Impact of Inter Vehicle Communication (IVC) on network and road traffic simulation using bidirectional coupled network through one hop broadcasting technique

Prof.Rekhapatil#1, Jyothi.N*2

#1Professor, Head of the Department of computer science and engineering, Poojya doddappa Appa College of engineering, Gulbarga, Karnataka, India,
*2Department of computer science and engineering, Poojya doddappa Appa College of engineering, Gulbarga, Karnataka, India,

Abstract— Vehicular Adhoc Network (VANET) is a autonomous wireless network comprising of moving vehicles. A small communication unit is installed in the devices that are capable of transmitting its GPw position and gather important information from other vehicles and road side junctions. No base station is needed and network supports low to moderate mobility. Routes are preferred being obtained on demand before a node starts communicating with other. Due to very high mobility and unpredictable signaling conditions, packets in such network are prone to collisions and signal strength at the receiver is weaker due to multipath fading and shadow fading. In this paper our goal is to incorporate all the real time parameters in VANET into simulation and to evaluate the performance of the system with the help of one hop broadcasting technique. Based on this we develop the simulation framework VEINS (vehicles in network simulation) composed of the network simulator OMNET and road traffic simulator SUMO. Hence we propose a bidirectional coupled inter vehicular communication where traffic model is generated using microscopic traffic generation tool of Sumo and simulation is performed on real time 802.16.4 nodes. Generally 802.16.4 is used in sensor network for data dissipation from source nodes to sink node. However we use this protocol for its low energy mode. Node broadcast the data only to a single hop. Hence no routing is involved. Nodes upon receiving information from their neighbor they accumulate a neighbor table along with delay, signal strength and neighbor ID. We can advance the state of the art in performance evaluation of IVC and provide means to evaluate better results more accurately.

Keywords— vehicular ad hoc network, road traffic simulation, network simulation, veins, inter vehicle communication.

I. Introduction

One of the main challenges in the vehicular ad hoc network (VANET) research domain is the realistic simulation of inter vehicle communication protocol (IVC). We see the need for bidirectional coupling of network and road traffic simulation for more realistic experiments.[1][2][3]. Mobile adhoc network (MANET) is a self configuring network composed of a collection of independent mobile wireless nodes connected with each other without requiring an underlying infrastructure. Each node in MANET is free to move independently in any direction and therefore links can be changed frequently. Equipping vehicles with wireless communication devices is a subject that has interested the research community and the automotive industry. Advances in wireless networking technologies rise to the emergence of Mobile Ad-hoc Networks (MANETs).

Soon, the research community and the automotive industry studied the application of MANET technologies to deploy networks among vehicles equipped with certain mobile devices as GPS navigators or smart phones. From this work two different technologies appeared: IVC (Inter-Vehicle Communications) and RVC (Road-Vehicle Communications). The first one enables vehicles to communicate with each other and it is also known as communication V2V (Vehicle-to-Vehicle). RVC provides communications between vehicles and the roadside units (RSU) that gather and broadcast information, this kind of communication is also known as communication V2I (Vehicle-to-Infrastructure). The union of IVC and RVC germinated in what we understand today as Vehicular Ad-hoc Networks or VANETs.
Using these technology vehicles can communicate with each other to transmit different kinds of information. The interchange of real-time traffic information conditions among vehicles can make driving safer and more efficient, for this reason the research community is mainly working to develop such applications.

The above figure shows that a man at work signal which may broadcast information about the existence of the road works so that drivers would know their existence in advance. VANET simulation environments only takes into account of network characteristics like node position, mobility and Network traffic conditions The impact of mobility models on VANET simulation results, as well as the inadequacy of the mobility models usually adopted in MANET simulations [4], is well documented. For this reason, recent work in the field of VANET simulation commonly uses mobility traces which are more appropriate for VANETs. Such traces can be generated by real-world experiments, i.e., the observation of real road traffic behavior, or by a dedicated road traffic simulator beforehand fed as input to a network simulation environment. When these road traffic simulators are employed in VANET simulations, traces are commonly generated offline to speed up network simulation performance, which can then reuse generated trace files. In order to achieve this goal, more sophisticated simulation techniques such as bidirectional coupling between a network traffic simulator and a road traffic simulator are needed [5]. Simulation has become an indispensable tool because it makes possible to build a dedicated VANET for its evaluation. Simulators also gather statistical data about the network usage during the simulation that allows to measure the protocols performance. Moreover, it is possible to visualize the VANET in order to easily specify the scenarios for the protocol evaluation. Due to the complexity of the real world, a lot of the events related to the signal propagation that plays an important role in the performance of the outdoor experiments are missed in the simulations: passing by obstacles, reflection problems, signal interferences, etc. Thus, simulation also presents an important drawback: the fidelity of the generated results. The first approach used for simulating VANETs lies in using road traffic simulators capable of generating mobility traces, which are later evaluated by an existing specific MANET simulator. The public availability of many of these MANET simulators is the main motivation for the success of this approach. However, it has a major drawback: the majority of VANET applications implies that vehicles react to the network events and this behavior is difficult to be modeled with this scheme. The specially-designed VANET simulators join scalable vehicular mobility descriptions and network stack modeling in a single tool. These combined approaches have the big advantage of allowing a direct interaction between the communication network system and the vehicular traffic dynamics. It is clear from the description of VANET simulator that most of the simulator uses SUMO for traffic modeling in VANET. However different simulators emphasize different aspects in simulation.

Three important modules in Omnet Mixim framework based simulation solves the problems presented by other VANET Simulators. Firstly, The main simulation scenario comprises of connection manager and obstacle manager. Connection manager is a socket based solution that communicates with sumo server using a proxy TCP communication. Sumo server returns the state of vehicles at any given instance of time. Therefore, the system uses live traffic feed rather than relying on traffic generation traces. Secondly, Obstacle manager receives, models and annotates data about road side architectures which includes several buildings and architecture whose shapes are annotated using real polygonal structure. Analog Module to handle modulation, fading, Gaussian Noise mixing in the network. A separate field called signal is incorporated in the packets that deals with bit level signal system for data transmission. Every layer records it's own statistics. Hence result of communication at every layer can be traced through different simulation parameters. Hence proposed simulation model not only helps to analyze mobility model but also realistic channel states traffic simulation is performed by the microscopic road traffic simulation package SUMO[10].

II. RESEARCH ELABORATIONS

Traditionally, the mobility models used in many network simulation tools do not take into account driver behavior or specific characteristics of the urban environment (presence of stop lights, intersections, merge lanes, etc). As a result, the used mobility models, and thus, the simulation of network protocols may be unrealistic[7]. One major advancement in this domain was the concept of trace-based mobility modeling to be used in network simulation environments. Here, realistic mobility patterns are generated (offline), then used as representative models for the evaluation of network protocols. In fact, as a common practice in many simulation platforms, the mobility traces are inserted into network simulation modules as independently generated offline files. This way, the system complexity is reduced. Two methods for the generation of such trace files can be...
distinguished. First, real-world observations can be used, i.e., the mobility of real vehicles is observed in a city or highway environment and the resulting trace information is processed for use in network simulations[8][9]. Similarly, mobility patterns can be extracted from these real-world observations to analytically model traffic flows [10].

Veins: vehicles in network simulation, the developed simulation framework Veins incorporates all the benefits from state-of-the-art simulation techniques of both the network simulation and the road traffic micro simulation domains.

Network Simulation, Network simulation is commonly used to model computer network configurations long before they are deployed in the real world. Through simulation, the performance of different network setups can be compared, making it possible to recognize and resolve performance problems without the need to conduct potentially expensive field tests. Network simulation is also widely used in research, in order to evaluate the behavior of newly developed network protocols [11].

Road Traffic simulation, Traffic simulation in Veins is performed by the microscopic road traffic simulation package SUMO. SUMO allows high-performance simulations of huge networks with roads consisting of multiple lanes, as well as of intra junction traffic on these roads, either using simple right-of-way rules or traffic lights. Vehicle types are freely configurable with each vehicle following statically assigned routes, dynamically generated routes, or driving according to a configured timetable. The use of such microscopic road traffic simulation in combination with IVC protocol analysis using a state-of-the-art network simulator can provide deeper insights into the behavior of VANET protocols than is possible with one alone. This is especially the case if IVC can directly influence the road traffic, e.g., through incident warnings or other traffic messages. Such an evaluation requires a bidirectional coupling of both simulators.

Bidirectional Coupled Simulation, We achieved bidirectional coupling of both frameworks, the network simulator OMNET++ and the road traffic simulator SUMO, by extending each with a dedicated communication module. During simulation runs, these communication modules exchange commands, as well as mobility traces, via TCP connections. OMNET++ is an event-based simulator, so it handles mobility by scheduling node movements at regular intervals. This fits well with the approach of SUMO, which also advances simulation time in discrete steps. The control modules integrated with OMNET++ and SUMO were able to buffer any commands arriving in-between time steps to guarantee synchronous execution at defined intervals.

III. SYSTEM DESIGN

Simulation description
OMNET++ 4.2: OMNET++ is an object-oriented modular discrete event network simulation framework. It has a generic architecture, so it can be (and has been) used in various problem domains:
• modelling of wired and wireless communication networks
• Protocol modelling
• Modelling of queuing networks
• Modelling of multiprocessors and other distributed hardware systems
• Validating of hardware architectures
• Evaluating performance aspects of complex software systems

In general, modelling and simulation of any system where the discrete event approach is suitable, and can be conveniently mapped into entities communicating by exchanging messages.

SUMO: Simulation of the Urban Mobility Server:
TraCI uses a TCP based client/server architecture to provide access to SUMO. Thereby, SUMO acts as server that is started with additional command-line options: --remote-port <INT> where <INT> is the port SUMO will listen on for incoming connections. When started with the --remote-port <INT> option, SUMO only prepares the simulation and waits for an external application that takes over the control. Please note, that the --end <TIME> option is ignored when SUMO runs as a TraCI server, SUMO runs until the client demands a simulation end.

Simulation parameters
The simulation focuses on some of the network properties such as: Throughput and packet delivery ratio.

<table>
<thead>
<tr>
<th>TABLE I Simulation Experimental Setup</th>
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<tbody>
<tr>
<td>Channel type</td>
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<tr>
<td>Nodes</td>
</tr>
<tr>
<td>Number of vehicles</td>
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<td>Routing protocols</td>
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<tr>
<td>Time of the simulation start</td>
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<td>Time of the simulation end</td>
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Algorithm
Step1: Set up sumo with ‘n’ nodes carry out simulation for ‘T’ period of time for ‘N’ number of vehicles.log vehicle position in CFG(configure file).
Step2: In OMNET start communicating with SUMO server. nodes move by following linear mobility model and updating
the positions depending upon the values(coordinates) logged by the SUMO server.

**Step3:** Road side buildings are incorporated to simulation by using obstacle module.

**Step4:** Each independent block car is marked by ARP(address resolution protocol).NIC is 802.11 link layer with management and MAC sub layers.

**Step5:** The link layer is modeled as radio(ray liege model).

**Step6:** At every node measure SNR and link losses. Then based on the available hops select the one with least fading(local repair).

**Step7:** Measure the cumulative statistics (packet delivery ratio, avg bit error rate, SNR).

Firstly run SUMO server which is responsible for communicating with OMNET simulation and for passing it with vehicle position by which it gets connected and it manages the connections sent through the SUMO server by sending SUMO data then data will be sent to the mobility manager in which it checks for the congestion and the position of the vehicle. Application layer determines the network packet performance by bursting of the packets then moves to the MAC layer in which it seeks for the data for sensing the channel if it is idle it moves to ferr scheduling module in which the program should be scheduled and then sends the frame to the physical layer ,if it is not idle then it sends the data for accessing the channel by giving proper inputs. Obstacle manager receives models and annotates the data about the road side architecture which includes several buildings and architecture whose shapes are annotated using real polygonal structure for sensing the channel analog module produce the inputs to the signals used for fading ,modulation by sending Mac frames present with noise after sensing the channel through fading the frames will be received. Decider module which upon receiving the signal checks that if signal meets snr threshold or not.

**IV. RESULTS AND ANALYSIS**

Sumo server returns the state of the vehicles at any given instance of time. Obstacle Model of Omnet Integrated into simulation it specifies the specific position of the vehicle at any given instance of time. Omet model vehicles are receives the models and annotates the data about the road side architecture,whose shapes are annotated are represented using sum real polygonal structures.
Fig. 6 Obstacle Model of OMNET integrated into Simulation

Fig. 7 Omnet Model Vehicles

BEACON INTERVAL.

Fig. 8 Debugging

REPRESENTS the amount of time between beacon transmissions or it is the time interval between beacon transmissions. The time at which a node (access point or station) must send a beacon.

Fig. 9 & 10 Packet delivery vs Throughput of the Beacon interval
Fig.11 & 12 Sensitivity: The minimum input signal required to produce a specified output signal.

V. CONCLUSION

It can be said that vanet is an autonomous wireless network comprising of moving vehicles. It is clear from the description of the vanet simulator that most of the simulator uses SUMO for traffic modeling in vanet. The proposed simulation model not only helps to analyze mobility model but also the realistic channel states. It can be said that bidirectional coupled network and road traffic simulation provides major advantage compared to uncoupled simulation. The impact of IVC on road traffic can be directly evaluated. Traffic models are inappropriate for road traffic simulation. They have the negligible impact on the simulation run time.

REFERENCES


