Performance Analysis of AODV & CLWPR Routing Protocols in VANETs

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Abstract- Vehicular Ad-hoc Network is an emerging field in networks that provides services ranging from safety to entertainment. Starting from selection of traffic road scenario to movement of vehicles (mobility model) and using appropriate routing protocols to flow monitor modules plays a very important role in evaluation of simulation. This research paper is contributing in providing comparative analysis of performance metrics such as end to end delay, throughput and packet delivery ratio using AODV and CLWPR routing protocols for NS3.

1. INTRODUCTION

Wireless communication, now days are at the peak of research activity. It is a self-configuring and self-organizing intelligent transportation system in which message dissemination can be done through vehicle to vehicle communication (V2V) and vehicle to infrastructure (V2I) communication. The range of communicating frequency between vehicles is 5.38Hz [8]. The concept of communication between mobile nodes (vehicles) came from MANETs [4]. In VANET, vehicles can move in a predefined lane with varying velocity which leads to dynamic topology change and signal fading. Number of constraints arises due to fast motion of vehicles like link breaking and message flooding. These vehicles travel in different streets and communicate with each other with or without fixed infrastructure [2]. VANET is considered as the most promising approach for collecting traffic information and disseminate it into real-time environment through wireless channel, providing safety application. Although safety is the basic concern to enhance the development of VANETs, which can further be used in variety of diversified application such as monitoring traffic status, gathering information and broadcasting through on board units (OBU) in vehicles [13] [16]. For sharing information, pattern of moving nodes is the key point [2].Vehicles follow different mobility patterns constrained by traffic congestion, speed limit depending on different scenario like highway scenario, urban-road scenario [17].Generating realistic road scenario and performance of communicating vehicles using appropriate mobility pattern and routing protocol is a crucial point that greatly affects the simulating results [2]. Instead of using costly and complex set-ups, one route itself to software- simulated environment. Various traffic simulators like Simulation of Urban Mobility (SUMO), Mobility Model Generator for Vehicular Networks (MOVE) and network simulators such as NS2, NS3, VanetSim, OMNET++ can be used by VANETs for generating traffic models and simulations [18]. To improve the quality of services in safety related services, message dissemination between vehicles can be possible using different transmission strategies - Unicast, Multicast and Broadcast [5]. Various ad-hoc routing protocols are provided by researchers to solve many issues like route request, route reply, sending messages to all nodes, sending message to specific nodes [4] [15].

2. PROTOCOL STANDARDS

Protocol stack in VANETs has to deal with vehicular communication among nearby vehicles considering distinct factors. Various routing protocols are designed in NS3 according to layers of network
architecture. Physical layer is used in multipath fading whereas MAC layer is for safety applications [14]. In network layer, vehicular network provides different communication models [17]. This information exchange in VANETs is a challenging task. There are basically two strategies for message forwarding in ad-hoc networks – Topology based and Position based routing protocol [3] [7]. Some of the routing protocols are not compatible with latest version of NS3 [10]. Thus, efficient routing protocols are necessary for good performance. The road scenario selected is from Chandigarh city in INDIA for my work. The selected city road is highly preferred for automobiles whether in emergency conditions or for travelling. The speed of vehicles varies according to road status. Hence in peak hours the traffic on the road is very high and chances of traffic congestion increases whereas during less traffic there is link breakage [9]. So, for the selected city scenario performance analysis using AODV and CLWPR routing protocols has been done because these routing protocols possess the novel approach towards the characteristics of urban environment [10]. AODV – RFC 3561 is single path Reactive routing protocol which provides fast adaptation to memory overhead, dynamic link condition and low processing. It helps in obtaining routes for packet transmission by sending route request (RREQ) which actually is the broadcasting of message [14]. Once the receiving node receives the RREQ it sends the request reply (RREP) to the sender node in the unicast approach of transmitting messages. If there is a link breakage the route error (RERR) message is generated or route reinitialize takes place [5] [6]. On contrary to AODV, CWPLR is a position based routing protocol which frequently updates the position of neighboring nodes. It not only works with the information of neighboring node but also utilizes PHY and MAC layer information and provides unicast approach of communicating messages. For implementing any routing protocol in NS3 there are two methods – Ipv4Routing Protocol and Ipv4L3Protocol whose architecture is already described in NS3 manual. The CLWPR has two repositories Neighbor Set to facilitate the information and secondly, Position Association Set which keeps track of neighboring nodes on which data is to be delivered [11].

3. SIMULATING AODV & CLWPR

To simulate the scenario in NS-3, we need to connect the nodes, net devices and its channels. Helper classes are available to accomplish this task. AODV and CLWPR come with helper classes. For AODV, there is AODV helper class (AodvHelper) and for CLWPR there is CLWPR helper class (ClwprHelper) [10].

A. Application Used to generate Traffic

There are mainly five applications available in NS3 defined as follows:-

- Bulk Send Application
- On/Off Application
- Packet Sink Application
- UDP Client Server Application
- UDP Echo Application

For the selected AODV & CLWPR routing protocols, On/Off application and UDP Client Server application is used to generate traffic [14]. In On/Off application one can specify data rate and packet size which can send messages on demand i.e. ON/OFF application can generate traffic whenever nodes need to communicate wherein UDP application is only capable to show compatibility with flow monitors in CLWPR [12].

B. Propagation Model

Propagation Model is defined as the path followed by packets to transfer from one node to another. Depending on the scenario one has to select the propagation delay and loss models. Variety of propagation models is available in NS3. Propagation Loss Model selected for the scenario is RandomPropagationLossModel and RngSeedManager is used to generate random number to generate flow between the nodes [19].

```c
wifiChannel.AddPropagationLoss("ns3::RandomPropagationLossModel");
ns3::RngSeedManager::SetSeed (3); // Changes seed from default of 1 to 3
ns3::RngSeedManager::SetRun (7);   // Changes run number from default of 1 to 7
Ptr<UniformRandomVariable>r=CreateObject<UniformRandomVariable>();
r->SetAttribute("Min",DoubleValue(1));
r->SetAttribute("Max",DoubleValue(10));
```

C. Flow Monitors

In general, simulators require major programming code to evaluate the performance metrics. Thus, Flow monitor module is contributing in NS3 by performing valuable calculation automatically. Flow monitor is a
class which collects and stores data for simulation. It helps in measuring the values of performance metrics such as jitter, end to end delay, and throughput and packet delivery ratio. One has to include the flow monitor module which automatically calculates the statistics of a particular flow of generated traffic. Here, end to end flow data is collected in class Stat [1].

D. Performance Metrics

In the considered scenario, Wifi adhoc nodes are running the AODV and CWPLR routing protocol. Packet size taken is 1000 bytes and data rate is of 10kbps. Performance is analyzed at 20,40,60,80 and 100 nodes for both routing protocols. .tcl file is used to generate all the parametric measures. Following are the formulas to find the performance metrics of network [1].

1. End to End Delay
End to end delay is defined as the total delay from one node to another in a network.

   End to End Delay = DelaySum/rxPacketSum

   where DelaySum is the total delay during the flow and rxPacketSum is the received packets [1].

2. Average Throughput
Average throughput is defined as the sum of all the packets received during communication in the network.

   Average Throughput=iter->second.rxBytes * 8.0 / (iter->second.timeLastRxPacket.GetSeconds()-iter->second.timeFirstTxPacket.GetSeconds())/ 1024

   Where, iter is the variable declared while using Flow monitors, rxPacketSum is the receiving packets during the flow and TotalTime is the simulation time [1].

3. Packet Delivery Ratio
Packet delivery ratio is the ratio of total number of packet received to the total number of packets transmitted.

   Packet Delivery Ratio = rxPacketSum *100/ txPacketSum where rxPacketSum is the total number of received packets and txPacketSum is the total number of transmitted packet [1].

4. VISUALISATION OF SCENARIO
This is the NetAnimator already present in NS3. It is used to generate animator file which helps us to showcase the nodes graphically. Version compatibility is the most important part to run the animator file. One has to install qmake to run NetAnim. Following code line has to be inserted in the code for the generation of animation file.

   AnimationInterface anim ("animation.xml");

   This code line shows the output what we are doing? In the following figure 1.1 and 1.2 defines number of nodes taken and finally wireless communication between the nodes respectively. In the figure 1.1, adhoc nodes are shown and in figure 1.2, wireless communication is shown.

5. SIMULATIONS & RESULTS
Comparative analysis of the performance of AODV and CLWPR routing protocol has been done for the considered city scenario. Packet delivery ratio, End to end delay and Average throughput is calculated for the following simulator parameters shown in table 1.1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Simulator</td>
<td>NS 3.23</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>50 Seconds</td>
</tr>
<tr>
<td>Number of Nodes</td>
<td>20,40,60,80,100</td>
</tr>
<tr>
<td>Simulation Area</td>
<td>PGIMER, Chandigarh</td>
</tr>
<tr>
<td>Propagation Model</td>
<td>Random Propagation Delay Model</td>
</tr>
</tbody>
</table>
From the figures 2.1 and 2.2, it can be concluded that as the number of nodes increases, packet delivery ratio and throughput decreases in AODV and CLWPR. CLWPR gave better results as compared to AODV because it mainly focuses on modularity and reusability to improve efficiency and reliability of the protocol. In figure 2.3, end to end delay of CLWPR is less as compared to AODV. This is due to communication link breakage and delay in message dissemination with increased number of vehicles in AODV whereas CLWPR mainly focuses on the regular updates or creates a new entry of neighboring position of nodes by sending the “HELLO” packet thus achieving lower end to end delay [11].

6. CONCLUSION

In this paper, we analyzed the performance of AODV and CLWPR routing protocol in an urban scenario. The results clearly show that position based routing protocol CLWPR is better than AODV which is a topology based routing protocol. This is mainly due to the regular position updates of the nodes in CLWPR which helps it to deal with the frequent topology changes in VANETs. We simulated a city scenario using NS-3 by varying the number of nodes in a real time environment and concluded that packet delivery ratio and throughput is more in CLWPR routing protocol whereas end to end delay is less as compared to AODV routing protocol.

References


