CLUSTER HEAD SELECTION FOR VEHICULAR AD-HOC NETWORKS USING DISTRIBUTED PARAMETERS

DISSERTATION-II

Submitted in partial fulfillment of
the Requirement for the award of the
Degree of

MASTER OF TECHNOLOGY
IN
Electronics and Communication Engineering
By

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December, 2017

CERTIFICATE

This is to certify that **Aneesh Doharey** bearing Registration no. **11616430** have completed objective formulation/Base Paper implementation of the thesis titled, **“**cluster head selection for vehicular ad-hoc networks using distributed parameters **”** under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of thesis has ever been submitted for any other degree at any university.

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ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude and appreciation to my guide Rajeev Kumar Patial**,** for his whole-hearted and invaluable guidance, inspiring discussions, encouragement, and support throughout my work. I found him always sincere in helping me even during his busiest hours of the day. His ardor and earnestness for studies are respected and will never be forgotten. Without his sustained and sincere effort, this report would not have taken this shape.

We are also indebted to all authors of the research papers and books referred to, which have helped us in carrying out the research work.

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DECLARATION

I, Aneesh, student of M. Tech under Department of Electronics and Communication of Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation-II report is based on my own intensive research and is genuine.

This report does not, to the best of our knowledge, contain part of my work which has been submitted for the award of my degree either of this University or any other University without proper citation.

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Abstract

Vehicular ad hoc network (VANET) is a prominent type of Mobile ad hoc networks (MANETs) in which network terminals are mostly road vehicles. It provides an efficient mechanism to enhance the safety for vehicle passengers, drivers and to the public and enables to improve traffic management techniques. It establishes distant communication between vehicles, roadside infrastructure units and traffic management centres. VANETs provide a great significance in accessing an enormous variety of applications to the vehicle passengers. With its increase in number of applications and services provided by it, it is also associated with an increase in susceptibility of vulnerable attacks in inter-vehicular communications and services resulting an increase in number of threats and security attacks. It has been evolved as operative field of exploration, standardization, and progress with an extreme capability to enhance road, vehicle and passenger safety, traffic efficiency, and ease as well as amenity to drivers, passengers, and public. This paper is dedicated to establish an organized and thorough summary of the previous research advances on various parameters of VANETs.

ABBREVIATION

VANET	**Vehicular ad hoc Network**
DTIS	**Distributed Traffic Information System**
RSU	**Road side Unit**
DSRC	**Dedicated short range communication**
TMC	**Traffic Message Channel**
V2R	**Vehicle To Roadside**
MRR	**Message Reception Rate**
TOs	**Task Organizers**
WAVE	**Wireless access in Vehicular Environment**
TIS	**Traffic Information System**
CTIS	**Cooperative Traffic Information System**
P2P	**Peer To Peer**
V2V	**Vehicle To Vehicle**
V2I	**Vehicle to infrastructure**
IFTIS	**Infrastructure-Free Traffic Information System**
SOTIS	**Self-Organizing Traffic Information System**
DTMon	**Dynamic Traffic Monitoring On**
RF	**Regular Forwarding**
DTR	**Dynamic Transmission Range**
VS	**Virtual Strips**
VM	**Virtual Machine**
TMC	**Traffic Management Centers**
SAC	**Store And Carry**

RCP	**Resource Command Processor**
SVA	**Slow Or Stop Vehicle Advisor**

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Chapter 1: Introduction

1. Vehicular Ad hoc Network: Advances in ad hoc wireless technology give rise to the outgrowth of vehicular ad hoc networks (**VANETs**). VANETs are a lead role of the intelligent transportation systems (ITS) framework and it is also called intelligent transportation network. This field rescued from the problem facing in vehicular network wireless communications among vehicles, vehicle to infrastructure and different number of protocols used in devices. Various forms of wireless communications technologies have been proposed for deploying VANETs. Wi-Fi (IEEE 802.11 based) technologies are the most commonly used for deploying VANETs. The vehicles are set up with wireless network interfaces which use the IEEE 802.11b or IEEE 802.11g protocols for accessing to the RSUs. Currently, **DSRC** (Dedicated Short-Range Communication), called also **IEEE 802.11p**, has been proposed as the communications standard specifically for VANETs. The main characteristic of the VANET is the infrastructure absence, such as access point or base stations, existing in the Wi-Fi, Wi-Max, UMTS. The Main problem occurs at the time of bandwidth usage because of large group of clusters are made and consumed more bandwidth from vehicle to vehicle information. Cluster based traffic information generalization in vehicular ad-hoc networks intends a new three steps approach for estimation of traffic volume in a road segment based on actual volume of wireless equipped vehicles. Vehicular ad-hoc networks(VANETs) provides various interesting features because of attracting applications such as collision avoidance systems, driving assistance systems etc. It allows people to access internet, share information to other people by making use of active data streaming. It secures and supports the exchange of data which permits applications that can save lives such as position based navigation applications, path combination based information applications etc. Exclusively it also provides various advantages such as de-acceleration warning, congestion detection, public safety applications, traffic management applications, traffic coordination and assistance applications, traveller information support applications, broadband services etc.

According to today’s scenario, traffic congestion is a very big problem which can be overcomes by using TISs (Traffic Information Systems) technology. Earlier technologies provide a very limited amount of bandwidth to traffic information system. Also these kind of drawbacks are overcome by CTISs (Cooperative traffic information systems) which will be discussed briefly in literature survey and using a new cluster algorithm which provide an proper consumption of bandwidth with better services.

Vehicular ad hoc networks(VANETs) provides various interesting features because of attracting applications such as collision avoidance systems, driving assistance systems etc. It allows people to access internet, share information to other people by making use of active data streaming. It secures and supports the exchange of data which permits applications that can save lives such as position based navigation applications, path combination based information applications etc. Exclusively it also provides various advantages such as; de- acceleration warning, congestion detection, public safety applications, traffic management applications, traffic coordination and assistance applications, traveler information support applications, broadband services etc.

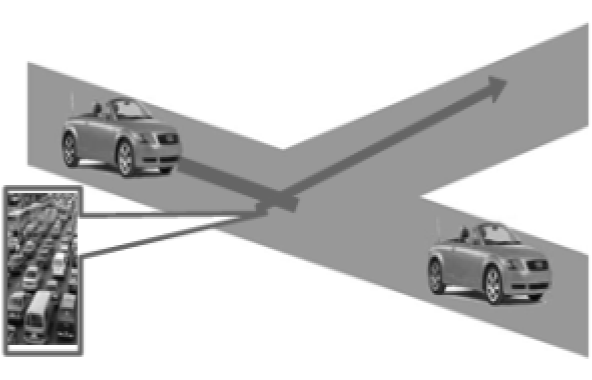

Figure 1.Congestion detection using VANETs

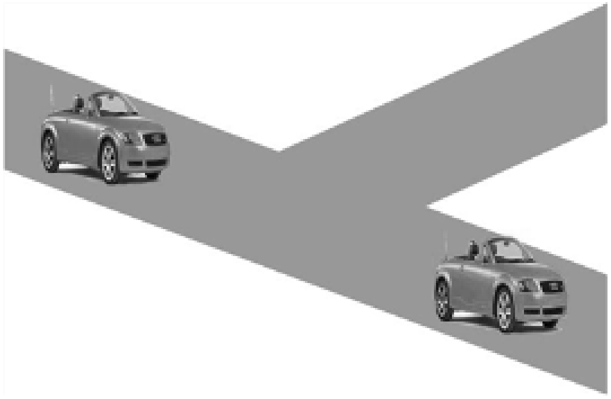

Figure 2.De-acceleration warning

Irrespective of these numerous advantages VANETs, it is also associated with several challenging characteristics specifically in the field of privacy, security and large scale rapidly changing topology. Due to less enhanced authentication features there is a lack of authenticated data present in the network which increases the chance of malicious attacks and abuse of services, therefore can impose a threat to the public, passengers and to the drivers. These challenges can overcome by improving primary security essentials such as; integrity, authenticity and availability needs to be properly developed before implementing it practically.[1].Each vehicle in the network consists of a set up known as on board unit (OBU) used for the purpose of integrating the functionality of vehicle in wireless communication, embedded systems, micro-sensors used for sensing various environmental conditions, Global positioning system used for the purpose of providing positioning information of the vehicles. Vehicles involved in this network can not only communicate with each other but also with other infrastructural units including road side units (RSU) such as; traffic lights, traffic signs etc. results in an improvement in safety and driving experience of the participating drivers. The messages that are exchanged between vehicles are concerned to provide real-time traffic conditions to make the drivers aware about present knowledge of driving environment in order to make a proper mechanism for rare situations as quick as possible.

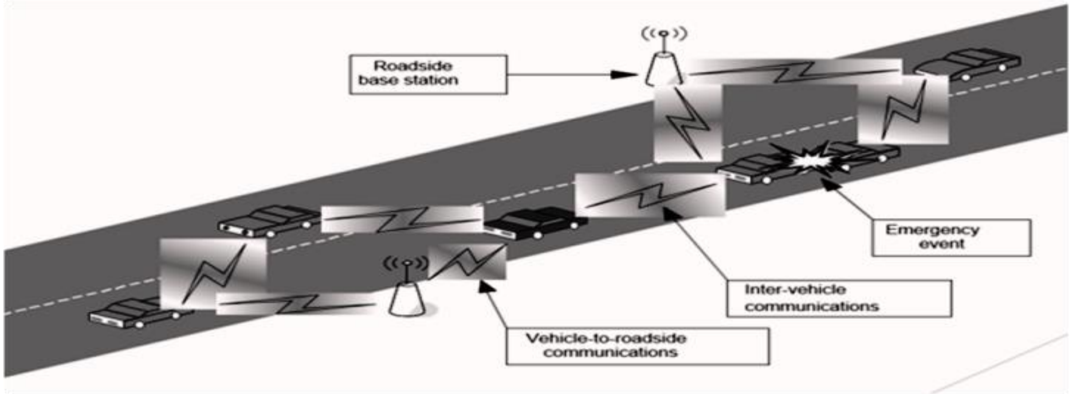

Figure 3: intelligent transportation systems

1.2 Intelligent Transportation Systems (ITSs): In intelligent transportation systems, each vehicle takes on the role of sender, receiver, and router to broadcast information to the vehicular network or transportation agency, which then uses the information to ensure safe, free-flow of traffic. For communication to occur between vehicles and road Side Units (RSUs), vehicles must be equipped with some sort of radio interface or on Board Unit (OBU) that enables short-range wireless ad hoc networks to be formed. Vehicles must also be fitted with hardware that permits detailed position information such as Global Positioning System (GPS) or a Differential Global Positioning System (DGPS) receiver. Fixed RSUs, which are connected to the backbone network, must be in place to facilitate communication. The number and distribution of roadside units is dependent on the communication protocol is to be used. For example, some protocols require roadside units to be distributed evenly throughout the whole road network, some require roadside units only at intersections, while others require roadside units only at region borders. Though it is safe to assume that infrastructure exists to some extent and vehicles have access to it intermittently, it is unrealistic to require that vehicles always have wireless access to roadside units. These include inter-vehicle, vehicle-to-roadside, and routing-based communications. Inter-vehicle, vehicle-to-roadside, and routing-based communications rely on very accurate and up-to-date information about the surrounding environment, which, in turn, requires the use of accurate positioning systems and smart communication protocols for exchanging information. In a network environment in which the communication medium is shared, highly unreliable, and with limited bandwidth smart communication protocols must guarantee fast and reliable delivery of information to all vehicles in the vicinity.

1.3 VANETs (Vehicular ad-hoc networks) Architecture:-

This portion gives the detailed architecture of vehicular ad-hoc networks. On the basis of domain the basic components of VANETs architecture is explained first followed by network architecture and then the communication architecture.

1.3.1 Basic components: Referring to the IEEE1471-2000 and ISO/IEC42010 architecture guidelines and standards, VANETs system architecture can be divided into following three domains:

- Mobile domain.
- Infrastructure domain.
- Generic domain.

Mobile domain	**Generic domain**	**Infrastructure domain**
Mobile device domain	Internet infrastructure domain	Roadside infrastructure domain
Vehicle domain	Private infrastructure domain	Central infrastructure domain

Table 1: vanets system architecture

1.3.1.1 Mobile domain:-It is further divided into two parts: the mobile device domain and the vehicle domain. The mobile device domain consists of all types of portable devices smart phones and personal navigation devices. The vehicle domain consists of all types of vehicles like buses, cars etc.

1.3.1.2 Infrastructure domain:-It is further divided into two parts: the central infrastructure domain and the roadside infrastructure domain. The central infrastructure domain consists of vehicle management centres and infrastructure management centres for example traffic management centres (TMCs).

1.3.1.3 Generic domain:-It is further divided into two parts: the internet infrastructure domain and the private infrastructure domain.

1.4 Fundamental network architecture:

Though the growth of architecture of VANETs varies from one region to another. It has the following basic components:

- On board Unit (OBU) equipped on vehicles.

- Road Side Unit (RSU) distributed over the infrastructure of the network.
- Trusted Authority(TA)

Communication can take place between vehicles that is vehicle to vehicle and between vehicle and infrastructure. Each vehicle's on board unit consists a group of sensors to obtain the information such as velocity, breaking information etc. Roadside unit acts as a router to cover wider area as compared to that of the area covered by vehicles. Vehicles are equipped with global positioning system to provide the information related to the positioning of the vehicles, electronic license plate (ELP) to provide the information related to the identification of the vehicles, (RADAR) radio detection and ranging or light amplification by stimulated emission of radiation (LASER) can also be used to provide the information related to the positioning of the vehicles. The trusted authority equipments are equipped in the back end. The on board units and road side units communicate in a wireless manner using Dedicated Short Range Communications protocol with an operating bandwidth of 75 Mhz at 5.9 Ghz frequency. Each roadside unit is connected with each other which in turn are connected with the Trusted Authority (TA) by means of a wired connection. The Trusted Authority maintains the VANET system model.

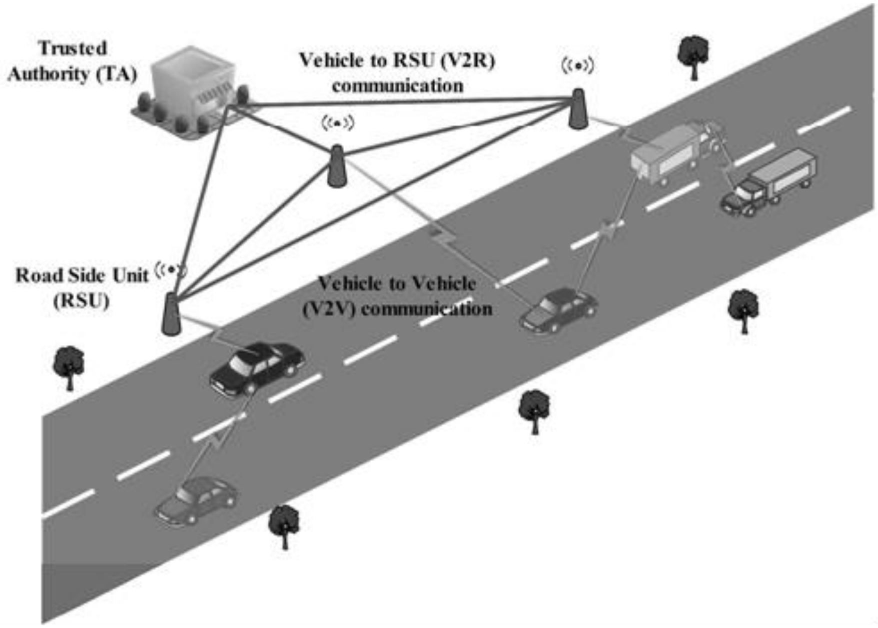

Figure 4: Network Architecture of VANET system.

1.4.1 On board Unit (OBU):- On Board Unit (OBU) is a transceiver equipped on vehicles for the exchange of information with the transceivers (OBU) of other vehicles including the computational device and with the Road Side Unit (RSU). The basic components of an OBU are resource command processor (RCP) for the purpose of computation, storage and retrieving of information, DSRC (Dedicated Short Range Communication) based on a radio technology IEEE 802.11p standard for the purpose of wireless communication. OBUs obtain its power from the battery of a car. Each vehicle is equipped with sensors such as Global Positioning System (GPS) receiver, Event Data Recorder (EDR), Tamper Proof Device (TPD), forward and rear sensors to provide the input to the OBU, speed sensors etc. The sensors obtain the information from the surroundings of the vehicle, GPS receiver provides the information about physical position of the vehicle. The Event Data Recorder (EDR) records the information of vehicle crashes or accidents. The Tamper Proof Device (TPD) stores the critical data including private key, identification proof of vehicles and group key. The speed sensors obtain the information related to the velocity of the vehicles. The forward and rear sensors collect the information related to the activities occurring around the vehicle by monitoring in the front and back side of the vehicle. This collected information is then forwarded as a message to the neighbouring vehicles by making use of wireless medium.

1.4.2 Road Side Units (RSUs):- These are usually stationary that is ; these devices are fixed on the sides of the road or on the specific places such as road curves, parking places etc. It consists of an antenna, sensors, processor, and transceiver. These units on the sides of the road provide the services to the vehicles such as road intersection is used to control the traffic in that particular intersection and to reduce accidents. Each RSU makes use of directional antenna or an omni-directional antenna for the purpose of wireless communication based on DSRC (dedicated short range communication) IEEE 802.11p technology. To transmit a message to a particular location RSU makes use of a directional antenna. RSU possesses the capability of storing information obtained from OBU of vehicles and from the TA (trusted authority).

1.4.3 Trusted Authority (TA):- it is meant for the registration of RSU, vehicle users and the OBU of vehicles. It verifies the authentication and authorization of OBU of vehicles and vehicle users in order to prevent the entry of malicious vehicle into the VANET system. It provides high capability of storage and computation. It possesses the ability to uncover the real identity of OBUs when malicious messages are being broadcasted or when it shows a malicious behaviour.

1.5 Communication Architecture: - Communication taking place in VANETs can be classified into following four categories. This type of architecture describes the functions of communications occurring in VANETs system.

- In-vehicle communication: - It refers to the communication in vehicle domain. It is responsible of collecting information related to the vehicle’s performance. It detects the exertion, drowsiness etc. of the driver meant for the safety of public, passengers, and the driver himself.
- Vehicle to vehicle communication (V2V): - It refers to the communication between vehicles for the exchange of information including warning messages etc between them. This type of communication provides assistance to the driver.
- Vehicle to roadside infrastructure (V2I) communication: - It refers to the communication between vehicles and infrastructural units. It provides the information related to the current updates of weather, traffic etc. it possesses the ability to monitor and sense environmental conditions.
- Vehicle to broad cloud (V2B) communication: - It refers to the communication between vehicles by making use of broadband (for example 3G or 4G). It includes the traffic information, monitoring data etc. This type of communication provides the real-time and an active assistance to the drivers and is also responsible for vehicle tracking.

1.6 Standards for Wireless Access in VANETs

Standards simplify product development, help reduce costs, and enable users to compare competing products. Only through the use of standards can the requirements of interconnectivity and interoperability be guaranteed and the emergence of new products be verified to enable the rapid implementation of new technologies. There are many standards that relate to wireless access in vehicular environments. These standards range from protocols that apply to transponder equipment and communication protocols through to security specification, routing, addressing services, and interoperability protocols.

1.6.1 Dedicated Short Range Communication (DSRC)

Dedicated Short Range Communications (DSRC) is a short to medium range communications service that was developed to support vehicle-to-vehicle and vehicle-to-roadside communications. Such communications cover a wide range of applications, including vehicle-to-vehicle safety messages, traffic information, toll collection, drive-through payment, and several others. [7]DSRC is aimed at providing high data transfers and low communication latency in small communication zones. In 1999, the United States Federal Communications Commission (FCC) [8] allocated 75 MHz of spectrum at 5.9 MHz to be used by DSRC.

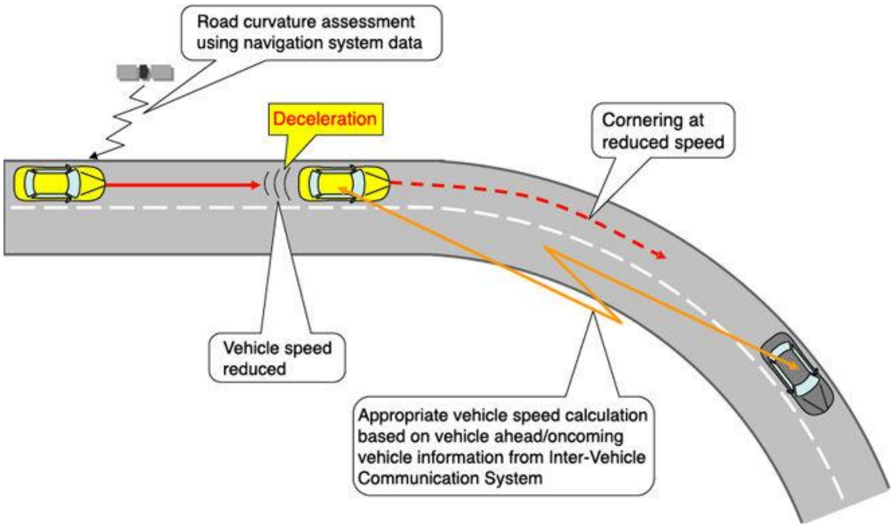

Figure 5: Dedicated short range communication.[24]

In 2003, The American Society for Testing and Materials (ASTM)[9] approved the ASTM-DSRC standard which was based on the IEEE 802.11a physical layer and 802.11 MAC layer [ASTME, 2003]. This standard was later published as ASTM E2213-03. In February 2004, the report issued by the FCC established service and licensing rules that govern the use of the DSRC band. DSRC is a free but licensed spectrum. Such communications cover a wide range of applications, including vehicle-to-vehicle safety messages, traffic information, toll collection, drive-through payment, and several others. DSRC is aimed at providing high data transfers and low communication latency in small communication zones.

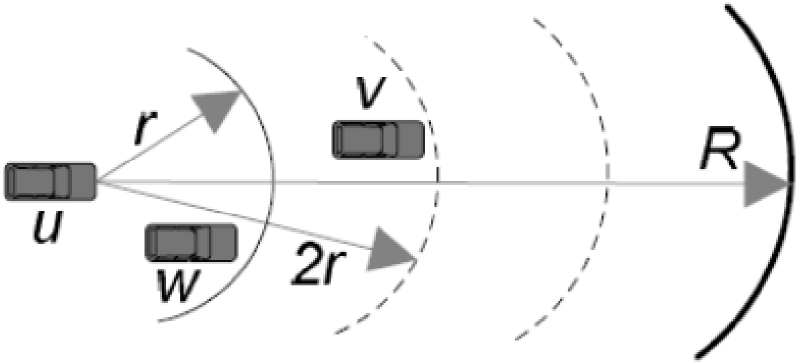

Figure 4: DSRC range, r: service channel transmission range, R: control channel transmission range.

1.6.2 IEEE 1609 – Standards for Wireless Access in Vehicular Environments (WAVE) (IEEE 802.11p) Wireless connectivity between moving vehicles can be provided by existing 802.11a compliant devices with data rates of up to 54 Mbps being achieved with 802.11a hardware [IEEE STD, 2007]. However, vehicular traffic scenarios have greater challenges than fixed wireless networks, caused by varying driving speeds, traffic patterns, and driving environments. Traditional IEEE 802.11 Media Access Control (MAC) operations suffer from significant overheads when used in vehicular scenarios. For instance, to ensure timely vehicular safety communications, fast data exchanges are required. In these circumstances the scanning of channels for beacons from an Access Point along with multiple handshakes required to establish communication are associated with too much complexity and high overheads (for example, in the case of a vehicle encountering another vehicle coming in the opposite direction, the duration for possible communication between them is extremely short making it difficult to establish communications). To address these challenging requirements of IEEE MAC operations, the DSRC effort of the ASTM 2313 working group migrated to the IEEE 802.11 standard group which renamed the DSRC to IEEE 802.11p Wireless Access in Vehicular Environments (WAVE) [10]. In contrast to the regional standards of DSRC, by incorporating DSRC into IEEE 802.11, WAVE will become a standard that can be universally adopted across the world. As illustrated in Figure 4, it is worth noting that IEEE 802.11p is limited by the scope of IEEE 802.11 which strictly works at the media access control and physical layers. The operational functions and complexity related to DSRC are handled by the upper layers of the IEEE 1609 standards. These standards define how applications that utilize WAVE will function in the WAVE environment, based on the management activities defined in IEEE P1609.1**,** the security protocols defined in IEEE P1609.2**,** and the network-layer protocol defined in IEEE P1609.3. The IEEE 1609.4 resides above 802.11p and this standard supports the operation of higher layers without the need to deal with the physical channel access parameters.

WAVE defines two types of devices: Road Side Unit (RSU), and On Board Unit (OBU) which are essentially stationary and mobile devices respectively. RSUs and OBUs can be either a provider or a user of services and can switch between such modes. Normally stationary WAVE devices host an application that provides a service, and the mobile device which hosts a peer application that uses such a service. There may also be applications on devices remote from the RSU whose purpose is to provide services to the OBU. This WAVE standard describes applications that resides on the RSU but is designed to multiplex requests from remote applications thus providing them with access to the OBU. WAVE uses Orthogonal Frequency Division Multiplexing (OFDM) to split the signal into several narrowband channels to provide a data payload communication capability of 3, 4.5, 6, 9, 12, 18, 24 and 27 Mbps in 10 MHz channels.

1.7 Routing, Qos, Broadcasting, and Security in VANET

VANET has been an active field of research and development for years but it is fair to say that, with the recent dramatic improvements in communication and computing technologies, it is only in the last decade that this field has really gained a lot of momentum. In fact, VANET research has attracted a lot of attention from researchers working in various fields including electronics, networking, security, software engineering, automotive, transportation, and so on. Recent results covering VANET-related issues include areas such as routing, Quality Service (QoS), broadcasting, security attacks and threats, capacity, collision and interference, the effects of transmission power on protocol performance and power control algorithms, congestion control, and service discovery. It is beyond the scope of this work to review each of these topics. Instead, we present, discuss, and review recent research results that have been achieved in the most active VANET areas which include routing, broadcasting, QoS, and security. In addition, the rationale for selecting these specific areas also stems from the fact that they are the ones with the most active interest from the VANET research community as evidenced by the number of recent publications we found during our literature review on VANET.

1.7.1 Routing

Routing in VANET has been studied and investigated widely in the past few years[11][12]. Since VANETs are a specific class of ad hoc networks, the commonly used ad hoc routing protocols initially implemented for MANETs have been tested and evaluated for use in a VANET environment. Use of these address-based and topology-based routing protocols requires that each of the participating nodes be assigned a unique address. This implies that we need a mechanism that can be used to assign unique addresses to vehicles but these protocols do not guarantee the avoidance of allocation of duplicate addresses in the network [13]. Thus, existing distributed addressing algorithms used in mobile ad-hoc networks are much less suitable in a VANET environment. Specific VANET-related issues such as network topology, mobility patterns, demographics, density of vehicles at different times of the day, rapid changes in vehicles arriving and leaving the VANET and the fact that the width of the road is often smaller than the transmission range all make the use of these conventional ad hoc routing protocols inadequate.

1.7.2 Proactive Routing Protocols

Proactive routing protocols employ standard distance-vector routing strategies (e.g., Destination-Sequenced Distance-Vector (DSDV) routing) or link-state routing strategies (e.g., Optimized Link State Routing protocol (OLSR) and Topology Broadcast-based on Reverse-Path Forwarding (TBRPF)). They maintain and update information on routing [15] among all nodes of a given network at all times even if the paths are not currently being used. Route updates are periodically performed regardless of network load, bandwidth constraints, and network size. The main drawback of such approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. Since a network between cars is extremely dynamic proactive routing algorithms are often inefficient.

1.7.3 Reactive Routing Protocols: Reactive routing protocols such as Dynamic Source Routing (DSR), and Ad hoc On-demand Distance Vector (AODV) routing implement route determination on a demand or need basis and maintain only the routes that are currently in use, thereby reducing the burden on the network when only a subset of available routes is in use at any time. Communication among vehicles will only use a very limited number of routes, and therefore reactive routing is particularly suitable for this application scenario.

1.7.4 Position-based Routing: Position-based routing protocols require that information about the physical position of the participating nodes be available. This position is made available to the direct neighbours in the form of periodically transmitted beacons. A sender can request the position of a receiver by means of a location service. The routing decision at each node is then based on the destination’s position contained in the packet and the position of the forwarding node’s neighbours. Consequently, position-based routing does not require the establishment or maintenance of routes. Examples of position-based routing algorithms include Greedy Perimeter Stateless Routing (GPSR) and [16] Distance Routing Effect Algorithm for Mobility (DREAM). Karp et al. describe a position-based routing protocol based on a greedy forwarding mechanism in which packets are forwarded through nodes geographically closer to the destination than the previous node. Thus the position of the next hop will always be closer to the destination node than that of the current hop. The “perimeter routing” mode of GPSR (greedy perimeter stateless routing) that searches for alternate routes that may not be geographically closer is not considered since in a highway scenario the width of the road is often smaller than the range of transmission. Thus in this scenario there is no way for a route to move away from the destination and still find its way back. Existing ad hoc networks employ topology-based routing where routes are established over a fixed succession of nodes but which can lead to broken routes and a high overhead to repair these routes. The special conditions and requirements for vehicular communications, including frequent topology changes, short connectivity time and positioning systems have justified the development of dedicated routing solutions for wireless multi-hop communication based on geographic positions. The use of Global Positioning System (GPS) technology enables forwarding to be decoupled from a nodes identity and therefore the position of the destination node is used rather than a route to it which requires traffic flow via a set of neighbours [Harsch, 2007]. Thus position-based routing provides a more scalable and efficient forwarding mechanism appropriate for highly volatile ad hoc networks found in VANETs. Position based routing constitute three core components: beaconing, location service and forwarding (geographic unicast and geographic broadcast): Four recent important initiatives in position-based routing include: Naumov et al. [Naumov, 2007] describe a recent innovation protocol called Connectivity Aware Routing (CAR) for VANETs. It is a position based routing scheme capable of finding connected paths between source and destination pairs. Leontiadis et al. [Leontiadis, 2007] describe a geographical opportunistic routing protocol suitable for vehicular networks which exploits the topology of VANETs as well as geographical routing information.

Hartenstein [Hartenstein, 2001] describes a position-based routing scheme which employs a unique identifier such as an IP address which is used to identify a vehicle along with its current position (GPS coordinate). This scheme only requires that a vehicle knows its own position and that of its one-hop neighbors. Assuming a packet contains the destination position, the router forwards the packet to a node closer to the destination than itself. Given the relatively high speeds of the large number of vehicles involved, this scheme is both adaptive and scalable with respect to network topology.

1.7.5 Beaconing and Location Service

Vehicles periodically broadcast short packets with their identifier and current geographic position. Upon receipt of a beacon, a vehicle stores the information in its location table. The requesting vehicle issues a location query message requesting the identification and sequence numbers and hop limit when it needs to know the position of a required vehicle not available in its location table. This message is rebroadcast to nearby vehicles until it reaches the required vehicle or the hop limit is reached. If the request is not a duplicate, the required vehicle answers with a location reply message carrying its current position and timestamp. Upon receipt of the location reply, the originating vehicle updates its location table [17].

1.7.6 Forwarding

A geographic unicast transports packets between two nodes via multiple wireless hops. When the requesting node wishes to send a unicast packet, it determines the position of the destination node by looking at the location table. A greedy forwarding algorithm is then used to send the packet to the neighbouring vehicle, detailing the minimum remaining distance to the destination vehicle and this process repeats at every vehicle along the forwarding path until the packet reaches its destination.

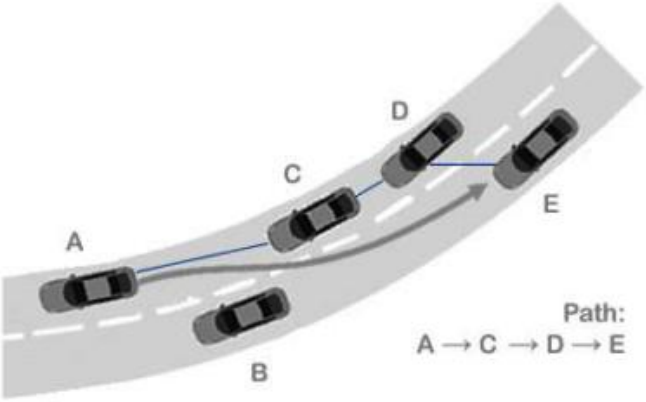

Figure 5: Forwarding

1.8 Quality of Service (QoS)

The term Quality of Service (QoS) is used to express the level of performance provided to users. High levels of QoS in traditional networked environments can often be achieved through resource reservation and sufficient infrastructure, however, these cannot be guaranteed in dynamic, ad-hoc environments, such as those used in VANETs due the VANETs inherent lack of consistent infrastructure and rapidly changing topology. Most QoS routing strategies aim to provide robust routes among nodes and try to minimize the amount of time required to rebuild a broken connection. However, factors such as node velocity, node positioning, the distance between nodes, the reliability of and delay between links can seriously affect the stability of a particular route. In their paper, Biswas et al. [Biswas, 2006] introduced LDM-STREAM, a signalling mechanism of spatial divided network conditions to guarantee QoS in a VANET.

1.9 VANETs (Vehicular ad-hoc Networks) applications

VANET based communication can used tremendously in numerous applications. It provides the capability to handle highly diverse requirements. Under broader sense applications of VANETs can be broadly classified into three categories which are safety directed, convenience directed and commercial directed.

Safety directed applications monitors the surroundings of the road, vehicles, curves of the road etc. Convenience application involves the management of the traffic. Commercial applications handles services provided to the driver. These services include the service of entertainment, web services, streaming of audio and videos etc. Based on the representation and requirement of applications, certain applications are identified below:-

- Traffic signal:- It is possible to create a communication from the traffic lights by making use of technologies embedded in VANETs. Slow or stop vehicle advisor (SVA) meant for safety applications provides information about the slow or motionless vehicle by broadcasting alert messages to their neighbourhood. In order to notify the road congestion, congested road notification (CRN) detects the road congestion, on the basis of which journey and route is being planned. The toll collection at the toll booths without interrupting the vehicles is another type of application of VANETs. Vehicular networks are particularly useful in management of traffic. However VANETs for the road tolling is widely deployed.

Figure 6: traffic signal control

- Weather and other hard conditions: it consists of vehicle sensors such as wiper movement sensor, thermometer present outside to collect and update the weather information by making use of an application through DSRC(dedicated short range communication). During an accident, when a vehicle is involved in an accident a warning message is being generated which would be broadcasted to the nearby travelling vehicles so that this information is passed on to the highway patrol for support. It also provides us the capability to notify the space availability in a parking lot for a specific geographical area by making use of Parking Availability Notification (PAN). It also possesses maps of highway and urban areas in order to avoid the traffic jam, conditions for an accident and to provide the shortest path in critical situation leading to an efficient usage of time.

- Vision enhancement: It provides the clear view of vehicles and obstacles and enhances the vision during the heavy fog conditions. It provides ability to the drivers to recognize the existence of vehicles hidden behind obstacles, buildings and by other vehicles.

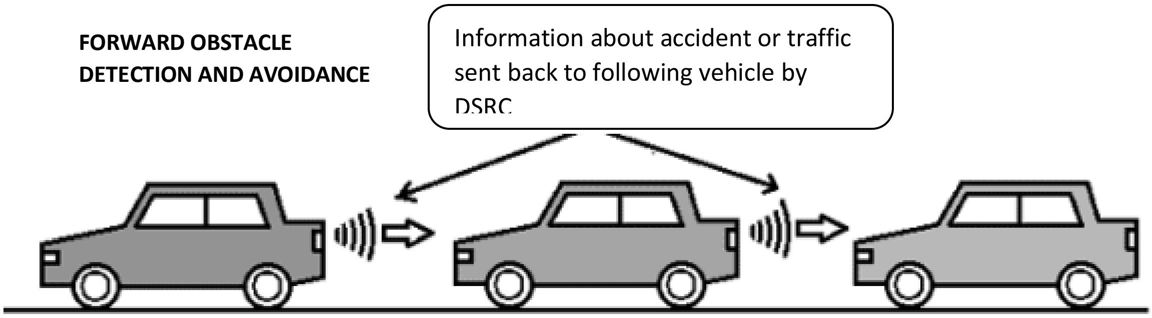

Figure 7: congestion detection[26]

- Assistance to the Driver: VANETs provide the ability to support exercises in military driving by giving information to the drivers. Since vehicles may exhibit driving patterns in an abnormal way including dramatic change of direction, broadcast message to inform cars that are present in their locality, therefore, drivers can be warned by letting them know about the potential hazards in order to prevent accidents and get time to react. Thus, provides a support to the driver in decision making.
- Automatic parking: this type of application involves parking of a vehicle itself without any need of driver's interference. In order to perform such an action a vehicle needs an installation of distance estimator, a sub meter precision and a localization system.
- Information of roadside locations: It provides the ability to search roadside location and also provides the direction to the vehicles. Thus, for passengers which are unknown to any particular location helps them to find the specific location (for example: shopping centres, hotels, hospitals, etc.) in that area. It makes the use GPS, database from the nearest roadside base station, sensors makes them able to perform such functions by calculating information.
- Emergency electronic brake lights: vehicle that has to hard brake informs other vehicles, by using the cooperation of other vehicles and/or road side units, about this situation.

- Wrong way driving warning: a vehicle detecting that it is driving in wrong way, e.g., forbidden heading, signals this situation to other vehicles and road side units.
- Stationary vehicle warning: in this use case, any vehicle that is disabled, due to an accident, breakdown or any other reason, informs other vehicles and road side units about this situation.
- Traffic condition warning: any vehicle that detects some rapid traffic evolution, informs other vehicles and road side units about this situation.
- Signal violation warning: one or more road side units detect a traffic signal violation. This violation information is broadcasted by the road side unit(s) to all vehicles in the neighbourhood.
- Collision risk warning: a road side unit detects a risk of collision between two or more vehicles that do not have the capability to communicate. This information is broadcasted by the road side unit towards all vehicles in the neighbourhood of this event
- Entertainment: Since number of applications is involved to make the entertainment of passengers who are going to spend a long time in travelling. Entertainment is provided in the form of internet access, communication between passengers in car’s vicinity, games.
- Safety: It involves collision warning, obstacle detection and prevention, road condition warning, cooperative driving (such as lane merging warning), sign movement assistance, collision prevention of highway or railway, turn assistance, changing of lane warning.

1.10 Security

The security of VANETs is crucial as their very existence relates to critical life threatening situations. It is imperative that vital information cannot be inserted or modified by a malicious person. The system must be able to determine the liability of drivers while still maintaining their privacy. These problems are difficult to solve because of the network size, the speed of the vehicles, their relative geographic position, and the randomness of the connectivity between them. An advantage of vehicular networks over the more common ad hoc networks is that they provide ample computational and power resources.

1.10.1 Threats to Availability, Authenticity, and Confidentiality

Attacks can be broadly categorized into three main groups: those that pose a threat to availability, those that pose a threat to authenticity and those that pose a threat to driver confidentiality. The following sections present threats posed to each of the areas of availability, authenticity, and confidentiality.

1.10.2 Threats to Availability

The following threats to the availability of vehicle-to-vehicle and vehicle-to-roadside communication (including routing functionality) have been identified:

Denial of Service Attack: DoS attacks can be carried out by network insiders and outsiders and renders the network unavailable to authentic users by flooding and jamming with likely catastrophic results. Flooding the control channel with high volumes of artificially generated messages, the networks nodes, onboard units and roadside units cannot sufficiently process the surplus data.

Broadcast Tampering: An inside attacker may inject false safety messages into the network to cause damage, such as causing an accident by suppressing traffic warnings or manipulating the flow of traffic around a chosen route.

Malware: The introduction of malware, such as viruses or worms, into VANETs has the potential to cause serious disruption to its operation. Malware attacks are more likely to be carried out by a rogue insider rather than an outsider and may be introduced into the network when the onboard units and roadside units receive software and firmware updates.

Spamming: The presence of spam messages on VANETs elevates the risk of increased transmission latency. Spamming is made more difficult to control because of the absence of a basic infrastructure and centralized administration.

Black Hole Attack: A black hole is formed when nodes refuse to participate in the network or when an established node drops out. When the node drops out, all routes it participated in are broken leading to a failure to propagate messages.

1.10.3 Threats to Authenticity

Providing authenticity in a vehicular network involves protecting legitimate nodes from inside and/or outside attackers infiltrating the network using a false identity, identifying attacks that suppress, fabricate, alter or replay legitimate messages, revealing spoofed GPS signals, and impede the introduction of misinformation into the vehicular network. These include:

Masquerading: Masquerading attacks are easy to perform on VANETs as all that is required for an attacker to join the network is a functioning onboard unit. By posing as legitimate vehicles in the network, outsiders can conduct a variety of attacks such as forming black holes or producing false messages.

Replay Attack: In a replay attack the attacker re-injects previously received packets back into the network, poisoning a nodes location table by replaying beacons. VANETs operating in the WAVE framework are protected from replay attacks but to continue protection an accurate source of time must be maintained as this is used to keep a cache of recently received messages, against which new messages can be compared.

Global Positioning System (GPS) Spoofing: The GPS satellite maintains a location table with the geographic location and identity of all vehicles on the network. An attacker can fool vehicles into thinking that they are in a different location by producing false readings in the GPS positioning system devices. This is possible through the use of a GPS satellite simulator to generate signals that are stronger than those generated by the genuine satellite.

Tunneling: An attacker exploits the momentary loss of positioning information, when a vehicle enters a tunnel and before it receives the authentic positioning information the attacker injects false data into the onboard unit.

Position Faking: Authentic and accurate reporting of vehicle position information must be ensured. Vehicles are solely responsible for providing their location information and impersonation must be impossible. Unsecured communication can allow attackers to modify or falsify their own position information to other vehicles, create additional vehicle identifiers (also known as Sybil Attack) or block vehicles from receiving vital safety messages.

Message Tampering: A threat to authenticity can result from an attacker modifying the messages exchanged in vehicle-to-vehicle or vehicle-to-roadside unit communication in order to falsify transaction application requests or to forge responses.

Message Suppression/Fabrication/Alteration: In this case an attacker either physically disables inter-vehicle communication or modifies the application to prevent it from sending to, or responding from application beacons.

Key and/or Certificate Replication: Closely related to broadcast tampering is key management and/or certificate replication where an attacker could undermine the system by duplicating a vehicle’s identity across several other vehicles. The objective of such an attack would be to confuse authorities and prevent identification of vehicles in hit-and-run events.

Sybil Attack: Since periodic safety messages are single-hop broadcasts, the focus has been mostly on securing the application layer. For example, the IEEE 1609.2 standard does not consider the protection of multi-hop routing. However, when the network operation is not secured, an attacker can potentially partition the network and make delivery of event-driven safety messages impossible.

1.10.4 Threats to Confidentiality

Confidentiality of messages exchanged between the nodes of a vehicular network are particularly vulnerable with techniques such as the illegitimate collection of messages through eavesdropping and the gathering of location information available through the transmission of broadcast messages. In the case of eavesdropping, insider and/or outsider attackers can collect information about road users without their knowledge and use the information at a time when the user is unaware of the collection. Location privacy and anonymity are important issues for vehicle users. Location privacy involves protecting users by obscuring the user's exact location in space and time. By concealing a user's request so that it is indistinguishable from other users‟ requests, a degree of anonymity can be achieved.

Chapter 2: Terminology

2.1 Vehicle-to-vehicle communication: It is also called inter vehicle communication. The inter-vehicle communication configuration uses multi-hop multicast/broadcast to transmit traffic related information over multiple hops to a group of receivers.

Figure 8: V2V communication

In intelligent transportation systems, vehicles need only be concerned with activity on the road ahead and not behind (an example of this would be for emergency message dissemination about an imminent collision or dynamic route scheduling). There are two types of message forwarding in inter-vehicle communications: naïve broadcasting and intelligent broadcasting. In naïve broadcasting, vehicles send broadcast messages periodically and at regular intervals. Upon receipt of the message, the vehicle ignores the message if it has come from a vehicle behind it. If the message comes from a vehicle in front, the receiving vehicle sends its own broadcast message to vehicles behind it. This ensures that all enabled vehicles moving in the forward direction get all broadcast messages. The limitations of the naïve broadcasting method is that large numbers of broadcast messages are generated, therefore, increasing the risk of message collision resulting in lower message delivery rates and increased delivery times.

2.2 Vehicle to roadside communication: The vehicle-to-roadside communication configuration represents a single hop broadcast where the roadside unit sends a broadcast message to all equipped vehicles in the vicinity. Vehicle-to-roadside communication configuration provides a high bandwidth link between vehicles and roadside units. The roadside units may be placed every kilometre or less, enabling high data rates to be maintained in heavy traffic. For instance, when broadcasting dynamic speed limits, the roadside unit will determine the appropriate speed limit according to its internal timetable and traffic conditions. The roadside unit will periodically broadcast a message containing the speed limit and will compare any geographic or directional limits with vehicle data to determine if a speed limit warning applies to any of the vehicles in the vicinity. If a vehicle violates the desired speed limit, a broadcast will be delivered to the vehicle in the form of an auditory or visual warning, requesting that the driver reduce his speed.

2.3 Dedicated Short Range Communication (DSRC): DSRC (Dedicated Short Range Communications) is a two-way short- to- medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications. In Report and Order FCC-03-324, the Federal Communications Commission (FCC) allocated 75 MHz of spectrum in the 5.9 GHz band for use by Intelligent Transportations Systems (ITS) vehicle safety and mobility applications. DSRC based communications is a major research priority of the Joint Program Office (ITS JPO) at the U.S. Department of Transportation (U.S. DOT) Research and Innovative Technology Administration (RITA). The cross-modal program is conducting research using DSRC and other wireless communications technologies to ensure safe, interoperable connectivity to help prevent vehicular crashes of all types and to enhance mobility and environmental benefits across all transportation system modes.

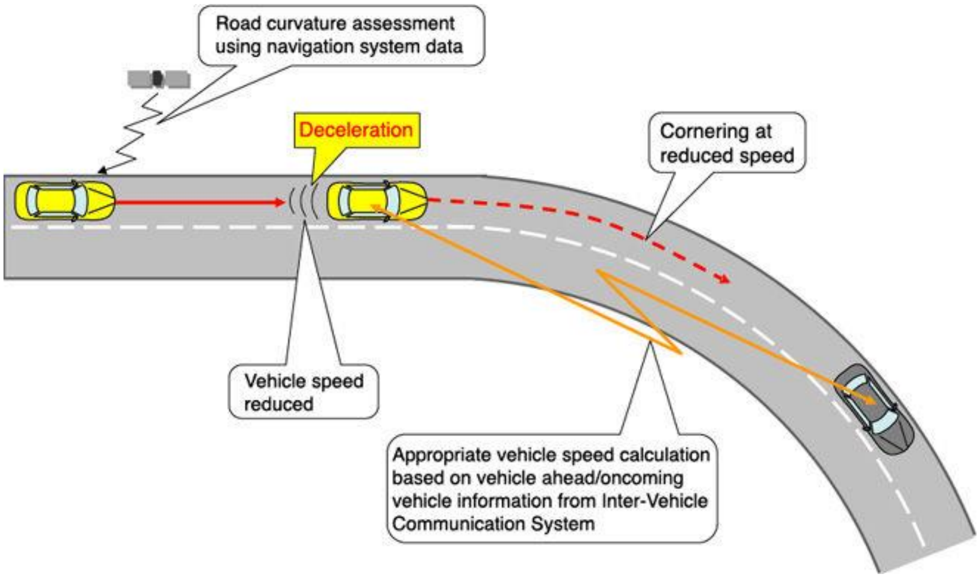

Figure 9: Dedicated short range communication.[27]

2.4 IEEE 1609 – Standards for Wireless Access in Vehicular Environments (WAVE) (IEEE 802.11p) : Wireless connectivity between moving vehicles can be provided by existing 802.11a compliant devices with data rates of up to 54 Mbps being achieved with 802.11a hardware [IEEE STD, 2007]. However, vehicular traffic scenarios have greater challenges than fixed wireless networks, caused by varying driving speeds, traffic patterns, and driving environments. Traditional IEEE 802.11 [18] Media Access Control (MAC) operations suffer from significant overheads when used in vehicular scenarios. For instance, to ensure timely vehicular safety communications, fast data exchanges are required. In these circumstances the scanning of channels for beacons from an Access Point along with multiple handshakes required to establish communication are associated with too much complexity and high overheads (for example, in the case of a vehicle encountering another vehicle coming in the opposite direction, the duration for possible communication between them is extremely short [Jiang, 2008] making it difficult to establish communications). To address these challenging requirements of [19] IEEE MAC operations, the DSRC effort of the ASTM 2313 working group migrated to the IEEE 802.11 standard group which renamed the DSRC to IEEE 802.11p Wireless Access in Vehicular Environments (WAVE) [IEEE STDP, 2007]. In contrast to the regional standards of DSRC, by incorporating DSRC into IEEE 802.11, WAVE will become a standard that can be universally adopted across the world.

WAVE defines two types of devices: Road Side Unit (RSU), and On Board Unit (OBU) which are essentially stationary and mobile devices respectively. RSUs and OBUs can be either a provider or a user of services and can switch between such modes. Normally stationary WAVE devices host an application that provides a service, and the mobile device which hosts a peer application that uses such a service. There may also be applications on devices remote from the RSU whose purpose is to provide services to the OBU.

2.5 Routing: Routing in VANET has been studied and investigated widely in the past few years. Since VANETs are a specific class of ad hoc networks, the commonly used ad hoc routing protocols initially implemented for MANETs have been tested and evaluated for use in a VANET environment. Use of these address-based and topology-based routing protocols requires that each of the participating nodes be assigned a unique address. This implies that we need a mechanism that can be used to assign unique addresses to vehicles but these protocols do not guarantee the avoidance of allocation of duplicate addresses in the network [Mohandas, 2008]. Thus, existing distributed addressing algorithms used in mobile ad-hoc networks are much less suitable in a VANET environment. Specific VANET-related issues such as network topology, mobility patterns, demographics, density of vehicles at different times of the day, rapid changes in vehicles arriving and leaving the VANET and the fact that the width of the road is often smaller than the transmission range all make the use of these conventional ad hoc routing protocols inadequate.

2.5.1 Proactive Routing Protocols

Proactive routing protocols employ standard distance-vector routing strategies (e.g., Destination-Sequenced Distance-Vector (DSDV) routing) or link-state routing strategies (e.g., Optimized Link State Routing protocol (OLSR) and Topology Broadcast-based on Reverse-Path Forwarding (TBRPF)). They maintain and update information on routing among all nodes of a given network at all times even if the paths are not currently being used. Route updates are periodically performed regardless of network load, bandwidth constraints, and network size. The main drawback of such approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. Since a network between cars is extremely dynamic proactive routing algorithms are often inefficient.

2.5.2 Reactive Routing Protocols: Reactive routing protocols such as Dynamic Source Routing (DSR), and Ad hoc On-demand Distance Vector (AODV) routing implement route determination on a demand or need basis and maintain only the routes that are currently in use, thereby reducing the burden on the network when only a subset of available routes is in use at any time. Communication among vehicles will only use a very limited number of routes, and therefore reactive routing is particularly suitable for this application scenario.

2.5.3 Position-based Routing : Position-based routing protocols [Fubler, 2002] require that information about the physical position of the participating nodes be available. This position is made available to the direct neighbours in the form of periodically transmitted beacons. A sender can request the position of a receiver by means of a location service. The routing decision at each node is then based on the destination’s position contained in the packet and the position of the forwarding node’s neighbours. Consequently, position-based routing does not require the establishment or maintenance of routes. Examples of position-based routing algorithms include Greedy Perimeter Stateless Routing (GPSR) [Karp et al., 2000] and Distance Routing Effect Algorithm for Mobility (DREAM) [Basagni et al., 1998]. Karp et al. [Karp et al., 2000] describe a position-based routing protocol based on a greedy forwarding mechanism in which packets are forwarded through nodes geographically closer to the destination than the previous node. Thus the position of the next hop will always be closer to the destination node than that of the current hop. The “perimeter routing” mode of GPSR (greedy perimeter stateless routing) that searches for alternate routes that may not be geographically closer is not considered since in a highway scenario the width of the road is often smaller than the range of transmission. Thus in this scenario there is no way for a route to move away from the destination and still find its way back. Existing ad hoc networks employ topology-based routing where routes are established over a fixed succession of nodes but which can lead to broken routes and a high overhead to repair these routes. The special conditions and requirements for vehicular communications, including frequent topology changes, short connectivity time and positioning systems have justified the development of dedicated routing solutions for wireless multi-hop communication based on geographic positions.

Chapter 3: Literature survey

3.1 M. Satyanarayanan, P. Bahl, R. Cáceres, N. Davies[1]: In this author try to reduces the effect causes by jitter which takes place in the computing, failure etc. The research toward the mobile computing is deviated or shifted when we have web services on our finger tips. The market is know less interested toward the mobile computing. In this paper author use a technique which is called as virtual machine (VM) where virtual means imaginary or feasible. By using this architecture we use the cloud technique and that helps us to access anything anytime when we required. IT helps us to reduce the peak bandwidth demand which take place in multiple user In critical or emergency we can use this system because it is easy to establish. In this the author try to transient the infrastructure using by cloudlet hardware. The virtual mechanism open many doors for us so that the market can use this and make a drastically change in mobile computing.

3.2 R. Yu, Y. Zhang, S. Gjessing, W. Xia, K. Yang[2]: In this paper author explain the cloud computing technique in vehicular networks. A variety of information technologies have been interconnected to the central cloud, roadside cloud, vehicular cloud. DSRC standard popularly known as IEEE 802.11p is specifically enabled for vehicle communication. In this paper author aimed toward to make a cloud environment which is more beneficial and scalable with the upcoming internet protocol. He made a three stage cloud architecture which is more secure and easily accessible by wireless internet. Resources reservation scheme is for VM migration at the time of vehicle mobility. According to author vision, he focused on architecture based network which consumes storage resources, bandwidth resources in more appropriate way.

3.3 H. Arbabi, M. Weigle[3]: In this paper author analyzes DTM_{on} using VANETs under non congested traffic. He introduced a different method to delivering data from vehicle to RSU. VANETs have global positioning system and DSRC devices which are assembled in vehicles to determine the speed and their location at different time zone. RSU and TMC directly used to observe the travel time. The author envisioned to add on a method to improving MRR. TOs connected at section of road/lanes. Traffic offices which are programmed by TNC. A vehicle passed to the VS forward message to the closest nearby TO. RF transmits the data using DSRC range from 300m-1000m then the nearby neighbour vehicle SRC founded to next TO. Furthermore ensuring the reception SAC send it to the next TO and replace the duplicate report to the original/recent report. The main drawback is to increasing the message delay at the TOs for improving the MRR.

3.4 B.S.C. Lochert, J. Rybicki, M. Mauve[4]: In this paper, author examines that TIS having key challenge providing more scalability in environment by capturing and providing data by partake vehicles in large area. Author directly focused on non-safety applications that come under DTIS These applications enhance the driving security, reduction of road blocking to availing the parking lots cars travel from different areas and enhance their observation and aggregated knowledge. Infrastructure based communication realizes that server architecture take probably overhead charges. In this approach, all the collaborated data stored in central knowledge base and a vehicle directly request for gathered information from client architecture to navigate the best route. Author envisioned that vanet is more profitable if a car manufacturer introduce a more scalable and flexible technology to improve the safety of user/passenger.

3.5 Gongjun Yan, Stephan Olariu, Michele C. Weigle [20]: In this paper, author proposes a cross layer design to achieve location validation. This design is useful for those vehicles which are enabled with GPS, radar and transceiver. On different-different layers to validate the information and location measured. It is well deserved design in V2V, V2I communication for accurate position, proper information and updated data to the vehicles. Cross layered design is GPS enabled design which can gives the position information then radar detects the vehicles location. DSRC used for the transmission range which is upto 300 m range. Afterwards, the data at the infrastructure units updated and broadcast this in the form of message to the user i.e neighbour vehicles. Ref left

3.6 Hamid Reza Arkian, Reza Ebrahimi Atani[21]: vanet is an emerging technology and by using clustering technique vanets separate the network into the small group of mobile vehicles which improve the routing, data dissemination which is more reliable to the field of many road applications. In this paper, author proposed a two layer stable clustering scheme which combines the both feature of static and dynamic clustering methods. By proposing this scheme clustering stability become higher and quality of service also achieved. Fro the previous researches, clustering in vanet is more robust to link failure, less data gathering, more delay to update the data, lack of RSU link transmission. In this paper, idea proposes a feature of dynamic and static clustering. Static cluster is every fixed RSU implemented at certain places like junctions, traffic signals, congested places, toll gates over highways. While the dynamic cluster is related to the mobility of vehicles on road called cluster head. Cluster head provide connectivity and all kind of service to the all cluster members connected to it. It quickly updates the information onto the RSU which is further transferred to the vehicle. The main idea behind the scheme is better connectivity to the mobile vehicle to achieve the better Qos.

3.7 Yanyan Xu, Qing-Jie Kong and Yuncai Liu[22]: in this paper author shed the light on the advancement on the ITS to the modern traffic congestion scenario. Author proposes a CART model to represent the non parametric model by considering the 4 main challenges to develop a new classification model. They are definition of an appropriate state space vector, definition of various traffic patterns recognized from the historical observations, model of finding the best corresponding pattern to the current traffic state vector, and selection of a forecast generation method that can give the current conditions and the corresponding traffic pattern. The behind the cart model is predicting the target variable y with input variable x based on the decision tree. The purpose of decision tree is for learning the cluster and training data set into various patterns. Further, tree growing is split the decision node which stops the growing. Tree pruning is a node doesn't split anymore, if the training number is smaller than a certain percentage of the training set regardless of the impurity or error. This is because of the idea that any decision based on too few instances can cause variance and thus generate errors. After the cart model has been created, the further traffic state can be predicted through assigning the traffic state vector to an optimal subset and calculating by using corresponding regression model. Main advantage of CART model is to predict he further traffic volume by using previous trained model, which is more suitable and efficient for practical applications.

3.8 Moez Jerbi, Sidi-Mohammed Senouci[23]: in this paper, author proposed a concept which estimates the road density by using completely distributed and infrastructure free mechanism. This mechanism leads to the better ITS technology. Earlier researches on IFTIS are approached for traffic estimation with high delay and large response time. The sparse network takes more time to update the current data on RSUs. The author used this concept to make better communication between vehicle and RSU. V2I infrastructure approach is based on the distributed exchange and maintenance of traffic information between the vehicles. In other words it provides a particular cell IDs and road IDs to a road segments using CDP. CDP contains the message in which the cell IDs, transmission time, road segment, list of position of cells. The results show the updated scenario of traffic density estimation of the system on the 2500m road by no. of vehicle with 60 LD (low density) and 120 HD (high density).

<table>
<tr><td colspan="4">Cell data packet</td></tr>
<tr><td colspan="2">Road ID</td><td colspan="2">Time</td></tr>
<tr><td>Cell ID</td><td colspan="2">Cell density</td><td>Cell position</td></tr>
</table>

Table 2: CDP’s

3.9 Javier Barrachina, Manuel Fogue, Piedad Garrido[24]: In this paper , author proposed to estimate the traffic density on road side unit via ITS.ITS is powerful application in vanet which is easily enabled into the vehicle and provide numerous application to the user. The concept used by the author to estimate the traffic density in different cities to achieve the experimental results. They represents a solution of capability of V2I communication to the dense road traffic road segments. In simulation results they obtain no. of street, no. of road segments, and distance between segments. Overall, author shed a light on estimating the vehicle density in urban environment. Via V2I communication using density formation function to perform to the topological analysis of studied map at different cities. The beacons located at the cities received periodic messages these periodic message not propagate by other vehicles. Vehicle accident ontology (VEACON) provide touchstone to enable data interoperability which is used to exchange the warning messages between vehicles and RSUs. Results show that vehicle density in urban areas estimated accurately to improve the traffic control system and retards the no. of accident.

3.10 Gongjun Yan Stephan Olariu Michele C. Weigle[25]: in this paper, author proposes a cross layer design to achieve location validation. This design is useful for those vehicles which are enables with GPS, radar and transcevier on different- different layers to validate the information, location are measured. It is well deserved design in V2I, V2V communication .for accurate position, proper information, and updated data to the vehicles. Cross layer design in GPS enabled design which can give the position information then radar detects the vehicle location. DSRC is used for the transmission range which is upto 300 m ranges. Afterwards, the data at the infrastructure units update and broadcast this in the form of message to the users i.e neighbours vehicles.

3.11 Christoph Sommer , Armin Schmidt , Yi Chen[28]: ITS is the cornerstone of present generation Of vanets which surpluses the advancement in road applications. In this paper, author proposes an UMTS based ITS framework. Earlier researchers keep focusing on transmission time, quick response, less load network. This framework is based on the cat to infrastructure node which is called vehicle to infrastructure communication. UMTS plays a main role in the growth of the TIS application i.e WLAN based TIS application. In this paper, the proof of concept study for a typical highway scenario. The simulation is done as application layer model of respective services. TIC and co car enabled vehicle which send or response co car messages. All the process is done in application model of three layer protocol. From the uplink vehicle use FTAP to send the message to co car TIC which is very compact and further from downlink side the message transmitted to the all vehicles by FTAP protocol.

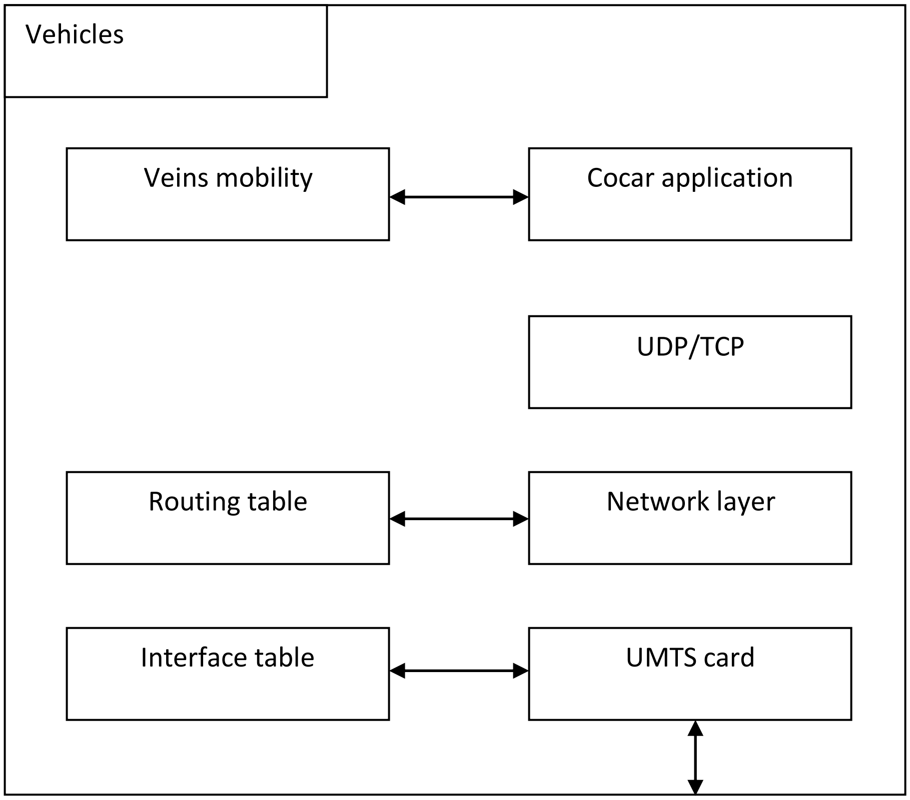

Figure 10:Cocar enabled vehicle

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3.12 Zaydoun Y. Rawshdeh, *Member, IEEE* and Syed Masud Mahmud [27]: clustering algorithm is upcoming technique in vanet. Clustering in ease of technology to make traffic scalable and introduce able. In this paper, author approach is the grouping of vehicle with speed, time, distance between vehicles, and relative speed of mobile vehicles. A new multi metric technique called CH election used which operate the cluster and give response quick respond to the connected users. The simulation results shows the clustering stability is 50% compared to earlier used techniques. In this work, we assume that the speed of the vehicles is a random variable following the normal distribution with mean, μ, and variance, $\sigma 2$, [9]. Thus, the probability density function (pdf) is:

$$f_s\,(s) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(s-\mu)^2}{2\sigma^2}}$$

Using DSRC, which provide a control channel having transmitted power is 44.8 dbm and service channel with transmitted power 23-24 dbm.

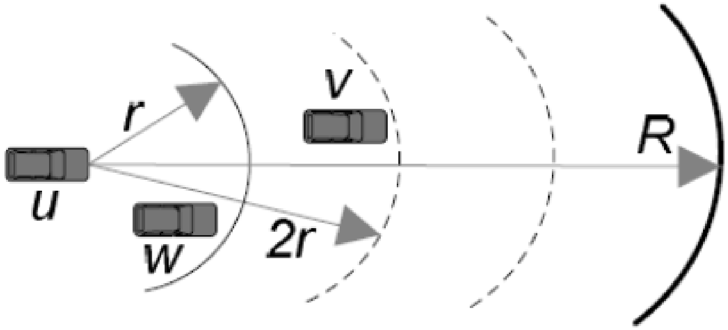

Figure 11: DSRC range, r: service channel transmission range, R: control channel transmission range.[27]

Chapter 4: Scope of the study

As the vehicles are growing, accidents are also increased and according to the National Highway Traffic Safety Administration (NHTSA), there are approximate 43000 deaths per year, 2.5 million people injured per year because of the lack of communication and it can be done by the vanets. This technology makes a vehicle more intelligent to decreases the possibility of accidents. Vanet have that much capability to provide every kind of facilities in the form of message/information, data etc. Now according to the present scenario, vanets have an ample amount of growth because of its accuracy and reliability in communication with low delay among vehicles. Most of the benefits related to the communications, V2V, V2I and Infrastructure related communications, IEEE protocols etc. are as follows:

Fuel Saving*:* When the TOLL system application for vehicle collects toll at the toll booths without stop-ping the vehicles, the fuel around 3% is saved, which is consumed when a vehicles as an average waits normally for 2-5 minutes.

Active road safety: Active road safety applications are those that are primarily employed to decrease the probability of traffic accidents and the loss of life of the occupants of vehicles. A significant percentage of accidents that occur every year in all parts of the world are associated with intersection, head, rear-end and lateral vehicle collisions. Active road safety applications primarily provide information and assistance to drivers to avoid such collisions with other vehicles. Moreover, information exchange between the vehicles and the road side units is used to locate hazardous locations on roads, such as slippery sections or potholes.

Intersection collision warning: in this use case, the risk of lateral collisions for vehicles that are approaching road intersections is detected by vehicles or road side units. This information is signalled to the approaching vehicles in order to lessen the risk of lateral collisions.

Lane change assistance: the risk of lateral collisions for vehicles that are accomplishing a lane change with blind spot for trucks is reduced.

Overtaking vehicle warning: aims to prevent collision between vehicles in an overtake situation, where one vehicle, say $vehicle_1$ is willing to overtake a vehicle, say $vehicle_3$, while another vehicle, say $vehicle_2$ is already doing an overtaking manoeuvre on $vehicle_3$. Collision between $vehicle_1$ and $vehicle_2$ is prevented when $vehicle_2$ informs $vehicle_1$ to stop its overtaking procedure.

Head on collision warning: the risk of a head on collision is reduced by sending early warnings to vehicles that are travelling in opposite directions. This use case is also denoted as “Do Not Pass Warning”, [18].

Rear end collision warning: the risk of rear-end collisions for example due to a slow down or road curvature (e.g., curves, hills) is reduced. The driver of a vehicle is informed of a possible risk of rear-end collision in front.

Co-operative forward collision warning: a risk of forward collision accident is detected through the cooperation between vehicles. Such types of accidents are then avoided by using either cooperation between vehicles or through driver assistance.

Emergency vehicle warning: an active emergency vehicle, e.g., ambulance, police car, informs other vehicles in its neighbourhood to free an emergency corridor. This information can be re-broadcasted in the neighbourhood by other vehicles and road side units.

Co-operative merging assistance: vehicles involved in a junction merging manoeuvre negotiate and cooperate with each other and with road side units to realize this manoeuvre and avoid collisions.

Emergency electronic brake lights: vehicle that has to hard brake informs other vehicles, by using the cooperation of other vehicles and/or road side units, about this situation.

Wrong way driving warning: a vehicle detecting that it is driving in wrong way, e.g., forbidden heading, signals this situation to other vehicles and road side units.

Stationary vehicle warning: in this use case, any vehicle that is disabled, due to an accident, breakdown or any other reason, informs other vehicles and road side units about this situation.

Traffic condition warning: any vehicle that detects some rapid traffic evolution, informs other vehicles and road side units about this situation.

Signal violation warning: one or more road side units detect a traffic signal violation. This violation information is broadcasted by the road side unit(s) to all vehicles in the neighbourhood.

Collision risk warning: a road side unit detects a risk of collision between two or more vehicles that do not have the capability to communicate. This information is broadcasted by the road side unit towards all vehicles in the neighbourhood of this event.

Hazardous location notification: any vehicle or any road side unit signals to other vehicles about hazardous locations, such as an obstacle on the road, a construction work or slippery road conditions.

Control Loss Warning: in [18] an additional use case is described that is intended to enable the driver of a vehicle to generate and broadcast a control-loss event to surrounding vehicles. Upon receiving this information the surrounding vehicles determine the relevance of the event and provide a warning to the drivers, if appropriate.

Vehicle absolute positioning capabilities, such as (1) Global Navigation Satellite System (GNSS), e.g., Global Positioning System (GPS), (2) Combined positioning capabilities, e.g., combined GNSS with information provided by a local geographical map.

Traffic efficiency and management applications*:* Traffic efficiency and management applications focus on improving the vehicle traffic flow, traffic coordination and traffic assistance and provide updated local information, maps and in general, messages of relevance bounded in space and/or time. *Speed management* and *Co-operative navigation* are two typical groups of this type of applications [13].

Speed management*:* Speed management applications aim to assist the driver to manage the speed of his/her vehicle for smooth driving and to avoid unnecessary stopping. Regulatory/contextual speed limit notification and green light optimal speed advisory are two examples of this type.

Co-operative navigation*:* This type of applications is used to increase the traffic efficiency by managing the navigation of vehicles through cooperation among vehicles and through cooperation between vehicles and road side units. Some examples of this type are traffic information and recommended itinerary provisioning, co-operative adaptive cruise control and platooning.

Electronic Toll Collection*:* Payment of the toll can be done electronically through a Toll Collection Point as shown in **Figure 3**. A Toll collection Point shall be able to read the OBU of the vehicle. OBUs work via GPS [17] and the on-board odometer or hectograph as a back-up to determine how far the Lorries have travelled by reference to a digital map and GSM to authorize the payment of the toll via a wireless link. TOLL application is beneficial not only to drivers but also to toll operators.

Parking availability: The notifications regarding the availability of parking in the metropolitan cities helped to find the availability of slots in parking lots in a certain geographical area.

Active Prediction*:* It anticipates the upcoming topography of the road, which is expected to optimize fuel usage by adjusting the cruising speed before starting a descent or an ascent. Secondly, the driver is also assisted [10].

Comfort and infotainment: Its aim to provide the road traveller with information support and entertainment to make the journey more pleasant. In the next subsections we will describe the main aspects of safety and entertainment applications.

Chapter 5: Objective

- Clustering technique is cornerstone of modern Cluster-based traffic information generalization in Vehicular Ad-hoc Networks
- Main purpose to use the clustering technique to divide the network into small group of road segments.
- Division use of the number of equipped vehicles moving in a road segment to optimally estimate the total traffic density.

Chapter 6: Research methodology

A new three steps approach for estimation of traffic volume in a road segment based on actual volume of wireless-equipped vehicles. For this propose, we first collect the traffic information for different groups of vehicles using a new clustering algorithm. Then, a chaining technique between the clusters transmits this information to a roadside cloud. Finally, we employ a generalization method to extension of the total traffic volume from the collected data. Clustering as a technique to form groups of nodes, can greatly improves vehicular networks performance. The cluster dynamically moves on the road and vehicles join or leave the cluster according to their speed and proximity to identified Cluster Head (CH); also, vehicles can communicate with other Cluster Members (CMs) based on V2V communication.

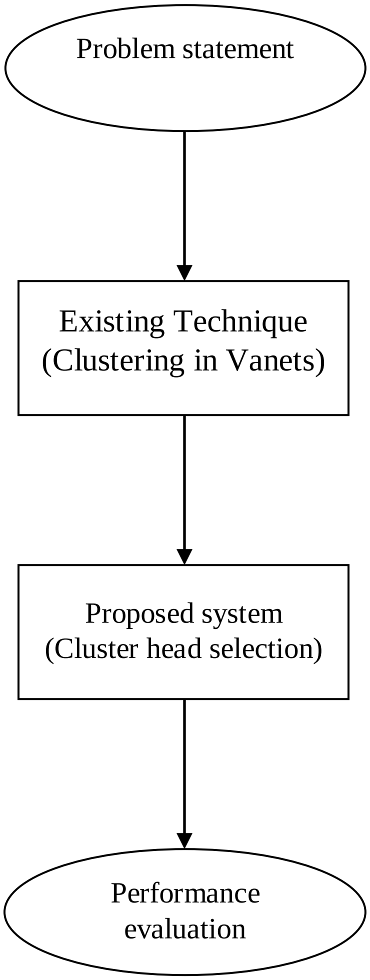

Figure 11: Flow chart

The V2V communication is flexible and independent of the roadside conditions, which is particularly attractive for the areas where the roadside infrastructures are not necessarily available [6]. In addition, other main challenges in vehicular networks such as network stability and scalability which is issues by high mobility and frequently changes of topology can be addressed by clustering technique. Clustering is applied in VANETs to divide the network into smaller groups of mobile vehicles and improve routing, information dissemination and data gathering Clustering is a technique to form grouping of nodes and can greatly improves network performance. It allows the formation of a virtual communication backbone that supports efficient data delivery in VANETs and also improves the consumption of scarce resources such as bandwidth [2]. The clustering technique has been well studied in Mobile Ad-hoc Networks (MANETs) in recent years. According to the characteristics of VANETs, such as high speed, frequently changes of topology, scale of the network, etc., the traditional clustering schemes are not suitable for VANETs [3]. Therefore, new clustering schemes should be designed specifically based on VANET characteristics. To maintain connectivity, some new algorithms were introduced. A clustering algorithm is proposed in [12] working with a hierarchical routing protocol to achieve the network stability ASPIRES as a distributed clustering algorithm based on local network criticality is presented in [6]. This scheme has two main objectives: creating large clusters and providing high network connectivity. It uses criticality metric to increase robustness of the network. Moreover, ASPIRE captures more cluster stability with postponing the re-clustering process for some times when the two cluster heads meet each other. Another significant parameter which is considered in clustering algorithms is direction of vehicles. In this case, proposed algorithms are constructed either one-hop or multi-hop structure. The direction-based clustering [13] is suggested for VANETs and takes into consideration the moving direction of vehicles and leadership of cluster heads. Also, a vehicular clustering based on the weighted clustering algorithm (VWCA) is presented in [14]. VWCA is a scheme using multiple metric derived from distrust value, number of neighbours based on dynamic transmission range and vehicle movement direction to increase cluster stability and connectivity. According to distance between a potential cluster head and its neighbour cluster associate node as a metric to select a cluster head, a new cluster construction technique is presented in [15].

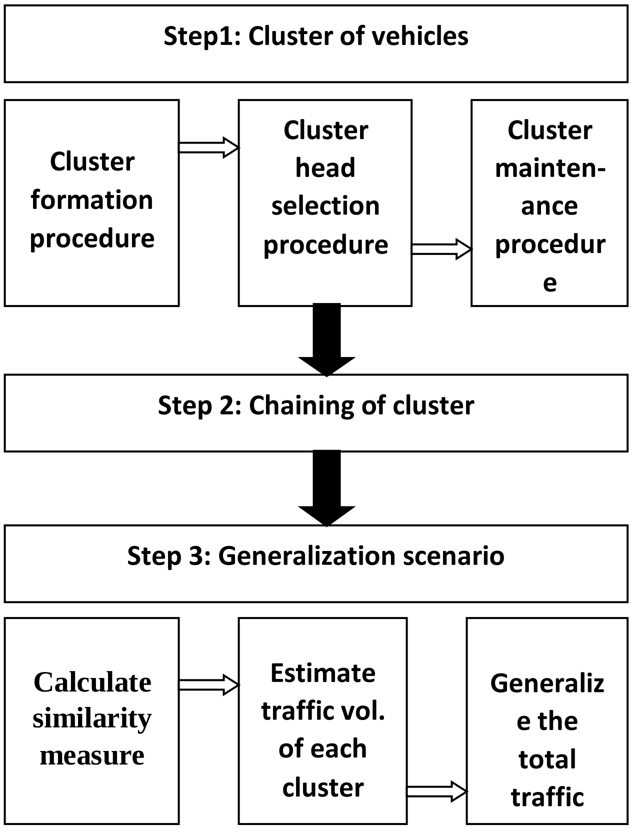

Figure 11: steps for clustering technique.

A Moving Cluster Multiple Forward (MCMF) architecture based on clustering of vehicles, cluster movement and continuous transmission of messages in a multi-hop manner was proposed in [16]. MCMF introduces a hierarchical multiple forwarding mechanism enabling communication between every vehicle and RSU via other vehicles. In [17] a stable clustering algorithm for N-hop clustering is proposed. A game theoretical approach is proposed to stimulate vehicles to disseminate the ad packets cooperatively in a stable cluster-based VANET. Thus, the network is modelled as a two level graph game: a cluster level and an inner level. Although, presented clustering algorithms are proposed for different purposes such as clusters stability and overhead minimization; however, these algorithms ignore the Quality of Service. In the case of achieving QoS few approaches was presented in the literature. A Dynamic Backbone Assisted (DBA) MAC protocol is presented in [25] to support geocasting communication on highway scenarios. The architecture of proposed protocol contains a distributed clustering algorithm that provides stability and channel quality of each link. A new cluster-based protocol proposed in [26] aiming to prolong the network lifetime. However, it ignores the mobility of nodes while computing the QoS that make it unsuitable to achieve the VANET requirements. In [7] a new QoS based clustering algorithm is discussed. This algorithm forms the stable clusters by considering the mobility of vehicles and maintains the stability during communications and link failures while satisfying the Quality of Service requirements. Most of these works attempt to increase the stability of the cluster structure, by using different metrics in cluster formation such as direction, speed and connectivity while select the cluster head based on other metrics such as mobility pattern and number of neighbours metrics).

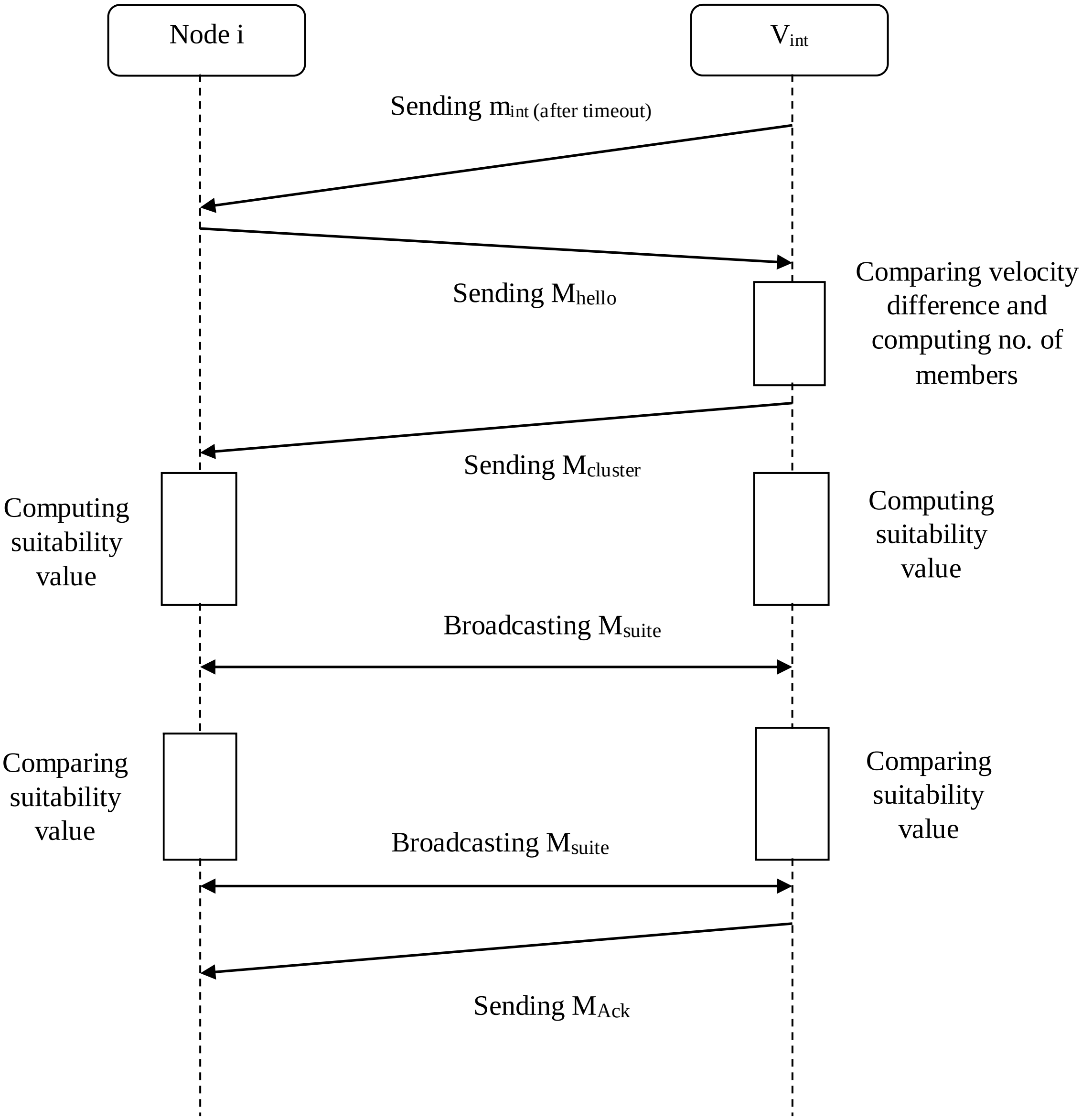

Figure 12: cluster forming algorithm

M_{CJR}	Cluster joining request
M_{init}	Initialize the cluster formation process
M_{HELLO}	Acknowledged to the cluster member
$M_{cluster}$	Notifications the V_{init} ID as temporary CH
M_{BF}	Befit factor values
M_{Vote}	Vehicle votes
M_{ack}	Acknowledgement of electing as a cluster

Table 3: message types

Algorithm 1: Cluster formation procedure.

```
– $T_w$: time to waiting for a cluster head response
– v: leading vehicle entering a new segment of the road
– $V_{neighbor}$: the vehicle in the transmission range of v
– $S_{neighbor}$ : speed of $V_{neighbor}$
– $S_{init}$: speed of $V_{init}$
——————
(In the vehicle $v_{side}$):
If there is no RSU in the vicinity of v then
    Broadcast MCJR
    If time of the MCJR > $T_w$ then
        set current state of vehicle v to Vinit
        $V_{init}$ broadcasts $M_{init}$
End if
(In the vehicle $V_{neighbor\ side}$):
If $V_{neighbor}$ receives a $M_{init}$ from $V_{init}$ then
    $V_{neighbor}$ broadcasts M HELLO
End if
(In the vehicle $v_{side}$):
For all $V_{neighbor}$ do
    If $| S_{neighbor} - S_{init} | \le S_{thr}$ then
        Add $V_{neighbor}$ID to primitive group list
    End if
End for
```

```
    If number of group members >$MEM_{thr}$ then
        $V_{init}$ broadcasts $M_{cluster}$
    else
        $V_{init}$ discards the cluster formation process
    End if
    (In the vehicle $V_{neighborside}$):
    If $V_{neighbor}$ receives a $M_{cluster}$ from $V_{init}$ then
        $V_{neighborset}$  its $_{IDCH}$ to the $ID_{init}$
    End if
End if.
```

Chapter 7: Results and discussion

7.1 Cluster formation procedure: A leading vehicle entering a new segment of the road would first search for any available cluster by broadcasting a cluster join request message (*MCJR*), or by communicating with an RSU when it in its communicating range.

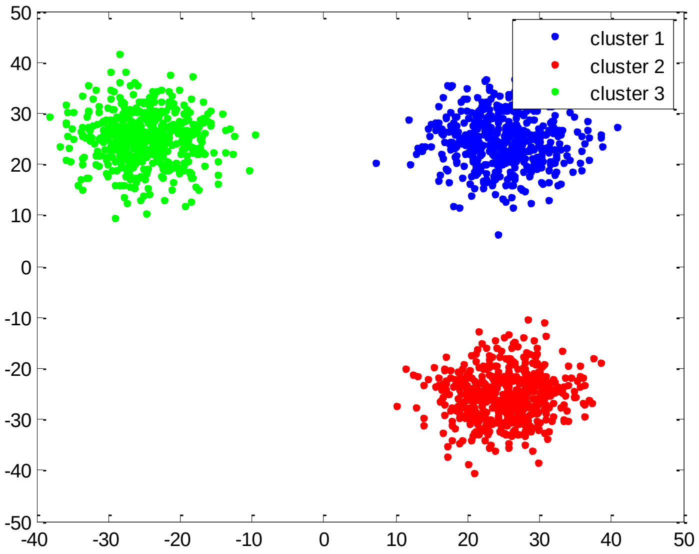

Figure 13: clusters in vanets

7.2 Vehicle to infrastructure communication: All the vehicles at road segment are communicating to the roadside units. It is related to the no. of vehicles connected to the rsu to provide the entire clustering applications.

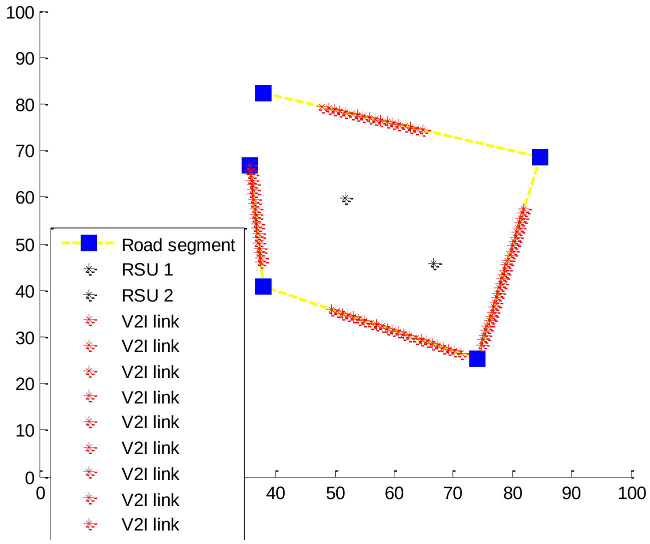

Figure 14: Vehicle to infrastructure communication.

7.3 Cluster head selection: We model a cluster head selection that allows to electing a set of optimal cluster heads. Cluster head selection in-formation for any node is limited to the nodes that are within *r* distance. Total no. of nodes is 20 with selected 3 cluster heads.

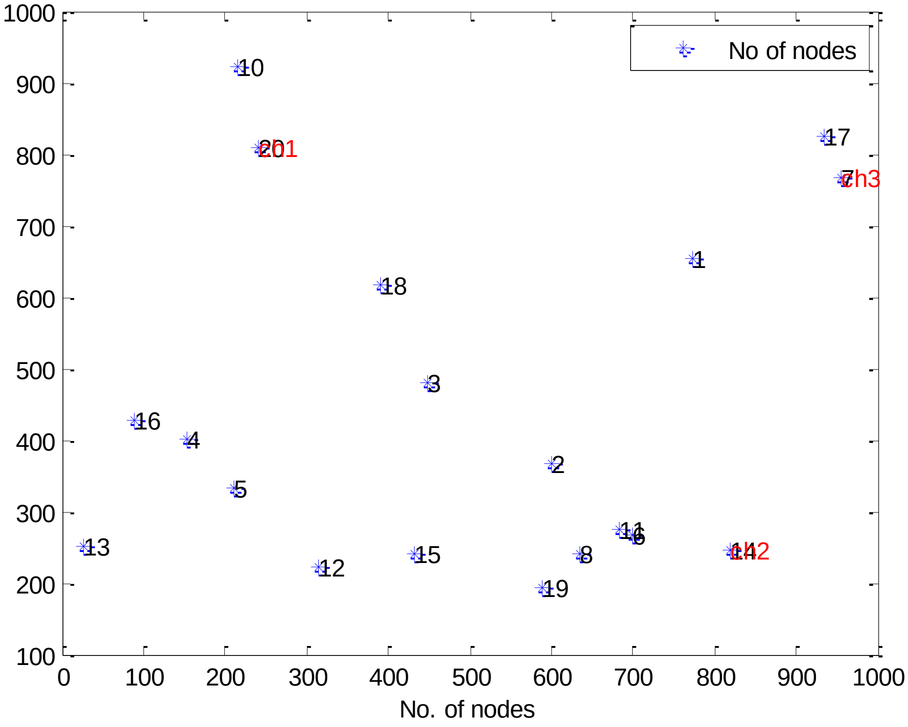

Figure 15: cluster head selection

7.4 Discussion and work till date: clustering algorithm is used to divide the network to provide all the updated information. A chaining technique between the clusters transmits this information to a roadside cloud. Afterwards, V2I communication is done at particular road segments to communicate with two of the RSUs. Now, new multi-metric Cluster Head (CH) election technique has also been developed**.** The criteria of computing node's suitability are defined to increase the stability of the cluster structure and maximize its lifetime. Hence, the elected cluster head is expected to stay connected with its members for the longest period of time. Here, the elected cluster head is calculated using Euclidian distance to select upto 3 CHs.

Chapter 8: Conclusion

In this paper, we presented a hybrid cooperative traffic information system to provide traffic data to drivers and other suppliants. The hybrid approach is a scalable mechanism that makes efficient use of the number of equipped vehicles moving in a road segment to optimally estimate the total traffic density. For this reason, we provided a new clustering method, a cluster chaining technique, and also a traffic generalization method. Also, a comprehensive simulation was conducted which its illustrative results demonstrate the superiority of the proposed clustering algorithm in the case of forming more stable dynamic clusters comparing with two existing algorithms. Moreover, the estimating simulation results depicted the accuracy of our approach in comparison with OLWSVR scheme.

Some of the additional research issues that can be investigated for future extension of the work are as follows: (1) cluster-based detecting congestion and monitoring end-of-queue situaStions, (2) ability of the approach to deliver data in transient sparse traffic, (3) evaluation of the approach overheads including memory, computational and communication overhead, (4) consideration of urban scenarios as noisy environments with traffic lights and signs at the intersections, (5) extending the approach to a spatiotemporal method to further improve the prediction accuracy of traffic flows

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