NATIONAL INSITITUTE OF TECHNOLOGY, ROURKELA

SIMULATION OF TRAFFIC MOVEMENT IN VANET USING SUMO

by

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A thesis submitted in partial fulfilment for the degree of
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under the guidance of
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Computer Science & Engineering

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NATIONAL INSITITUTE OF TECHNOLOGY

CERTIFICATE

This is to certify that the work in the thesis entitled " SIMULATION OF TRAFFIC MOVEMENT IN VANET USING SUMO" submitted by Ajay Kumar Pandey is a record of an authentic work carried out by him, under my supervision and guidance in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering at National Institute of Technology, Rourkela.

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An assemblage of this nature could never have been attempted without reference to and inspiration from the works of others whose details are mentioned in reference section. I acknowledge my indebtedness to all of them.

At the last, my sincere thanks to all my friends who have patiently extended all sorts of helps for accomplishing this project.

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Abstract

VANETS are expected to support a large spectrum of mobile distributed applications that ranging from traffic alert dissemination and dynamic route planning to context-aware advertisement and file sharing. In VANET, or Intelligent Vehicular Ad-Hoc Networking, it defines the intelligent way of using Vehicular Networking. VANET integrates on the multiple ad-hoc networking technologies. In VANET helps in defining the safety measures in the vehicles, streaming communication between different vehicles, infotainment and telematics. Vehicular Ad-hoc Networks are expected to implement a variety of wireless technologies like Dedicated Short Range Communications (DSRC) which is a type of WiFi. Vehicular Ad-hoc Networks can be viewed as component of the Intelligent Transportation Systems (ITS). "Simulation of Urban Mobility", or "SUMO" for short, is an open source, microscopic, multi-model traffic simulation. It allows to simulate how the given traffic demand that is consists of single vehicles moves through a given roadmap. The simulation allows addressing a large number of set of traffic management topics. It is purely microscopic in nature: each vehicle is modelled explicitly, has its own route, and moves individually through the network. After having generated a network, one could take the look at it with the help of SUMO-GUI, but no cars would be driving around. One must need some kind of description about the vehicles. We can it as his the traffic demand.

Task is to create the Street road and simulate the vehicles created on that road considering the traffic using the traffic lights. It gives us idea how the movement of vehicles in a network take place to show the affect traffic on the vehicle and how to tackle with the heavy traffic and ways to ignore the on-going traffic by taking different routes. It a very good application of VANET which helps to analyse that which route should be taken by the vehicle and how we should complete the journey in minimal time and what will be the optimal path with less traffic in it .

Road side unit (RSU) provide the periodic information about the traffic so that the chances of road accidents can be minimised and the driving become convenient for the drivers.

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CHAPTER 1

Introduction

INTRODUCTION

1.1 <u>What is VANET</u>?

A Vehicular Ad-Hoc Network or **VANET** is a technology that has moving vehicles as nodes in a network for creating a mobile network. We can say that VANET turns each and every vehicle into a wireless node, allowing cars to connect to each other which are 100-300 metres apart and, in turn, create a wide range of network. As cars fall out due to signal range and drop out of the present network, other cars can join in to connect vehicles to one another so a mobile Internet can be created. It is assumed that the first systems in which it is integrated are police and fire vehicles to communicate with one another to provide safety. It is a term which is used to describe the spontaneous ad hoc network that is formed over vehicles moving on the roads. Vehicular networks are very fast emerging for deploying and developing new and traditional applications. It is characterized by rapidly changing topology, high mobility, and ephemeral, one-time interactions. Both MANETs and VANETs are characterized from the movement and self-organization of the nodes (*i.e.*, in the case of VANETs it is Vehicles).

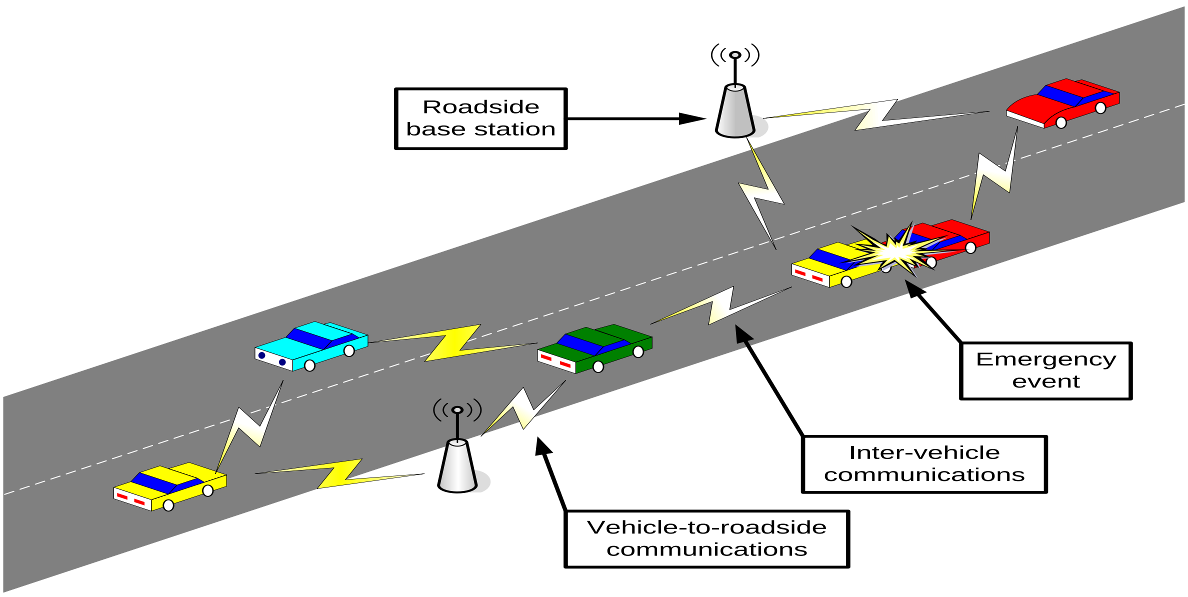

Fig 1.1:- Vehicular Ad- hoc Network

1.2 <u>What is Smart Vehicle</u>?

Vehicles which are equipped with multi interface cards and sensors, on board unit and externally. The number of vehicles equipped with on-board wireless devices (*e.g.*, UMTS, IEEE 802.11*p*, Bluetooth, etc.) and sensors (*e.g*., radar, ladar, etc.), is increasing for efficient transport and management applications are focused on optimizing flows of vehicles by reducing the time taken to travel and avoiding any traffic congestions. As an instance, the radar present on on-board could be used to sense traffic congestions and automatically slow the vehicle. In another accident warning systems, sensors can be used to determine that a crash may be occurred if air bags were deployed; this kind of information is then relayed via V2I or V2V within the vehicular network.

A provide different levels of functionality is provided by using number of systems and sensors. The major systems and sensors exploited for intra-vehicle communications we cite: crash sensors, the data recorder, the braking system, the engine control unit, the electronic stability control, the infotainment system, the integrated starter generator, the electronic steering, the tire pressure monitoring system ,the power distribution and connectivity, the lighting system, seat belt sensors , etc. For the brake systems, there are also the antilock brake system and the parking brake system. The parking brake is also referred to as an emergency brake; it controls the rear brakes using a series of steel cables. It allows the vehicle to be stopped when the event of a total brake failure occur. Vehicle-mounted cameras are mainly used to display images on the vehicle console of smart vehicle.

Commonly, a smart vehicle is equipped with the following technologies and devices:

(i) A wireless transceiver for data transmissions among vehicles (V2V) and from vehicles to RSUs (V2I);

(ii) A Central Processing Unit (CPU) which implements the applications and communication protocols;

(iii) A Global Positioning Service (GPS) receiver for navigation and positioning services;

(iv) An input/output interface for the interaction of human with the system;

(v) Different sensors laying outside and inside the vehicle is used to measure various types of parameters (*i.e.*, acceleration, speed, distance between the neighbouring vehicles, etc.

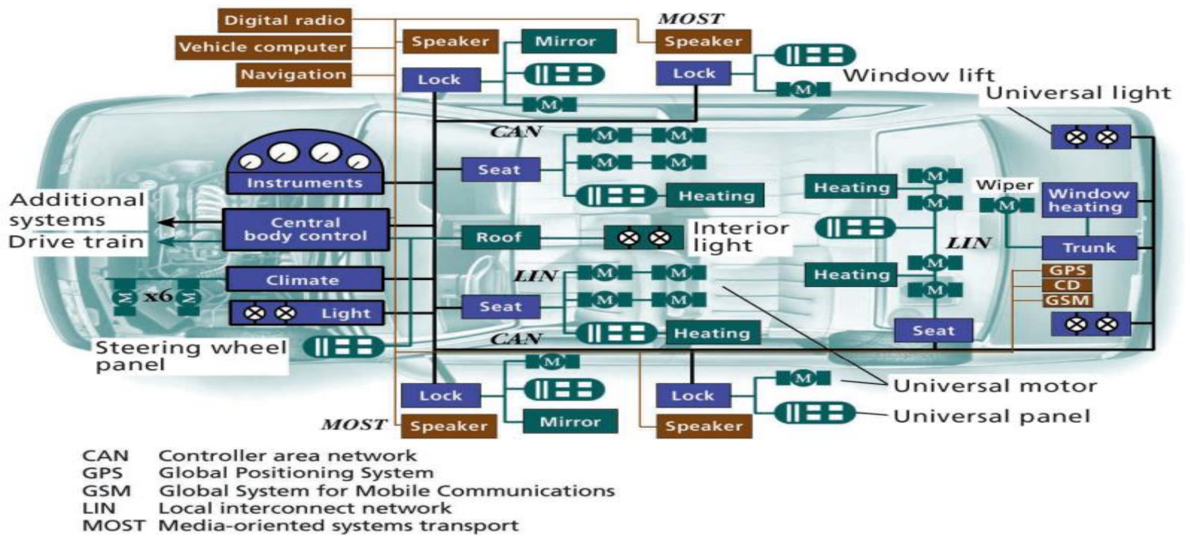

Fig 1.2.1:- Smart Vehicle

The basic idea behind smart vehicles is addressed to safety issues of vehicles, and then by with a proper combination of functionalities like communications, control and computing technologies, it will become possible to assist the driver decisions, and also helps to prevent driver's wrong behaviours' .The control functionality is directly added into smart vehicles for connecting it with the vehicle's electronic equipment..

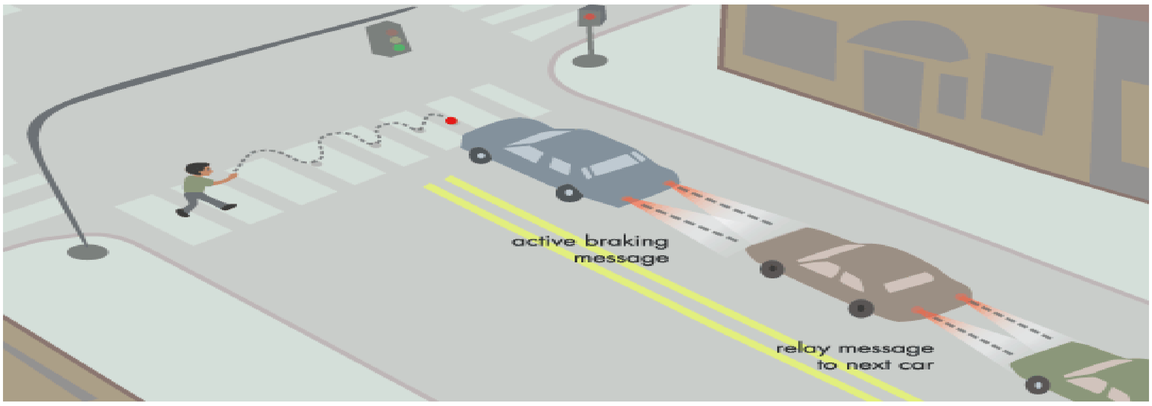

Fig 1.2.2: - Safety application (*i.e.*, brake messaging) by the use of Visible Lighting Communications (VLC)s.

1.3 VANET APPLICATION

Vehicular applications are classified in

(i) Road safety applications,

(ii) Traffic management and efficiency applications

(iii) Infotainment and Comfort applications.

Road safety applications aims to avoid the risk of car accidents and it make the driving safer by distributing information about obstacles and hazards The basic idea behind it is to broaden the range of perception of driver , allowing him/her to react much faster, thanks to alerts reception through the wireless communications. Traffic efficiency and management applications focus on optimizing the flows of vehicles by reducing the time taken by vehicle
and situation of avoiding traffic jam. Applications like enhanced route navigation/ guidance, lane merging assistance and traffic light optimal scheduling, are intended to optimize
the routes, while also providing a reduction of fuel consumption and gas emission.
Although the primary purpose of VANETs is to provide safety applications and the non-safety applications are there expected to create commercial opportunities by increasing number of vehicles which are equipped with on-board wireless devices.
Comfort and infotainment applications has goal to provide the driver with information support and entertainment to make their journey more pleasant. The collisions of cars are currently one of the major dead causes.
Safety applications are always used to significantly reduce the number of accidents, with the main focus to avoid accidents from happening in the very first place. Take example,
Street-smart and Traffic View inform drivers with the help of vehicular communications of the traffic conditions. Vehicle platooning is the other way to improve the safety of road.
By removing the hassle of adjusting speed and changing lane, vehicle platooning allows vehicles to travel closely yet safely together. Fuel economy is also get benefitted from the reduced aerodynamic as a vehicle headway is very much tightened (e.g., the spacing can be less than 2 m). Together with the adaptive cruise control used by V2V communications, the problem of the crashes of the vehicles due to error done by driver can be alleviated.
Some of the most requested applications that is by polls, currently under investigation by several car manufacturers are Congestion Road Notification (CRN), Lane Change Assistance (LCA), Post Crash Notification (PCN) and Cooperative Collision Warning (CCW).

In Post Crash Notification, the vehicles which is involved in an accident would broadcast the warning messages about their position to the other trailing vehicles so that it can take decision with time remaining in hand.
The PCN application may be implemented both on V2I and V2V network configurations. In fact the V2V gives the advantage of giving quickly the information needed through a discover-and-share policy. By using the specific sensors, it helps in measuring possible changes in the rational behaviour of the driver (e.g., rapid direction changes, quick brake use and so on), that are then communicated back with directional antennas to the other vehicles that is in the same direction. Once the messsge is received, the closest vehicle can share this information with the other nodes present with a flooding routing. In some particular case of false alarm by the very first vehicle experiencing the irrational behaviour of the driver, this type of information floods on the VANET. It is then very important to fix the issue of false alarms.

Let us assume a driver has been distracted by something on the panorama and moves the steering wheel, because of that the direction of the vehicle changes accidentally. Once the error is recognized , the driver will react very quickly by changing direction or by using a quick and strong brakes..
If the very first following driver does not experience accidents, then the vehicle does not forward this type of information and false alarm probability is much reduced. With the use of V2I architecture, the access points must gather information (e.g. Alarms for quick changes in speed), coming from different vehicles and the data is merged that
reducing the signalling from the vehicles.

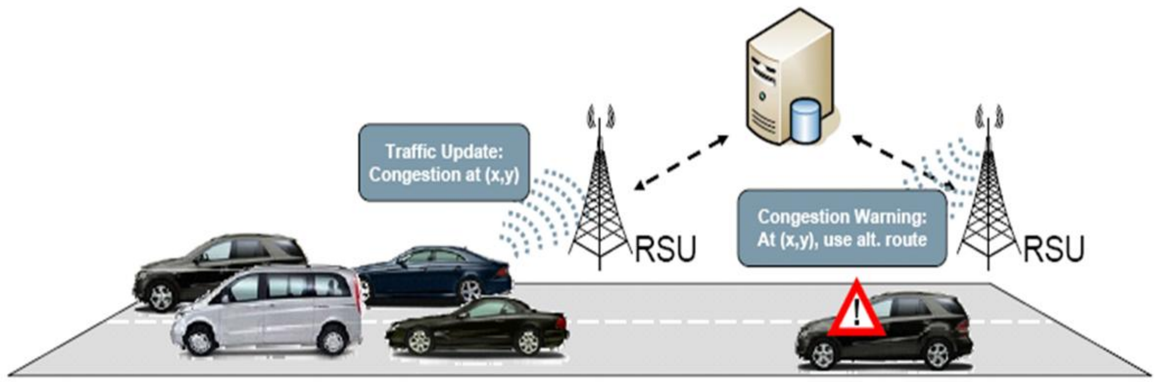

Fig 1.3.1: Congestion Detection

Traffic monitoring and management are very essential to avoid traffic Congestion and maximize road capacity. Crossing intersections in the streets of city can be dangerous and tricky at times. Traffic light scheduling can be used by the drivers to cross intersections. Allowing a very smooth flow of traffic can mainly reduce travel time and increase vehicle throughput. A token-based intersection traffic management scheme is a scheme in which each vehicle waits to take a token before entering in an intersection. On the other side, with knowledge of traffic conditions, drivers should optimize their driving routes, thereby the problem of (highway) traffic congestion can be minimised.
Congestion Road Notification detects and notifies about road congestions that can be used for route and trip planning. This kind of use is partially implemented in the recent GPS-based applications where a new route is evaluated when heavy congestion has been detected on the present route or in a portion of it. Till now several commercial tools are available for the smart-phones and special purpose devices.

TMC messages have a considerable amount of information’s:

- Location: the road, area or specific location affected;
- Identification: what is the cause of the traffic problem and its seriousness;
- Extent: how far the problem stretches in each direction;
- Direction: the directions of the traffic are affected;
- Diversion advice: use alternative routes to avoid the congestion.
- Duration: how long the traffic flow problem is affected;

The service provider (SP) encodes the message and sends it to FM radio broadcasters, who transmit messages as an RDS (Radio Data System) signal within the normal FM radio transmissions. There is usually only about 30 seconds gap between the first report of an incident

to the traffic information centre (TIC) and the RDS-TMC receiver getting the message.This application may be implemented according to a V2I configuration or a V2V one. In fact, it is very possible to encapsulate information about the direction, the position and the average speed, that are then communicated back to the vehicle following on the street. As it appears very clearly, this solution suffers for a much large amount of data to be processed by the vehicles themselves. The worth in this environment is the use of V2I since access points can process information coming to it and communicate to the incoming vehicles the new route after processing request information about their destination.
Finally, Cooperative Collision Warning the system works with a cut-out revealing a stopped car or slow-moving car before its arrival at the curve or downhill. All these type of applications require radio transceivers for the exchange of messages sensor and GPS on board car and road side units. Even in this case the dualism between V2I and V2V is renovated.

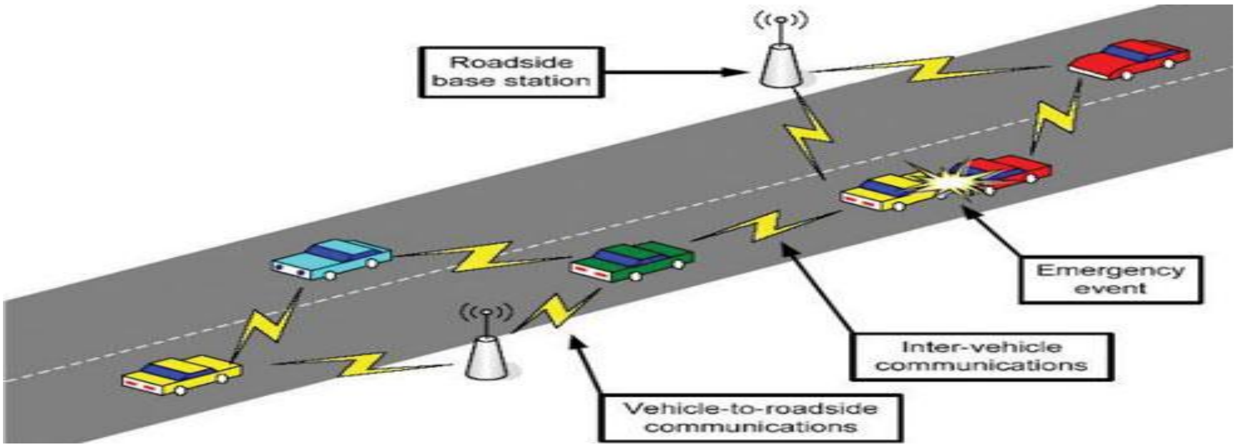

Fig 1.3.2: - Intelligent Transportation

In general, these applications is motivated by the desire of the passengers to Communicate either with ground-based destinations or other vehicles(e.g., Internet hosts or the Public Service Telephone Network).As an instance, the driver could receive local information about the hotels and restaurants etc.
The main aim of infotainment applications is to offer comfort and convenience to drivers and/or passengers. For example, Fleetnet provides a platform for gaming and peer-to-peer file transfer on the road. A real-time parking navigation system is proposed to inform drivers of any available parking space. Digital billboards for the vehicular networks are proposed for advertisement. Internet access can be provided to the vehicle through V2I communications; therefore, the business activities can be performed as usual in a vanet environment, realizing the notion of mobile office. On-the-road media streaming between the vehicles can be available making long travel more pleasant. An envisioned goal is to have human-vehicle-interfaces, such as colour reconfigurable head-up and head-down displays, and very large touch screen active matrix Liquid Crystal Displays, for the high-quality video-streaming services. Driver can enjoy their traveling time by the means of real-time applications e.g., online gaming and video streaming, using individual terminals next to their seats.

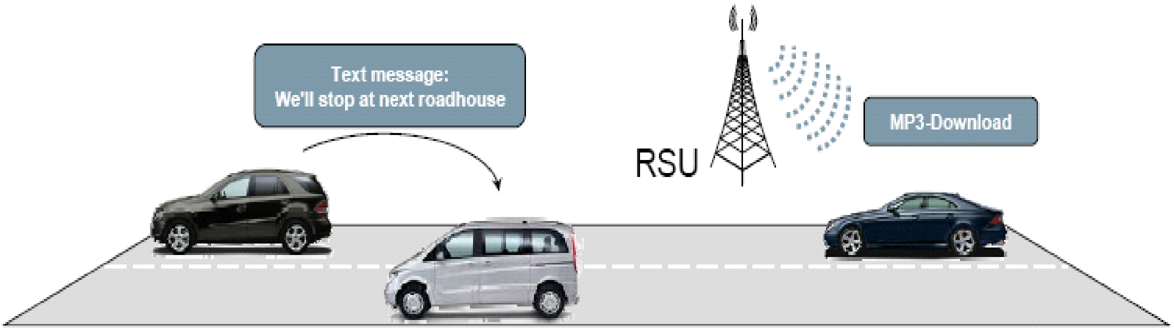

Fig 1.3.3: - MP3- Download and message passing

Message passing is continuous between the vehicles to show their latest location and activity that is very essential for the nearby vehicles to avoid any chances of collision.

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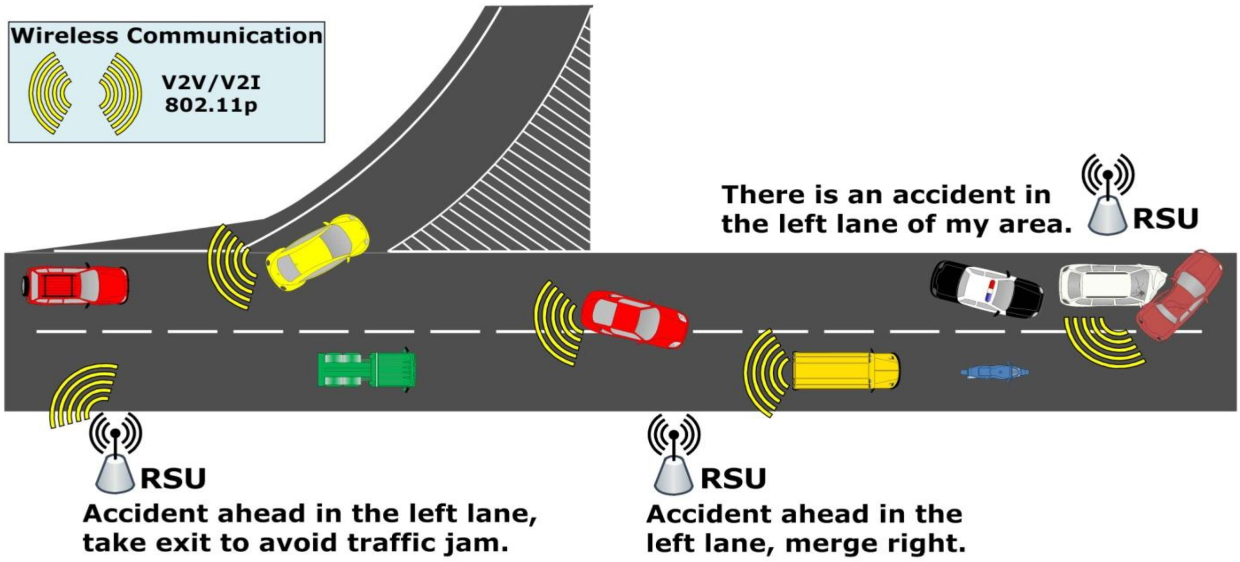

Fig 1.3.4 :- Communication between vehicle at the time of Accident

1.4 Security Architecture Of Vanet

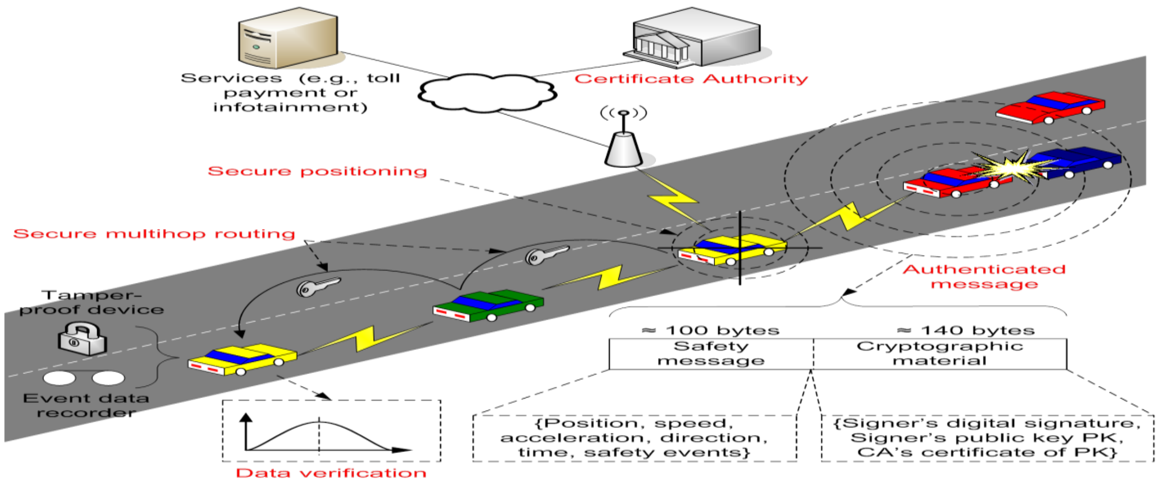

Fig 1.4.1: Security Architecture Of Vanet

Tamper Proof Device

- Every smart vehicle carries a tamper-proof device
  - Contains the secrets of every vehicle itself
  - Has its own battery
  - Has its own clock.
  - Is incharge of all the security operations
  - Is accessible or used only by authorized users

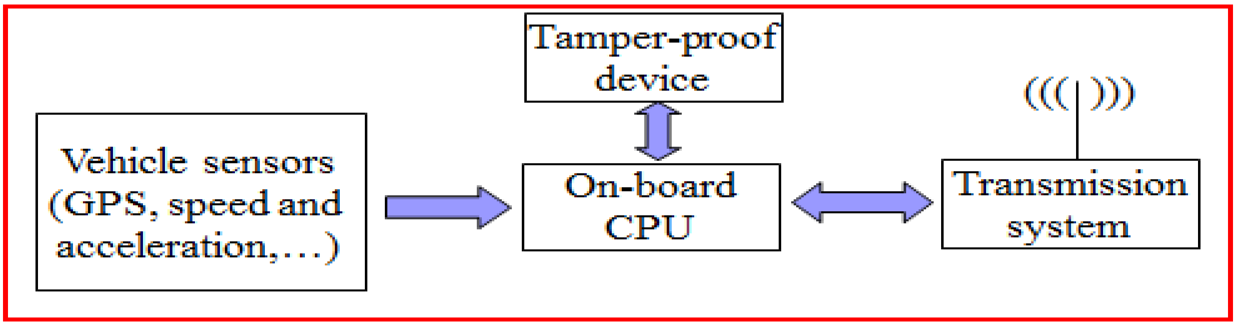

Fig 1.4.2:- Tamper Proof Device

DIGITAL SIGNATURE

- Symmetric cryptography is not good for messages are of large scale, non-repudiation requirement and standalone.
- Each message that to be send should be signed with a Digital signature (DS).
- Liability messages must be stored in the EDR.

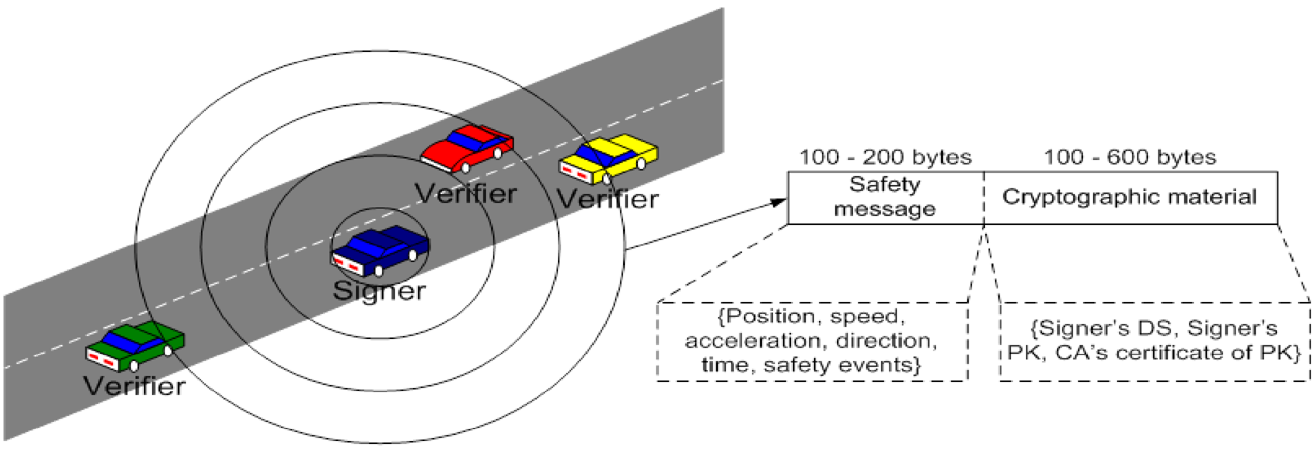

Fig 1.4.3: Application of Digital signature

VPKI (Vehicular PKI)

- Each smart vehicle carries in its Tamper-Proof Device (TPD):
  - A certified and unique identity: Electronic License Plate (ELP)
  - The set of certified anonymous public or private key pairs
- Before a smart vehicle sends a safety message, it signs the message with its private key and includes the essential CA's certificate.
  - Mutual authentication can be done without using a server
- Authorities (regional or national) are cross-certified.

1.5 Types Of Communications In Vanet

Vehicle to vehicle communication

- Using multi-hop/multi cast technique.
- It uses two types of broadcasting i.e.
  1. Naive broadcasting
  2. Intelligent broadcasting

Vehicle to infrastructure communication

- Have a high bandwidth link with vehicle and roadside equipment.
- Roadside units broadcast messages for communications.

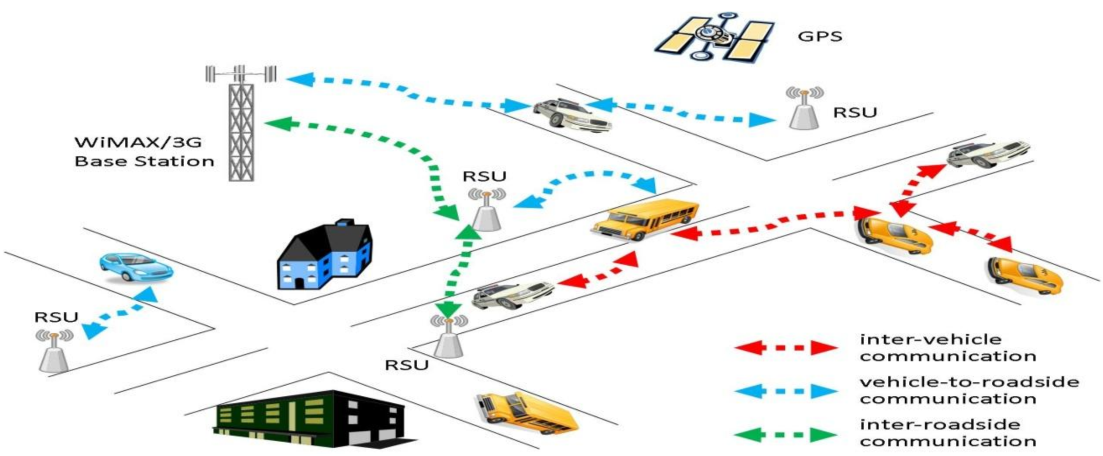

Fig 1.5:- Different Types of Communication

Routing based communication

- Uses multi hop unicast

1.6 MOTIVATION

The original impetus for the interest in VANET was provided by the need to inform fellow drivers of actual or imminent road conditions, delays, congestion, hazardous driving conditions and other similar concerns. Now days accidents are the major cause of death in many cities or countries. so it is vary necessary to have a technology which can be used to minimised the road accidents and provide security to the peoples. To avoid the accidents the driver should be well aware of the traffic movements and congestion so that he can easily take the best optimal path to reach its destination.

1.7 PROPOSED WORK

Avoiding Collision by the proper use of the traffic signalling in VANET

- ☐ To minimize the accidents cases the knowledge of the ongoing traffic is very much necessary. Hereby A Road Map is first created to define the path for the vehicles and after that the vehicle movement is verified by seeing whether the vehicles are coming from both directions or not.
- ☐ By implementing the traffic light signal we want to assure that no two or more vehicles coming from opposite side are on the same Lane causing accident scenario.
- ☐ Whenever a vehicle is going in one lane then no other vehicle coming from opposite direction are allowed to use that lane.

CHAPTER 2

Literature Survey

2.1 <u>Overview of security issues in Vehicular Ad-hoc Networks</u>

VANETs are a subset of MANETs (Mobile Ad-hoc NETworks) in which communication nodes are mainly vehicles. As such, this kind of network should deal with a great number of highly mobile nodes, eventually dispersed in different roads. In VANETs, vehicles can communicate each other (V2V, Vehicle-to-Vehicle communications). Moreover, they can connect to an infrastructure (V2I, Vehicle-to-Infrastructure) to get some service. This infrastructure is assumed to be located along the roads.

VANET MODEL OVERVIEW

There are many entities involved in a VANET settlement and deployment. Although the vast majority of VANET nodes are vehicles, there are other entities that perform basic operations in these networks.

Common VANET entities

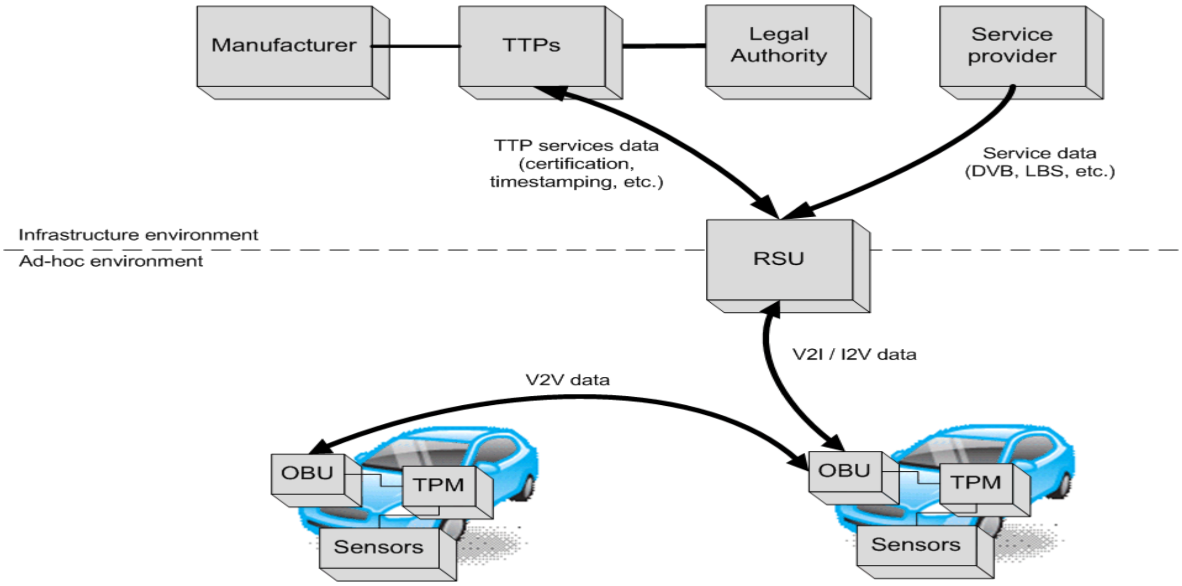

Fig 2.1.1 :- VANET Entities

Infrastructure environment.

It is mainly composed by those entities that manage the traffic or offer an external service. *vehicle registration* and *offence reporting* are two important task.

Ad-hoc environment

From the VANET point of view, they are equipped with three different devices. Firstly, they are equipped with a communication unit (**OBU**, On-Board Unit) that enables Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I, I2V) communications. On the other hand, they have a set of **sensors** to measure their own status (e.g. fuel consumption) and its environment (e.g. slippery road, safety distance). These sensorial data can be shared with other vehicles to increase their awareness and improve road safety. Finally, a Trusted Platform Module (**TPM**) is often mounted on vehicles.

VANET settings

1. V2V warning propagation
2. V2V group communication
3. V2V beaconing
4. I2V/V2I warning

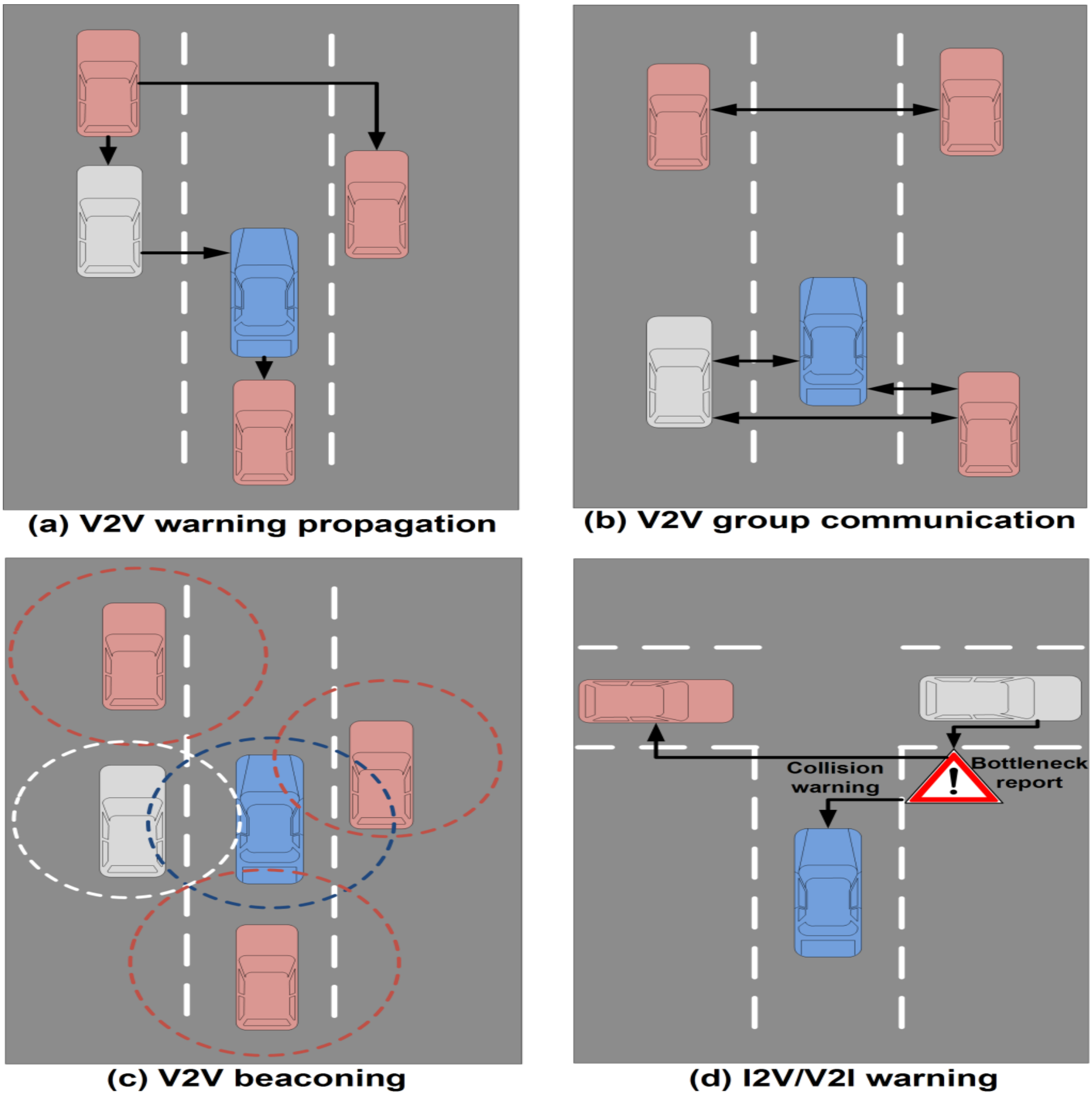

Fig 2.1.2 :- Communication via VANET

2.2 A framework to simulate VANET scenarios with SUMO

- Framework that enhances OPNET simulation scenario using realistic vehicular mobility models. This framework makes use of the open source software called "Simulation of Urban MObility" (SUMO) and the "input trajectory files" feature of OPNET.

- OPNET Modeller enables both *random mobility* and *trajectory mobility*. The last-mentioned is setting with one trajectory file per node. This method allows elaborating complex node movements. Unfortunately, interactions between nodes are not taken in account, so realistic mobility is limited.

- To avoid flooding, we define a forwarding scheme to limit the number of packet sent.

- On message reception, a vehicle starts a timer *T* inversely proportional to the distance from previous sender :

$$T = tmax. (1- d/R)$$

  with *tmax* the maximum contention time, *d* the distance from previous sender, *R* the radio range. When the timer reaching zero the node forward the packet. Other waiting nodes, receive this packet and cancel their timer. Thus, we reduce the number of packet sent in the network.
- Integrate a direct and bidirectional communication with SUMO allowing us to define more complex simulation scenarios in OPNET modeller.

2.3 Vehicle Tracking using VANET (VETRAC)

- Vehicle tracking systems can be used in theft prevention, retrieval of lost vehicles, providing traffic oriented services on lanes. The Vehicle tracking systems VETRAC enables vehicle drivers or any third party to track the location of any moving vehicle.

- The goal is to create a system whereby vehicles can exchange information about traffic conditions in an effort to provide drivers with an early warning of traffic hazards and congestion. For example, when an accident occurs, emergency Responders could provide information about road or lane closures and the estimated time of re-openings to oncoming traffic. The oncoming traffic could then carry the information to vehicles that have not yet reached the traffic slowdown.

- VETRAC system works on the principle identify of a vehicle, which is assigned as Mobile-IP address to a vehicle. The system tracks the vehicle information through Wi-Fi access points, which are established at various locations in lane or parks or in large campus. The carrier is a navigation server that connects with multiple clients (vehicle) and is also responsible for the client's request data. The client control panel system (provider / consumer) running on client side helps the user for identifying current location, destination client location, and landmark, the distance to be travelled. Traffic intensity of each lane at an instant is notified though carrier access points.

Purpose:

The application of inter-vehicular communication over a MANET are raises several interesting issues in regard to data forwarding. One such issue is in which an unpredictable traffic has both a limited area of the relevance and a limited time of relevance. For example, carriers should not be forward information about road closures after the road has re-opened. This requires carriers to not only forward received messages, but also to analyse the semantics of the messages to first determine if they must be forwarded. As another example, carriers may be traveling to destinations hundreds of miles away from the traffic slowdown.
VETRAC proposes to introduce relevance filtering at the carriers
before forwarding event messages.

VETRAC system works on the principle identify of a vehicle, which is assigned as Mobile-IP address to a vehicle. The system tracks the vehicle information through WiFi access points, which are established at various locations in lane or parks or in large campus. The carrier is a navigation server that connects with multiple clients (vehicle) and is also responsible for the client's request data. The client control panel system (provider / consumer) running on client side helps the user for identifying current location, destination client location, and landmark, the distance to be travelled. Traffic intensity of each
Lane at an instant is notified though carrier access points.

A. Functionality of VETRAC

The architectural and functionality overview of Vehicle Tracking System (VETRAC), which has complex modules classified based on functionality. The core functionality of VETRAC focuses on vehicle tracking and controlling the lane (route) selection process tracking system. System establishes connection with the client, updates the client location in the database, gathers the traffic information and controls the streaming traffic video during conference process. The system has various modules

a. Connection establish server
b. Location Management Server and
c. Traffic server

2) Vehicle Tracking System:

System gets connectted with WiFi access point and tracking the client with in the access point range. The system detects the clients in its range and automatically
pass the client current location to the navigation server.

3) Client Control Panel:

The user should know about current location, destination location, landmark of the said campus, traffic information in a campus, traffic video information about the junction in campus. The registered users can only have access to this navigation system. The system has Various modules.

i. Establish connection
ii. New client registration
iii. Client current location
iv. Destination client's location
v. Traffic information
vi. Traffic video information

4) Display Map System:

The system which runs in the client device and it indicates the client's current location, destination client location, landmark identification and traffic information by the map.
.
VETRAC is currently implemented for locations that to be identified within range of 500 meters to 800 meters. Any user can easily access to the system as well VETRAC system can be implemented in any vehicles.

CHAPTER 3

Simulation of **U**rban **M**obility (SUMO)

INTRODUCTION

Simulator: - Device or system that simulates specific conditions or the characteristics of a real process or machine for the purposes of research or operator training.

"**S**imulation of **U**rban **MO**bility",(SUMO) is an open source, microscopic, multi-model traffic simulation. It allows us to simulate how a given traffic demands or network which consists of single vehicle moves through a given road map. This simulator allows addressing a large set number of traffic management topics. It is purely microscopic in nature: each vehicle is modelled explicitly, has its own route, and moves individually through the given network.

To build a network in SUMO a street network consists of nodes i.e junctions and edges (streets connecting the given junctions) are necessary.

A **SUMO** network file describes the traffic-related part of a map. It mainly contains the network of roads/ways, intersections/junctions, and traffic lights in a map

Network Format

- At a coarse scale, a SUMO network is a directed graph. "Nodes" represent intersections/junctions, and "edges" roads/streets.

A SUMO network contains further traffic related information:

- every street (edge) as a collection of lanes,
- the position, shape and speed limit of every lane,
- the right of way regulation,
- the connections between lanes at junctions (nodes), and
- the position and logic of the traffic lights.

Files used in SUMO to make a Road Map:-

- Node file(.nod.xml)
- Edge file(.edg.xml
- Route file(.rou.xml)
- Network file (.net.xml)
- Configuration file(.sumo.cfg.xml)

Nodes

All nodes have specific location (x- and y-coordinate, that describe distance to the origin in meters) and also an id for future references. Thus our simple node file looks as follows

```
<nodes>

<node id="0" x="-500.0" y="0.0" type="traffic light" />

<node id="1" x="500.0" y="0.0" type="priority" />

<node id="2" x="0.0" y="-500.0" type="priority" />

<node id="3" x="0.0" y="500.0" type="priority" />

</nodes>
```

File can be edit with a text and save the instance as name.nod.xml where .nod.xml is a default suffix for Sumo node files.

Edges

Now ,we have to connect the nodes with edges. We have a target node id, a source node id, and an edge id for future reference. Edges are directed, thus every vehicle that are travelling this edge will start at the node given *infrom* and end at the node given in *to*.

```
<edges>
<edge id="1m1" from="0" to="1" priority="2" speed="11.11" />
<edge id="m10" from="1" to="0" priority="3" speed="13.89" />
<edge id="01" from="2" to="3" priority="1" speed="11.11" />
<edge id="2m2" from="3" to="2" priority="2" speed="11.11" />
</edges>
```

Save this data into a file called name.edg.xml. Now that we have nodes and edges we can call the first SUMO tool to create a network. Make sure tha the **NETCONVERT** is somewhere in the PATH and call

```
netconvert --node-files=name.nod.xml --edge-files=name.edg.xml --output-file=name.net.xml
```

This will generate our network that is called name.net.xml.

Routes

Now that we have a network file, we still need a car. In **SUMO** the vehicles have different types defining their basic properties such as the length, acceleration and the deceleration, and given maximum speed. Furthermore it needs a so called sigma parameter it introduces some of the random behaviour and is because of car following model used. Setting it to 0 implies a deterministic car.

Now we define a route for the car which simply consists of the two edges that defined. The reason why we need two edges is that in **SUMO** the car disappears as soon as it will reached the last edge of its own route (the position of a car is defined by the position of its front).Last but not least we define the single car mainly referring to the entries giving it a departure time as the type name.rou.xml file.

```
<routes>
   <vType accel="1.0" decel="5.0" id="C1" length="2.0" maxspeed="100.0" sigma=’"0.0"’’
/>
   <route id="route01" edges="1to2 out"/>
   <vehicle depart="1" id="veh0" route="route0" type="Car" />
</routes>
```

Configuration

Now we attached everything together into the configuration file(.cfg.xml)

```
<configuration>
   <input>
      <net-file value="name.net.xml"/>
      <route-files value="name.rou.xml"/>
   </input>
   <time>
      <begin value="0"/>
      <end value="10000"/>
   </time>
</configuration>
```

Saving this to name.sumo.cfg we can start the simulation by either

```
sumo -c name.sumocfg
```

or with GUI by

```
sumo-gui -c name.sumocfg
```

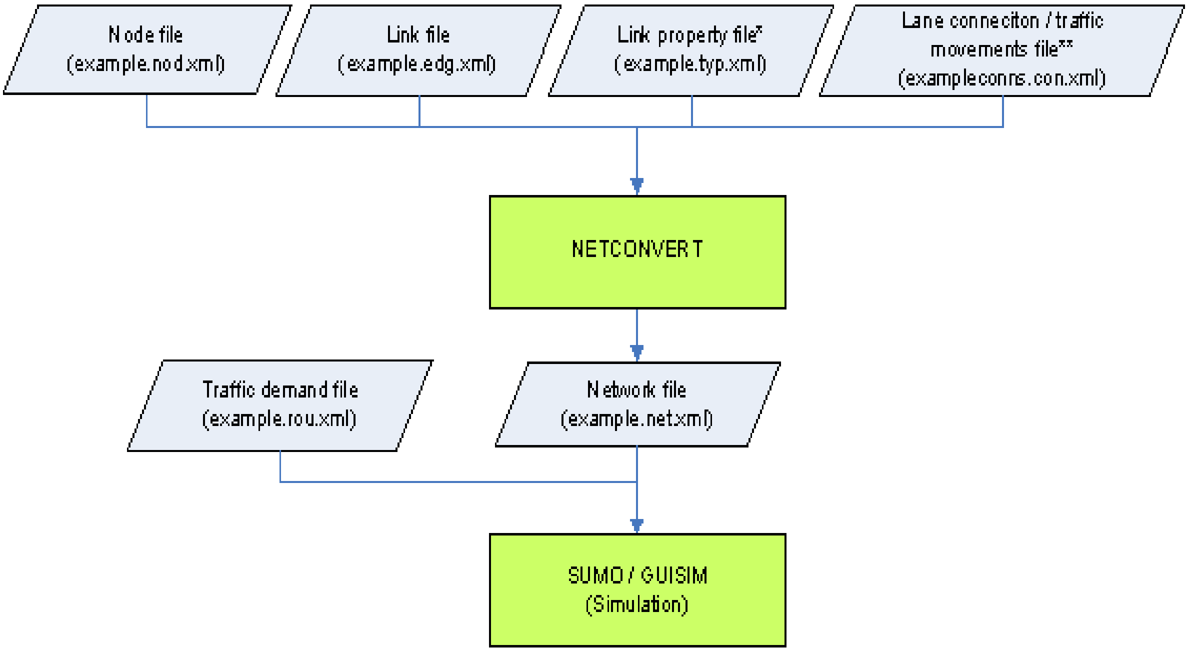

Fig 3:- Flow chart of creation of VANET

CHAPTER 4

SIMULATION AND RESULTS

4.1 Creation of the Road Network

➢ To create a road map

- **Node** (.nod.xml) and **Edge** file (.edg.xml) is to be created for road map.
- Transformed into a **Network** file(net.xml) with the help of NETCONVERT

Command of **NETCONVERT**

netconvert --node-files=MyNodes.nod.xml –edge files=MyEdges.edg.xml \ --output-file=MySUMONet.net.xml

- Now, Create **Route** file (rou.xml) to define the path followed by the vehicles to reach from one place to the destination.
- At last network file and route files are combined to make the **configuration** file.

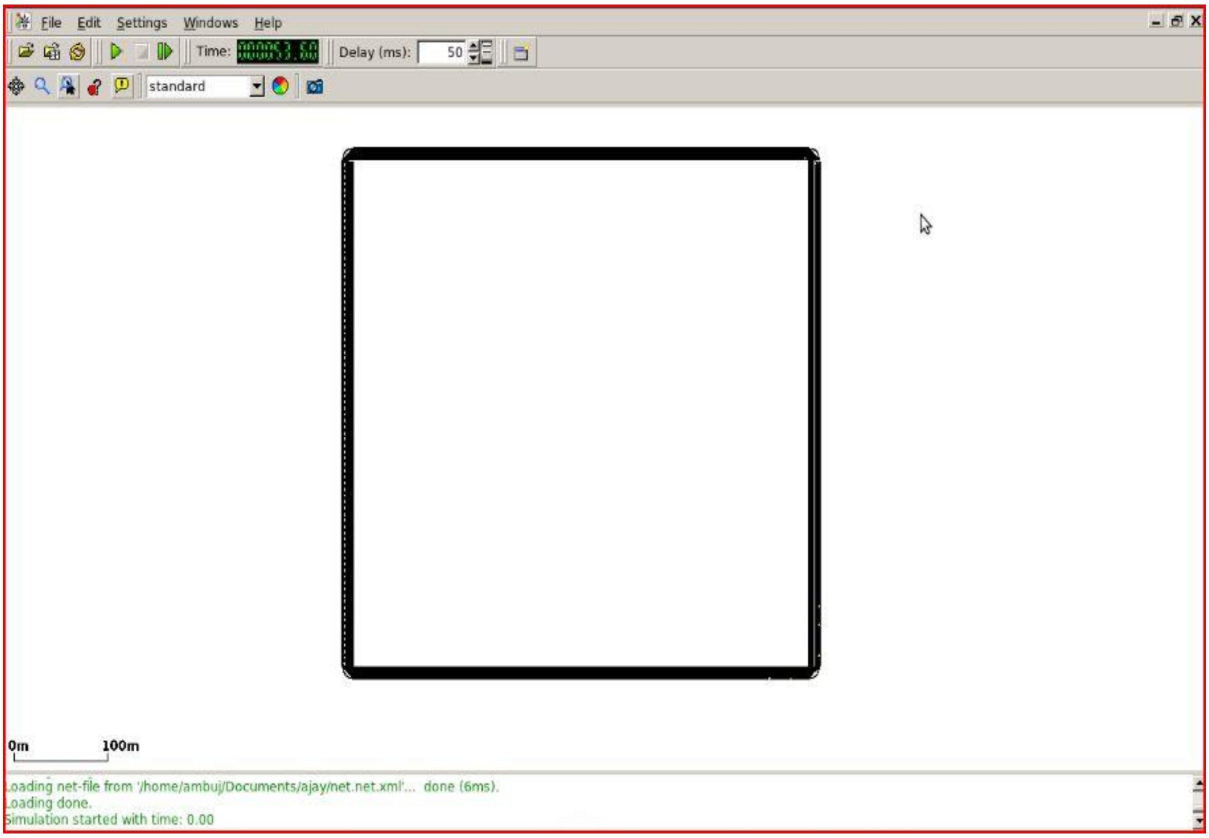

Fig 4.1: - STREET MAP

4.2 <u>USING OPEN STREET MAP:</u>

- The project that used to creates and distributes free geographic data for the world is called the OPEN STREET MAP.
- It is saved as .osm file.

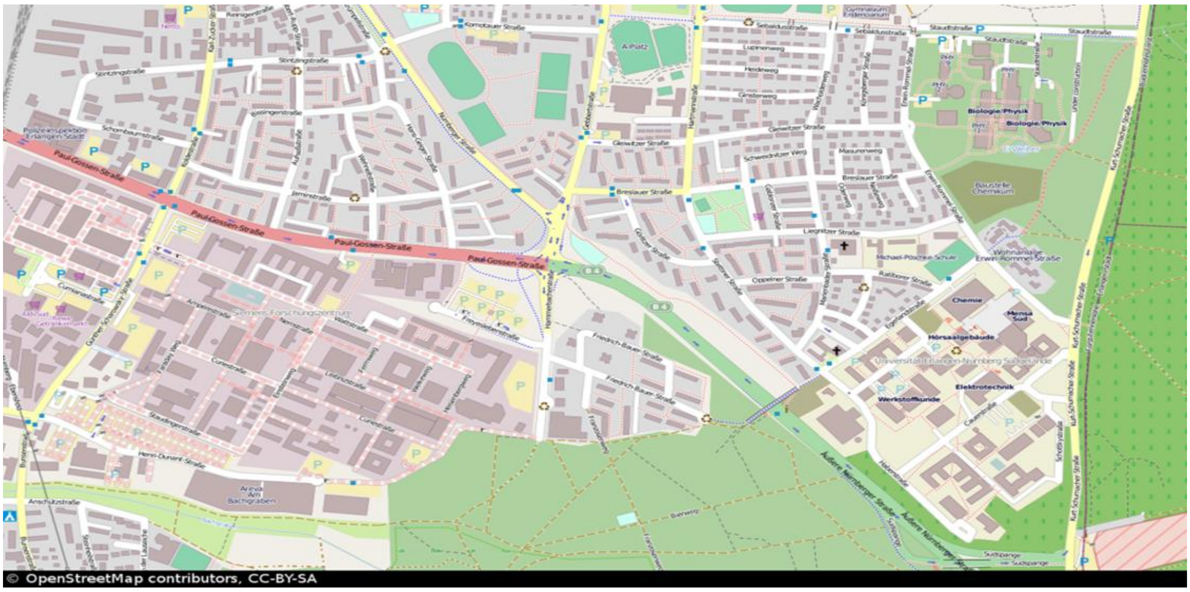

Fig 4.2.1: - Open street map

- After downloading the OSM file it must be filtered in veins to have a clear view of the streets.

Fig 4.2.2 :- Filtered OSM

4.3. <u>Traffic movement in a network:</u>

- The vehicles running on the network from the specified source to destination in a two lane system.
- It gives us a clear idea how the vehicles run in a particular network and how its speed is affected by the other vehicles to avoid collision.
- Blinking of the RED light in a vehicle shows that the particular vehicles are maintaining its speed according to its front vehicle.
- Yellow blinking showing the direction in which the vehicle will take a turn.

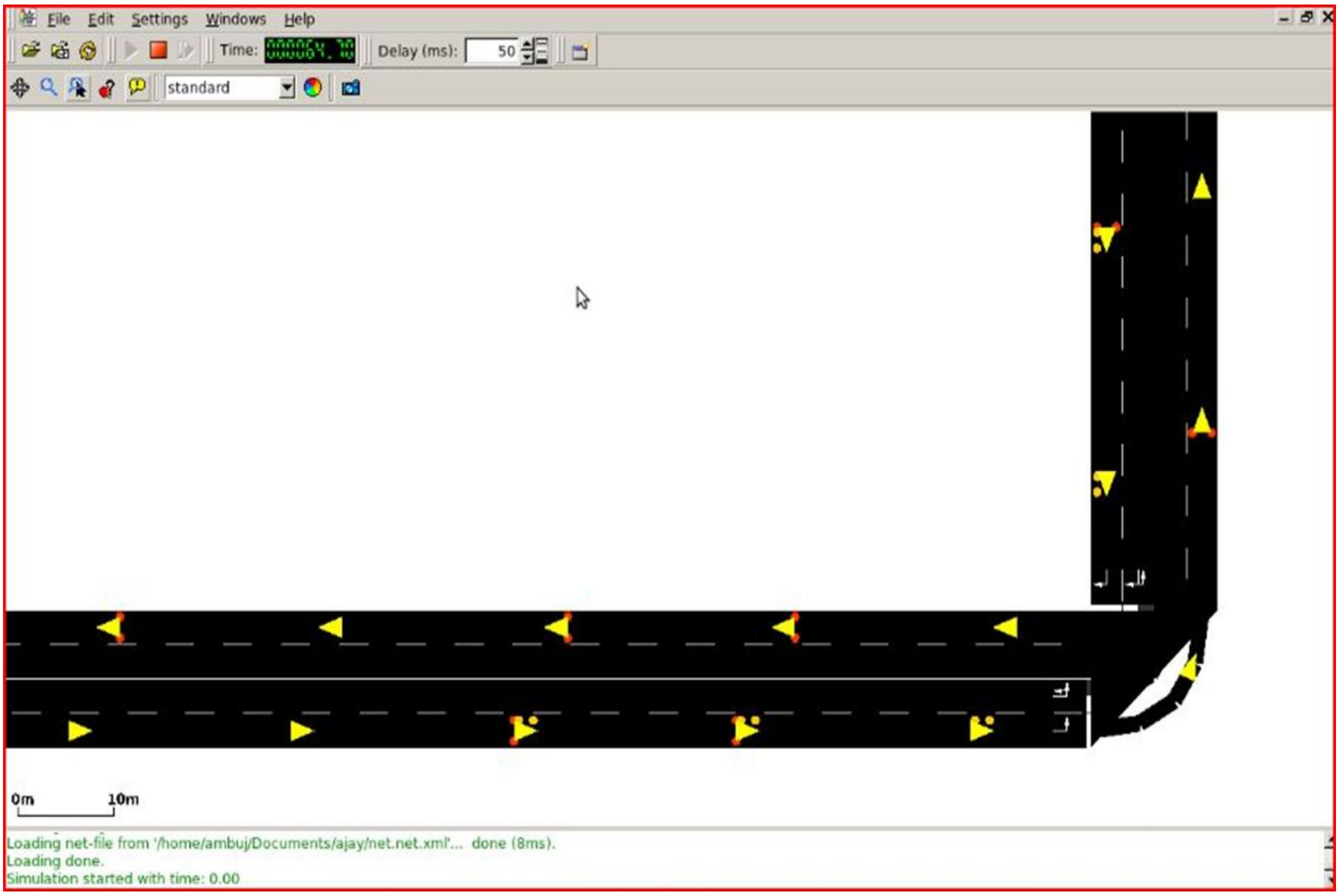

Fig 4.3:- Traffic Movement

4.4. Traffic Signalling:-

- To avoid the conditions of collision traffic management is the most important thing.
- When the Light goes Red it indicates that the particular lane can’t be used for communication.

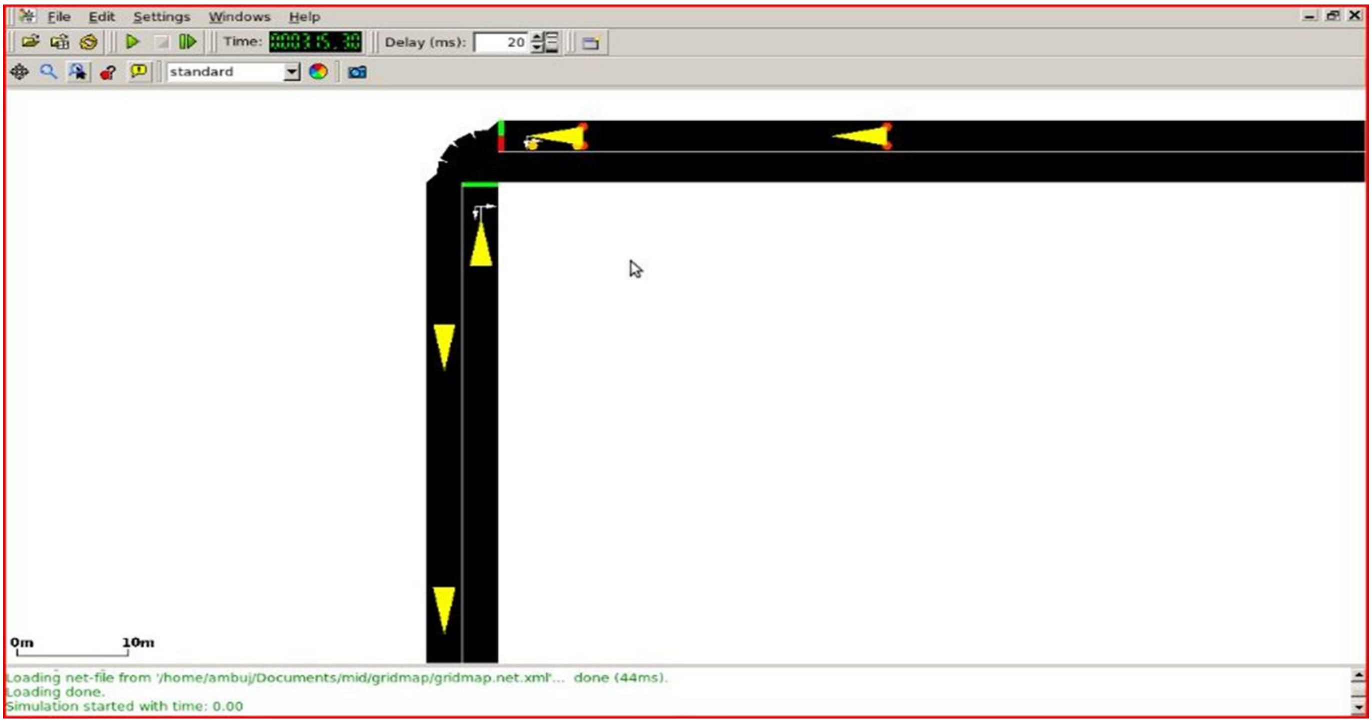

Fig 4.4:- Traffic Signalling

CHAPTER 5

CONCLUSIONS

- ✓ Hereby I have implemented the traffic signalling to avoid the chances of collision in a VENET.
- ✓ The two lane system is used to have a clear view of how the vehicle responds at traffic signal.
- ✓ The VANET network can be used for the real time simulation of the city map.
- ✓ In Future, a person can select an optimal path from source to destination to minimise the risk of accidents and also the communication time will be minimised.

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