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A REALISTIC VEHICLE TRACKING AND INFOTAINMENT SERVICE PROVISIONING IN VEHICULAR NETWORKS

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ABSTRACT

The Vehicular Ad hoc Networks (VANETs) have been driven by Dedicated Short-Range Communication (DSRC) technology or IEEE 802.11p, which is designed to help drivers travel more safely and reduce the number of fatalities due to road accidents. This paper aims at proposing a novel framework for achieving Intelligent Transport System (ITS) by incorporating On Board Unit (OBU) and Road Side Unit (RSU) communications for Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) modes offering better tracking, seamless handoff and other factors like safety and traffic optimization. Also, the IT'S has enabled to access the cloud based infotainment services during travel in VANET environment.

Keywords: vanet, ITS, WAVE, ns-3, VanetSim, vehicle-tracking.

1. INTRODUCTION

AVANET is the subset of mobility ad-hoc networks (MANET), and each node, inside a MANET, serves as both as a terminal for data interchange and a modem or router. The hubs in the system utilize the remote medium to speak with different hubs inside of their radio extent.

The advantage of utilizing specially appointed systems is it is conceivable to send these systems in regions where it isn't achievable to introduce the framework. In the United States there are heaps of miles of streets. It would be costly and improbable to introduce access focuses to give scope to all the roads in the United States. For this same argument, ad-hoc networking systems are the realistic solution. Vehicles inside a VANET speak with each other utilizing the DSRC conventions and calculations. In actuality, a VANET is not an immaculate specially appointed system since roadside access units (RSU) are accessible

Considering the colossal advantages anticipated from vehicular interchanges and the tremendous number of vehicles, it is clear that Vehicular Ad Hoc Networks (VANET) is prone to end up the most applicable acknowledgment of portable specially appointed systems. The suitable combination of on-board PCs, guides, and GPS gadgets along with correspondence abilities, opens gigantic open doors, additionally raises imposing exploration challenges.

Vehicular Ad hoc Networks are not only for the sake of entertainment, their point is even to maintain a strategic distance from mischances (e.g. utilizing occasional telecast of messages containing vehicles' status data, for example, position and speed vector and a security framework mindful of its encompassing to identify potential risky circumstances for the driver). Vehicular Networks are portrayed by

- High speed of the vehicles
- Environment components: deterrents, burrows, roads turned parking lots, and so on.
- Decided portability designs that rely on upon source to destination way and on movement conditions
- Irregular correspondences (disconnected systems of autos because of the fragmentation of the system)
- High blockage channels (e.g. because of high thickness of nodes

While security applications could maintain a strategic distance from wounds, accommodation and relaxation applications could expand the solace of the driver and travelers. in the text.

The Wireless Access in Vehicular Environment (WAVE) and Dedicated Short Range Communication system is an enabling technology in realizing vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications for the realization of more intelligent transportation. DSRC/WAVE is a 75 MHz communication medium between 5.85 GHz and 5.925 GHz. The DSRC/WAVE system provides high speed radio link and mobility between Road Side Unit (RSU) and On-Board Unit (OBU) within the narrow communication area. Moreover, compared with other methods like as microwave, infrared rays or Wi-Fi, the effective distance of the DSRC/WAVE system is 300~1000(m) more than others.

A RSU has a handset, radio wire, processor, and sensors. RSUs are deliberately submitted along the street in request to give administrations to vehicles. For example, a RSU might be set almost a crossing point to enhance the stream of movement through that convergence furthermore, to lessen mishaps. Likewise, a business element can send a RSU to give esteem included administrations, for example, the declaration of conceivable spots of hobby to the driver (e.g., eateries, motels, and service stations). Another advantage of specially appointed systems is they can be immediately conveyed with no overseer contribution.

2. BACKGROUND AND RELATED WORKS

A. Challenges in VANETS

The following section depicts different challenges currently prevailing in VANETs.

- **Potentially high number of nodes:** An expanding number of ITS clients will be furnished with remote correspondence capacities to take an interest in their systems. A convention in those vehicles must be versatile to dodge high clog.
- **High mobility and frequently disconnected network:** Because of a limitation of street design, a bi-directional activity makes high relative versatility between directional vehicles. The vehicles have around 10 seconds to convey to each other if their rates are 25 m/s with remote transmission scope of 250 m. In the same bearing, the vehicles are prone to move into bunch, bunches which might bring about dividing systems if the edge of both gatherings are too far separated
- **Various communication environments:** In wireless networks, a node surrounding so as to gather unwavering quality is influenced situations. A radio sign does not generally have a viewable pathway particularly in city. It is regularly hindered by structures, trees, also, different snags. Indeed, even in an interstate situation, a few vehicles like trucks and enormous autos can deter and constrict a radio sign.
- **Privacy and Security:** A vehicle reveals information about driver's identity, e.g., speed, position, mobility pattern, and destination. This information can be abused by any bad persons. In some cases, the false information may be disseminated in safety application for any bad objective

B. Wireless Access in Vehicular Environment (WAVE)

Due to the fact that Wi-Fi systems and cellular systems are designed to operate in well controlled environments, IEEE task group P and IEEE 1609 proposed Wireless Access in Vehicular Environments (WAVE) standards to use in VANETs because VANETs have many applications with various constraints (e.g., extreme Doppler shift, multi-path problems, rapidly changing conditions, real-time exchanging data, and other requirements). In the WAVE standards, there are two units called roadside units (RSUs) and onboard units.

The RSUs are usually installed in infrastructures, for example, light poles, traffic lights road signs, and so on. The RSUs might transport to many locations but they cannot work in transit. The OBUs are equipped in vehicles and can operate in moving environment. A WAVE basic service set (WBSS) is small networks which similarly operate in IEEE 802.11. In particular, the WBSS might consists of only OBUs (vehicle-to-vehicle) or both OBUs and RSUs (vehicle-to infrastructure).

3. REALISTIC VEHICLE TRACKING MODEL

A. Problem definition

This objective is to implement a scenario in the network simulator-3 and VanetSim tool where the user will be able to inject several vehicle nodes inside a city-highway based map or model in real time. These vehicle nodes will be assigned respectives Ids generated randomly by the ns-3 simulator. Also these nodes will be capable of communicating with each other and also with the static nodes which will act as RSUs (road side units). Hence the idea of achieving vehicle-to-vehicle (v2v) and vehicle-to-infrastructure (v2i) modes of communication will be implemented.

Using these two modes of communication the Tracking of vehicle nodes using the Ids assigned to each and every node will be achieved. The Figure-1 shows the scenario of as thought VANET.

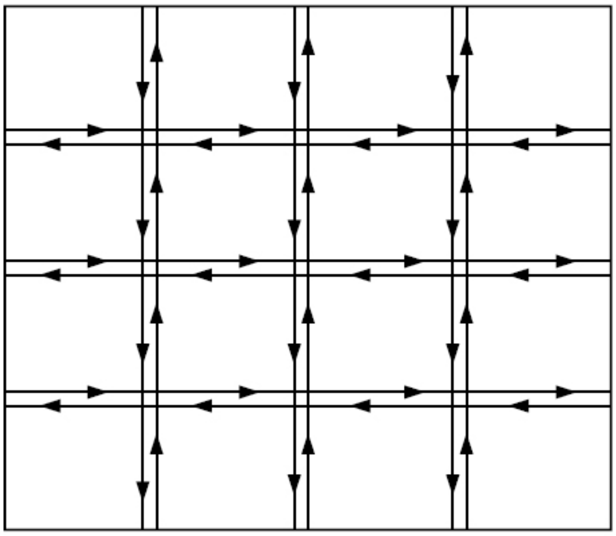

Figure-1. Road topology based on a city map. Arrows shows the direction of vehicle nodes.

B. Block diagram

In this section, the segments of the project outline are depicted, which comprises of five fundamental classes, namely:

a) Vehicle - a real time mobility node that is able to transmit data using a wireless transceiver (OBU in real life)

b) Obstacle - a randomly generated static node acting as a obstacle.

c) Model - the model used is the IDM (intelligent driver model)

d) LaneChange - the MOBIL lane change model

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e) Highway - holds Vehicle and Obstacle objects and uses a Vehicle's Model and LaneChange properties to control its mobility

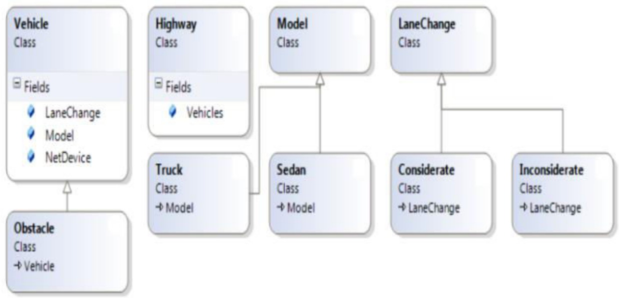

Figure-2. Different classes used in the program.

Here two main classes Vehicle. cc and Highway. cc are described as they are extensively used in the paper.

a) Vehicle

A Vehicle is a mobile node that contains a wireless tranceiver (namely OBU) with the following characteristics:

- VehicleID
- Width - width of the vehicle in meters
- Length - length of the vehicle in meters
- Lane - lane number on the highway where the vehicle is located
- Direction - {-1, 1} (Assume eastbound is 1 and westbound is -1).
- Position - a vector (*x*, *y*, *z*), where *x* is the rear position of the vehicle, *y* is the center of the vehicle, and *z* is the altitude of the vehicle above the highway (all units in meters)
- Velocity - in m/s
- Acceleration - in m/s2
- Model - mobility model settings, desired velocity is associated with the mobility model
- Lanechange - lane change model settings

b). Highway

Highway is the most important class of this paper's source code. As every other class is linked with Highway class. Highway class calls every other class when the program is executed in the network simulator-3.

Highway is the class that holds *Vehicles* and manages their mobility. Now the physical properties of the multi-directional highway model used in the paper are discussed.

Highway represents a straight highway topology and has the following physical properties:

- Length - length of the highway in meters (up to 10,000 m)
- Number of lanes - in each direction [1,5]
- Lane width - in meters
- Median gap - width of the median, in meters
- Bidirectional - true if the highway contains two-way traffic, false if the highway is one-way

C. Mobility model for realistic vehicle tracking

This project uses the Intelligent Drivel Model (IDM) for vehicle tracking. IDM is a Car-Following model i.e. the state of the traffic is characterized by the positions, speed, and the lane indicator of the vehicle node at any given instant of a time.

The decision of any driver to accelerate or brake depends on his own velocity and on the front vehicle immediately ahead of him. Lane-changing decisions, however, depend on his neighbours. Specifically, the *acceleration dv/dt* of a given driver depends on his *velocity v*, on the *distance s* to the front vehicle (if when on free road, i.e., no front car, then $s = \infty$), and on the velocity difference ΔV (positive when approaching) which can be calculated as per equation 1 and 2.

$$dv/dt = a[1-(v/v_0)^{\delta}-(s^*/s)^2] \quad (1)$$

where

$$s = s_0 +(vT+(v\Delta v/2\sqrt{ab})) \quad (2)$$

Table-1. Parameters and their default values used in IDM model.

Parameters	Default value used
Desired Speed v_0	80 kmph
Optimum time T	1.5s
Max acceleration a	$1 m/s^2$
Deceleration b	$1.5 m/^2$
Traffic Jam Distance s_1	0.0m
Safe Distance s_0	2.0m
Acceleration Exponent δ	4

D. Lane changing model

Lane Changing comes into action when

- The potential new target lane is more inept or less traffic ridden. Also the incentive criterion should be satisfied

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- Lane changing ccan performed safely without any cause for collision.

In the Lane Change Model MOBIL criteria on the acceleration is based on both old and prospective new lane, which is as calculated using the IDM mobility model. The safety criteria in the MOBIL model is satisfied if the braking deceleration of the vehicle B' of the target lane after a possible change does not exceed a certain limit b_{safe}. This results in the safety criterion as shown in the equation 3.

$$acc'(B') > -b_{safe} \quad (3)$$

To calculate the incentive criterion for MOBIL model, the advantage on the target lane, measured by the increased acceleration is weighed against the disadvantage imposed to other drivers, again measured by the increased braking deceleration for these drivers. The disadvantage imposed on other drivers is weighed with a politeness factor 'p' whose values are typically less than 1, resulting in incentive criterion according to equation 4.

$$acc'(M') - acc(M) > p\,[\,acc(B) + acc(B') - acc'(B') - acc'(B')\,] + a_{thr} \quad (4)$$

As above, acc means the actual IDM acceleration while acc' means the acceleration after a possible change. The car labels M and M' mean "Me" before and after a possible lane change, respectively, while B and B' mean the back vehicle before and after a possible lane change, respectively. Table 3.2 shows the deafult values of the parameters used in Lane Change MOBIL model.

For the error (€) calculations according to equations 4 and 5, an maximum possible velocity v_0 and maximum deceleration and acceleration, 'b' and 'a' respectively are considered.

$$€_{dec} = ½\,|b|^2\,T_{s\,;}\ \ €_{acc} = ½\,|a|^2 T_s \quad (4)$$

$$€ = max(€_{dec}\,,\,€_{acc}) \quad (5)$$

Here T_s is defined as time step function. Default value for T_s = 5ms for simulating the simulation sceanrio.

Table-2. Parameters and their default values used in MOBIL model.

Parameter	Default value	Remark
Politeness Factor p	0~0.5	
Max safe decelaration b_{safe}	4m/s^2	<Max decelaration 9m/s^2
Threshold a_{thr}	0.2m/s^2	<lowest acceleration of IDM

While other lane-change models typically assume purely egoistic behaviour of the drivers, i.e., p = 0, it is possible to model different behaviours by varying factor, p as follows:

- p > 1) a very altruistic behaviour
- p in [0, 0.5]) a realistic behaviour:
- p = 0) selfish behavior

E. Collision detection probability

This paper uses the Intelligent Drivel Model (IDM) for Car following and MOBIL lane change model for directing vehicl nodes. This two model give rise to possibility of collision at the intersections. The probablity of collision detection is calculated by using 'Uniform Distributuon' of all the possible values between maximum acceleration and deceleration of the vehicle nodes. Probablity of collision is P(c) is calculated as

$$p(c) = \begin{cases} \frac{1}{b-a}, & if\ b < a_0 < a\ otherwise \\ 0, & \end{cases}$$

This results in

$$P_c = \frac{1}{(b-a)^2} \int_b^a \int_b^a coll\begin{pmatrix} a \\ a_0 \\ b \end{pmatrix}$$

4. SIMULATION MODEL AND RESULTS

A. Simulated scenario of traffic based city model

The first part of the implementation is carried out in Network simulator-3 and then it is patched with VanetSim simulator. The project's architecture's primary container is Highway class. The Highway class's primary duty is to generate the XML document which will represent the Highway configuration, wiring the programming of the various program classes linked with the Highway class. The code for this paper has been designed in such a way that the user gets a command line interface during the course of simulation where he/she can actually input the values variables. Table 3 describes some of these variables.

Table-3. Variables the user can set during the course of simulation.

Variable	Function	Default value
simTime	Defines total simulation time	User dependent
plot	Generates gnu plot	True
dis	Type of vehicle distribution	1=exponential 2=log normal
spdstd	Default speed	80
spl	Speed linit of nodes	120
pw	Transmission power of vehicle nodes	20.5

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After the simulation is complete, the Highway class produces 3 different files - one markup file (.xml) and two trace files, namely "vehicleTrace.csv" and "networktrace.csv". All these files are generated and stored in the default ns-3 directory

The 'vehicleTrace.csv' files show all the information about vehicle location. It contains information like Simulation Time (Nanoseconds), Vehicle ID (Integer), Message (String), and User Index (an integer based on the type of message).

A xml file map of Chennai city or a part of a Chennai city using OpenStreetMap was created. This map shows multi-directional Highway perfect for our Vehicle-Tracking scenario. It has multiple lanes, multiple intersections most suitable for our paper. After the xml file is loaded in VanetSim, it shows the Highway Topography as shown in Figure-3.

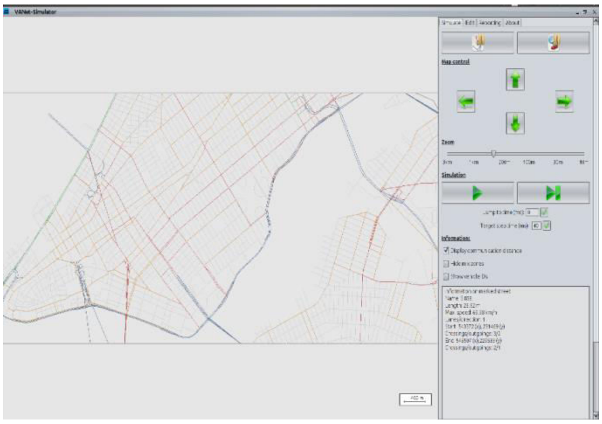

Figure-3. Map generated using OpenStreetMap.

Dimensions of the map generated using OpenStreeMap should not be less than the topographical dimension declard in the Highway class. Dimension for this ppaper has been defined inside the Highway class as (10000, 10000) in (x,y) co-ordinates. Figure-4 shows the vehicle nodes loaded onto the map inside the VanetSim simulator.

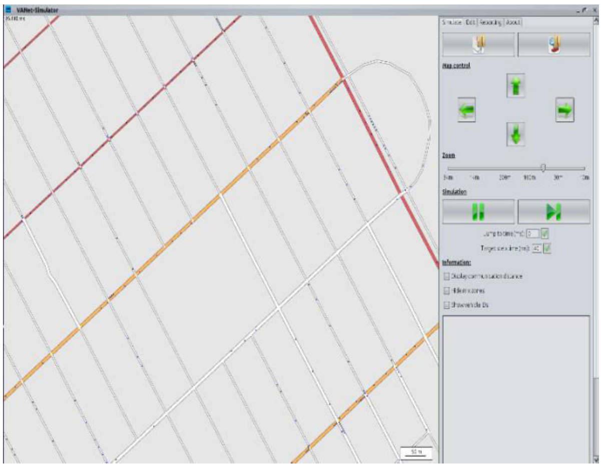

Figure-4. Vehicle nodes loaded onto the Highway model.

For the proposed scenario, two types of vehicles class are defined in Vehicle class (See architecture). - One is Sedan class depicting normal class of vehicles in the traffic of a city, while other is Truck class depicting heavy-duty section of the traffic scenario in the city. Next step is the simulation in the VanetSim.

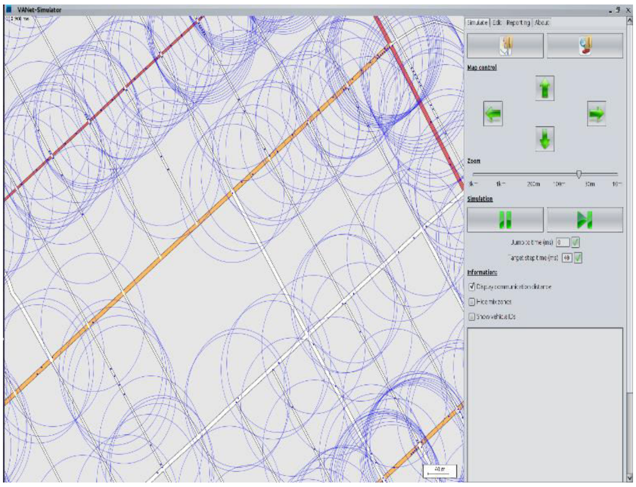

Figure-5. Vehicle nodes communicating with each other.

Figure-5 shows the wireless transmission carried out by vehicle nodes. The transmission range can be defined inside the Highway class of the paper. For this paper it has been kept at 20m surrounding the vehicle node. This means that if a vehicle node is inside the 20 m are of another vehicle node, they both can communicate with each other.

This scenario shows nothing else but the vehicle-to-vehicle mode of communication in Vanet structure. We can map this in real life scenario by implementing the On Board Units (OBUs) inside the car. The wireless system defined in the vehicle node can be duplicated via the wirless transceiver fitted inside the On Board Unit of a car. Hence this simulation is totally implementable in real life traffic in a city.

B. Vehicle tracking using V2V communication

To take into consideration input between the system and the portability model, there must be a path for the client's application code to associate with individual Vehicle objects. Highway class permits the client to get to any Vehicle object through its VehicleID utilizing FindVehicle() subclass.The user can then utilize this item to change any of the Vehicle's parameters.

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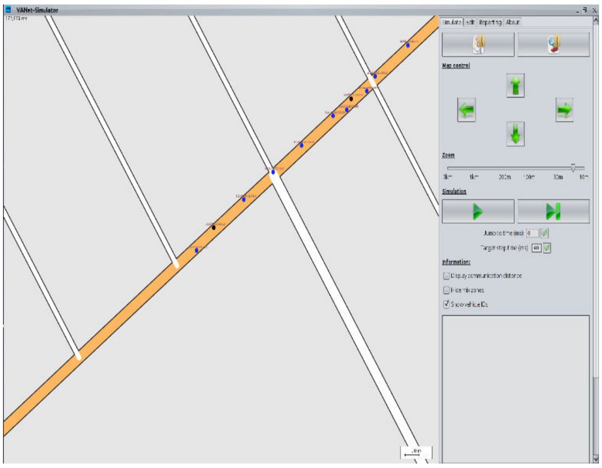


Figure-6. Depiction of vehicle with their respective Ids.

Furthermore, Highway gives Find Vehicles In Range() which provides back a rundown of all Vehicle objects inside of range(meters) of the given Vehicle. Find Vehicles In Segment() gives back a rundown of all Vehicle objects in a specific path between positions x1 and x2.

To get to these Vehicle objects at specific times, Highway triggers a few occasions that can be bound to an occasion handler made by the client. The occasions InitVehicle, ControlVehicle, and ReceiveData are talked about beneath. Also, there are a few different occasions, for example, DevRxTrace and PhyRxErrorTrace, for the reasons for following the correspondence channel, the PHY/MAC layer, and the conduct of the system gadgets introduced on vehicles.

The current Highway scenario is mapped into x-y topography where the user can track the vehicle node using the co-ordinates. This can be compared to real time scenario where the x-y co-ordinates can be mapped as GPS latitude and longitude co-ordinates. This is depicted in Figure-7.

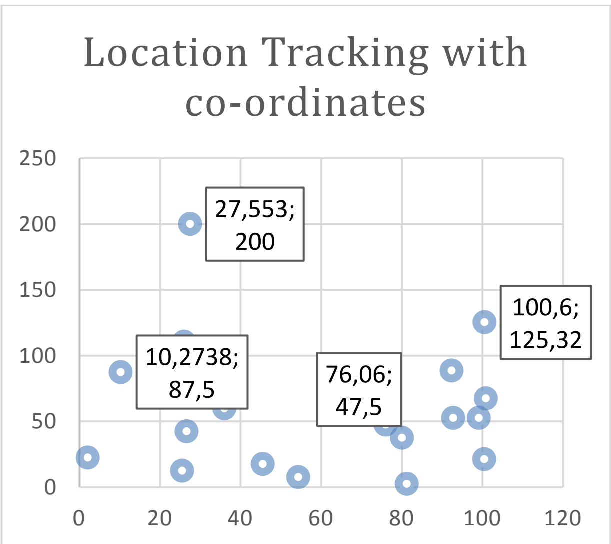
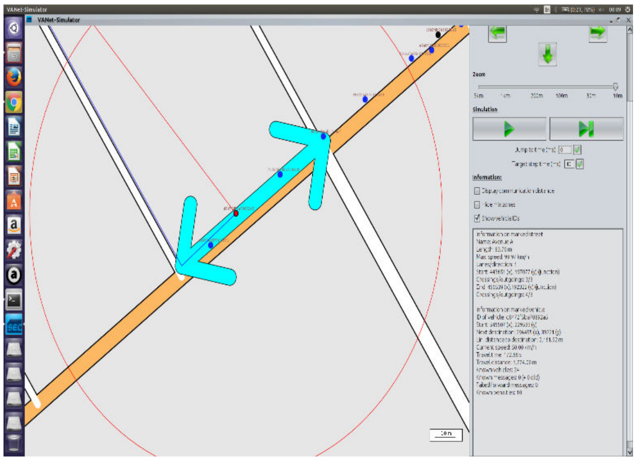


Figure-7. Vehicle tracking details w.r.t. their co-ordinates in the Map.

C. Infotainement Provisioning using V2I communication

The proposed work also provides the capability to the user to get information of any vehicle node in the map. If the user clicks on any of the vehicle node, it shows all the possible direction the vehicle can move next.

Like shown in the Figure 8, it shows a particular vehicle node selected, and it shows the next two possible direction it can go next. Now if this node would have been at an intersection then it would have shown 4 possible direction. Also the VanetSim provides with the feature called Information extraction. As seen from the Figure-8 the bottom left pane shows all the information about the selected node



Fiugure-8. Bottom left panel showing all the information about selected node.

This information includes Starting Position of the node, next nearest destination or intersection, velocity of the vehicle, total distance travelled from the starting position and etc.

D. Handoff scenario for vehicle nodes

Since this paper aims at implementing Vehicle-to-Infrastructure (V2I) mode of communication, it is required to study handoff quality between two RSUs for a vehicle. So the tracegraph was generated for one vehicle node. Tracegraphs were used to study if there are drop in packets when a vehicle moves form one RSU to another RSU.

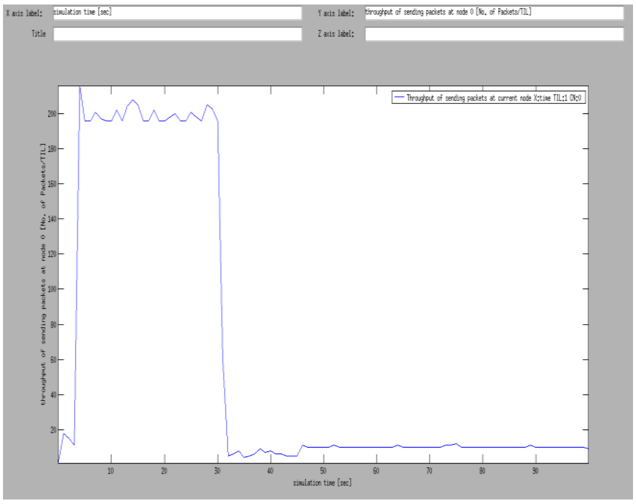


Figure-9. Throughput details for vehicle in RSU-1.

Simulation time was set to be 50 sec where the vehicle would be in RSU-1 coverage and would move to RSU-2 after 30 sec.

Figure-9 shows the throughput details when vehicle iss in RSU 1. And Figure 10 shows the through put details when the vehicle moves toRSU-2 coverage

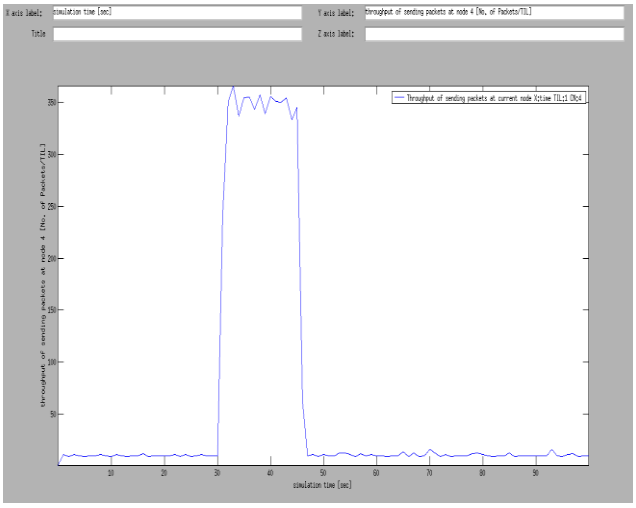


Figure-10. Throughput details for vehicle in RSU-2.

After studying both Figures 9 and 10, it can be said that there is no loss or no delay of packets when the Vehicle moves from one RSU to another. So a seamless Handoff which is a crucial standpoint for successful Infotainment Provisioning in the VANET,has been obtained for the proposed framework.

5. CONCLUSIONS

A good VANET simulator is required to have both an excellent networking simulator and a good approximation of vehicle traffic. The objective of implementing simulation scenario using ns-3's mobility model and IDM and MOBIL was a great step forward. Ns-3's excellent network simulation was combined with a fairly accurate and intelligent driver model.

Realistic vehicle mobility is achieved through the validated implementation of the IDM car-following model and the MOBIL lane-change model. The *Highway* class introduced in the project, which not only simulates a straight roadway, but also manages the mobility of all vehicles on the highway. This project's implementation also allows the user to take advantage of automatically created and inserted vehicles or to manually insert vehicles at any point along the highway. Also the code was successfully updated for VanetSIm to add the following functionality: omni-directional Highways, connected Highways, separated Vehicle generation to a separate class, basic traffic light functionality, and xml-based configuration. This was done without sacrificing the accuracy of IDM and MOBIL. In addition a seamless Handoff sceanrio was achieved for the better Infotainment Servies.

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REFERENCES

[1] Yongtae Park, Jihun Ha, Seungho Kuk, Hyogon Kim, Chieh-Jan Mike Liang and JeongGil Ko. 2014. A Feasibility Study and Development Framework Design for Realizing Smartphone-Based Vehicular Networking. IEEE transactions on mobile computing. 13(11).

[2] Miao Wang, Hangguan Shan, Rongxing. 2015. Real-Time Path Planning Based on Hybrid-VANET-Enhanced Transportation System. IEEE transactions on vehicular technology. 64(5).

[3] Nabeel Akhtar, Sinem Coleri Ergen, Oznur Ozkasap. 2015. Vehicle Mobility and Communication Channel Models for Realistic and Efficient Highway VANET Simulation. in IEEE transactions on vehicular technology. 64(1).

[4] 2015. Vehicle Detection Techniques for Collision Avoidance Systems: A Review. IEEE transactions on intelligent transportation systems. 16(5).

[5] Stefan Joerer, Michele Segata, Bastian Bloessl. 2014. A Vehicular Networking Perspective on Estimating Vehicle Collision Probability at Intersections IEEE transactions on vehicular technology. 63(4).

[6] Debasis Das, Rajiv Misra. 2014. Efficient Vehicle to Vehicle Communication Protocol for VANETs.

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Proceedings of 2014 RAECS UIET Panjab University Chandigarh.

[7] Morteza Hassanzadeh, Mathias Lidberg, Mansour Keshavarz, Lars Bjelkeflo. Path and Speed control of heavy Collison vehicles at intersection.

[8] Alvin Sebastian, Maolin Tang, Yanming Feng, andMark Looi. Context-Aware Multicast Protocol for Emergency Message Dissemination in Vehicular Networks. Hindawi Publishing Corporation International Journal of Vehicular Technolog Volume 2012, Article ID 905396.