High Speed Vehicle Detection in Vehicular Ad-hoc Network

Rajendra Prasad Nayak

Department of Computer Science and Engineering
National Institute of Technology Rourkela
Rourkela – 769 008, India

High Speed Vehicle Detection in Vehicular Ad-hoc Network

Thesis submitted in

May 2013

to the department of

Computer Science and Engineering

of

National Institute of Technology Rourkela

in partial fulfillment of the requirements

for the degree of

Master of Technology

by

Rajendra Prasad Nayak

(Roll No. 211CS2283)

under the supervision of

Prof. Ashok Kumar Turuk

Department of Computer Science and Engineering

National Institute of Technology Rourkela

Rourkela – 769 008, India

Dedicated to my family

Computer Science and Engineering
National Institute of Technology Rourkela
Rourkela-769 008, India. `www.nitrkl.ac.in`

May 22, 2013

Certificate

This is to certify that the work in the thesis entitled ***High Speed Vehicle Detection in Vanet*** by ***Rajendra Prasad Nayak*** is a record of an original work carried out by him under my supervision and guidance in partial fulfillment of the requirements for the award of the degree of *Master of Technology* in *Information Security* specialization of *Computer Science and Engineering* department. Neither this project nor any part of it has been submitted for any degree or academic award elsewhere.

Ashok Kumar Turuk
Professor
Computer Science and Engineering, NIT Rourkela

Acknowledgment

I would like to express my deep gratitude to all who have supported and encouraged me in various ways. This dissertation would not have been possible without you.

Foremost, I would like to express my deep gratitude to my advisor, Prof. Ashok Kumar Turuk for providing me with a platform to work on very exciting field of Vehicular Ad-hoc Network. His untiring effort, commitment, encouragement, guidance and support helped me in understanding and giving word to my research.

I am gratified to Prof. Bainsidhara Majhi, Prof.S.K.Jena, Prof B.sahoo, Prof. M.N. Sahoo of NIT Rourkela who has provided me with continuous encouragement and advised me at different stages of thesis work.

I am very much indebted to all the Professors of computer Science department for their advice and insightful comments at different stages of thesis that were indeed thought provoking.

I would like to thank my friends for their support. I especially want to thank Alekha kumar Misra, Harun Rashid, and Ambuj Kumar for all the help, moral and intellectual over the year. There have been ups and there have been downs and the cycle is likely to continue.

Most importantly, this would not have been possible without the love and support of my family. My family, whom this thesis is dedicated to, has been a constant source of love, concern, support and strength all these years. I would like to express my heart-felt gratitude to them.

Rajendra Prasad Nayak

Email: rajendra.cet07@gmail.com

Abstract

Millions of people are dying in car accidents. Accidents occur mainly due to the alcoholic nature of the driver or due to high speed of vehicle. So, by controlling the high speed of vehicle we could decrease the number of accidents. In this thesis we propose the mechanism for detecting high speed vehicle in Vehicular Ad Hoc Network (VANET). The proposed scheme uses the position of a vehicle to compute its average speed. In order to know the surrounding condition, each vehicle periodically broadcasts its position, timing information in its communication range. When a vehicle enters the radio range of an Road Side Unit (RSU), the RSU receives the position and timing information of the vehicle and send it to the Central Server. The Central Server computes the average speed of the vehicle using time and position information received from the RSUs. When a vehicle is found to have more speed than the speed limit of the specific region, the Central Server broadcasts this information to all RSUs in its range. When the vehicle again comes into the range of an RSU, it informs the vehicle to drive within the speed limit using a warning message. When a vehicle is found violating the speed limit a number of times more than a threshold, then Central Server forwards this violation information to the Certification Authority (CA). Based on the threshold, the CA takes appropriate action on the high speed vehicle. In order to evaluate the performance of our scheme, we have used Veins hybrid simulator which works on OMNeT++ as a network simulator, Simulation of Urban mobility (SUMO) as traffic simulator. Traci is used for interlinking network simulator with road traffic simulator. By doing simulation with these simulators we have compared our scheme with that of other scheme.

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Chapter 1

Introduction

Introduction
VANET Overview
Intelligent transportation System (ITS)
Routing Protocols in VANET
VANET Applications
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Thesis Motivation
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Thesis Organization

1.1 Introduction

Traffic congestion on roads is a big problem in cities. The congestion and vehicle accumulation problem is accompanied by a constant threat accidents. Lack of road traffic safety and increase in the no of high speed vehicle takes a no of precious human lives and poses a serious threat to our environment as well. Other consequences are related to environmental pollution and energy waste.

According to National Highway Traffic Safety Administration, 6.3 million Police reported traffic accidents, 43,000 people were killed. The economy effects caused due to these accidents were more than $230 billion and Millions of people were injured [1]. Preliminary precautions like airbags and seat belts are used but they cannot eliminate problems due to drivers inability to predict the situation ahead of time. On a highway or in a turning point a vehicle cannot predict the current speed of other vehicles. However, with the use of wireless communication equipment, sensor and computer speed could be predicted and a warning message sent every 0.5 seconds could limit the risk of potential accidents [2].

1.2 VANET Overview

A Vehicular Ad-Hoc Network, or VANET, is a type of Mobile ad-hoc network which provide communications between vehicles, among nearby vehicles, and nearby fixed units, usually described as a roadside unit (RSU). The main goal of VANET is to provide safety and comfort for passengers, drivers and other road users. To achieve this special electronic device will be connected to each vehicle which will provide Ad-Hoc Network connectivity to the passengers. Each vehicle is equipped with VANET device, will be a node in the Ad-Hoc network and can receive and relay others messages though the network. Road sign alarms, Collision warning and traffic view will give the driver to decide the best path along the way to reach the destination. There are also other services like multimedia and Internet connectivity facilities for passengers, all of which will be provided within the wireless coverage area of each car. Automatic parking and toll collection are other examples of VANET.

Most of the concerns of interest to MANETs are of interest in VANETs, but the two differ as MANET can contain many nodes that have un-controlled moving patterns [3]. But since VANET is formed mainly by vehicles so node movement is restricted by factors like a road structure, traffic congestion and traffic regulations and rules. Because of the strict node movement it can be said that VANET will be supported by any fixed infrastructure that provide some services and access to stationary networks. Rather than moving at random way, vehicles in VANET tend to move in an organized way. The interactions with roadside equipment can be characterized as fairly accurate, and finally, most vehicles can move only in their range of motion.

Controlling traffic, especially at road junctions, is a challenging task for metropolitan city planners. This situation can be irritating if robots at robot controlled intersections stop working or got malfunction and the police are not available at that time to control the traffic flow. Once in a while the robots are not working and the traffic police are not available to give hand signals to the hooting and yelling swearing, and cursing road users. The situation get even more worse if there is an accident along one way or a big truck containing goods has had a breakdown at the narrower intersection point. Long queues, slow winding queues of moving vehicle pileup and the situation can be very discouraging for one to use certain notorious roads. Driving through a city where there are narrower roads and inadequate parking area during pick hours is a catastrophe for time-savers and the impatient. Recent surveys in the United States of America (USA) show that traffic congestion costs are a staggering total amount in: Wasted Fuel of 2.3 billion gallons, Delay of 3.7 billion hours, and an Annual Cost of $63 billion to the US economy alone [4]. These from of such experiences and observations that Intelligent Transportation Systems (ITS) can become handy in easing, if not solving this traffic jungle madness [5]. ITS applies advanced technologies to surface transportation systems and are viewed widely as the solution to the traffic control problems and transportation that the 21st Century societies will face.

1.3 Intelligent transportation System (ITS)

VANET uses Intelligent Transportation System (ITS) for vehicular communication where each vehicle acts as sender, receiver, and the router [6] to broadcast information to the vehicular network.

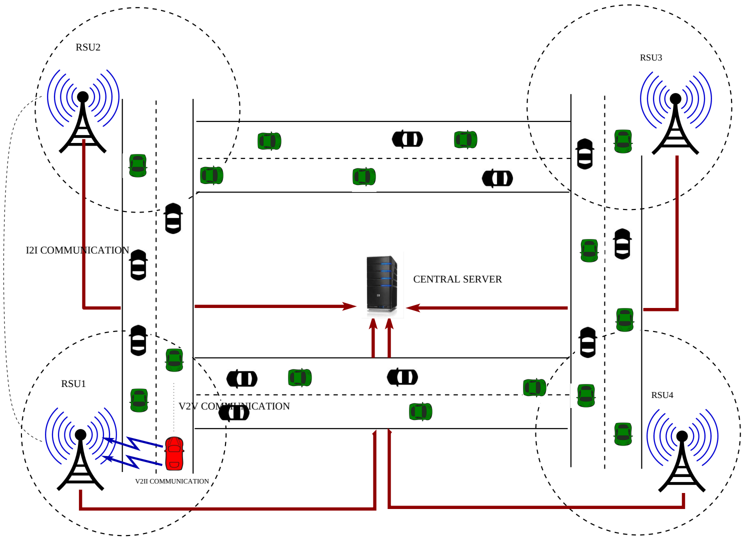

Figure 1.1: Basic VANET Architecture

An ITS as shown in figure 1.1 mainly consists of mobile nodes (e.g. Vehicles), infrastructure nodes (e.g. Roadside units) and certification authorities (CAs) [7]. Roadside units (RSUs) and CAs are static units and vehicles are mobile units. RSUs are fixed and connected to the backbone network and helps in communication. The frequency and distribution of RSUs depend upon the communication protocol used and mainly divided into two types. One is dense RSUs based where regions of RSUs are overlapped with each other and the other one is sparse RSUs region where the ranges of RSUs do not overlap with each other.

Our proposed scheme is based on the protocol which uses sparse RSUs region. Each vehicle is equipped with On Board Unit (OBU), Trusted Platform Module

(TPM), sensors, Global Position System (GPS) device etc. OBU is used for communication purpose like vehicle to vehicle (V2V), vehicle to infrastructure (V2I), and routing based communication. Sensors are used to measure status like fuel consumption and environmental condition like slippery road, safety distances [8]. GPS gives information about the vehicles current position and TPM is used for secure communication. Vehicles are also fixed with LASER, RADAR, Sensors, etc. to know other vehicle positions. RSU acts as an intermediate between vehicles and CA and also gives information about road conditions and traffic information to the vehicles which come under its region.

1.4 Routing Protocols in VANET

A routing protocol monitors the way that two communicable entities exchange information. It includes the procedure in establishing a route, forwarding data, and action in maintaining the route or recovering from routing failure [9]. Most of the routing protocols of VANET are same as that of the MANET routing protocols. VANET routing protocols can be classified into 2 two types. One is topology-based and the other is geographic (position-based) based routing.

1.4.1 Topology- based Routing Protocols

These routing protocols use link information that exists in the network to perform packet forwarding and can be divided into proactive (table-driven) and reactive (on-demand) routing protocols.

(1) Proactive Routing Protocols: It carries the unique feature : the routing information such as the next forwarding hop is maintained in the background regardless of communication requests [10]. Packets which are used for control are constantly broadcast and flooded among nodes to maintain the paths or the link states between any pair of nodes even though some paths are never

used. A table is maintained within the nodes such that each entry in the table indicates the next hop node toward a certain destination [11]. The advantage of the proactive routing protocols is that there is no discovery of route since route to the destination is maintained in the background and is always available upon lookup [12]. Despite its good property of providing low latency for real-time applications, maintenance of unused paths takes a significant part of the available bandwidth, especially in highly mobile VANETs. DSDV is an example of this type of routing protocol.

(2) Reactive Routing Protocols: Based on the necessary for a node to communicate with another node, this routing protocol opens a route. It maintains only the routes that are currently in use, as a result reduces the burden on the network. It has a route discovery phase where query packets are flooded into the network in search of a path [13]. The phase completes after getting a route. Some of the examples of this type of routing protocols are described below.

(a) AODV: Stands for Ad Hoc On Demand Distance Vector routing. By receiving a broadcast query (RREQ), each node record the address of the node sending the query in their routing table. This procedure of recording its previous hop is called backward learning [14]. By reaching the destination, a replay packet called as route replay (RREP) is then sent through the complete path obtained from backward learning to the source [15]. At each stop of the path, the node would record its previous hop, thus establishing the forward path from the source to the destination. The flooding of query and sending of reply establishes a full duplex path. After the path has been established, it is maintained as long as the source uses it[16]. The failure will be reported recursively to the source and will in turn trigger another query-response procedure to find a new route.

(b) AODV+PGB: It is a combination of the AODV with that preferred group based broadcasting. It is a broadcasting mechanism that aims to reduce broadcast overhead associated with AODVs route discovery and to provide route stability especially important in VANETs where fast moving vehicles are used as wireless hosts [17]. Based on the received signal of the broadcast, receivers can determine whether they are in the preferred group and which one in the group to broadcast. Since only one node is allowed to broadcast and the preferred group is not necessarily the one that makes the most progress towards the destination, route discovery might take longer than before [18]. Other drawback is that broadcast can discontinue if the group is found to be empty because of sparse networks. Packet duplication can happen as two nodes in the preferred group can broadcast at the same time [19]. This creates the same type of overhead in the packet as DSR (Dynamic Source Routing).

(c) DSR: Stands for Dynamic Source Routing. It uses source routing, that is, the source indicates in a data packets the sequence of intermediate nodes on the routing path [20]. In DSR, the query packet copies in its header the IDs of the intermediate nodes that it has traversed. The destination then retrieves the entire path of the query packet, and then uses it to respond to the source. As a result, the source can establish a path to the destination. If we allow the destination to send multiple route replies, the source node may receive and store multiple routes from the destination. An alternative route can be used when some link in the current route breaks. In a network with low mobility, this is advantageous over AODV since the alternative route can be tried before DSR initiates another flood for route discovery.

1.4.2 Geographic (Position-based) Routing

In geographic routing, the forwarding decision by a node is primarily made based on the position of a packets destination and the position of the nodes one-hop neighbors. The position of the destination is stored in the header of the packet by the source. The position of the nodes one-hop neighbors are obtained by the beacons sent periodically with random jitter (to prevent collision) [21]. Nodes that are within a nodes radio range will become neighbors of the node. Some of the examples of this type of routing are described below.

(a) CAR: stands for Connectivity Aware Routing. CAR uses AODV-based path discovery to find routes with limited broadcast from PGB. However, nodes that form the route record neither their previous node from backward learning nor their previous node that forwards the path reply packet from the destination [22]. Rather, anchor points, which are nodes near a crossing or road curve, are recorded in the path discovery packet. A node determines itself as an anchor point if its velocity vector is not parallel to the velocity vector of the previous node in the packet. The destination might receive multiple path discovery packets; it chooses the path that provides better connectivity and lower delays.

(b) GPSR: Stands for Greedy Perimeter Stateless Routing where a node forwards a packet to an immediate neighbor which is geographically closer to the destination node. This mode of forwarding is termed as greedy mode. When a packet reaches a local maximum, a recovery mode is used to forward a packet to a node that is closer to the destination than the node where the packet encountered the local maximum [23]. The packet resumes forwarding in greedy mode when it reaches a node whose distance to the destination is closer than the node at the local maximum to the destination.

1.5 VANET Applications

Vanet applications are those applications that increase the safety of the driver and passengers. Transportation-related applications starts from safety applications such as cooperative forward collision warning or extended electronic brake lights to traffic management applications such as road-condition warnings or alternative route warnings. Convenience applications increase the comfort of the passengers and the drivers. These applications range from gaming, Internet access, P2P services or sharing files.

Typical safety applications are characterized as being applications in which the main objective is to distribute certain event that has occurred in the vicinity of the sender. Some examples described in [24]) are:

(1) Cooperative awareness: to extend non-cooperative driver assistance systems Which perception is limited to the operating range of on-board sensors (ad-Verse weather, obstacles or dangerous road conditions).

(2) Cooperative assistance: distribution of data (e.g. Warning of accidents).

(3) Car to Car: exchange of information between car users (e.g. Files, platoon traveling, etc).

(4) Car to infrastructure: information received by a car from hot spots giving road and traffic information and car access to Internet.

(5) Car to Mobile devices: those applications between the car and mobile devices (e.g. mobile phone, MP3, laptop, etc).

(6) Car to Enterprise: communications between the car and companies (e.g. restaurants, gas stations, parking areas, etc.) that give road services.

1.6 Current VANET Projects

In recent years, several intelligent transportation system initiatives and projects have been undertaken by different countries and organizations. For example, in 2006 the European Commission implemented a new safety program which was designed to reduce road fatalities by 50% by 2010 as well as to improve the efficiency of traffic flows [7]. These research and development trials are in progress and gives an important step towards the goals of improving road safety and traffic efficiency as well as providing Internet services to vehicles. Several organizations such as the automotive industry, highway control authorities, toll service providers and safety organizations are now involved in different projects all of whom main objective is to provide safety to the people and drivers. So in order to reduce the no of accidents, provide safety for people, control congestion on roads, various Vehicular Ad Hoc Network (VANET) projects have been carried out by various governments, car industries and academic institutions around the world [7]. Current Projects like WAVE, IVI, VSC, IVI, etc. In the USA, DEMO, JARI, ASV1, ASV2, etc. In JAPAN and C2C-CC, FleetNet , PReVENT, Carlink, etc. At European Union are in progress, which main objective is to provide safety and service to the people. Besides providing safety and service to people, VANET also provide different commercial applications, data access to people. Due to these large no of applications, it becomes an active area of research.

1.7 Thesis Motivation

Millions of people are dying now a days because of car accidents and the accidents are because of the high speed vehicles. So Speed detection is an important area of research in VANET as by detecting the high speed vehicle, accidents as well as congestion can be reduced. The chances of occurrence of accident because of high speed vehicle is more than that of the normal speeding vehicle. So it takes the life of people by directly or indirectly. As the life of a person is important , by detecting high speed vehicle and reducing the no of accidents, safety can be provided to the people as well as to the drivers. Other use like capturing the theft vehicles, detecting important vehicles can also be known by the vehicle detection scheme.

1.8 Thesis Objective

The objective of the thesis is to improve the accuracy of high speed vehicle detection in VANET so that it can be used to detect maximum no of vehicles and increase the safety of the road. The main objective is as follows

1 To study the performance of some existing vehicle detection and speed estimation system.

2 To design and develop an efficient vehicle detection and speed estimation system in VANET.

3 To evaluate the performance of the proposed scheme using the veins hybrid simulator which consists of the OMNeT++, SUMO simulators and veins package.

1.9 Thesis Organization

This thesis is organized into 5 chapters where we start by giving an introduction of the thesis. The remainder of the thesis is organized as follows.

Chapter 2 describes related research and background for vehicle detection and speed estimation.

Chapter 3 describes the proposed scheme in detail, that include the system model description and assumptions taken.

Chapter 4 gives the implementation details of the mechanism and presents the results of the implementation with varying parameters.

The work presented concludes in chapter 5.

Chapter 2

literature Review

Literature review

2.1 Literature Review

In general, there are two methods of vehicle detection: intrusive technologies (pneumatic road tubes, inductive loop detectors, piezoelectric sensors) and non-intrusive technologies (video image processors, microwave radars, infrared sensors, and ultrasonic sensors) [25]. An inductive loop detector consists of three components: a loop, a loop extension cable and a detector [26]. Loop detectors are placed at specified locations on roadways to count vehicles and to estimate vehicle speed based on the occupancy time of vehicles on the detectors. However, installing these detectors requires a great number of saw-cuts on roadway surfaces, which makes them difficult to deploy and maintain. This work is much more expensive on roadway sections which need a large number of loop detectors. Moreover, loop detectors can provide data only from vehicle to infrastructure and not vice versa.

In order to improve the vehicle detection technique for ITS, wireless communication systems have already been studied. Wireless communication systems used in ITS can be classified into 2 types: vehicle-to-vehicle communication (V2V) and vehicle-to-infrastructure communication (V2I). Some systems such as VETRAC [27] and COC [28] which employ V2V and V2I to provide more functions for roadway security and management are being developed.

In [29] paper proposes a vehicle volume and speed measurement method using wireless communications between roadside equipment and vehicles. Vehicles are equipped with Global Positioning System (GPS) receivers and wireless communication devices, to detect their geographical location and to provide ad-hoc network connectivity with the roadside unit respectively. To carry out the functions of a loop detector, roadside equipment collects data from vehicles to detect their locations periodically and then counts the number of vehicles passing a given position in a period, but the authors have taken the scenario that the ranges of RSUs are set in such a way that they do not overlap with each other but also there should not be any gap in the coverage range of the RSUs. This scenario gives a good detection result but could not be applied to the sparse RSUs region where no of

RSUs are less. In [30] the authors propose a novel RF-based Vehicle detection and Speed Estimation system (ReVISE). It makes use of the fact that the wireless signal strength in an RF environment is affected by the presence and motion of objects and hence the wireless signals can be used to infer the state of the environment and identify objects in the area Of interest only, not in all regions. So a vehicle can move to any speed in the area where there is no existence of RF signal. In order to overcome these all drawbacks we propose a novel detection system which can detect vehicles in all regions.

Chapter 3

Proposed Scheme

Introduction
Assumptions
Network Model
Proposed Model
Simulation and Results
Conclusion

3.1 Introduction

In order to remove the problems of detecting higher speed vehicles explained in the previous chapters, in this chapter we proposed a scheme by which high speed vehicles can be detected efficiently. In this chapter, we propose the mechanisms for detecting high speed vehicle in VANET. The proposed scheme uses the position of a vehicle to compute its average speed. Each vehicle periodically broadcasts its position in its communication range. When a vehicle enters the radio range of an RSU, the RSU receives the position and timing information of the vehicle and send it to the Central Server. The Central Server computes the average speed of the vehicle using its time and position information received from the RSUs. When a node is found to have more speed than the speed limit of the specific region, the Central Server broadcast this information to all RSUs in its range. When the vehicle again comes into the range of an RSU, it informs the vehicle to drive within the speed limit using a warning message. When a vehicle is found violating the speed limit a number of times more than a threshold, then Central Server forwards this violation information to the Certification Authority (CA). Based on the threshold the CA takes appropriate action on the high speed vehicle.

3.2 Assumptions

In this scheme we have taken the following assumptions like each vehicle is equipped with Global Positioning System (GPS) receiver for identifying its own location, On Board Unit (OBU) for communication and other sensors. All vehicles beacons at a particular interval to update the location information of other vehicles. Each vehicle in the network has its own id. High power batteries are connected to the cars which provide necessary power to the sensors. If a vehicle switch off its sensors like OBU, then that vehicle is treated as a faulty or malicious vehicle and the CA takes appropriate action on the vehicle.

All the vehicles which are used in the simulation are of the same type and they maintained a uniform distance between them. The movement pattern of the normal vehicles is also same. A particular lane is assigned to each vehicle and the vehicle have to move in that particular lane. Normally the ranges of the vehicles are less than that of the ranges of RSUs but here the range is taken in such a way that when a vehicle comes under the range of an RSU and broadcast periodic beacons then the RSU could receive the beacons from the vehicle.

3.3 Network Model

In this section we are going to describe the created network using the network simulator, the standards used for communication and the broadcast mechanism for sending the information in the network.

3.3.1 Network Design

We created the network by using the network simulator OMNeT++ and the road by using the traffic simulator SUMO. The road system in our network consists of links and connectors. Each element has a different ID. A connector joins two links. Roadways may have only one link (one-way street) or two links (2-way street) which depends upon the scenario. A link refers to one side of a roadway where vehicles move in the same direction. A link may have one or more lanes. Lanes are defined areas on a link which generally allow only one type of vehicle to travel with in it. Lanes of a link are assigned a number starting from 1. We define nodes (waypoints) which are also numbered starting from 1 along the imaginary central line of a link in its direction. Nodes are chosen in such a way that the shape of the imaginary line that joins them is most similar to the shape of the link. In addition, the distance between nodes is greater than the average length of vehicles (5 m) so that a vehicle cannot occupy 2 nodes at the same time. We have placed the RSUs in the position of the nodes. Each of the RSUs is connected to the central server through a wired connection. So the transmission time from the RSU to the server is negligible. The coverage area of RSUs is set in such a way that during some period of time a vehicle comes under the range of RSU while moving in the lane.

3.3.2 Communication Standard

We have used the Intelligent Transportation Systems (ITS) for our simulation which uses DSRC (Dedicated Short Range Communication) with 5.9 GHz band spectrum. There are still some discrepancies in the channel allocation between several countries and organizations [31]. Architectures using DSRC (Dedicated Short Range Communication) have a dedicated band for ITS services ranged from 5.885 to 5.905 GHz in USA and from 5.795 to 5.815 GHz in Europe [32]. Furthermore, the ITU has requested for ITS Safety applications the allocation of 75 MHz from 5.850 to 5.925 GHz with the idea of supporting both 10 and 20 MHz channels. IEEE 802.11a works on the unlicensed bands 5.15-5.25 (USA UNII lower band), 5.25-5.35 (USA UNII middle band), 5.470-5.825 (USA/Europe) and 5.725-5.825 (USA UNII up- per band) [33, 34]. IEEE 802.11p WAVE, being part of the DSRC system, operates in the licensed 5.9GHz band. radio spectrum allocation in the 5 GHz band. Robust safety vehicular communications need a protected frequency band outside the unlicensed ISM band.

Figure 3.1 represents the DSRC communication standard.There is an effort pursued by several organizations to find a common architecture for VANETS. As a technology, DSRC will use IEEE802.11p as background technology, although C2CCC stands for a modified European IEEE802.11p version based on the ETSI channel allocation. ISO/CALM pursues a VANET architecture able to communicate continuously in any technology and based on IETF mobile protocols (e.g. Mobile IPv6) with IPv6 as a network protocol. C2CCC pursues an architecture based on IEEE802.11p technology and without any requirement at upper layers (e.g. They consider network technologies such as TCP/IP).

We have used IEEE802.11p, also called WAVE (Wireless Access in Vehicular Environments), as shown in figure 3.1 for our simulation which is a multichannel

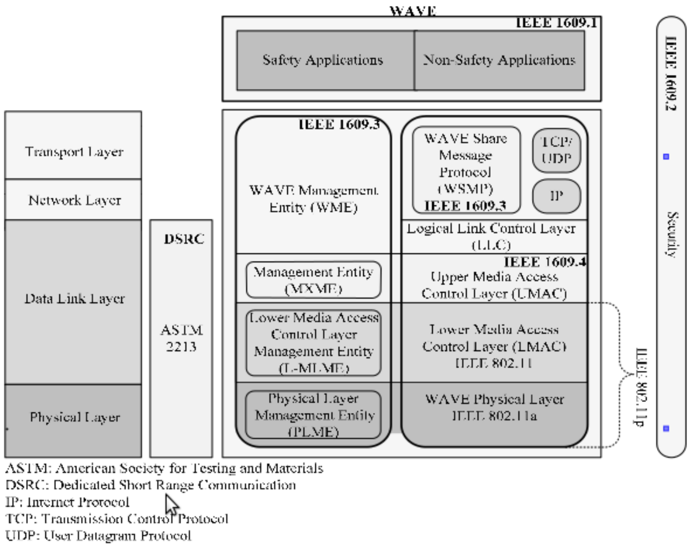

Figure 3.1: DSRC communicate Standard

wireless standard based on IEEE802.11a PHY standard and IEEE802.11 MAC standard (i.e. WAVE uses CSMA/CA as a basic medium access mechanism). WAVE would use one control channel to set up transmissions and data channels to send the data. WAVE allows high data rate ($\leq$ 27 Mbps) in short distances ($\leq$ 1 Km). Other properties like (i) operates in licensed bands at 5.9 GHz, (ii) with 7 channels supporting safety and non-safety applications, (iii) a 10 MHz channel bandwidth and (iv) is thought for outdoor high speed vehicles are supported for our simulation. Hence we use this standard for our simulation.

3.3.3 Broadcast and Dissimination Techniques

We have used push communication model in which information is exchanged through two different mechanisms: (i) flooding and (ii) dissemination. In flooding mechanisms, a node propagates information to neighbors. These neighbors retransmit each broadcast packet which they received. The objective of the broadcast is that each packet is received by each node of the network region. The differences between broadcast mechanisms is how to reach all the nodes with the minimum number of retransmissions. This is equivalent to choose the minimum number of forwarders to reach the whole network. In dissemination mechanisms, a node broadcast its own information and the information of other nodes in the network. A node by receiving a dissemination packet, it merges the received information along with its own information and retransmits the updated information in the next broadcast period.

Broadcast packets in a network may result in high redundancy, collisions and contention. In general, eliminating the redundancy is addressed through the use of topology information. Contention occurs due to the fact that several nodes decide to re-broadcast the packet in same time. The solution of the problem is a forwarding mechanism that uses the channel more efficiently minimizing the number of nodes that contend for the media and the number of re-broadcasted packets reaching the whole network. It must be noticed that the RTS / CTS mechanism decreases the effect of the hidden terminal and therefore collisions while the ACK makes the channel more reliable. However, when broadcasting a packet the RTS/CTS is deactivated and there are no ACKs.

Paper [35] surveys and compares different broadcasting techniques to forward packets. The authors classify broadcasting mechanisms in four classes:

(1) Simple Flooding: each node retransmits the packet so packets are flooded to the whole network. Simple mechanism at the cost of maximum number of retransmissions per packet.

(2) Probability-Based Methods: in the Probabilistic scheme packets are retransmitted using certain probability, so, no all nodes retransmit each packet. Probabilistic schemes behave well in dense networks. However in sparse networks there will be packets not received unless the probability tends to 1

(3) Counter-based Methods: in the counter based schemes the nodes initiate a counter to one and increase the counter upon reception of each copy of

the packet. After a RAD (Random Assessment Delay) time, the packet is retransmitted if the counter is less than a threshold. Under this scheme there will be nodes not retransmitting in dense networks while all nodes will tend to retransmit in sparse networks.

(4) Area-Based methods: try to maximize the additional coverage area that will cover the node that re-broadcasts the packet. However, nodes have not knowledge of other existing nodes in the covered area.

In our simulation we have used the simple flooding broadcasting mechanism to broadcast data from vehicle to vehicle and from vehicle to road side unit to know the information about the surroundings.

3.4 Proposed Model

The vehicle moves in a particular lane on the road. During the movement of the vehicle, in order to know the information of the surrounding, each vehicle periodically broadcasts beacons to the surrounding. Each vehicle has a coverage range. If a beacon comes under the coverage range of a vehicle then the vehicle receives the beacons and updates its database. In order to provide information like congestion, traffic condition, road condition like slippery or plain, to the vehicles, RSUs are placed at the junctions or at the cross-section of the road. Each roadside unit manages offline data which refer to the information of roadway infrastructure within its direct radio range. So in order to know the information about the no of vehicles, speed in its radio range, RSU sends query messages to vehicles with certain interval of time. This time period is called as the query period (Tquery) [29]. This query period differs from protocol to protocol based on the data rate and the range of RSU.To ensure the update of vehicular data, Tquery must be longer than the transmission delay between vehicles and the RSU. Before dealing with Tquery, we first need to estimate the maximum transmission delay. We assume the size of exchanging messages does not exceed 50 bytes or 400 bits. We follow the DSRC standard for the communication having a bit rate of 11 Mbps. Hence the transmission delay for each message is 400/11=.000036 Sec. This delay increases if there are several vehicles communicating with a V2I station at the same time. In the case where the effective range (R) of the V2I station is 100 (m), its coverage area is given by 31400 m^2. We also set the average space size for a vehicle is 5 m in length and 3.5 m in width (equals to the lane width). So the maximum number of vehicles present in this area is 31400/(3.5*5)=1794. So the maximum transmission delay is 1794*0.000036=0.065 (s). In our simulation we have taken 0.1 as the maximum transmission delay.

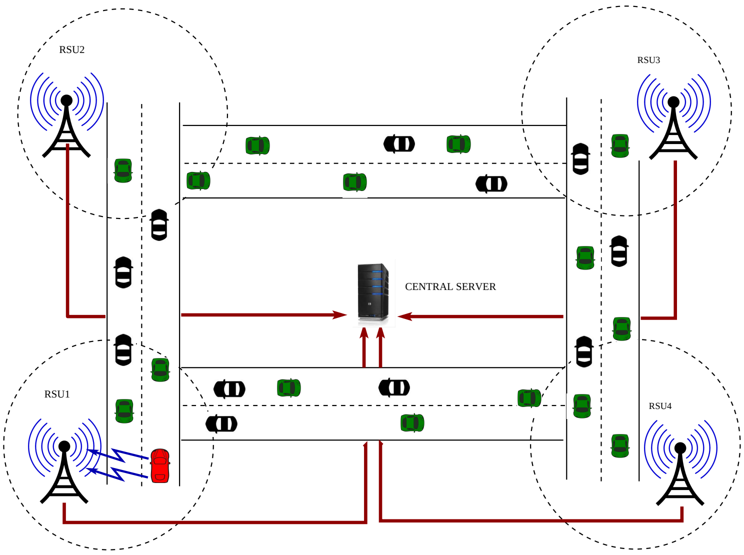

Figure 3.2: Vehicle under RSU1 region

When a vehicle comes under the radio range of an RSU as shown in the figure 3.2 , it receives the periodic messages from the vehicle. Received periodic messages contain several information about the vehicle. This data is called online data which stored in form of Vehicle table(VT) as follows:

Vehicle_table(VT) = {X1_vehicle, Y1_vehicle, vehicle ID, transmitted time(T1), speed, station ID }

Where

(X1, Y1) is the position of the vehicle under RSU1 region at which it broadcasts the beacon, which is obtained through GPS device connected to the vehicle.

T1 is the time at which vehicle broadcasts the beacon to RSU1.

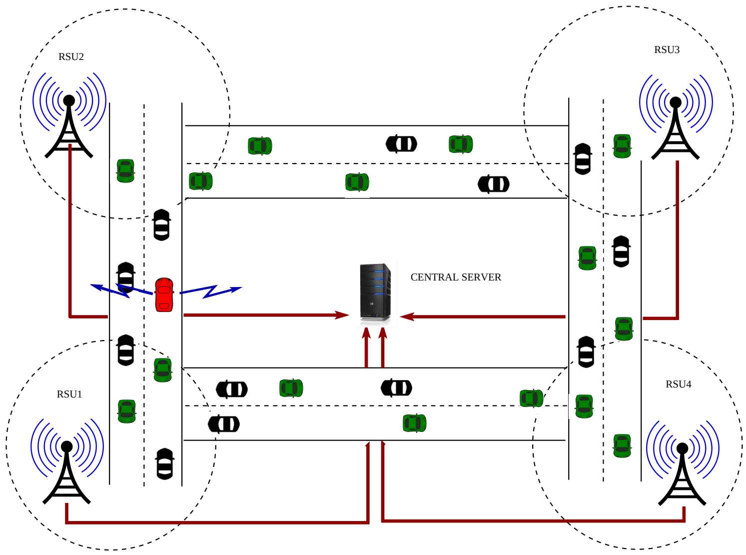

Figure 3.3: Vehicle doesnot come under any RSU Region

The data stored in the RSU is called offline data and stored as follows: Rsu_table={Vehicle_table{}, X_station, Y_station, station id, transmission range}. By receiving the information from the vehicle, RSU can know the speed of the vehicle within its radio range and compare the speed of the vehicle with that of the permitted speed in that lane i.e 33 m/s in our case and take appropriate action on the vehicle, but when the vehicle goes out of the scope of the RSU as shown in the figure 3.3, where there are no existence of RSUs and then at that position speed of the vehicle could not be determined, as a result the vehicle could move at any speed in this region. So in order to determine the average speed of the vehicle in a particular lane, we have to take the two Rsu_table values.

After getting the information form the vehicle, RSU1 sends two Vehicle_table information to the central server; one is during the entry into the RSU1 and the other during the exit from that RSU1. Time taken to send information from RSU to server is negligible as their existence of wired connection between them. So the delay due to this transmission can be neglected. The speed of a vehicle is calculated

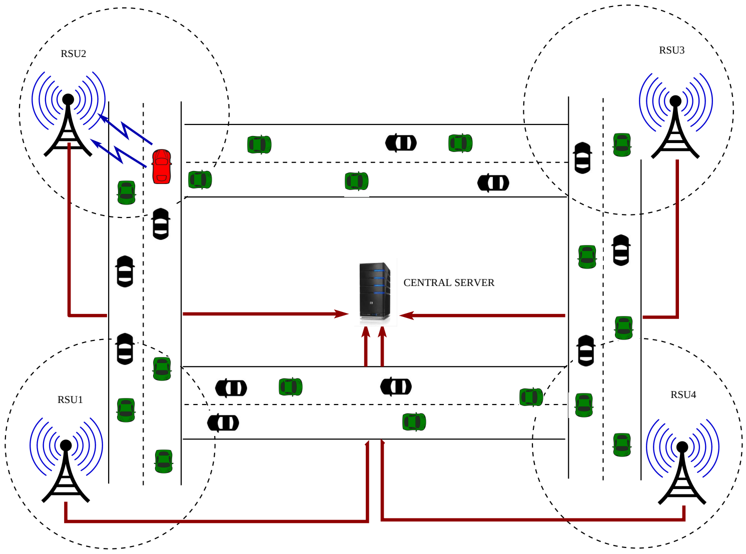

Figure 3.4: Vehicle under RSU2 Region

from the two Vehicle_table information, one is while the vehicle enters into the one RSU and the other when the vehicle exists from the another RSU.

Let the vehicle table send by RSU1 to the central server as follows:

Vehicle_table = {X1_vehicle, Y1_vehicle, vehicle ID1, transmitted time(T1), speed1, station ID1 } This is during the exit of the vehicle from RSU1.

Where

(X1, Y1) is the position of the vehicle under RSU1 region at which it broadcasts the beacon.

T1 is the time at which vehicle broadcasts the beacon to RSU1.

After some period of time again vehicle enters into another RSU region i.e RUS2 as shown in the figure 3.4 and the vehicle table send by the RSU2 to the central server is

Vehicle_table = {X2_vehicle, Y2_vehicle, vehicle ID1, transmitted time (T2), speed2, station ID2 }

This is during the entry into the RSU2. Where

(X2, Y2) is the position of the vehicle under RSU2 region at which it broadcasts the beacon.

T2 is the time at which vehicle broadcasts the beacon to RSU2.

Now the central server has two position information (X1, Y1) and (X2, Y2), two timing information T1 and T2. Since the central RSU is highly efficient and have calculation and manipulation power, it calculates the velocity of the vehicle by

$$V = \frac{((X2 - X1)^2 - (Y2 - Y1)^2)^{1/2}}{T2 - T1}$$

Now this velocity (V) is compared with that of the maximum permissible velocity up to that extent a vehicle can move. If this velocity is greater than that of the permitted velocity then the central server broadcasts a warning message to all RSUs about the high speed of the vehicle. Each of the RSUs checks whether the vehicle comes under its region or not. If the vehicle comes under any of the RSU's region then the RSU sends the warning message to the vehicle about its high speed. Depending upon the level and frequency of misbehavior i.e. if the frequency or level of misbehavior is greater than some particular value, then the RSU which is closest to the Certification Authority (CA) informs the CA about the misbehavior of the vehicle. Since CA has the right to revoke the certificate or give penalty to any vehicle, CA takes appropriate action on the misbehavior vehicle depending upon its frequency and level of misbehavior.

Chapter 4

Simulation and Results

Veins Hybrid Simulator
Grid Map Scenario

4.1 Veins Hybrid Simulator

We have used Veins (Vehicles in Network Simulation) hybrid simulator to achieve the bidirectional coupled simulation. Veins incorporate all the benefits from state-of-the-art simulation techniques of both the network simulation and the road traffic micro simulation domains. It uses OMNeT++ as the network simulator and SUMO (Simulation of Urban Mobility) as the road traffic simulator. OMNET++ and SUMO are integrated with TraCI (traffic control interface), which provides TCP connection between each other. Veins is able to generate the real time interaction between network simulation module and road traffic simulation module. It is also able to affect road traffic simulation module based on the network simulation module.

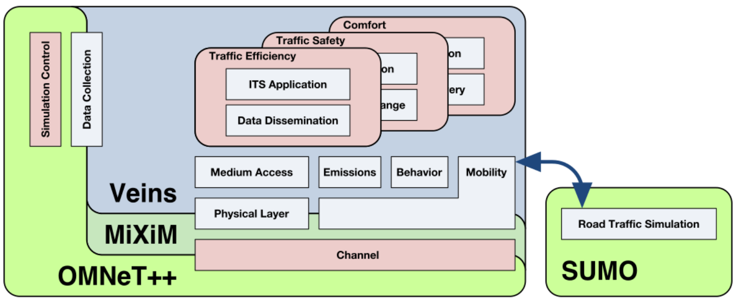

Figure 4.1: Veins hybrid Simulator

The structure of the Veins hybrid simulator is shown in figure 4.1. OMNeT++ is an event-based simulator, so it handles mobility by scheduling node movements at regular intervals[18]. This fits well with the approach of SUMO, which also advances simulation time in discrete steps. The control modules integrated with OMNeT++ and SUMO were able to buffer any commands arriving in-between timestep to guarantee synchronous execution at defined intervals. At each timestep, OMNeT++ would then send all buffered commands to SUMO and trigger the corresponding timestep of the road traffic simulation. Upon completion of the road traffic simulation timestep, SUMO would send a series of commands and the position of all instantiated vehicles back to the OMNeT++ module. This allows

OMNeT++ to react to the received mobility trace by introducing new nodes, by deleting nodes that had reached their destination, and by moving nodes according to their road traffic simulation counterpart. After processing all received commands and moving all nodes according to the mobility information, OMNeT++ would then advance the simulation until the next scheduled timestep, and allows nodes to react to altered environmental conditions. figure 4.2, and 4.3 shows the vehicle movement in OMNeT++ and SUMO respectively.

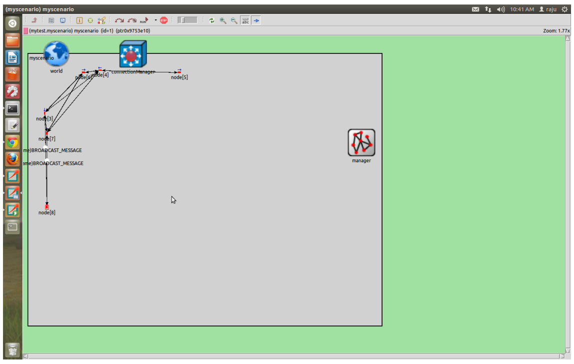

Figure 4.2: Vehicle Movement in OMNeT++

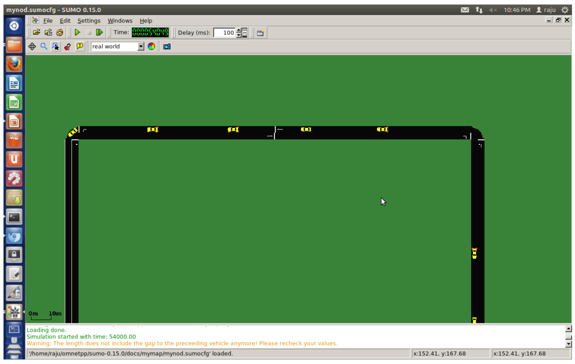

Figure 4.3: Vehicle Movement in SUMO

We have simulated our proposed scheme in the grid map topology and in the future going to simulate in the real street map of Bhubaneswar city with the help of Veins. We have placed RSUs in the four cross sections of the grid map scenario, set the radio range of the RSUs and connected the RSUs to the central server. After receiving the information from the vehicles, RSUs send the information to the central server and the server calculates the velocity of the vehicle and compare the velocity with that of the permissible limit in that lane. Figure 4.4, and 4.5 shows the grid map and the Bhubaneswar city map.

Detailed simulation and the result of the grid scenario is described below.

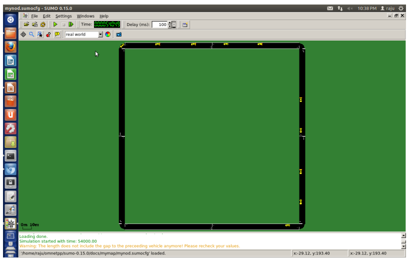

Figure 4.4: Grid Map used for Simulation

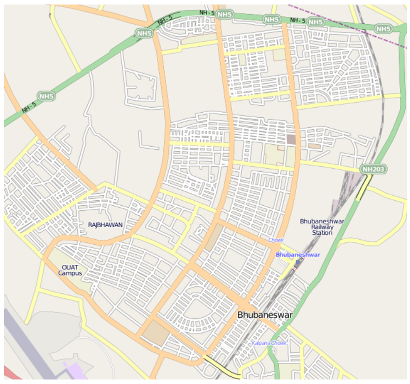

Figure 4.5: Bhubaneswar city map

4.2 Grid Map Scenario

To evaluate our results, we created a grid map scenario which contains two lane road. One lane is for moving the vehicles in clockwise direction and the other lane for the anticlockwise movement of the vehicles. In order to create edges and maintain connection between edges at first nodes are created and placed at the positions like (0,0), (1000,0), (2000,0), (2000,1000), (2000,2000), (1000,2000), (0, 2000), (0,1000). After creating the nodes, nodes are connected by the edges. Now the network file for the SUMO is generated from the nod and the edge file. Route file is then generated by giving the sequence of edges the vehicle follows. We have created two routes as mentioned earlier, one is clock wise and the other for anticlock wise movement of the vehicles. Initially we have taken 10 vehicles for our simulation and then we vary the no of vehicles to 20, 30, 40 and 50 for checking the efficiency of the proposed scheme. Table 4.2(a) lists the values used to parameterize the vehicles of the road traffic microsimulation and Table 4.2(b) lists the values used to parameterize the network simulator.

We created the RSUs which are equal to the car module provided by the OMNeT++ and having the mobility of Linear type. We place at the four corners of the grid map and set the effective range of 100 m and connected the RSUs to the central server by the ideal channels. We performed the simulation by varying the

Parameter	Values
Maximum vehicle speed	33m/sec
Maximum acceleration	2.6m/s2
Maximum deceleration	4.5m/s2
vehicle length	5m
vehicle width	3.5m
Driver imperfection	0.5

Parameters Used (OMNeT++)	VALUE
sim-time-limit	6000s
Mac.queuelength	5
Mac.maxTxAttempts	14
Mac.bitrate	11Mbps
Mac.txpower	100mW
Mac.contentionWindow	20
Mac.slotduration	0.04sec
Phy.sensitivity	-80dBm
UpdateInterval	0.1 sec

Table 4.1: Parametes taken for simulation (a) SUMO simulation parameters for vehicles and (b) Module parameters for OMNeT++

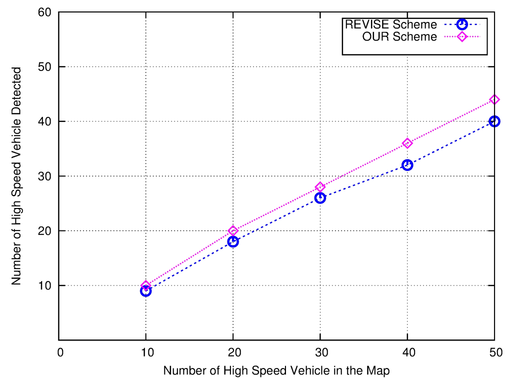

Figure 4.6: Obtained Results

simulation parameters and compare the results with the REVISE scheme which is basically an RF based vehicle detection scheme. We configured vehicles to drive at a maximum speed of 33 m/s and modeled dense inner-city traffic with inattentive drivers. The figure 4.6 shows that our scheme detects high speed vehicle with 96 - 100% of accuracy, and is greater than the ReVISE scheme which detects with 90% accuracy.

Chapter 5

Conclusion

Conclusion

We proposed a scheme for detecting the high speed vehicle. Our scheme uses position of the vehicle to detect the high speed vehicle. Each vehicle gives its position and timing information to the RSUs and RSUs send the information to the central server. The Central Server computes the average speed of the vehicle using timing and position information received from the RSUs. When a vehicle is found to have more speed than the speed limit of the specific region, the Central Server broadcasts this information to all RSUs in its range. When the vehicle again comes into the range of an RSU, it informs the vehicle to drive within the speed limit using a warning message. When a vehicle is found violating the speed limit a number of times more than a threshold, then Central Server forwards this violation information to the Certification Authority (CA). Based on the threshold, the CA takes appropriate action on the high speed vehicle. Our scheme detects high speed vehicle with 96 - 100% of accuracy, and is greater than the ReVISE scheme which detects with 90% accuracy. By implementing this scheme in the different areas of the road, we can detect no. of high speed vehicles and as a result this can reduce the no. of accidents in the roads and provide safety to people.

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Annexure: Integration of Simulators in Veins Framework

Deploying and testing in VANET involves high cost and intensive labour. Hence before implementing in real life, it should be simulated using the simulators. One important aspect in VANET is that the nodes or vehicles donot move independently with each other, they move in a well-established vehicular traffic models. So for the modelling and simulation purpose we have used the publicly available Veins open source framework. It is based on two well-established simulators: OMNeT++, an event-based network simulator, and SUMO, a road traffic simulator. It extends these simulators to offer a comprehensive models for Inter Vehicular Communication(IVC). The steps for the integration are described below

Step 1 OMNeT++ Installation: We have downloaded the omnetpp-4.2.2-src.gz and installed it in Ubuntu 12.04 version by following the installation procedure provided in the OMNeT++ install guide. After installing the packages as provided in the install guide for ubuntu then we follow the procedure used for linux. First we extract the archive and then enter into the omnetpp directory and set the environment using the . Setnev. Then set the path and configure it. After configuration we make it by using the command make and verify the installation using the dyna command as written in the InstallGuide. After installation i went through the tic-toc tutorials provided in it which gave basics of the creating the nodes, connecting the nodes and communicating the nodes in the network. The .ned files present in OMNeT++ describe the module structure with parameters, gates, etc. Ini files sets the parameters for the simulation and the .cc file add functionality to the Veins Framework.

Step 2 SUMO Installation: After installation of OMNeT++ we have installed sumo-0.15.0. The detailed procedure for installation is given in the `http://sumo.sourceforge.net/` but it is written in a complicated form. So i follow the procedure linked below in which it is written in a easier way. `http://www.brunosilva.info/2012/08/installing-sumo-with-gui-on-ubuntu-1204.html` After installation of sumo we created vehicles and roads using the sumo. Basic procedure for creating the roads, vehicles and movement pattern of the vehicles in the roads are provided in the `http://sourceforge.net/apps/mediawiki/sumo/index.php?title=Main_Page` After installation of SUMO make sure that SUMO is working for all examples provided in the SUMO.

Step 3 Download and build the Veins module framework: Initially we had tried to use MiXiM-2.1.tar.gz for the MiXiM module. But while importing the module into the OMNeT++ simulator it shows the integration error. For solving the integration error we mailed to the different groups and to the different people and at last we got the conclusion that this version of MiXiM is not supported by the $OMNeT++-4.2.2$. So in order to remove the problem we then download the Veins-2.0-rc2.zip and extract it and import it to the $OMNeT++-4.2.2$. We imported the veins module into the OMNeT++ but in the gui of $OMNeT++-4.2.2$, it shows as a MiXiM package and inside the MiXiM package we got examples subpackage. Inside the examples package we got different submodules like veins, traci_launched and we used these modules as a reference for our simulation purpose. Inside the MiXiM module, we got the src package. Inside the src package we got the basic modules for the simulation in the application layer. We use these packages for our simulation.

Since both simulators are installed and worked independently, so in order to integrate OMNET++ and SUMO we use TraCI (traffic control interface), which provides TCP connection between each other. So for the integration purpose we used a python script which is provided in the sumo. The command used for the connection is

omnetppinstallveins-2.0sumo-launchd.py -vv -c home/rajuomnetppinstallsumo-0.15.0binsumo

After entering the above command the gui would show a line like.

Listening on oport 9999

This shows that the integration is successfull and there is an existance of real time interaction between network simulation module and road traffic simulation module.