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Mobility Model of Reactive Routing Protocols for Vehicular Ad-hoc Networks

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Abstract - Vehicular Ad-hoc Networks (VANETs) have been magnetizing interest from research and industry. VANET technology is distinguished from mobile ad hoc networks (MANET) and wireless sensor networks (WSN) by large-scale deployed autonomous nodes with abundant exterior assisted information, high mobility with an organized but constrained pattern, frequently changed network topology leading to frequent network fragmentation, and varying drivers behavior factors. In this paper, we introduce a vehicular mobility model and evaluate the performance of routing protocols: AODV, DSR and TORA. A variety of highway scenarios characterized by the mobility, load, and size of the network. Our results signify the reactive routing protocols performance, which is suitable for VANET scenarios in terms of packet delivery ratio, routing load, and end-to-end delay.

Keywords - *AODV, DSR, MANET, TORA and VANET.*

1. Introduction

The growth of the increased number of vehicles equipped with wireless transceivers to communicate with other vehicles to form a special class of wireless networks, known as VANETs [1]. It mostly resembles the operation technology of MANET in the sense that the process of self-organization, self-management, low bandwidth and shared radio transmission criteria remain same. The interference in operation of VANET comes from the high speed and uncertain mobility of the mobile nodes along the paths [2]. This suggested that the design of efficient on-demand routing protocol demands upgradation of MANET architecture to accommodate the fast mobility of the VANET nodes in an efficient manner. This warranted various research challenges to design appropriate routing protocol. It is therefore important at this stage to say that the key characteristics of VANET [3] that may be accounted for the design of various routing protocols. As a special type of network, Vehicular Ad hoc Networks (VANETs) have received increasing research attention in recent years. Vehicular ad hoc networks are wireless networks that use multi-hop routing instead of static networks infrastructure to provide network connectivity.

VANETs have applications in rapidly deployed and dynamic military & civilian systems. The network topology in VANETs usually changes with time. So there are new challenges for routing protocols in VANETs since traditional routing protocols may not be suitable for VANETs [8]. Researchers are designing new VANETs routing protocols, comparing and improving existing ones by using simulations. This work is an attempt towards a comprehensive performance evaluation of commonly used mobile ad hoc routing protocols.

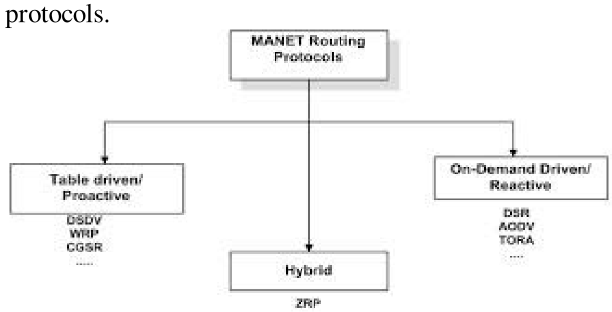

Fig. 1 Taxonomy of Various Routing Protocols in VANET

Fig. 1 shows that VANET routing protocols [9] which can be classified as topology-based and geographic (position-based). Topology-based routing uses the information about links that exist in the network to perform packet forwarding. Geographic routing uses neighbouring location information to perform packet forwarding [11]. Since link information changes in a regular basis, topology-based routing suffers from routing route breaks.

2. Related Work

In recent years, there are several open-source tools are utilized for the generation of vehicular mobility patterns. Most of these tools are capable of producing traces for network simulators such as NS-2 [12], Qual-Net [13]. Recent efforts are the most related to our work, as they also use simulation-based methodology i.e. NS-2 [12] is the first to provide a realistic, quantitative analysis comparing the relative performance of the four mobile ad hoc network routing protocols AODV, DSDV, DSR, and TORA[6-10]. They simulated 50 wireless nodes, moving according to the random waypoint (RWP) model over a rectangular (1500m ×300m) flat space for 900 seconds. The mobility patterns were generated with 7 different pause time (0, 30, 60, 120, 300, 600, and 900 seconds) and with 2 different maximum node speed (1 and 20 mps). The type of communication patterns was chosen to be constant bit rate (CBR), and the parameters experimented with 3 different communication pairs (10, 20, 30 traffic sources), each sending 1, 4, and 8 packets per second (packet sizes of 64 and 1024 bytes). Packet delivery fraction, number of routing packets transmitted, and distribution of path lengths were chosen as the performance metrics. Simulation results demonstrated that DSR and AODV performed significantly better than DSDV, and TORA acted the worst in terms of routing packet overhead.

3. Mobility Models and Simulator

Mobility Model defines the movement pattern of nodes. Network simulators can then, by using this information, create random topologies based on nodes position and perform some tasks between the nodes. Using VANET create a challenge and that is how to separate a mobility model at Macroscopic and Microscopic level [13]. Mobility Model includes some constraints like streets, lights, roads, buildings, cars, vehicular movements and inter-vehicle behaviour. These constraints are divided into two parts that are dealt with separately. The node mobility includes streets, lights, roads, buildings etc and is classified as Macroscopic, whereas the movement of vehicles and their behaviours are classified as Microscopic. We can also analyze mobility model as Traffic generator and Motion generator. Motion constraints are designed by car driver habits, cars and pedestrians and describe each vehicle movement. The Traffic generator creates random topologies from maps and defines the vehicular behaviour under environment.

The mobility model is described by the framework, which includes topological maps like lanes, roads, streets, obstacles in mobility and communication model, car velocities, the attraction and repulsion points, based on traffic densities relating to how the simulation time could vary, vehicular distribution on roads and intelligent driving pattern. Vehicular communication is expected to contribute to safer and more efficient traffic by providing timely information to drivers, and also to make travel more convenient. The illustration of this framework is given in the fig. below.

There are various models, which can generate mobility patterns based on certain criteria. While it is hard to present real world traffic scenarios in a single simulation model, ways can be adopted to develop a protocol suite which can support the implementation. The mobility patterns can be generated from various models. Since real-life implementation of protocols for these mobility models are not easily feasible, a common way of performance evaluation is through simulation. A different choice is the supposed ns-2 [12] which is among the most widely accepted network simulation tools in the scientific community.

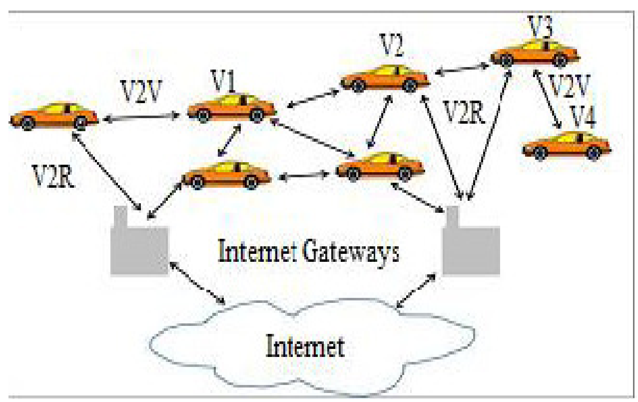

Fig. 2 The framework of VANETs

Its software architecture is prepared for extensions and enables attaching software modules for data exchange with other programs. NS-2 features a comprehensive model for simulating multihop wireless networks and includes an implementation of the IEEE 802.11 MAC-protocol. As radio wave propagation models, NS-2 basically provides the free space model and that supposed Two Ray Ground model, which takes into account both the direct communication path between two vehicles and an additional path due to reflections on the ground. This model is very well applicable to the VANET domain.

4. Simulation and Results

The experimental setup is used for performance evaluation of the AODV, DSR and TORA routing protocols. It measures the ability of protocols to adapt the dynamic network topology changes while continuing to successfully deliver data packets from source to their destinations. In order to measure this ability, different scenarios are generated by varying the number of nodes. We use following scenario generation commands for generating scenario file for 20, 40, 60, 80 and 100 nodes:

./setdest –v 1 –n 20 –p 2.0 –M 10.0 -t 100 -x 200 -y 200;
./setdest –v 1 –n 40 –p 2.0 –M 10.0 -t 100 -x 200 -y 200;

./setdest –v 1 –n 60 –p 2.0 –M 10.0 -t 100 -x 200 -y 200;
./setdest –v 1 –n 80 –p 2.0 –M 10.0 -t 100 -x 200 -y 200;
./setdest –v 1 –n 100 –p 2.0 –M 10.0 -t 100 -x 200 -y 200.

The following commands used to generate the connection pattern that we use cbrgen.tcl file.

ns cbrgen.tcl -type cbr -nn 20 -seed 1.0 -mc 10 –rate 4.0;
ns cbrgen.tcl -type cbr -nn 40 -seed 1.0 -mc 10 –rate 4.0;
ns cbrgen.tcl -type cbr -nn 60 -seed 1.0 -mc 10 –rate 4.0;
ns cbrgen.tcl -type cbr -nn 80 -seed 1.0 -mc 10 –rate 4.0;
ns cbrgen.tcl -type cbr -nn 100 -seed 1.0 -mc 10 –rate 4.0;

The trace file is created by each run and is analyzed using a variety of scripts, particularly one called file *.tr that counts the number of successfully delivered packets and the length of the paths taken by the packets, as well as additional information about the internal functioning of each scripts executed. This trace file is further analyzed with AWK file and Microsoft Excel is used to produce the graphs [12]. Simulations are run by considering AODV, DSR and TORA routing protocol. Simulation parameters are appended in Table-1.

Table 1: Simulation Parameters

Parameters	Specifications
No. of Vehicles	20, 40, 60, 80, 100
Connections	10
Protocols	AODV, DSR, TORA & IEEE 802.11
Antenna Model	Omnidirectional
Channel Type	Wireless Channel
Propagation Model	2-ray ground reflection model
Traffic Type	Constant Bit Rate
Maximum Speed	10 m/s
Data Rate	4 Mbps
Data Payload	512 Bytes / Packet
Pause Time	2.0
Simulation Time	100 s
Simulation Area	200m X 200m
Network Simulator	NS-2.34

We make an effort to measure the protocols performance on a particular terrain area of 200m x 200m at a speed of 10 m/s. The simulation time was taken to be of 100s for Constant Bit Rate (CBR) traffic type with a packet size of 512 Byte. Also, we have considered nodes with Omni-Antenna and Two Ray Ground Radio Propagation method. First, we will compare three protocols under the above simulation environment. Fig. 3 shows the behaviour by throughput of AODV, DSR and TORA. In certain time the total size of useful packets that received at all the destination nodes known as throughput.

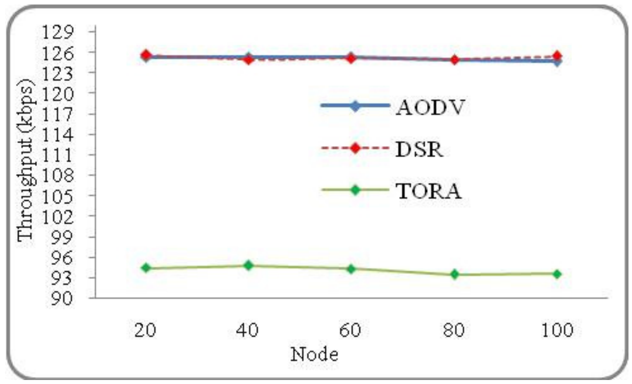

Fig. 3 Throughput of AODV, DSR and TORA

The following fig. 4 shows that Packet Delivery Fraction (PDF) for the same movement models are used, the no. of traffic sources is increasing at 20, 40, 60, 80 and 100. The maximum speed of nodes is set to 10m/s & the pause time is fixed 2.

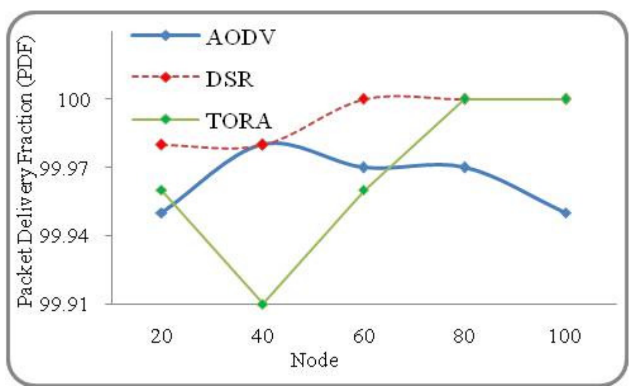

Fig. 4 Packet Delivery Fraction (PDF) of AODV & DSR

The average end-to-end delay in packet delivery is higher in TORA as compared to AODV and DSR, fig. 5. AODV and DSR are little and similar in the case of decreasing order of nodes. When the nodes increases 80 to 100, the transmission delay of data packet is slightly similar. The DSR becomes better rather than to AODV and TORA when nodes becomes 20 to 80.

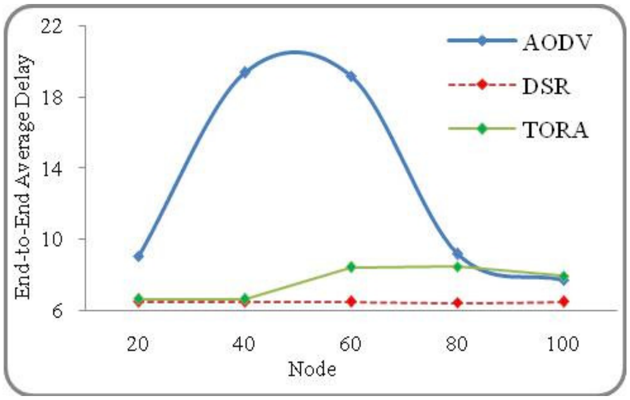

Fig. 5 End-to-End average Delay of AODV, DSR &TORA

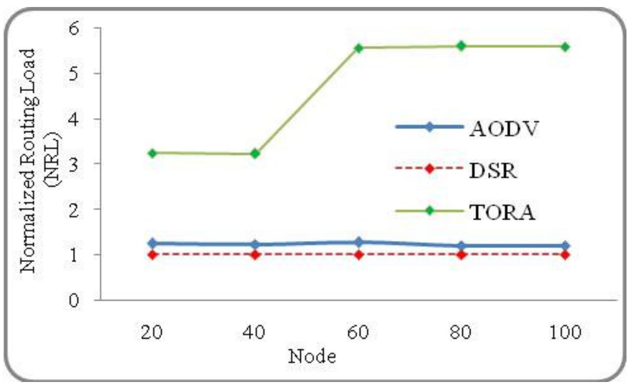

Fig. 6 Normalized Routing Load (NRL) of AODV, DSR and TORA.

DSR execute a little better load-wise and can possibly do even better with some fine-tuning of this timeout period by making it a function of node mobility. TORA has the worst delay characteristics because of the loss of distance information with progress.

5. Conclusion

This paper provides an overview of a mobility models with network simulator. The crash of V2V communication on traffic can be investigated in detail, which is crucial for evaluating the benefits for traffic safety & throughput. The simulation environment set up is a big step forward to a realistic representation of different scenarios, we focus on the routing performance in vehicular ad hoc networks. We present an extensive simulation studies to compare the following routing protocols: AODV, DSR and TORA, using a variety of highway scenarios, characterized by the mobility, load, and size of the networks. Our results indicate the reactive routing protocols performance, which is suitable for VANET scenarios in terms of packet delivery ratio, routing load, and end-to-end delay. The goal of this performance evaluation is a comparison of a VANETs routing protocols between AODV, DSR and TORA. DSR in our simulation experiment shows to have the overall best performance. TORA performs better at maximum number of nodes or high mobility.

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