Analysis of Routing Protocols for VANET using Real City Map Scenarios

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ABSTRACT
For accurate network performance analysis of routing protocols and access technology for VANET (Vehicular Ad hoc Network), realistic road map scenarios are required. This paper refers to analysis of network performance for VANET using existing MANET routing protocols under IEEE 802.11p standard. Simulation of routing protocols for VANET using realistic road map scenarios provides accurate results and can be useful for design and deployment of VANET applications. For VANET, speed of mobile nodes affects the routing path stability. It is important to use real world mobility models; so that the results obtained from the simulation of VANET routing protocols correctly reflect the real-world performance. In this paper, analyses the performance in terms of throughput, packet delivery ratio and packet loss. Comparison of routing protocols is done based on how it behaves when network density increases. Routing protocols like AODV, DSR and GPSR are used for performance analysis. GPSR shows better performance over other two protocols for the considered city map.

Keywords
IEEE 802.11; MANET; Routing Protocols; VANET;

1. INTRODUCTION
Vehicles like cars comprised of embedded GPS, and different types of sensors have become supporting systems for promoting intelligent Vehicular Ad hoc Networks [1 and 2]. Application of VANET technology includes urban traffic management, road safety and non safety related applications [1]. VANET assumes moving vehicles as mobile nodes and they can communicate via creating ad-hoc network between them. High speed of vehicles creates an unstable routing path. Constrained path of vehicles according to road structure also affects the network performance of VANET.

2. RELATED WORK
Dedicated short-range communications (DSRC) provides set of protocols and standards for medium-range wireless communication channels specifically designed for traffic management [1]. DSRC uses 75 MHz of spectrum in the 5.9 GHz band [1]. IEEE 802.11p [2] standard is used for wireless access in the vehicular environment (WAVE) [1]. IEEE 802.11p supports data communication between vehicles, in turn supports Intelligent Transportation Systems (ITS) applications. The channel capacity is 10 MHz, and there are two safety channel, one control channel and six service channel. Radio communication range is about 300 to 1000 meters and data rate is 6 to 27 Mbps [1 and 2]. References [3] and [4] describe ad-hoc network implementation using NS2. References [5] and [6] explain mobility generators for VANET. Authors of [8] and [9] explore routing performance for VANET. This paper deals with analysis of existing routing protocols for VANET using realistic city maps. GPSR shows better performance and suits well for the considered city map.

The rest of this paper is organized as follows. Section III describes the simulation tools required for VANET. Section IV presents the performance evaluation and paper is concluded in Section V.

3. SIMULATION TOOLS
This section describes the simulation tools used for performance analysis of proposed work. In this paper, used OpenStreetMap (OSM) [14], eWorld [15], SUMO (Simulation of Urban Mobility) to create realistic mobility model [4, 6 and 13], and NS-2.33 [3 and 4] for analysis of routing protocols for VANET [10-12]. These are open source applications and are described in more detail below.

3.1 Map Extraction
Urban road infrastructure differs from one place to other. The geographical physical obstacles like buildings, trees, traffic, deviations and path length of road segments, all should be taken into consideration for better analysis of networks protocols for VANET. In this paper, analyse the performance of AODV, DSR and GPSR routing protocols, using realistic city map.

In this paper consider Bangalore city map (Figure 4), instead of considering any random map or grid map, to find which type of routing protocol gives better performance. Considered real map has been taken and processed using OpenStreetMap (OSM) [14] and eWorld [15].

The map processing consists of embedding real time environmental events like traffic on road and traffic signals. The processed map is saved with the extension 'osm.xml'. Figure 1 shows how to extract real map for VANET simulation. This processed map is visualized using SUMO mobility simulator GUI. SUMO is an open source for simulating road traffic. It consists both user friendly GUI and also commands for generating vehicle mobility. Figure 2 show flow chart of processing city map using SUMO.

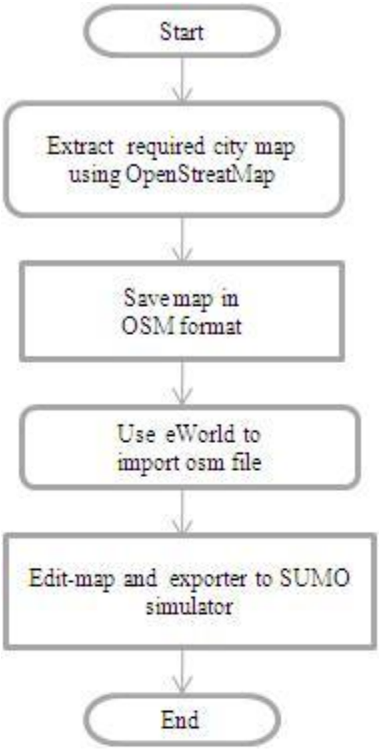

Figure 1. Map extraction

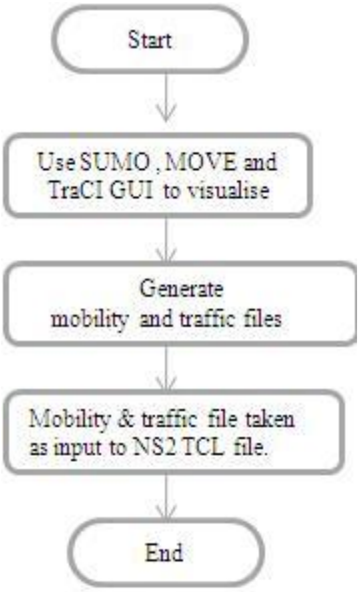

Figure 2. Extracted map used as input to SUMO for visualization

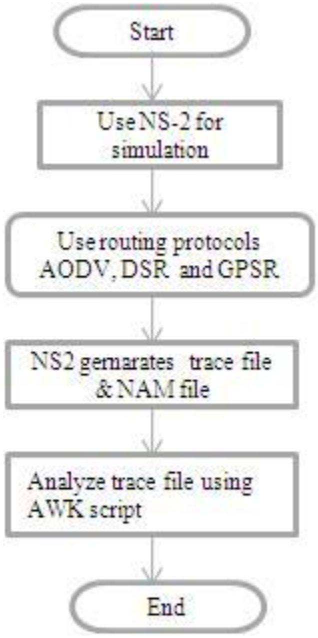

Figure 3. Generated mobility and traffic file used as input to NS2 for performance analysis

From the considered road map obtain edge, nodes and network input files (edg.xml, nod.xml and net.xml files). A file called as flow.xml has to be created which contains information of number of vehicles on selected roads traffic light on particular junction (Figure 2). The road maps consist of information like number of vehicles on street, street name, road segment ids, traffic signals details, vehicles speed. The generated vehicle mobility trace can be given as input to NS-2 for further analysis of network performance. Figure 3 show steps for analysing the performance of proposed work. Figure 4 shows extracted Open Street Map(OSM) of Bangalore. This map is considered as road map for the simulation. Extracted map contains road, road intersection, traffic signals and number of lanes. The Figure 5 shows vehicle trace mobility taken from SUMO and simulated in NS2.

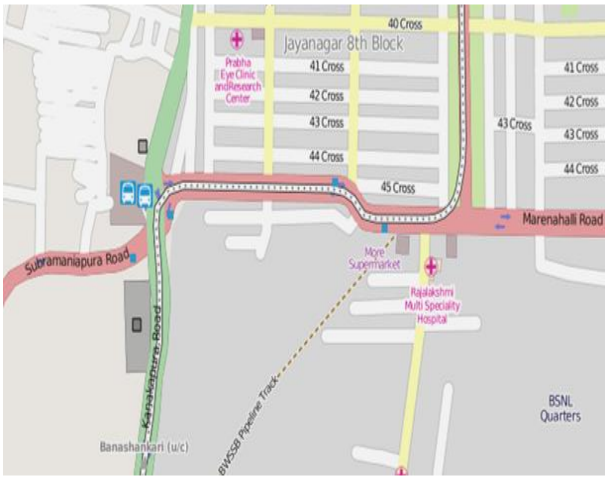

Figure 4. Bangalore map using OpenStreetMap (OSM)

Figure 5. Realistic scenario of Bangalore map trace used in NS2

3.2 Routing Protocol
In this paper, used existing AODV, DSR and GPSR routing protocols. AODV [10] and DSR [11] are MANET reactive routing protocols. GPSR [12] is a MANET geographical routing protocol.

In AODV (Ad hoc On Demand), when any source vehicle wants to communicate with any destination vehicle, a route is created on demand. The route request (RREQ) packet is flooded to reach the destination vehicle and reply (RREP) packet is unicast along the path given by the backward pointers.

In DSR (Dynamic Source Routing) intermediate nodes forward the RREP by changing their name as sender. If the reply is not received by given time, the source vehicle restarts again discovery of route.

In GPSR (Greedy Perimeter Stateless Routing), data forwarding from the source vehicle to the destination vehicle is based on geographic positions of vehicles and uses greedy method to choose intermediate vehicle.

4. PERFORMANCE EVALUATION
This section presents the evaluation of the routing protocols using the network simulator NS-2.33 [8]. To evaluate the performance use the city map scenario generated and described in above section. In this paper, existing AODV, DSR and GPSR are used. Considered simulation parameters for NS2 are given in Table 1. One assumption is that each vehicle has embedded GPS. The performance of the routing protocols is evaluated by varying the network density.

4.1 Performance Metrics
The following are metrics used to measure the performance

Average Throughput: This metric is defined as the number of data packets that were received at destination over simulation time.
Packet Delivery Ratio: This metric is defined as the number of data packets that were successfully delivered at destinations by the number data packets that were sent by sources.
Packet Loss: Number of packets that do not reach the destination.

Table 1. Simulation Parameters

Parameter	Value
Speed	40m/s
CBR rate	0.4(4 packets/sec)
Number of vehicles	40, 50, 60, 70, 80, 100, 120, 160
Mac	802.11p
Propagation Model	TwoRayGround
Simulation Time	300s
Frequency	5.9GHz
Packet Size	512 bytes
Simulation area	4000x4000
Transmission range	200m
Number of CBR Sources	20

4.2 Performance Results
Figure 6, 7 and 8 shows results in terms average throughput, successful packet delivery ratio and packet loss by considering varying node/vehicle density from 40-160 respectively.

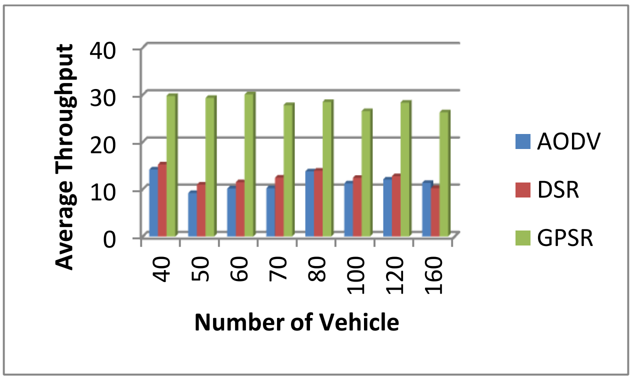

Figure 6. Average Throughputs for AODV, DSR and GPSR for Bangalore City Road Map

Figure 6 and 7 shows that GPSR outperforms AODV and DSR routing protocols in terms of average throughput and packet delivery ratio. It is also shown in figure that GPSR performance is twofold better than other considered routing protocols.

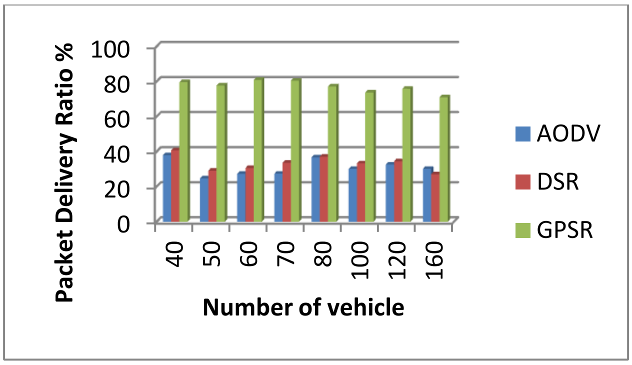

Figure 7. Packet Delivery Ratio for AODV, DSR and GPSR for Bangalore City Road Map

Figure 8 show that GPSR outperforms AODV and DSR routing protocols in terms packet loss, means GPSR reduces packet loss. Here also reduction of packet is twofold compared to other considered routing protocols.

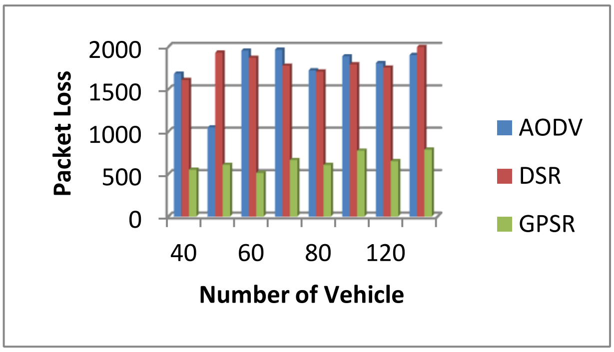

Figure 8. Packet loss for AODV, DSR and GPSR for Bangalore City Road Map

From Figure 6, 7 and 8, it is very difficult to distinguish the performance between AODV and DSR for considered performance parameter. Figure 8 also depicts that for considered city road map there is high packet loss rate for AODV and DSR routing protocols and less packet loss under GPSR.

5. CONCLUSIONS

In VANET, due to high speed of nodes mobility, network route path changes frequently and depends on urban road infrastructure. It is necessary to consider realistic and specific road map topology. By considering the simulation results, can suggest to use GPSR routing protocol for the city road considered in analysis work. For considered city environment, GPSR shows better performance in terms of throughput and packet delivery ratio compared to AODV and DSR. Number of packet loss is less in GPSR. Future work includes implementation of a complex network that could combine not only ad-hoc communication but also infrastructure communication.

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