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# Improve The Accuracy Of IVC Simulation Using Coupled Traffic And Network Simulator

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## Abstract

*Now a days, Vehicular Ad-Hoc Network (VANET) is very popular wireless network for vehicular applications. It is practically difficult to do the experiments on vehicular applications because it is very costly and it will take more time. So it is preferable to use the simulator tools for testing purpose before it is deployed in a real world to use. There are several research challenges in VANET. One of the main challenges in the VANET is realistic simulation of Inter-Vehicle Communication (IVC) protocols. For providing meaningful evaluation result of IVC protocols, an exact modelling of road traffic i.e. an exact movement and position of involved vehicles is very important. To obtain the more realistic simulation result in case of Inter-Vehicle Communication, one of the latest coupled traffic and network simulator (Vehicles In Network Simulation) is used in this paper. Here, the example of Distance based routing protocol using location service with packets power analysis, of vehicle to vehicle communication is taken and their result using VEINS (Vehicles In Network Simulation) simulation is shown.*

***Keywords :*** DSR-LS, IVC, Network Simulation, Road Traffic Simulation, VANET, VEINS

## 1. Introduction

Vehicular Ad-Hoc Network is one of the type of Mobile Ad-Hoc Network. It deploy the concept of continuously varying vehicular motion. The vehicles act as nodes in this network. Some features of VANET Are 1) The nodes in a VANET are vehicles and road side units 2) The movement of these nodes is very fast 3) The motion patterns are restricted by road topology 4) Vehicle act as transceiver i.e. sending and receiving at the same time while creating a highly dynamic network, which is continuously changing 5) The vehicular density varies from time to time for instance their density might increase during peak office hours and decrease at night times[1].

Vehicular Ad-Hoc Networks can be viewed as component of the Intelligent Transportation Systems (ITS). In this network, vehicles are equipped with communication equipment that allows them to exchange messages with each other in Vehicle-to-Vehicle communication (V2V) and also to exchange messages with a roadside network infrastructure (Vehicle-to-Roadside Communication –V2R)[2]. In Inter roadside communication, communication takes place between Road Side Units. Figure 1. Shows VANET with three communications 1) Inter-Vehicle Communication 2) Vehicle-to-Vehicle Communication 3) Inter Roadside Communication.



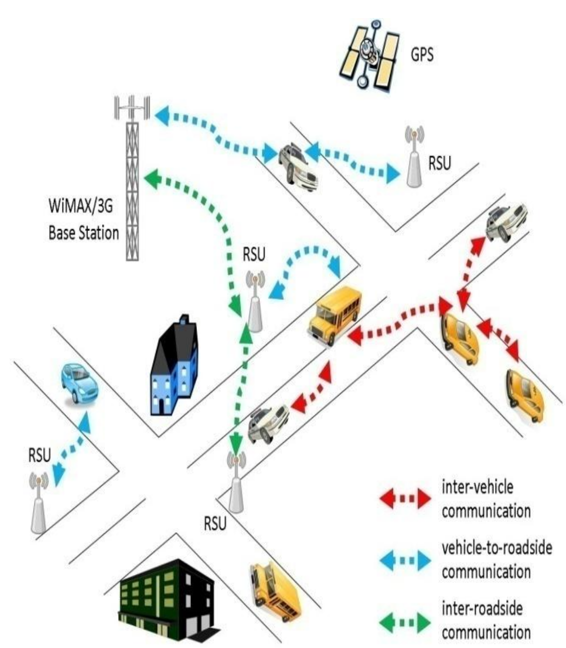


**Figure 1.** Vehicular Ad-Hoc Network

VANET relies on and is related to two other simulations for its smooth functioning, namely traffic simulation and network simulation. Network simulators are used to evaluate network protocols and application in a verity of conditions. The traffic simulators are used for transportation and traffic engineering. These simulations work independently but to satisfy the need of VANET, a solution is required to use these simulators together. There are a large number of traffic and network simulator and they need to be used together into what can be called VANET simulator. There are few tools for VANET simulation but most of them have the problem of proper 'interaction'. So that, in this paper, the bidirectional coupled network and road traffic simulation is used. Here, the Network simulator is OMNeT++ and Road Traffic simulator is SUMO. Coupling of these two simulation is called as Vehicles In Network Simulation (VEINS). Features of VEINS are show in this paper and to proof how the VEINS is better than other coupled road traffic and network simulators the example of distance based routing protocol using location service with power analysis of packet is taken and their result shown in VEINS simulator and according to them graphs are also plotted here.

## 2. Related Work

The movement pattern of nodes in Ad-Hoc network is given by some set of rules is nothing but mobility model[13]. Then based on the nodes position, according to the information from the mobility models, network simulators can create random topologies and perform some tasks between the nodes. Mainly mobility models are separated into two levels: macroscopic level and microscopic level. 1) Macroscopic Model: The mobility of cars, roads, buildings, etc. is comes under macroscopic model[15]. 2) Microscopic Model: The movement of vehicles and their behaviour are classified as Microscopic Model[16].

In urban mesh environment, the human behaviour is represented in survey models. In these kind of models work on data collected by survey performed on human activities. On the graph, the mobile nodes are placed and seen their behaviour. Example: UDel mobility model. The movement of human beings and vehicles monitor with the help of event driven models and based on their locomotion generated traces. Disadvantages: co relation of different traces and limited simulators.

Example: ELDA Model. In synthetic model, to develop realistic mobility models, all the nodes in this category, use mathematical equations. By comparing these mathematical models with real mobility model, the strength of mathematical models is obtained. First, conduct a survey and collect results and compare these results with synthetic models, is one way of the comparison. In case of software oriented models, different simulators like TRANSIM, CORSIM and VISIM are able to generate the traces of urban microscopic traffic. VANET MobiSim uses TIGER database and Voronoi graphs to extract road topologies, maps, streets etc for the network simulators[17]. The problems with such simulators are that they can only operate at traffic level and cannot generate realistic levels of details.

In VANETs, bi-directionally coupled simulation generally consists of two alternating phases: 1) During, the running of network simulation, if there are some changes in the parameter, that parameter changes sends to the road traffic simulator by network simulation for altering road traffic attributes or driver behavior, an influencing vehicles routing decisions. 2) According to these changes in parameter or new parameters, the road traffic simulation performs traffic computation at regular intervals and sends updates of vehicle movement to the network simulation. Bidirectionally coupled simulation have only negligible impact on the run-time of simulations. Data like position and speed of simulated vehicles, while other data like radio state and planned route is local to the network simulator or the road traffic simulator, respectively, shared by both processes. In separate Traffic and Network Simulator i.e Vanet MobiSim and NS-2, the road topologies from random, custom, GDF and TIGER topologies extracted by VanetMobiSim. A parser is contained by Vanet MobiSim to exact topologies from cluster, voronoi, GDF and TIGER graphs that will be used by network simulators. It does not allow any feedback among each other because, the traces are generated onces, are parsed and send to the network simulator, they cannot feed the data back between each other. In TraNs (Traffic and Network Simulator environment),is a combination of road traffic simulator SUMO and network simulator NS-2. TraNs is a java based application with a visualization tool. By using shape file or TIGER database it can extract mobility traces. The traffic file in a form of Dump file is translated by SUMO, which is later on read by network simulator. The output obtained from NS-2 can not be passed back to SUMO is the main problem with TraNs, thus the two loosely coupled simulator fails produce the results that are similar to real life examples. In Federating Traffic And Network Simulator i.e MOVE and NS-2/QualNet by generating mobility traces from the tiger database ar Google earth, MOVE can provide facility of simulation. Custom and Random generated graphs are supported by MOVE. The traces from the traffic simulators is received by the parser and then processed by network simulator. The traffic simulator receives the updated file from network simulator through parser. The interaction between two simulators are not held in timely manner. So that lack of interaction.

All the disadvantages of already proposed bidirectional coupled network and road traffic simulator are removed in VEINS. In VEINS there is real time interaction between network and road traffic simulation. So that it provide better simulation result show here with the help of example.

## 3. Distance Based Routing Protocol Using Location Service with Power Analysis of Packet

### 3.1. Location Based Routing Protocol (DBR )

Based on the propagation delay, every vehicle calculate the inter-vehicular distance between itself and its neighbouring vehicles in Distance Based Routing Protocol. Distance calculation between two vehicles is given by the formula D=S*T, Where D represent distance between two vehicles, S is the velocity and T is the propagation delay.

In this protocol, every vehicle uses digital map. By using GPS technology or from users all vehicles determine its initial position and according to that identify its location the digital map. In this case, Vehicle position, Speed of vehicle and destination coordinate are fundamental parameters. To determine the direction of travel of vehicle destination coordinates is useful parameter. Every vehicle has its own routing table. Whenever a vehicle change its velocity and direction, a vehicle broadcast hello message and according to this hello message all neighbouring vehicles updates their routing table. Routing table consist of Vehicle ID, Velocity, Position Information and Coordinates of destination.

If the destination vehicle is known the DBR, forward the data packet directly to the destination vehicle. But, if the destination vehicle ID is not in the table, then according to the location of destination of vehicle select next hop based on the direction, to forward the data packet firstly to hop and then hop to destination vehicle. Next hop is selected, based on the inter vehicular distance and current speed. Vehicle moving at a very high speed are less stable than the vehicle moving at the lower speed. Hence, less priority is given to vehicles moving with high speed in forwarding the data packet. Similar to routing table, every vehicle maintained its own data forwarding table. Data forwarding table contains Packet sequence number, Destination vehicle ID, Next hop, previous hop, Number hops.

### 3.2. Location Based Routing Protocol using Location Service (DBR-LS)

In Distance Based Routing Protocol using Location Service, vehicle which want to transmit the updated information to destination vehicle, uses location server to find the position of destination vehicle. The source node or vehicle generate request packet which has destination node ID and send to the nearest location server. The location server reply by sending required location information of destination node to source node and according to that forward data packet.

According to the request packet by source node, the location server updates its information and use this updated information about velocity and direction to get the geographic location of vehicle with digital map. In this protocol, time required to find the location of destination vehicle or node and next hop is less.

### 3.3 Power Analysis of Packet Transmission in DBR-LS

In Inter Vehicle Communication or Vehicle to vehicle Communication, the information between vehicles is transmitted in the form of packet. In Distance Based Routing Protocol using Location Service, this information is related to position of vehicle, speed of vehicle, velocity of vehicle and density of vehicle. But, the power required in transmission of packet is takes place an important role. Power required for packet transmission is the main parameter in any routing protocol. Because, power is only main parameter that send data packet from source node or vehicle to destination node in case of IVC. If power is not enough for packet transmission the packet may not be transmitted to the destination or it may be lost. The connectivity of vehicular Ad-Hoc Network in which DBR-LS protocol is used for routing the packet from vehicle to vehicle is totally depend on power. Connectivity of network is directly related to the vehicle density (veh/km), vehicle speed and transmit power.

The nodes need to maintain a relative high transmission power such that all vehicles can communicate with each other to ensure connectivity of the entire network. If the transmission power is too low, the nodes might be separated into isolated cluster, which affects the practical usability of a VANET. If the transmission power is too high, the interference will increase. So that, proper selection of transmit power is very essential to meet the required connectivity. The vehicle speed and traffic flow are independent and hence there are no significant interactions between individual vehicles. Hence MATLAB is used here to simulate the power transmission versus vehicle density.

The power control is depending on the packet length, signalling strength, number of packet transmission and channel fading. By adjusting these parameters we can easily select a proper power for packet transmission. So the network connectivity is not affected and packet transmission is also done in smooth way.

## 4. VEINS(Vehicle In Network Simulation):

Veins is an open source Inter-Vehicular Communication (IVC) simulation framework composed of an event-based network simulator and a road traffic micro simulation model. Both domains models are bi-directionally coupled and simulations are performed on-line. This way, not only the influence of road traffic on network traffic can be modelled, but also vice versa. In particular, the influences of IVC on road traffic can be modelled and complex interactions between both domains examined.

Veins is made up of two distinct simulators, OMNeT++ for network simulation and SUMO for road traffic simulation. To perform IVC evaluations, both simulators are running in parallel, connected via a TCP socket. The protocol for this communication has been standardized as the Traffic Control Interface (TraCI). This allows bi-directionally-coupled simulation of road traffic and network traffic. Movement of vehicles in the road traffic simulator SUMO is reflected in movement of nodes in an OMNeT++ simulation. Nodes can then interact with the running road traffic simulation, e.g. to simulate the influence of IVC on road traffic.



### 4.1 Features of VEINS

a) It is based on 100 percent open source software offering unrestricted extensibility.

b) It allows for online re-configuration and re-routing of vehicles in reaction to network packets.

c) It relies on trusted vehicular mobility model and implementation done by Transportation and Traffic ScienceCommunity.

d) It relies on fully –detailed models of IEEE 802.11p and IEEE 1609.4 DSRC/WAVE network layers, including multi-channel operation, QoS Channel access , noise and interference effects.

e) It can simulate city block level simulations in real timeonsingle-workstation.

f) It can be deployed on compute clusters for simulation in MRIP-distributed parallel fashion.

g) It can import whole scenarios from Open Street Map , including buildings, speed limits, lane counts, traffic lights, access and turn restrictions.

h) It can employ validated, computationally, inexpensive models of shadowing effects caused by buildings as well as by vehicles.

i) It supplies data sources for a wide range of metrics, including travel-time and emissions.

j) It is supported by solid and diverse user base from five continents.

## 5.Simulation Results

In Distance Based Routing Protocol, the message broadcasting between vehicles or nodes is as shown in figure 2. Here for finding the location of destination vehicle distance formula is used already explain in section 3.1. In figure 3, the packet transmission between nodes are by using location sever no need to calculate distance between nodes to find out the location of required destination node. Figure 4 shown below shows the Network Traffic Overhead with Distance Based Routing Protocol(DBR) and Distance Based Routing Protocol Using Location Service(DBR-LS). The implementation of Network Traffic Overhead with Distance Based Routing Protocol (DBR) is shown by Red dotted Lines.

Also, the Network Traffic Overhead implementation with Distance Based Routing Protocol with Location Service (DBR-LS) is shown by Green dotted lines shown in Figure 4 below.

Figure 5 shown below shows number of hops with Distance Based Routing Protocol (DBR)(shown by green dotted lines) and Distance Based Routing Protocol with Location Service(DBR-LS) (shown by red dotted lines). All the simulation results are taken by VEINS.

Figure 6 shows the graph of minimum transmit power versus average vehicle density. This graph is plotted by keep in mind packet length, signalling strength, number of packet transmission and channel fading of these parameters.

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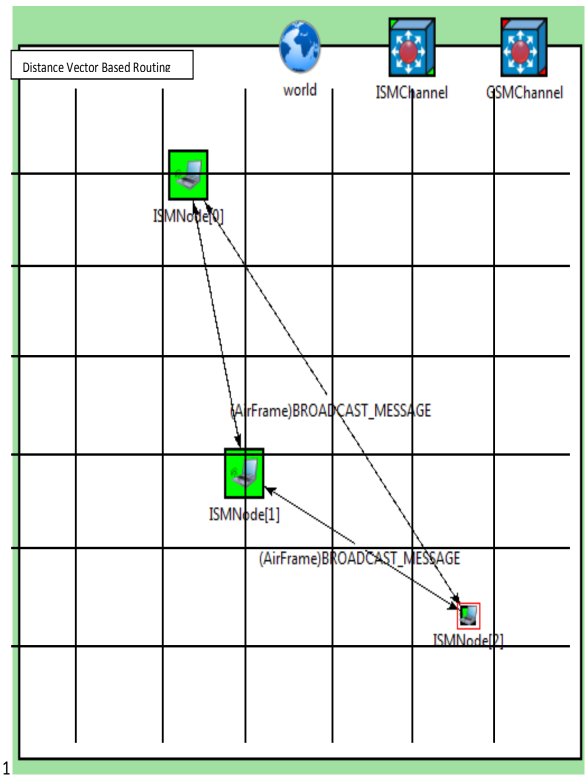


**Figure 2.** Transmission of Packets between Vehicles using Distance Based Routing Protocol

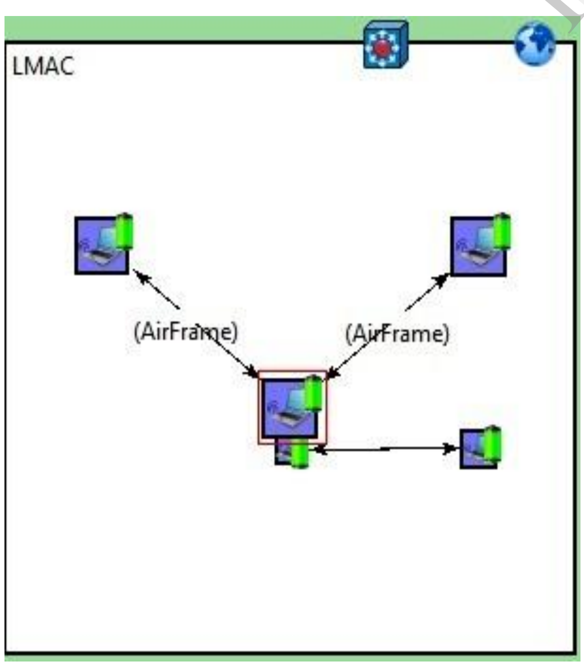


**Figure 3.** Transmission of Packets between Vehicles in Distance Based Routing Protocol using Location Server

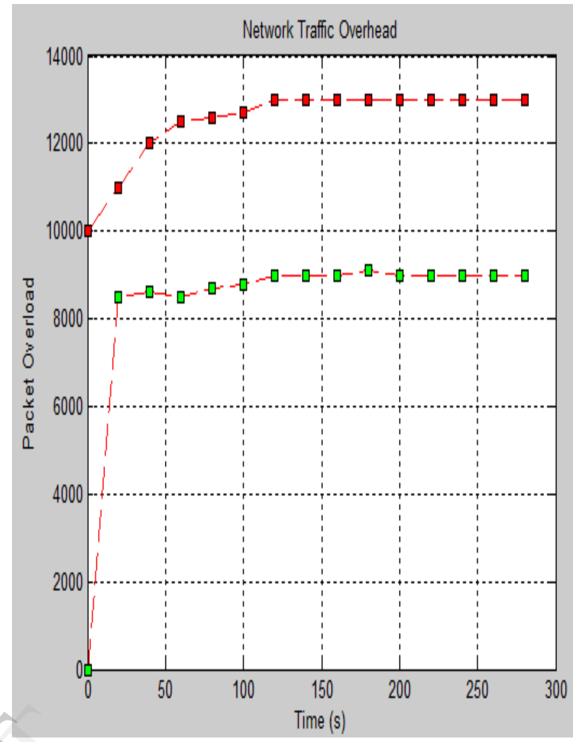


**Figure 4.** Network Traffic Overhead with Distance Based Routing Protocol (DBR) and Distance Based Routing Protocol with Location Service(DBR-LS)



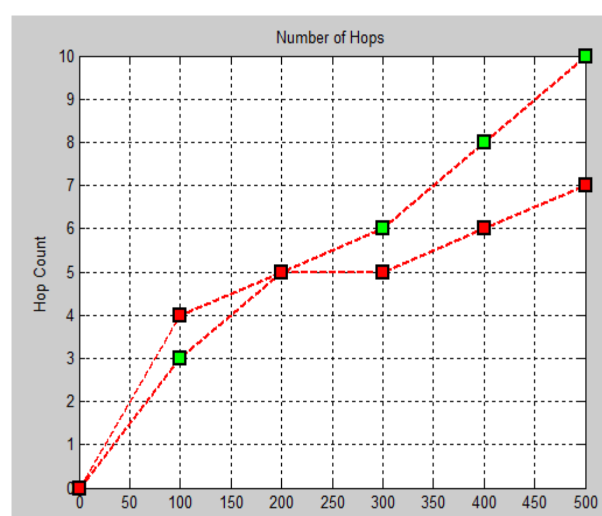


**Figure 5.** Number of Hops with Distance Based Routing Protocol(DBR) and Distance Based Routing Protocol with Location Service(DBR-LS)

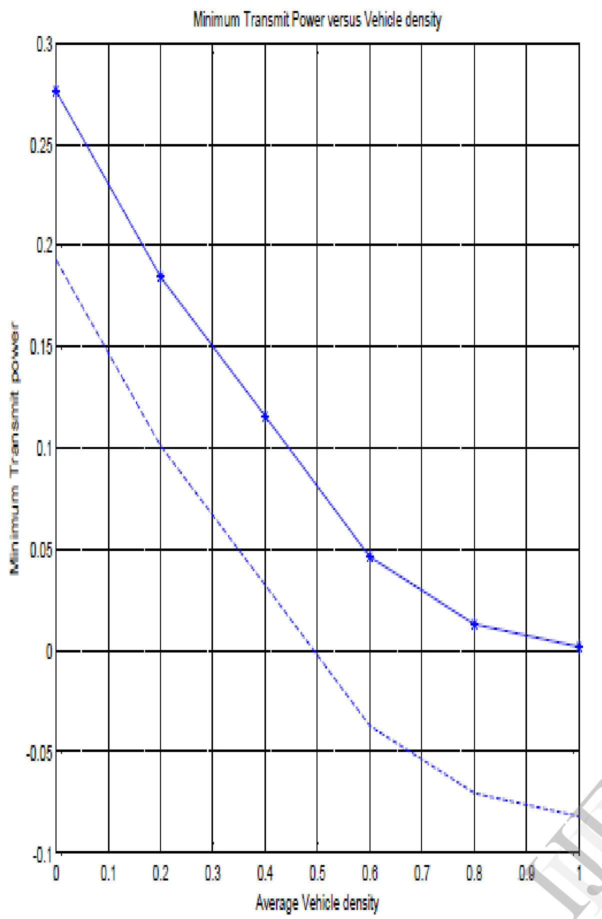


**Figure 6.** Minimum Transmit Power Versus Vehicle Density

## 6.Conclusion

One of the main challenges in the VANET is realistic simulation of Inter-Vehicle Communication (IVC) protocols. For providing meaningful evaluation result of IVC protocols, an exact modelling of road traffic i.e. an exact movement and position of involved vehicles is very important**.** In this paper, the latest coupled road traffic and network simulator (VEINS) is used. The Vehicle In Network Simulation gives more realistic result here. This paper not only describe the VEINS simulator but also shown the simulation result in VEINS. The distance based Routing Protocol using Location Server (DBR-LS) is simulated here by using VEINS. In DBR-LS one additional parameter i.e. power required for packet transmission is also analyzed and the minimum transmit power according to vehicle density is plotted graphically.

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