Vehicle to Vehicle Communication in Vehicular Network Simulation Environment: Analysis and Future Perspectives

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Abstract – Applications are required to be tested in networking environment in order to be evaluated for their reliability and performance in real time environments. Developers and researchers have used the networking simulation software to evaluate and test the applications in varying networking environments. It is being widely used by researchers due to their cost effectiveness and flexibility for setting up the desired networking environment. Simulation software provides capability to customize the networking environment as per the user requirements. Users can create networks of two or more nodes. Various networking modules can be incorporated such as different MAC layer and routing modules. In VANET, simulation environments are extensively used to support research on intelligent driving assistance and transpiration system. In this research work, we have presented analysis between various vehicular network simulators. Vehicles In Network Simulation (Veins) is used as preferable simulation tool. Simulation environment is created and applications performance is evaluated using Veins, OMNET++ and SUMO.

Index Terms – VEHICULAR AD-HOC NETWORK (VANET) simulators; network simulation tools; mobility model; Veins, OMNET++, SUMO

1. INTRODUCTION

Vehicular network is becoming vital part of fast growing intelligent transportation industries. It is accepted as emerging area for research in intelligent transportation solutions. Vehicle on roads are able to communicate to other vehicles through vehicle to vehicle communication and vehicle to infrastructure communications. Information and communication technologies have been incorporated into vehicular communication for reliable and secure data transmission in vehicular environment. Vehicular network is designed to support communication among highly movable wireless nodes. These vehicular nodes possess different networking characteristics with compare to normal wireless nodes due to their variable movements at high speed. Information and communication technologies are widely used to provide intelligent transportation capability for intelligent transportation system. Intelligent transpiration system is designed for safe driving, route planning and smart traffic management [1].

Road accidents are largely happened due to driving behavior of users. Human errors lead to fatal loss of human life and resources. These losses can be minimized by incorporating the driving assistance system for mitigating the human error possibilities. Various researches are being done in field of intelligent driving assistant. These researches have contributed in safer and improved driving and successfully reduce the losses due to accidents occurred due to human errors. VANET simulations can be performed using integration of one or more simulates such as vehicle simulator and network simulator. VNAET applications are mostly evaluated using the combination of network and vehicle simulator. Vehicle's wireless communications are tested for different traffic models [1][2].

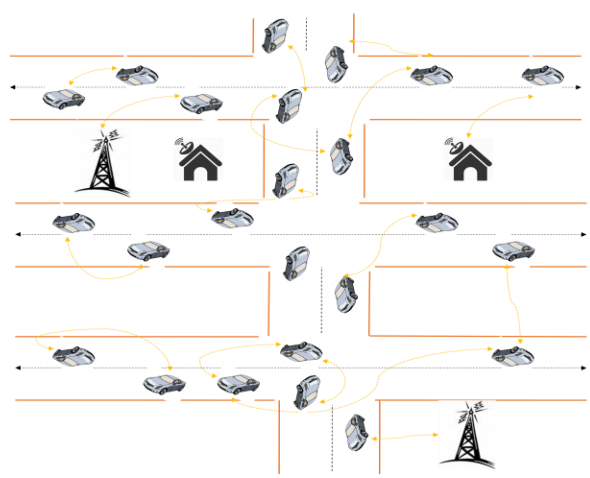

Figure 1: Vehicular ad-hoc network (VANET).

Transport industries and government have working towards to provide fully capable vehicular network for safer, reliable and enjoyable journey. Real time traffic information are used for calculating traffic behavior for proper traffic management solutions so that commuters can choose the most faster and safer route to their destinations. Smart vehicles can use real time traffic information to prevent accidents and human driving errors. Vehicles are capable to communicate with others by incorporating the wireless communication capabilities. They can work as wireless sensors and data relay nodes. Vehicles can be embedded with desired sensors for capturing necessary information for making accurate and proper decision. This information is very useful for creating intelligent transportation system. Technologies and infrastructure development can be used to make vehicles journey secure and resalable. Researchers and companies have come together to promote the VANET for intelligent transportation network [2].

Traffic jams and accidents are common phenomenon on roads. Every city having traffic jams on roads irrespective of their populations. Transportation is backbone for city financial cycle. Transportation industries are responsible for delivering goods to users. Passengers requires reliable and safe route for commute. Emergency services require faster and easily accessible routes for their purpose such as medical assistance and ambulance services. So, proper traffic management is important for important services and it requires proper attentions from authorities. Environments are at risk of using vehicles in large numbers. These vehicles produce more pollution to environments. Public transportation system and smart traffic management for vehicles can be important steps in order to save environments. Smart cities are latest trends which is getting acceptance from various well established cities. Latest technology trends can be used to provide solutions towards traffic related issues. These technologies provide safety measures for reducing risk of traffic accidents and loss of human life. Smart vehicles are equipped with sensors for providing real time information for decision making. This information can be used by intelligent transpiration system in managing vehicles movements to provide smart transportation system [3]. Vehicular network has potential for enhancement in vehicle wireless communication. It is important part of intelligent transport system and offer safety and non safety messages communication. In VANET, researcher has focused on protocol designing for simulated enlivenment. These protocols are evaluated for performance on various layers [4].

2. RELATED WORK

Maytheewat Aramrattana et. al., have analyzed cooperative intelligent transport systems. They have focused on developing cooperative intelligent transport applications in emerging area of vehicular network. Evaluation of cooperative intelligent transport system has been summarized for driving, traffic and network simulators. Cooperative adaptive cruise control applications are evaluated in simulation environments. The simulation framework future perspective is discussed for analysis of cooperative intelligent transportation systems. Human driving behavior is included for more accurate analysis of cooperative applications. A simulation frame work is defined which includes driving, traffic and network simulation environment. The proposed simulator includes three simulators. Driving software is included in vehicular network simulator. Various vehicles movement scenario is evaluated by experiments [1]. Ribal Atallah et. al., have proposed multi hop communication between vehicle and road side unit in VANET environments. The intermediate vehicles are assigned responsibility of forwarding data to other vehicles in their range of communication. Statistical model is presented for finding probability for stability for path connectivity. The path availably is calculated between source and destination vehicles. Proposed research work is examined for successful packet delivery and throughput in vehicular network simulated environment for dynamic network environment. It is shown that path availability is proportional to number of vehicles in an area [2].

Mussa et. al., have analyzed vehicular simulation tools applicability in vehicular network environments. Vehicular network are expensive to establish. It requires equipments, infrastructure, wireless communication capability and human efforts which is costly affair. Vehicular network simulators are economical and flexible solutions for evaluating performance of vehicle to vehicle communication and vehicle to road side unit communication. A comparative analysis of simulation tools is presented. Vehicular network simulators are combination of vehicular simulator and network simulator. These simulators perform direct interaction between network simulator and vehicular simulator for making simulation as close to realistic simulations [3]. Akhtar et. al., have proposed analysis of vehicular communication with respect to network topology for highway environment. Freeway performance measurement system database is used for real time network data for a microscopic mobility models. The proposed approach performs tuning between lognormal model and vehicle density [4].

Hamed Noori have studied Veins framework for behavior analysis of vehicle to vehicle and vehicle to road side communication. It uses SUMO traffic simulator for vehicle simulation and OMNeT++ network simulator for node communication in wireless environments [5]. Behrisch et. al., have presented an over view of traffic simulator Simulation of Urban Mobility. SUMO provides microscopic traffic simulation environments. Vehicles are assigned unique identification, movement route, velocity, acceleration, arrival time and departure time. In SUMO, vehicles environment can be simulated for measuring noise and emission generated from vehicles. This information can be used to design traffic management to reduce vehicles emission effects [6]. Sommer et. al., have developed vehicular network simulator Veins.

Veins imposes bidirectional coupling between network simulator and traffic simulator. It is developed for vehicle to vehicle communication. Safety applications evaluation is primary concern for vehicular networks. Evaluations of vehicular simulation in pure network simulator do not provide accurate analysis. Veins provides vehicular network environment for accurate evaluation of network protocols for VANET [7].

3. VEHICULAR AD-HOC NETWORK

VANET is network formed by vehicles to vehicles communication and vehicles to road side infrastructures communication. In VANET, vehicles can move as per road layout, vehicles density and user behaviors. A vehicle can move at low speed and high speed. Slower movement is beneficial for data transmission because vehicular nodes get more time for communication. In high speed movement, vehicles are very sort of communication due to frequent disconnection of communication links. Sometime communication has been lost in middle of communication establishment process. VANET can be established with vehicles equipped with wireless communication. These vehicles can form VANET any time anywhere and does not require any pre infrastructure support. VANET can form in side cities busiest areas, remote areas, highways, battlefield and natural disasters locations. Vehicles can communicate to other vehicles or road side infrastructure for data sharing. These communications are known as vehicles to vehicles (V2V) communication and vehicles to road side infrastructures (V2I) communications. In V2V communication, a vehicle establishes communication to another vehicle via wireless communication. In V2I communication, vehicles utilize the road side infrastructure for forwarding the data from one node to remote nodes [2].

In VANET, services can be offered in various ranges from security services to leisure services. The important services are collision warnin vehicles comes in communication range of RSU they can fetch the available services list and start initiating request for desired services [3][4].

4. VEHICULAR NETOWRK SIMULATORS

Vehicles to vehicles and vehicles to road side unit communications need to be tested through intensive experiments for proposed ideas. It is costly affair for testing vehicular network performance which involves creating diversified networking environments. A proposed research work should be tested for these environments for evaluating the strength and weakness of ideas against vehicular communication environments. These strengths and weakness needs to be improved by applying the carefully examined measures which further should be tested in VANET environments. These testing and performance improvement is not feasible for each proposed work by researchers due to unavailability of required infrastructures and higher expenses. So it is effective to simulate applications before actual deployments. Simulation environments should included different wireless channels and mobility models for analyzing comparative performances. Various wireless communication models have different effects on communication links. VANET simulator should be designed for realistic behavior of vehicular communication. Mobility models represent vehicles mobility patterns in simulated environment. Mobility models affect wireless communication in vehicular environments. Applications can behave differently for different mobility patterns and results into variable performance of applications. Simulation models should include mobility models for providing accurate simulation of real time vehicular networking environment. VANET simulation tool should be selected based on their compatibility with applications requirements and similarity to real time traffic.

In VANETs, applications designed for vehicle wireless communications should be checked for performance in real time before open to users. Intelligent transportation system is favorite among researchers and developers for developing smart applications for safety and non safety services. VANET is getting tremendous support from research and developer community. Evaluating vehicular network requires investments in from of infrastructures, equipments, wireless devices and human manual labor. It is costly for arranging necessary requirements for real time testing environment for vehicular network. Sometimes is is not economical and non feasible to arrange required infrastructures and equipments. VANET is very complex networking environments. VANET can be established in various geographical regions which lead to different networking environments for applications. Applications perform differently in these environments. Applications should be tested for their performance in order to evaluate in different scenarios otherwise they give inaccurate performance in real time. Simulation tools should be used for evaluation for these applications. They provides more accurate performance of applications in simulated environment and less costly compare to test bed environment [3].

Simulation environment	Simulator tools
Network simulator	NS2, OMNET, GloMoSim, SNS, J-SIM, JiST
Mobility simulator	SUMO, MOVE, STRAW, VanetMobiSim, VISSIM
Vehicular network simulator	Veins, TraNs, MobiREAL, NCTUns, GrooveNet

Table 1: Recent trends in simulation tools for vehicular network simulation.

5. DISCRETE-EVENT SIMULATOR OMNeT++

OMNeT++ is famous simulator among developers and research community. It supports large range of network protocols from routing layer, MAC layer and physical layer. It comes with graphical interface access and can be easily setup for different simulation environment [3]. It can be enhanced for developing various simulation environment from different networks such as wireless network, wireless ad hoc network, mobile ad hic network, wireless sensor network and vehicular ad hoc network. OMNeT++ provides a powerful customized environment for network simulation. It is used to develop various wireless channels models, nodes connectivity, nodes mobility, MAC layer protocol and PHY layer protocol [5].

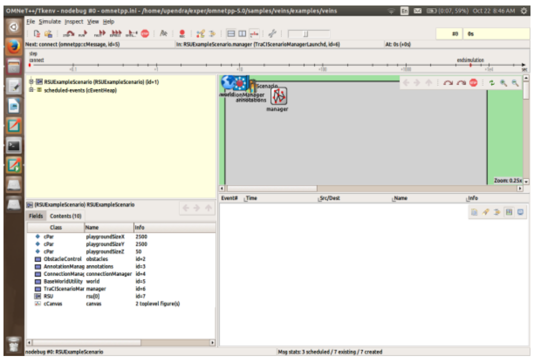

Figure 2: Discrete-event simulator OMNeT++ in Ubuntu 14.04

VANET simulation environment should provide realistic network behavior for representation of accurate vehicular wireless communication among vehicles. In realistic simulation, various networking characteristics should be implemented to as close as possible to their real counterparts such as mobility modeling, road topology and signal propagation. Realistic representation of vehicles mobility is important in developing or selecting vehicular network simulator. It should include microscopic mobility model and macroscopic mobility model and road topology. This input information should be generated from real time movement of vehicles on road [4]. Vehicular simulators are classified into microscopic traffic simulator and macroscopic traffic simulator. In macroscopic traffic simulator, individual vehicle is not focused but mobility of vehicles flow and traffic density is defined. In microscopic traffic simulator, mobility, road maps and behavior of each vehicle are defined. Vehicles initial, destination location, road maps, routes, vehicles speed, acceleration and travelling time is defined as parameters in microscopic traffic simulators. In VANET, DSRC/WAVE standards are defined as wireless communication standards. DSRC stands for dedicated short range communication which is defined for reliable vehicles wireless communication for small distance. WAVE stands for wireless access in vehicular environment. It provides PHY and MAC layer specification for VANET [5].

6. SUMO – SIMULATION OF URBAN MOBILITY

SUMO is developed for vehicular traffic simulation. It is microscopic mobility simulator and capable to provide modeling for driver behavior. It uses Krauss car following model for acceleration or deceleration of vehicles with respect to leading vehicle in different scenarios. It also includes lane changing model for deciding vehicles overtaking [4]. Sumo provides capability of traffic simulator. It is developed as open source software. Sumo simulation framework is used in to analyze strategies related to driving and traffic in various scenario. SUMO is developed by German aerospace center as open source traffic simulator. It has been evolved by contribution of researchers and developers. It includes features related to traffic modeling utilities. Road network can be generated from different source format. It is supported by communities related to traffic simulation research and development. It is freely available for developing algorithms and performs evaluation of research work. There have been various traffic simulators available. These simulator projects are developed as research or evaluation work in order to apply various proposed concepts in VANET. Some of them are not supported now [6].

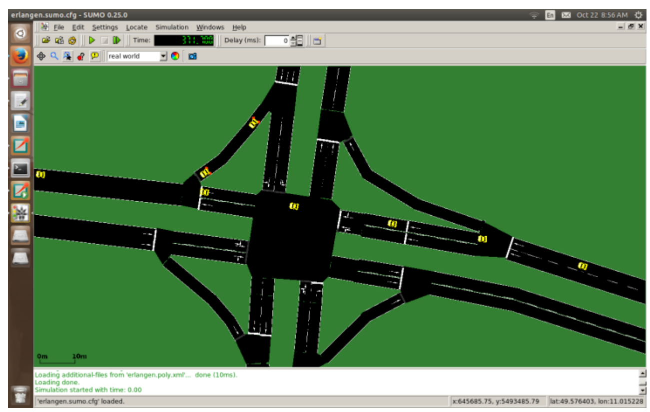

Figure 3: Simulation of Urban Mobility (SUMO) in Ubuntu 14.04

7. VEHICLES IN NETWORK SIMULATION (VEINS)

Veins have been developed by using event based OMNeT++ network simulator. It requires vehicles traffic models which is generated from SUMO vehicular simulator. SUMO and veins are designed to perform interaction with the help of Traffic Control Interface (TraCI). TraCI passes vehicle's movement information from SUMO to Veins simulator. Veins updates vehicles positions by latest updates received from SUMO traffic simulators. TraCI is implemented using transmission control protocol (TCP) which is used to transmit the vehicles status updates information between Veins and SUMO. SUMO and Veins are interacted as client and server model. SUMO waits for commands generated from Veins and Veins waits for the vehicles status updates sent from SUMO [1]. Veins framework includes communication between network simulator and vehicle simulator through TCP socket [5]. In this research work, we have evaluated vehicle to vehicle (V2V) communication for different scenario in vehicular ad-hoc network environment. Veins simulation frame work is selected to perform simulation of V2V communication in Ubuntu 14.04. Simulation analysis shows that successful packet delivery is varied for different communication. Simulation is performed for V2V communication on roads with intersections and without intersections.

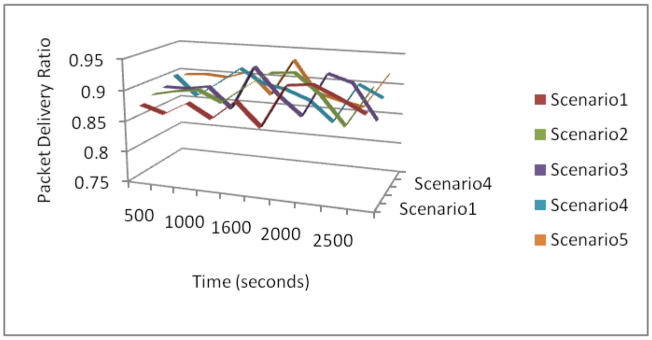

Figure 4: Simulation analysis for V2V communication in Veins.

8. CONCLUSION

In vehicular network simulator, network simulator is bi-coupled with vehicle simulator. Network simulator is responsible for simulation of network protocols and standards. Vehicle simulator takes care of simulation of vehicular nodes mobility. Network simulator fetches vehicular nodes position from vehicle simulator and periodically updates vehicular nodes position. In network simulator, nodes movement is controlled by update from vehicle simulator. In vehicular network simulator, network simulator and vehicle simulator are having impact of vehicle mobility and network environment on each other. Vehicles simulator provides information regarding vehicles movement and road layout to network simulator which perform changes into network topology, nodes position and controls nodes wireless communication in order to make simulation environment more realistic. Veins simulation frame work is used for analyzing applications behavior in VANET. It couple with OMNeT++ and Simulation of Urban Mobility (SUMO).

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