to connect vehicles traveling on the roadway in opposite directions by means of opportunistic connectivity links. This situation is described as bridging technique" [16]. Figure (2-1) show the vehicular ad hoc networks, It follows that interconnectivity and seamless connectivity issues in vehicular ad hoc networks represent a challenge for many researchers. Solutions based on both horizontal and vertical handover procedures have been largely investigated in recent works [15].
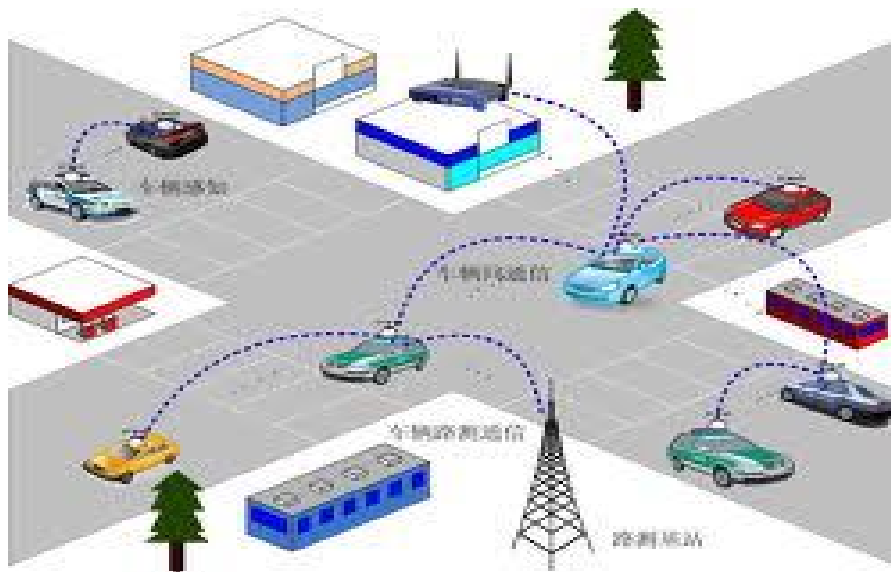
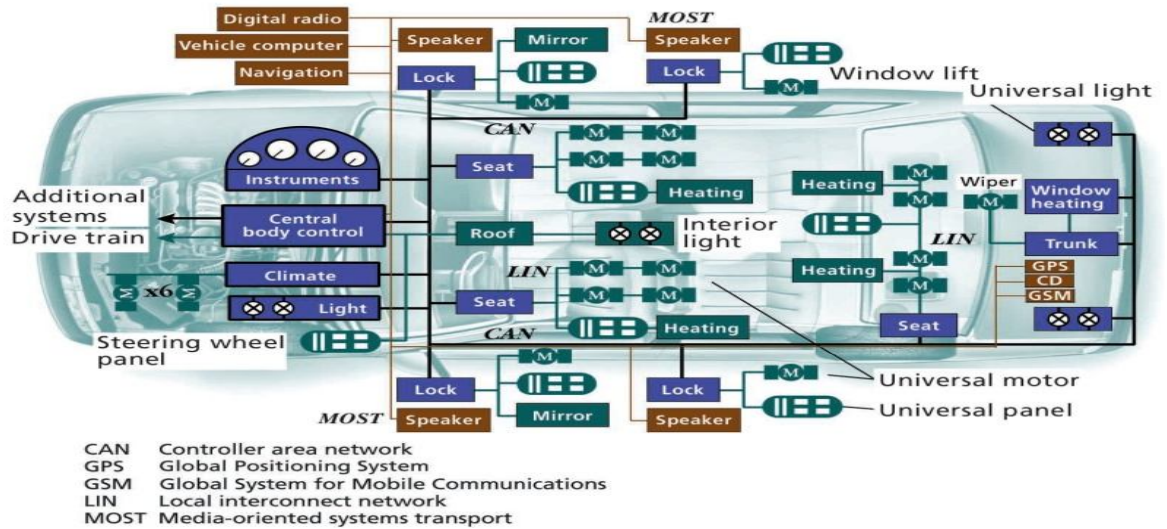Figure(2-1): Vehicular Ad hoc networks[24]

2-2 Smart Vehicles

In the next years, vehicles will be equipped with multi interface cards, as well as sensors, both on board (e.g., UMTS, IEEE 802.11p, Bluetooth, etc.)and externally. With an increasing number of vehicles equipped with on-board wireless devices and sensors (e.g., radar, etc.), efficient transport and management applications are focusing on optimizing flows of vehicles by reducing the travel time ad avoiding any traffic congestions. On board vehicle radar can be used to sense traffic congestion and determine accruing of crash if air bags were deployed, and then to relay this information via V2V or V2I As an instance, the on-board vehicle radar could be used to sense traffic congestions and automatically slow the vehicle. In other accident warning systems, sensors are used to determine that a crash occurred if air bags were deployed; this information is then relayed via V2V or V2I within the vehicular network[13].

"Particularly, for the brake systems, there are also the parking brake and the antilock brake system. The parking brake, which is also referred to as an emergency brake, controls the rear brakes through a series of steel cables. This allows the vehicle to be stopped in the event of a total brake failure. Moreover, also vehicle-mounted cameras are largely used to display images on the vehicle console"[13].

"The basic idea of smart vehicles is addressed to safety issues, and then by a proper combination of functionalities like control, communications, and computing technologies, it will be possible to assist driver decisions, and also prevent wrong driver's behaviors" [25]. "The control functionality is added directly into smart vehicles to connect the vehicle's electronic equipment. The technology used for control should take into account the need of limit vehicle weight; as a matter, the added wiring increases vehicle weight, and weakens performance. It has been proven that for an average well-tuned vehicle, every extra 50 kilograms of wiring —or extra 100 W of power— increases fuel consumption by 0.2 liters for each 100 kilometers traveled" [13].

Based on such considerations, today control and communications in a vehicular ad hoc network counter the problems of large amounts of discrete wiring. the Figure (2-2) show the sheer number of systems and applications contained in a modern vehicle's network architecture.

CAN   Controller area network
GPS   Global Positioning System
GSM   Global System for Mobile Communications
LIN   Local interconnect network
MOST   Media-oriented systems transport

Figure(2-2): number of systems and applications contained in a modern vehicle's network architecture[13]

LEDs are commonly used in automotive and infrastructure lighting (i.e., brake and traffic lights, as depicted in Figure (2-3), there remain key challenges to achieving effective modulation and communication between devices, especially while they are moving or in the presence of sunlight.

2-3 Technology of VANETs

"Several technologies are involved in Vehicular Ad hoc Networks, especially as enablers of Intelligent Transportation Systems (ITS). These are GSM, UMTS, Wi-MAX limited Wi-Fi and a new and specific technology thought for this kind of applications, namely Wireless Access in Vehicular Environments (WAVE), also known as IEEE 802.11/p" [13]. This implicitly suggests that a car should have on board different radio interfaces (and/or network card). About WAVE, it is member of the IEEE 802.11 family, this implicitly suggests that this solution (currently at the

stage of draft) is borrowed from IEEE 802.11 and adapted for the vehicular context.

"The use of GPS (and, more in general, the GNSS) unit within the vehicles allows knowing the vehicles' positions. The awareness of precise locations is very important to every vehicle in VANET so that it can provide accurate data to its neighbors. Currently, typical localization techniques integrate GPS (GNSS) receiver data and measurements of the vehicle's motion"[13].
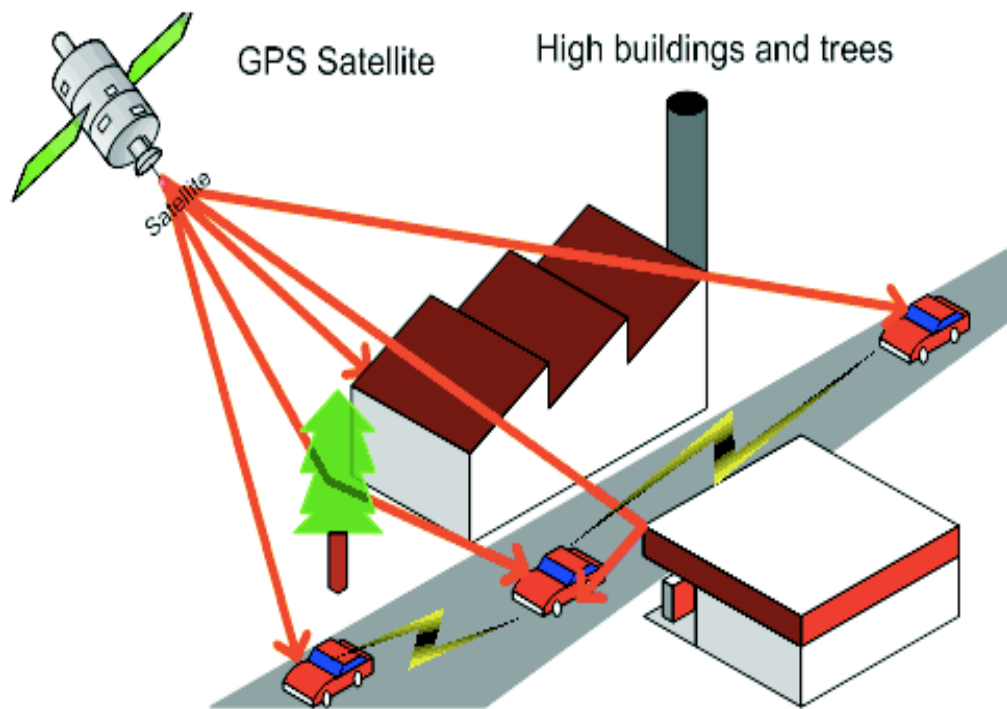
Figure(2-3): Satellite (GPS System) [13]

The use of satellite (GPS system) for outdoor localization. However, multipath effect affects the accuracy, [29].

"GPS is a positioning system developed and operated by the U.S. Department of Defence. A GPS system is formed from a network of satellites that transmit continuous coded information, which makes it possible to identify locations on Earth by measuring distances from the satellites. At the same time, the receiver has the ability to obtain information about its velocity and direction"[13].

With respect to VANET, many techniques have been proposed to the use of GPS as a localization technique, as shown in Figure (2-3).

2-4 Standards of VANETs

"Within the IEEE Communications Society, there is a Technical Subcommittee on Vehicular Networks & Telematics Applications (VNTA). The charter of this committee is to actively promote technical activities in the field of vehicular networks, V2V, V2R and V2I communications, standards, communications-enabled road and vehicle safety, real-time traffic monitoring, intersection management technologies, future telemetric applications, and ITS-based services"[19].

2-5 Applications of VANETs

Vehicular applications are typically categorized in : active road safety applications which aims to avoid the risk of car accidents and distributing information about hazards and obstacles to make driving safety, traffic efficiency and management applications this category focus on optimizing flows of vehicles by reducing travel time and avoiding traffic jam situations. Applications like enhanced route guidance/navigation, traffic light optimal scheduling, and lane merging assistance, are intended to

optimize routes, while also providing a reduction of gas emissions and fuel consumption.[13]

The applications regarding safety are strictly tied to the main purpose of vehicles: moving from a point to a destination. Car collisions are currently one of the most frequent dead causes and it is expected to become the third cause till 2020 . "This leads to a great business opportunity for infotainment, traffic advisory service, and car assistance" [13].

Safety applications are always paramount to significantly reduce the number of accidents, the main focus of it in the first place is to avoid happening of accidents.

"Dealing with the use of V2I architecture, the access points should gather information (e.g., alarms for quick speed changes), coming from different vehicles, and merging data so reducing the signaling from the vehicles. The V2V has the drawback of not allowing a quick communication if the vehicles are far away from each other (e.g., in low traffic density scenarios), while the V2I is more energy consuming since it should be on all the time" [13].

The LCA application constantly monitors the area behind the car when passing or changing lanes, and warns the driver from vehicles approaching from the rear or in the next over lane. This application has two different modalities, the first one is called the passive mode," while the other one is the active mode. In the passive mode the vehicle simply measures distances, by means of detection and ranging procedures, while in the active mode it communicates to the other vehicles that they are too close, so they should change their direction / behavior"[22].

2-6 Related Works

In this section, we provide an overview of some recent works that take data dissemination in vehicular networks. The motivation to develop specific dissemination protocols in this area is that traditional approaches for general mobile ad hoc networks (MANETs) are not suitable in such a highly dynamic environment [7].

The author in [5],proposed protocol called Anovel Autonomic Dissemination Method (ADM),this protocol sends message according to priority and density of traffic. The goal of this protocol is to make radio resources more effective use in case of sending many message as the same time. ADM allows any vehicles to send message according to priority of message .

A Content-Based Dissemination Protocol for VANETs: Exploiting the Encounter Probability in [3] is proposed .the protocol has ability to broadcast data about any event by setting agreeable weights for the different factors that will be affect to computation of the encounter probability. In[10],the author make evaluation and analysis of broadcast routing protocol in a VANET, also taking into account end to end delay .the simulation show the throughput is better . A trade-off among an increased throughput and decreased end-to-end delay.

In [9], Optimized Dissemination of Alarm Messages (ODAM) is proposed, this proposed protocol is limited rebroadcast of vehicle in risk zone without taking any advantage of vehicles located outside these zones .the simulation show when the transmission range is less than 200 meter the reliability is

not 100% . Furthermore, the new vehicles may not be notify due to the short broadcast period($\Delta\theta$), which generates useless overhead.

abiding geocast (AG) protocol is proposed in [6],the aims of this proposed protocol is to send any information about any event(accidents or congestions) to all vehicles before they arrive the warning line. In this protocol vehicles on same direction of roads carry safety messages to vehicles in the opposite direction of road periodically .when the vehicle receive message this is periodicity is change .the disadvantage of this protocol cannot ensure reliability In sparse networks.

Optimized Abiding Geocast is proposed in [7],(OAG),the goal of this protocol to actualize optimal time period that can ensures high reliability, limited delay and low overhead. this protocol proposed the vehicle that will become relay vehicle (vehicle receiving message) first must verify its position in report with the sender . If it is away than the sender, it begin to implement the DDT (Distance Defer Transfer) algorithm to see if it is the away vehicle from the sender or no. In case of two or more vehicles have the same distance from the sender they are becoming relay vehicles at the same time to the sender designate them self as relay at the same time , this lead to crashes .

CHAPTER THREE
MESSAGE DISSMINATION IN VEHCULAR NETWORKS

CHAPTER THREE
# MESSAGE DISSMINATION IN VEHCULAR NETWORKS

3-1 Proposed Protocol for Message Disseminations

The proposed protocol exploit the vehicles in the road in to sub groups (cluster). there are different types of vehicles in any cluster that depend to it is position and speed on cluster.

The proposed protocol assume that Each cluster in the VANET have unique identifier ID this ID is the medium access control address (Mac address) of coordinator vehicle and each node have unique identifier ID is the Mac address of itself, vehicles equipped with embedded computers, table of messages class, GPS receivers and are aware of their position and have two channel: channel one to communicate inside cluster and channel two to communicate with other cluster, Also the road is considered as bilateral. and unidirectional radio antennas of range R.

There are three types of vehicles : the first one is a coordinator vehicle and the seconded and third vehicles are relay vehicles(head vehicle and tail vehicle) ,and the rest of vehicles in cluster work as slave vehicles .

Figure(3-1) show the OCG protocol how it work .the vehicles in the road divided in cluster as shown in figure(3-1) the blue vehicle is coordinator, amethystine vehicle in the direction of flow is head vehicle and the vehicle in the opposite direction of flow is tail vehicle, yellow vehicle is the coordinator vehicle ,the circle with gray color is the transmission range of coordinator and the grid rectangular shape is the vehicle cluster and the distance between two vehicle cluster is the gab region.
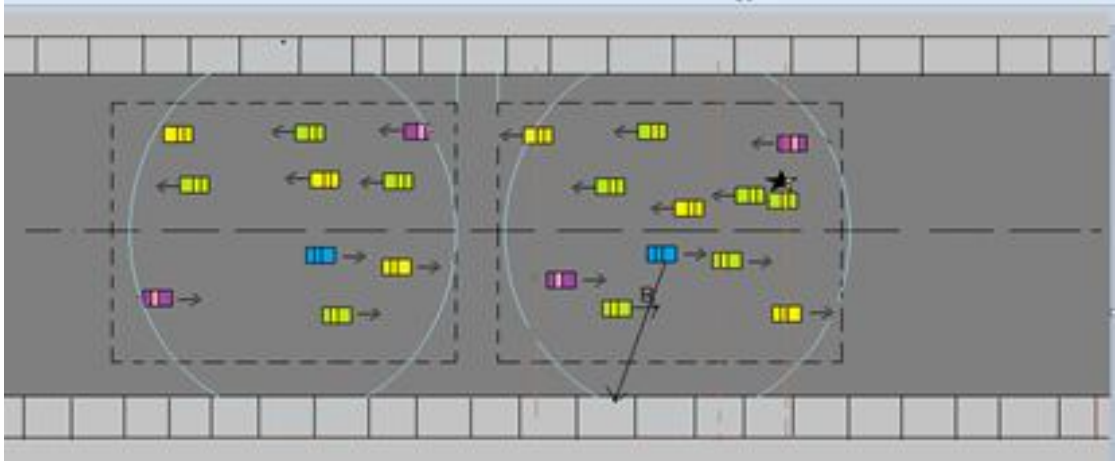
Figure(3-1):broadcast scheme model

🟡 **Slave vehicle**

⚪ **transmission range**

🟣 **Head and Tail vehicles**

🔵 **Coordinator vehicle**

⬚ **Vehicle cluster**

The Head node{vehicle}: is the vehicle at bounder of the cluster or has been leaving the cluster in front.

The Tail node {vehicle}:is the vehicle leaving the cluster in opposite direction .

3-2 Election Process

The election process is the process that determine the coordinator ,head and tail vehicles; according to their speeds, locations and directions.

3-2-1 Coordinator Election

the election of the cluster coordinator based on speed, direction and location.

The speed must be medium speed , direction in the direction of flow, and location at the middle of vehicles. That means the vehicle with smallest value of d_i is the coordinator vehicle. the rule to calculate the distance d_i is :

$$d_i = \min\left(\sum_{j=1}^{n} D_{ij} \right) \longrightarrow \qquad (3\text{-}1)$$

where

D_{ij}=the distance between vehicle i and vehicle j

$$D_{ij} = P_i \text{-} P_j \qquad \longrightarrow \qquad (3\text{-}2)$$

P_i=position of vehicle i

P_j =position of vehicle j

n=number of vehicles in cluster

Figure (3-2)shows how the coordinator vehicle determine, the figure (3-2) assume there is five vehicles and between each two vehicles distance equal normal distance(N),the distance d_i for vehicle i is determine as shown in equation(3-1) above.
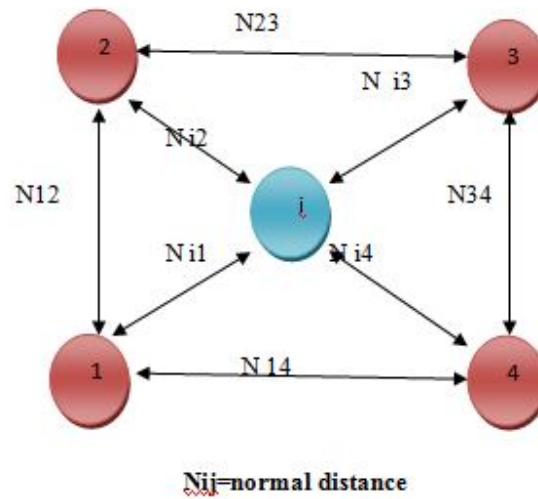

Nij=normal distance

Figure (3-2): selection of coordinator vehicle

🔴 Slave node(j:j=1——n:n=4)

🔵 Coordinator vehicle

3-2-2 Head Election

the election process of head vehicle is depend on direction and location of vehicle. the direction of vehicle must be in direction of flow and location in the front of the cluster at the bounder ,the head vehicle must be with the maximum value of distance H_i , T_i distance determine by equation(3-3) is the maximum distance between coordinator vehicle and vehicle to be tested .

$$H_i=\max(P_i\text{-}P_c) \longrightarrow \qquad (3\text{-}3)$$

P_i=position of the vehicle i

P_c=position if coordinator vehicle

3-2-3 Tail Election

the election process of tail vehicle is same to the election process of head vehicle expect the direction of vehicle must be in the opposite direction of flow direction, and location at the tail of cluster ,this node must have the maximum distance from coordinator T_i,as shown in equation(3-3).

$$T_i= \max(P_i\text{-}P_c) \longrightarrow \qquad (3\text{-}4)$$

P_i=position of the vehicle i

P_c==position if coordinator vehicle

3-3 The Dissemination Scheme Flow Chart

Figure (3-3) shows the dissemination scheme flow chart. At first time when the vehicle(node) receiving message it calculate the distance between self and other vehicles (d_i) if the result is equal to min($\sum_{j=1}^{n} D_{ij}$) as shown in equation number(3-1) ,then the vehicle become a coordinator vehicle(node) and scheduling all vehicles (nodes) in a cluster ; if else it

will be check to see the direction of the vehicle, in this case we have two cases: the first case is the direction of vehicle in the same direction of flow? if yes the vehicle will be check the distance H_i as own in equation (3-3) if equal maximum distance between it and coordinator the vehicle become a head vehicle and rebroadcast message, other wise ignore message and end.

Second case :the vehicle is in the opposite direction of the flow direction in this case the vehicle determine the distance between it and coordinator if is equal to maximum distance to distance T_i as shown if equation(3-4) the vehicle is being a tail vehicle and rebroadcast message; other wise it ignore message and end.
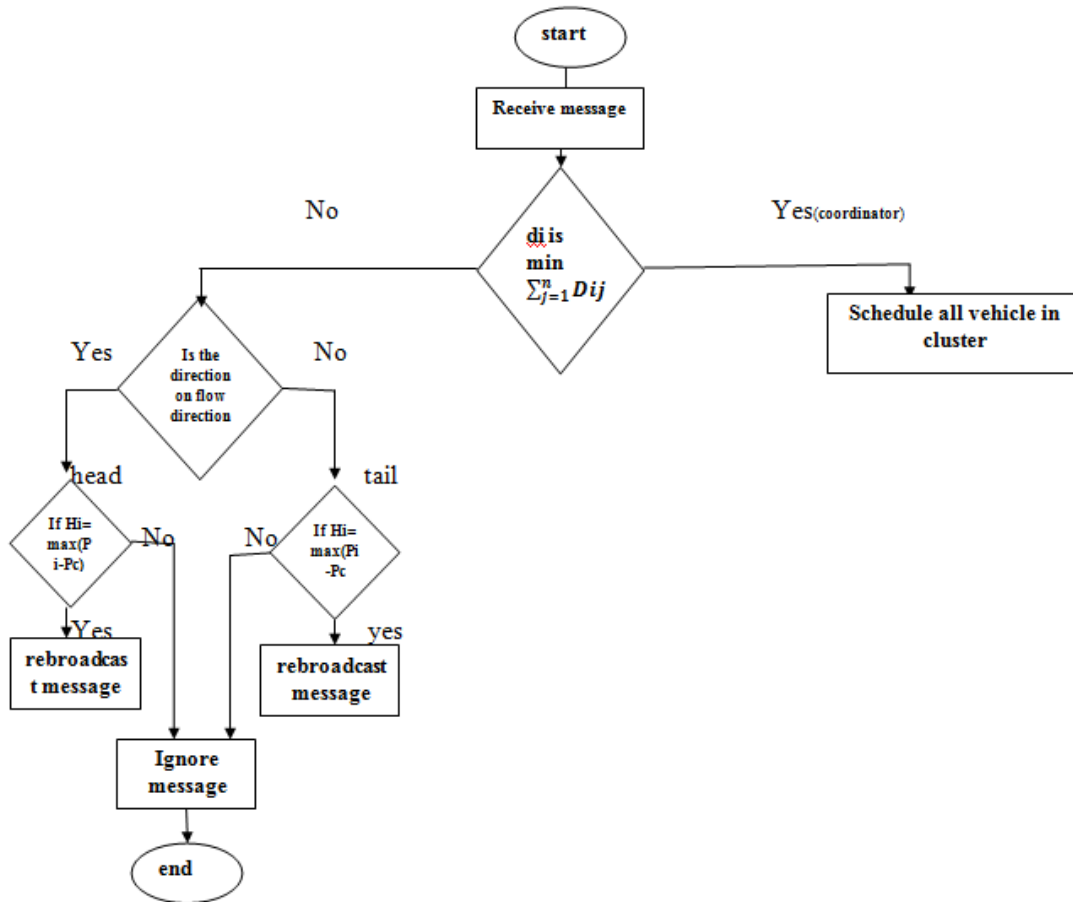

Figure(3-3): dissemination scheme flow chart

3-3-1 The Coordinator Flow Chart

Figure (3-4) show coordinator flow chart .After selecting coordinator , head and tail vehicles .the next step is to continue the tasks as vehicle type. the first vehicle is a coordinator vehicle, at beginning the vehicle check if it receive message is this case have two cases; the first case :the vehicle is check if actual had received message ,look at the table and check if it is still a coordinator ?if yes then set the message class , send it, and return to idle state. if it is not a coordinator select new coordinator ,disable channel two ,send class A message (as shown in appendix E) and return to idle.

Second Case : if the coordinator   vehicle is not receive message it will check that if is it time slot if actual is time slot it make the step in the first case, If is not a time slot then the vehicle wait one time slot and go to idle.
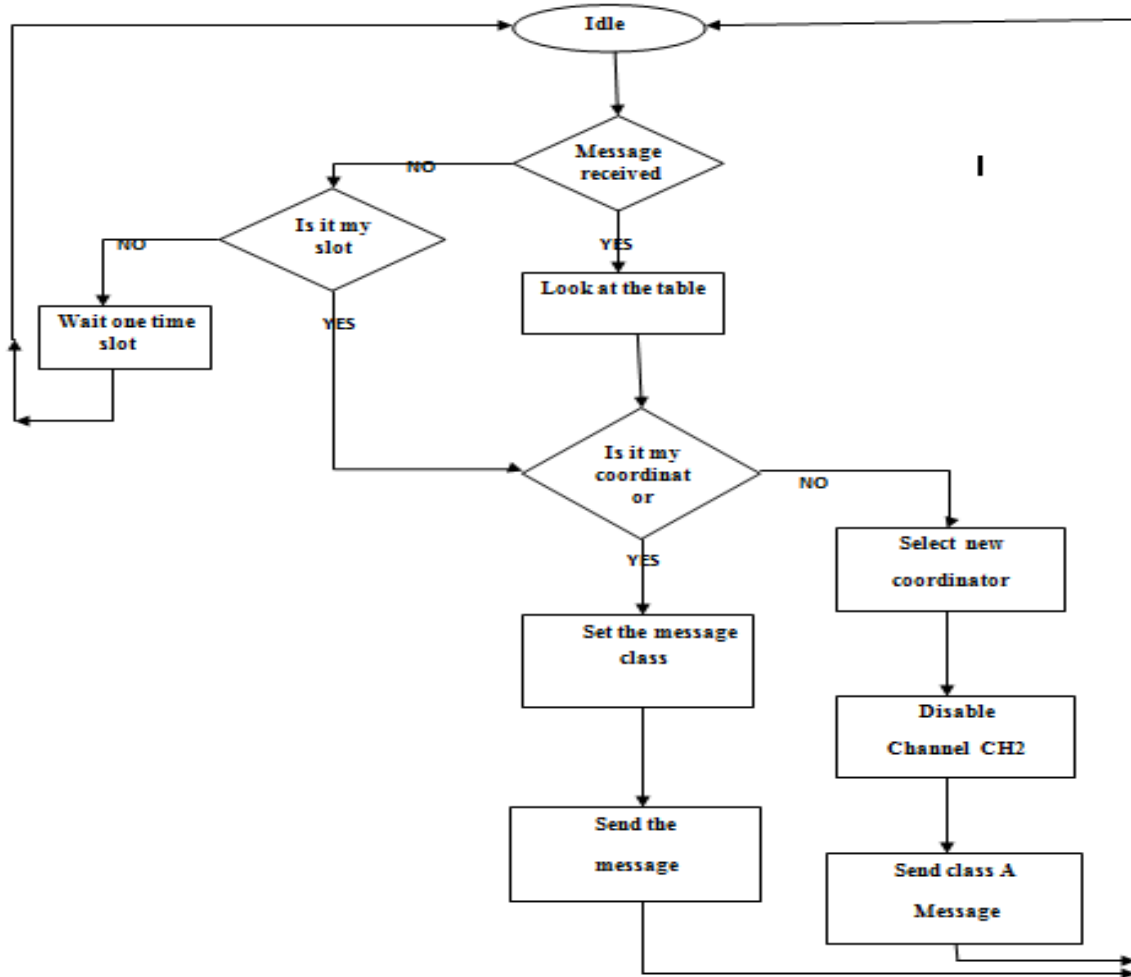
Figure(3-4): coordinator flow chart

3-3-2 The Head Flow Chart

Figure (3-5) show the head flow chart .at the beginning, The head vehicle check if received message. The first case if the head vehicle is not received   message in this case the head vehicle check is it a time slot to send or not if yes, send message to next cluster using channel two.

Case two : if the head vehicle actual receiving message then is check if is in the cluster(old cluster ID=new cluster ID) in case of equalize the

old and new cluster ID check that is a cluster coordinator vehicle control (CCVC)message if yes is response to control message and end .if is not a cluster coordinator vehicle control message update it is table and run the step in the first case (receiving message).
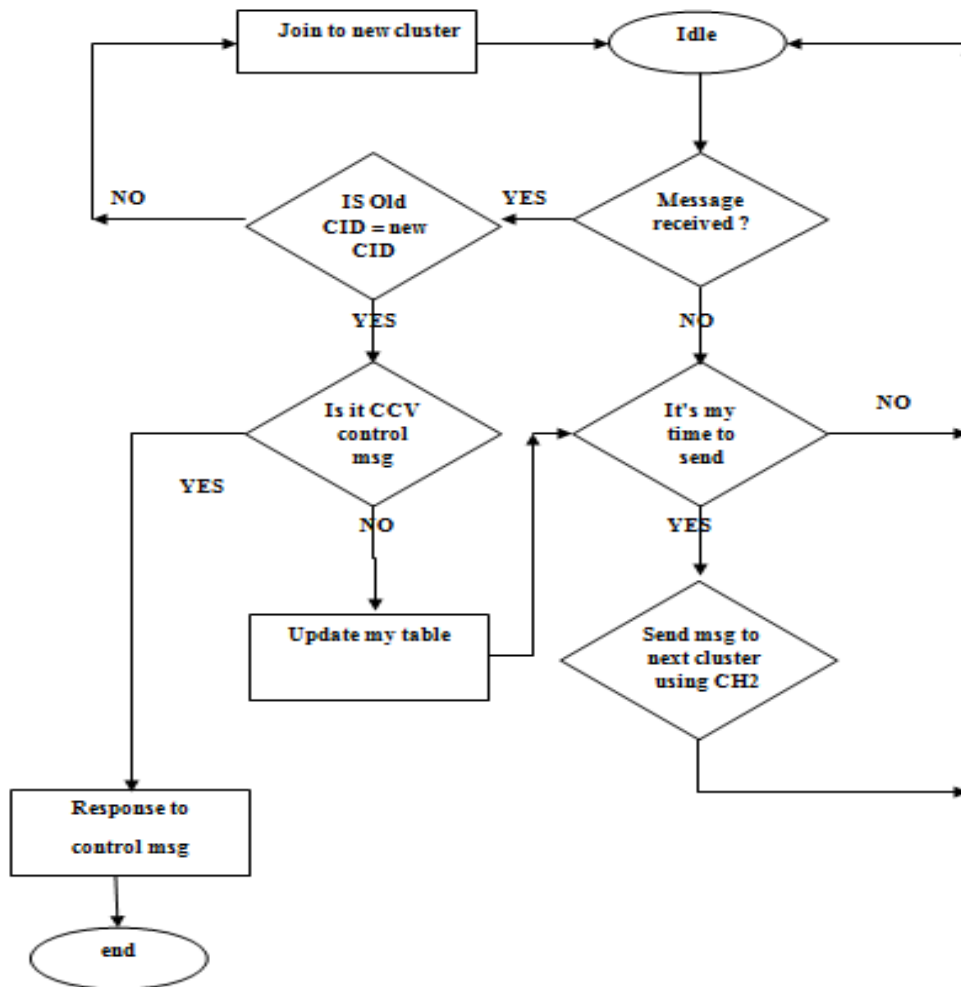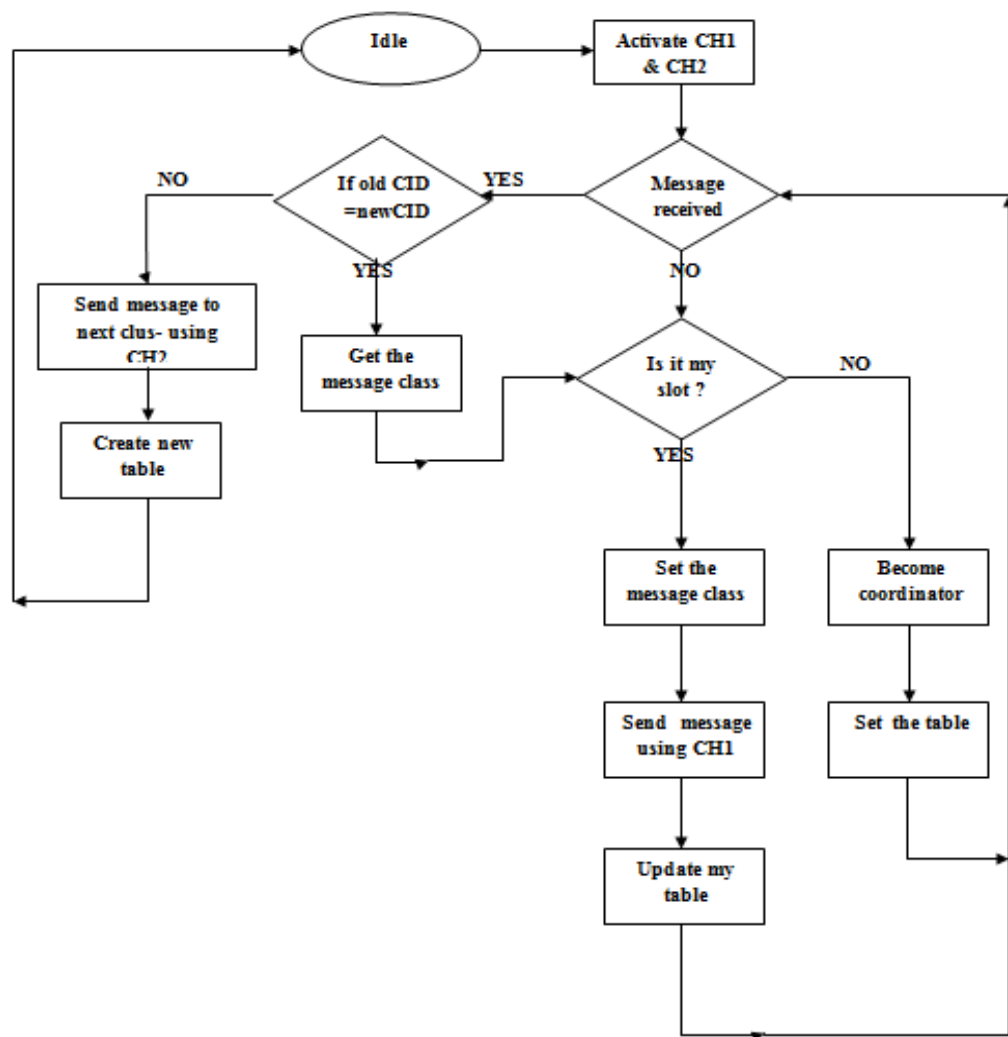

Figure(3-5): Head vehicle flow chart

3-3-3 The Tail Flow Chart

Figure(3-6) show the tail flow chart. When the vehicle is becoming as tail vehicle the first step is to enabling channel one and channel two after that check if received message? in the first case if the vehicle tail is not received message ,check is this time slot or not if yes set message

class, send message using channel one , update is table and go to check receiving message again. and if is not a time slot is become coordinator vehicle ,set it is table and go to check receiving message.

The second case: if the tail vehicle actually received message, check that if the old Cluster ID= new cluster ID if yes get message class and run the steps in first case. if not equalize(old Cluster ID ,new Cluster ID) send message to new cluster using channel two , create table and go to idle.
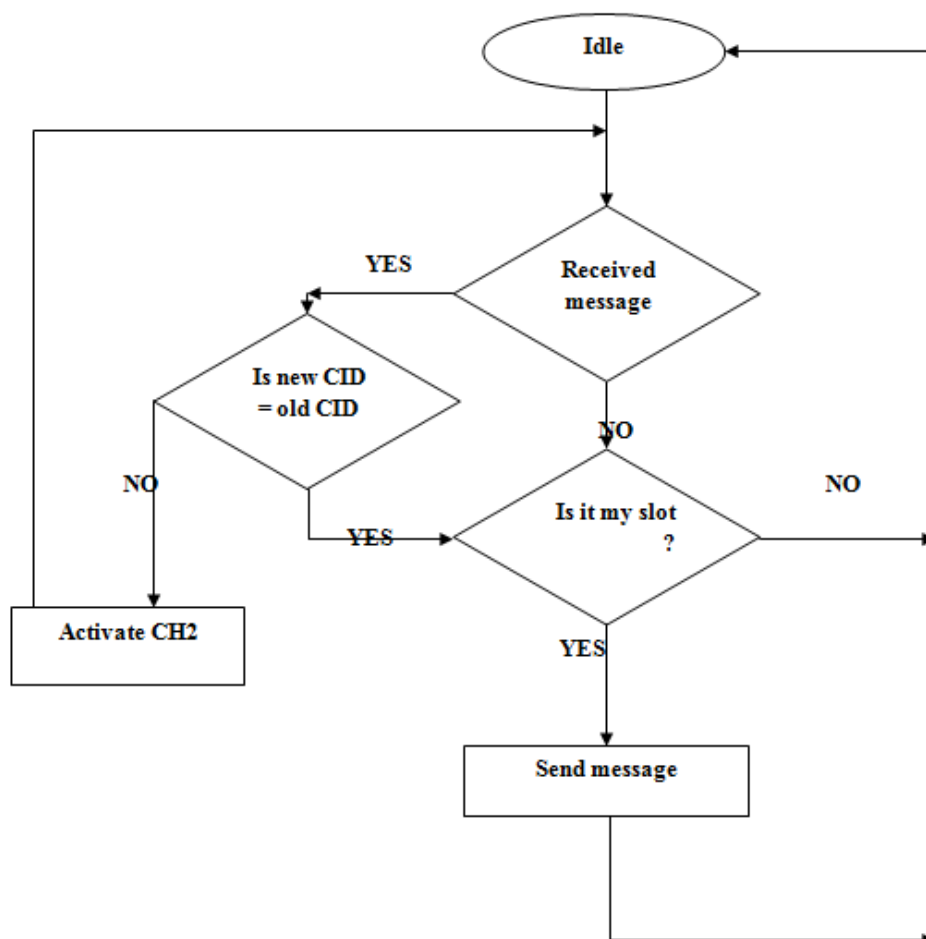
Figure(3-6): Tail vehicle flow chart

3-3-4 The Slave Flow Chart

Figure (3-7) shows the slave flow chart. the first step the vehicle check that is it a coordinator vehicle ,header or tail vehicles ;if not one of that vehicles it become a slave vehicle. the slave vehicle first is check if receive message: first case: if not Received message check is it a time slot if yes send message and go to idle.

Second case: if actual received message check is new CID=old CID if yes the vehicle run the steps as show in first case, if not equal(new CID ,old CID) activated channel two and go to check the received message.

Figure(3-7): Slave vehicle flow chart

3-4 Simulation Model and Parameters

In This thesis MATLAB is used as simulation tool of the proposed protocol with other parameters shown in table (3-1).

In the simulation 20 to 200 mobile nodes move randomly in bidirectional highway with one lanes per direction . this thesis assume that each vehicle move at a speed ranging between 18km/h to 80km/h.

The simulation experiments are conducted using two protocols: Optimized Abiding Geocast [OAG] protocol and our proposed protocol Optimal Clustered Geocast (OCG) .

Table(3-1):show parameter of simulation

Simulation parameter	Value
Simulation	MATLAB
Topology size	1500m*1500m
Transmission Range	250m
Bandwidth	2MHz
Traffic type	CBR
Packet Size	100bytes

3-4-1 Average Delay

Average Delay for OCG Is define as the end-to-end delay averaged over all delivered data packets for each source/destinations pair. the equation (3-5) show the delay is proportional with the transmission range of vehicle ,that means if the transmission range increase the delay is increase ,and if the transmission range decrease delay decrease

$$Delay(ED) = \frac{nR}{ETT*(n+1)*L} \longrightarrow \qquad (3\text{-}5)$$

Where:

n =the number of vehicle(nodes)

R =the transmission range

L=bandwidth of the link

ETT=expected transmission time

$$ETT = \frac{S}{L} \longrightarrow \qquad (3\text{-}6)$$

Where:

S =size of packet

L=bandwidth of the link

The Average Delay for OAG is determinate through the equation(3-7).

$$delay = \frac{\sum_{i=1}^{A} T_i}{A} \longrightarrow \qquad (3\text{-}7)$$

Where:

T = the time when approaching vehicle i was informed

A = the number of informed approaching vehicles.

3-4-2 Data Overhead

Data Overhead for OCG protocol define as the ratio of the number of data packets transmitted by all nodes to the number of data packets received at the destinations. the equation (3-8) can used to determine the overhead of OCG it shows that the overhead is proportional with the number of vehicles transmit(transmit and retransmitte) but the number of retransmit vehicle is constant and maximum equal three (from 1 to 3)

$$overhead = \frac{N_t + N_{re}}{N_r} \longrightarrow \qquad (3\text{-}8)$$

Where:

N_t= number of vehicles transmit

N_{re}= number of vehicles retransmit(rebroadcast)

N_r=number of vehicls receive

Data Overhead for OAG protocol is represents the number of broadcasted messages during the lifetime of the emergency. the lifetime of the event is 500s.the equation (3-9) determine overhead for OAG protocol is show overhead of OAG depend of number of transmit vehicles not on the receive vehicles

$$overhead = \frac{N_{tr}+N_{re}}{500} \longrightarrow \quad (3\text{-}9)$$

N_{tr}=number of vehicles transmit

N_{re}=number of vehicles retransmit

3-4-3 Network Reliability

Network Reliability for OCG protocol is define as the ratio of vehicles that receive the message to all the vehicles in ZoR (zone of R). equation (3-10) show the reliability of OCG is show the reliability depend on number of hidden vehicles and total number of vehicles

$$realibility = \frac{N_r}{N_{tot*(N_{hid}+1)}} \longrightarrow \quad (3\text{-}10)$$

Where:

N_r=number of vehicles receive

N_{tot}=number of vehicles in transmission range

N_{hid} = number of hiden vehicles

$$N_{tot=2*\beta*R} \quad - \longrightarrow \quad (3\text{-}11)$$

β=density of traffic(number of vehicles)

R=transmission range

$$N_{hid}=\frac{\beta*R}{8} \quad - \longrightarrow \quad (3\text{-}12)$$

Network Reliability for OAG in order to overcome network distribution of nodes over the area, the give a uniform distribution of the various value of relay vehicle has to broadcast the warning message defer time in [0, max-defer-time].The value of max-defer- periodically according to a period , The wait time of a relay vehicle for the next broadcast variable (that takes values of order ms) is calculated using equation (3-13) :

$$\theta = \frac{R + \left| cur_{loc} - saftyline \right|}{S_{max}} * \frac{2*R}{S_{max} + S_{self}} \underline{\hspace{3cm}} \qquad \text{-(3-13)}$$

where:

θ=wait time for a relay leaving or approaching the event

S_{max} = maximum allowable speed S .

S_{self}=vehicle speed

R = transmission range

cur_{loc} =current location

3-4-4 Data Delivery Ratio

Data Delivery Ratio for OCG is define as the ratio of the number of data packets received at the destinations to the number of data packets sent by the sources .the equation (3-14) shows the data delivery of OCG depend on the number of vehicles transmit and receive .

$$data\ delivery = \frac{N_r}{N_{t+}N_{re}} \qquad \underline{\hspace{3cm}} \qquad (3\text{-}14)$$

N_t= number of vehicles transmit

N_{re}= number of vehicles retransmit(rebroadcast)

N_r=number of vehicles receive

Data Delivery Ratio for OAG represents the ratio of the approaching vehicles that receive the message to the total number of approaching vehicles. the equation (3-15)show the data delivery depend on number of vehicles receives message .

$$\text{data } delivery = \frac{N_r}{N_{tot}} \qquad\qquad\qquad \text{(3-15)}$$

Where:

N_r=number of vehicles receive message

N_{tot}=number of total vehicles

CHAPTER FOUR
RESULTS AND DISCUSSIONS

CHAPTER FOUR

## RESULTS AND DISCUSSIONS

4-1 Performance with varied number of nodes
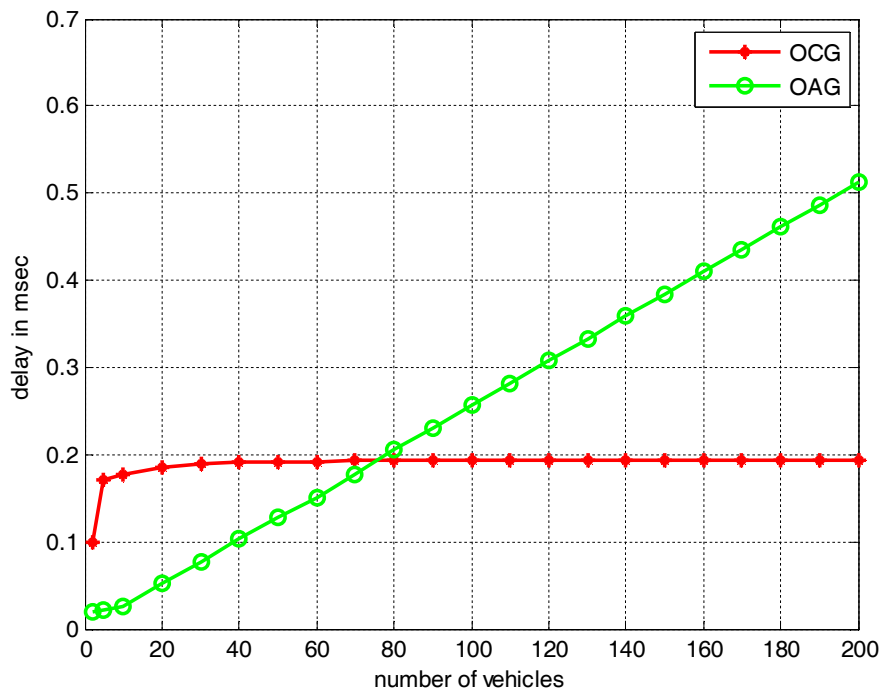
4-1-1 Average Delay

Figure (4-1)(see appendix A),compare the average end to end delay for different number of vehicles. The result shows that the delay in OAG protocol increase according to number of vehicles increase , this is fact because the OAG doesn't limit rebroadcast that is cause collision in network and the result of this appears in delay, OCG shows better performance is better than OAG due to limiting of rebroadcast and only vehicles allow to rebroadcast is coordinator, head and tail . also from the figure(4-1), the OCG delay appears approximately constant and doesn't effected by increasing of number of vehicles .

From the figure(4-1) the range of vehicle from zero to 90 the OAG delay is less than OCG because the OAG delay depend on density of traffic (number of vehicles) and OCG have cluster coordinator is task to divided the slots between vehicles with in transmission range.

The figures(4-1)a, b, c, d, e, shows the average delay (OCG) for different transmission range (R). The average delay(end to end delay) decrease when the transmission range decrease, and increase when transmission range increase because the delay in OCG depends on the transmission range of the coordinator vehicle.
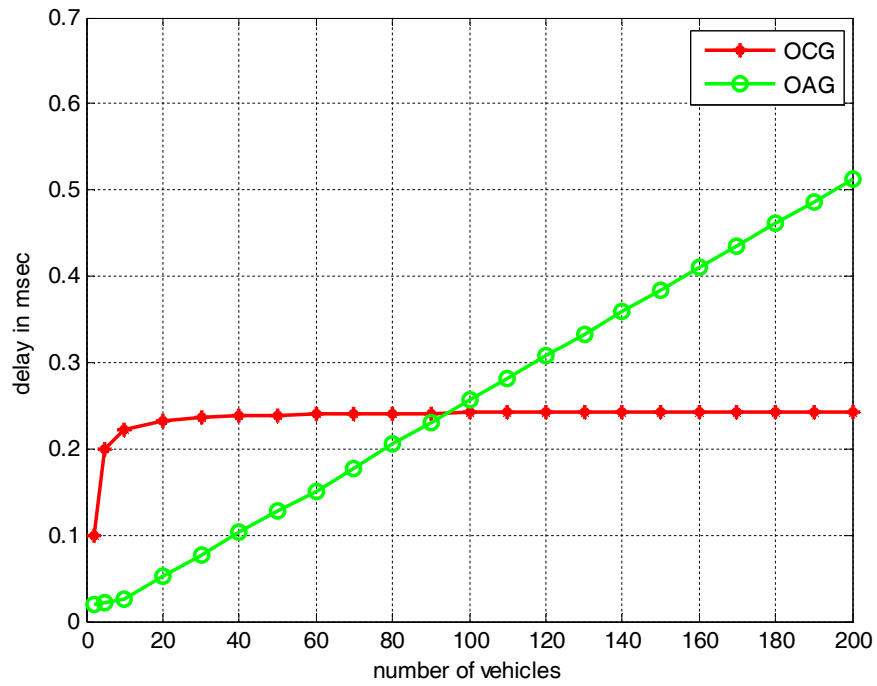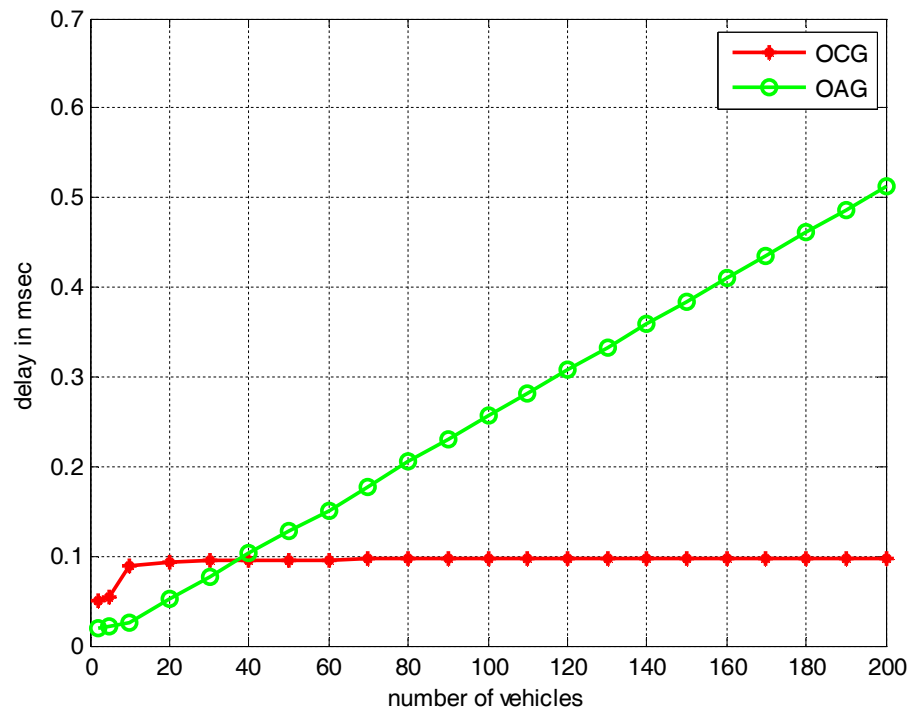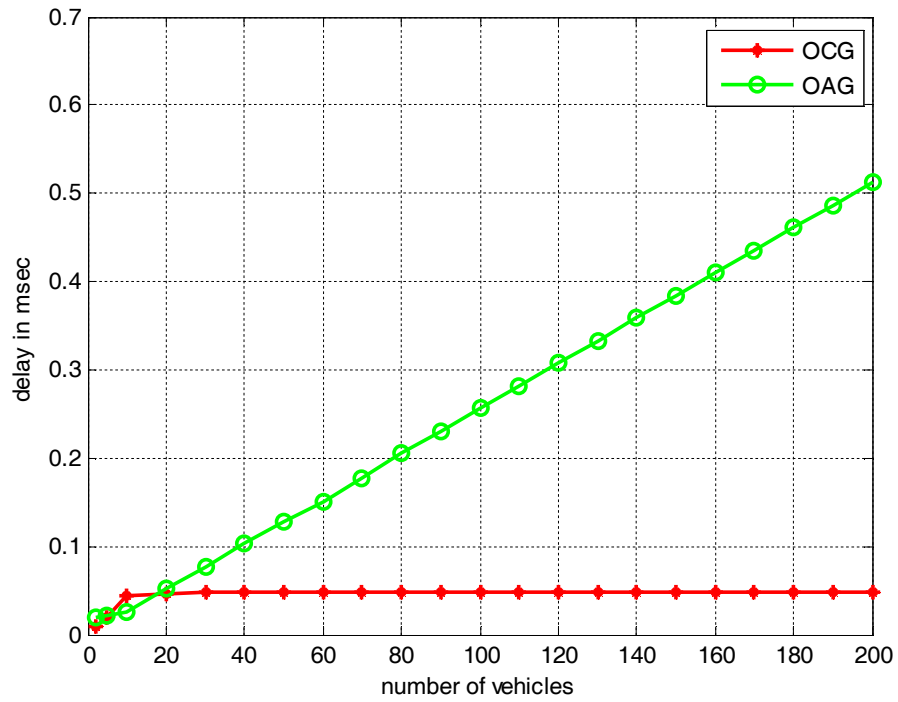
figure(4-1)a :average delay(R=250m)

figure(4-1)b: average delay(R=200m)
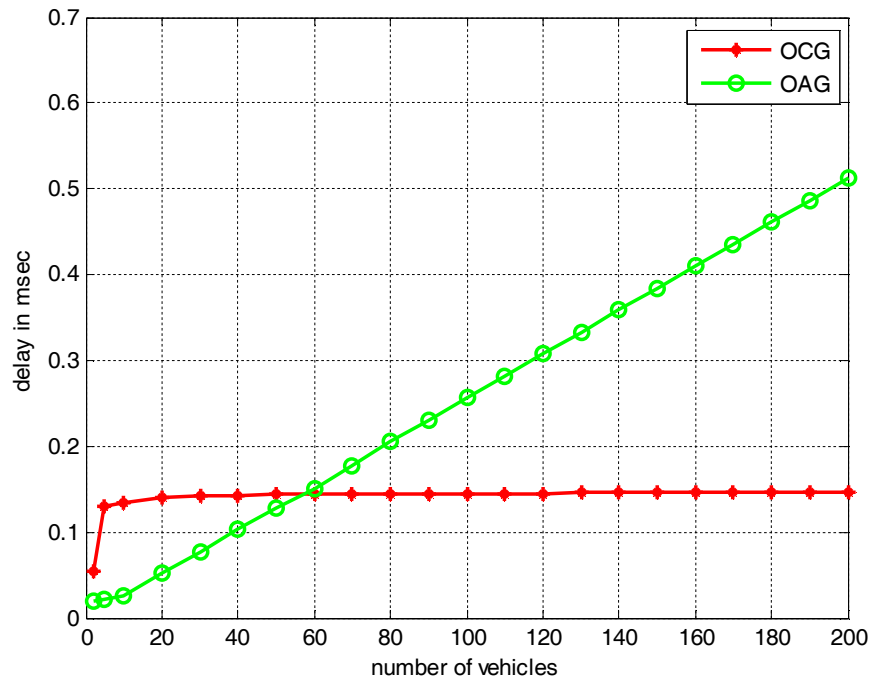
figure(4-1)c: average delay(R=150m)

figure(4-1)d: average delay(R=100m)

figure(4-1)e: average delay(R=50m)

Table (4-2) shows the comparison between OCG protocol and OAG protocol in average delay for different transmission range (R)

Table(4-2):average delay percentage in varied values of R

| Transmission Range In meter	Average Delay percentage
250	90%
200	93%
150	94.5%
100	96%
50	98%

From table(4-2) note that the average delay in OCG protocol depend on transmission range (R).the best transmission range that must use is in range (200-150) to get delay

4-1-2 Data Overhead

Figure(4-2) ,see(appendix B),compares the overhead data average for different number of vehicles.

OCG shows better performance(43%) than OAG for most numbers of vehicles . This is justified by the OCG limit the rebroadcast, and the OAG doesn't limit broadcast.

In OCG The rebroadcast message (cluster) is not increase after three and will not increase but may be decrease to one .The delay of OAG between (16-20)vehicles is small because the vehicles in OAG rebroadcast in low traffic density but the OCG still constant and doesn't increase than three even in high traffic density .
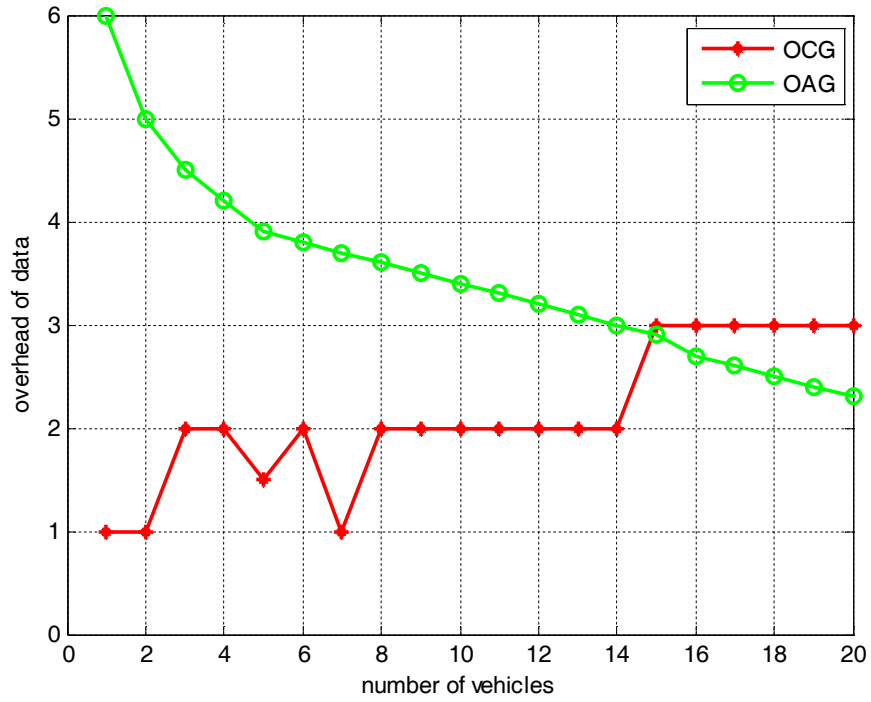
Figure(4-2):data overhead

4-1-3 Network Reliability

Figure(4-3),(see appendix C) compares the Network Reliability for different number of vehicles.

The OCG reliability is shows better than OAG because the OAG depend on relay vehicles to delivery data to other vehicles ,and in the OCG the coordinator vehicle is queried to delivery message to vehicles in the transmission range (cluster),head and tail vehicles is queried to delivery message to vehicles out of the cluster and this is confirm the message is delivery by high reliability.
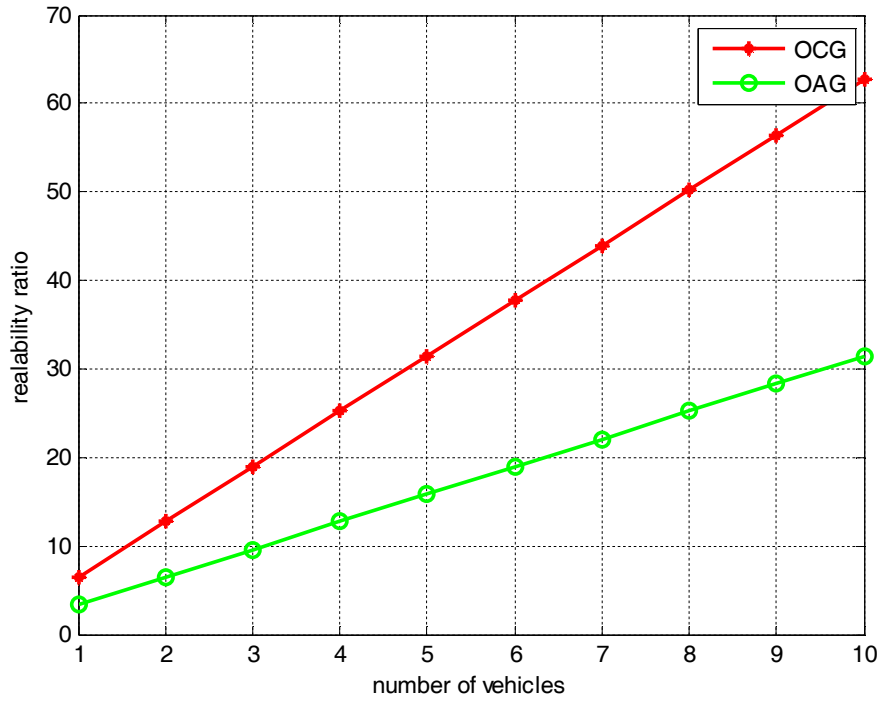
Figure(4-3) :reliability ratio

4-1-4 Data Delivery Ratio

Figure (4-4),(see appendix D) compares the message delivery rate for different vehicles densities. Figure(4-4) show the OCG have 100% delivery rate because the cluster coordinator is divided the time slot equals between all vehicles and ensure the delivered message for each vehicles, also We can remark that OAG achieve 100% delivery rate for all densities. This is justified by the relays availability in dense networks and by the initiator periodic broadcasts in sparse networks.
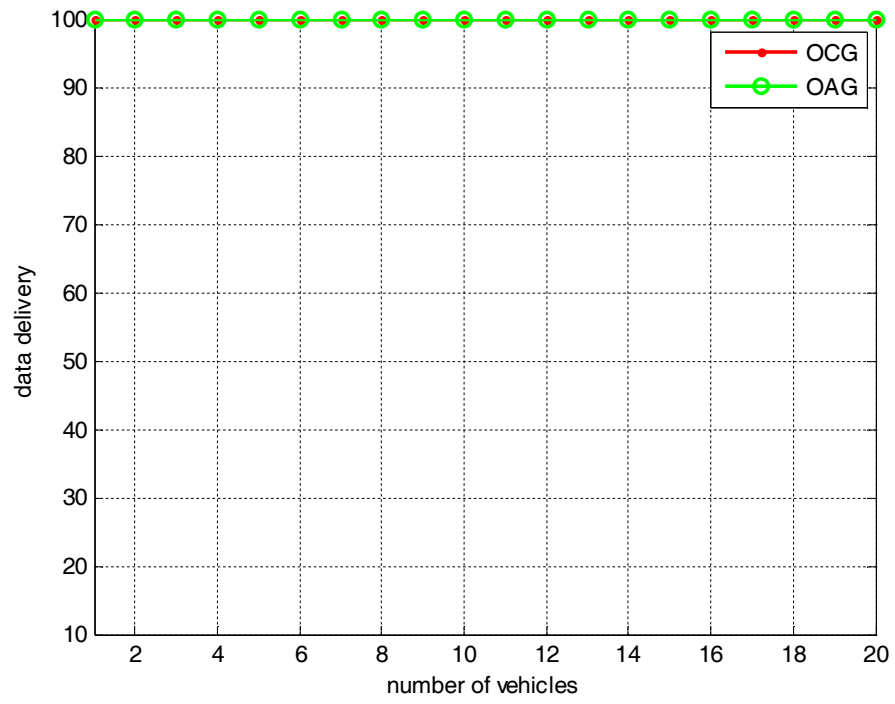
figure (4-4):data delivery ratio

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

The main ideas presented in the thesis are collected and summarized in this chapter and recommendation for future work.

5-1 Conclusion

In this project, we have proposed a method of how to make Reliability optimizing for message dissemination in vehicular network(VANET).

In this method, a combination of two broadcast mechanism are proposed the first one is a Geocast mechanism to carry out the solution of broadcast storm problem and Over head problem by using adaptive broadcast , and the second is to reduce the delay by using clustering flooding mechanism .the MATLAB simulation is used as tool of proposed protocol .

The proposed protocol Optimal Clustered Geocast protocol (OCG) will improve the latency by 90% and data delivery by 100%.

5-2 Recommendations

Safety applications in VANET provide a key role in ensuring road safety and Broadcast data dissemination is a key factor for safety and emergency applications.

I recommend in future research to do :

- In this thesis the delay is 90%,so must improve delay to be more accurate

- Find new approach to improve reliability of data and overhead .

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Appendices

Appendix A

Average delay code

```
n=[];
m=rand(1,200)
t=[m];
R=250;
l=2;
s=512;
ETT=(s/l)*2
for n=1:200
%EPD(n)=n*R/(ETT*(n+1))
delay(n)=1*(n*R/(ETT*(n+1)*l))
%throughput(n)=ETT*(n+1)*l/n*R

 y(n)=ETT/.2*n
end

plot(delay,'color','r','linewidth',2,'marker','.')
hold on
plot(y,'color','g','linewidth',2)
xlabel('number of nodes')
ylabel('delay in msec')
%axis([0 200 0.001  1])
grid on

hold
```

Appendix B

Overhead data Code

```
n=[];
m=[];
rand(3,.7)
f=1+rand(3,.7)

for n=1:20
   for m=1:20
     nr=3;
      x(n)=((n+nr)/m)
      k=x(n).*rand(20,1)
      r=k*2
      y(m)=((m+n)/500)
    z= y(m).*rand(1,20)
     g=z*20
   end
end

plot(r,'marker','.','color','r','linewidth',2)
hold on
plot(g,'marker','o','color','g','linewidth',2)

xlabel('number of vehicles','linewidth',5)
ylabel('reliability ratio')
axis([1 20 0 6])
grid on
legend( 'OCG','OAG', 'location', 'NorthEast');
```

Appendix C

Reliability Ratio Code

```
n=[];
m=[];
for i=1:20
    for m=1:20
        t(n)=500*n
h(n)=n*250/8
y(n)=1+h(n)
r(n)=n/t(n)*h(n)

x=n/r(n)
    end
end
plot(x,'marker','o','color','g','linewidth',2)
xlabel('number of vehicles','linewidth',5)
ylabel('reliability ratio')
axis([1 10  0 70])
grid on
legend( 'OCG','OAG', 'location', 'NorthEast');
```

Appendix D

Data Delivery Ratio Code

```
for i=1:20
   for j=1:20
   if i>=j
%r(i)=(i/(j+3))
r(i)=(i/j)*100
   end
p(i)=100
end
end
plot(r,'color','r','marker','.','linewidth',2)
hold on
axis([1 20  10 100])
plot(p,'color','g','marker','o','linewidth',2)
xlabel('number of vehicles')
ylabel('data delivery ')
grid on
 legend( 'OCG','OAG', 'location', 'NorthEast');
```

Appendix E

Message structure:

We have three classes of message :

1-classA message: It event or bad road condition message from coordinator

2-class B message: Its that message which send from any Internal vehicle to all vehicle inside the cluster , its format shown in the figure(1) below:

Figure(1):show class A message structure

Message hader		Warning information			Sender information					
Cluster ID	Message class	Event type	Event location	direction	Vehicle ID	location	directi on	speed	accelerati on	Send Time

Message header		Warning information				Sender information				
Cluster ID	message class	direction	safety Distance	time Limit	effect Distance	Vehicle ID	direction	speed	acceleration	Send time

Figure(2):show class B message structure

3-class C message: is message which send from any Cluster Front/Tail Vehicle (CFV) or (CTV) to all vehicles witch out of CCV range also to other cluster in its direction .

Message header		Warning information				Sender information				
Cluster ID	message class	direction	Event type	Event location	effect Distance	Vehicle ID	direction	speed	acceleration	Send time

Figure(3):show class C message structure