Traffic Avoidance in VANET using Ant Colony Optimization

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Abstract:
Nowadays traffic avoidance is most complicated problem in this urban area. This paper proposes how to avoid or quickly cross the traffic in large area based on Ant Colony Optimization (ACO) in VANET. It is proposed for identifying the best path to a destination in the simulation area. It has a traffic factor such as vehicle speed, number of vehicles percent in specific path, road capacity, and alternate path to the destination. The simulation results are analysis using SUMO, MOVE, NS2 tools.

Keywords: VANET, SUMO, NS2, ACO

1 Introduction
VANET networks are most complicated problem in today’s environment to apply the real time world. Economically very high costs to manage the traffic into the roadside. NS2 tool is used for simulating Traffic with low cost and apply into the real time environment. In this VANET using NS2 tool is used for simulating vehicle to the road and control the traffic in low cost. Using ACO methodology. The organization of the paper is as follows: Introduction about VANET, ACO and Mobility models. Finally the paper concludes with a summary and future research direction.

2 VANET

Vehicular Ad Hoc Networks (VANETs) are created by applying the principles of mobile ad hoc networks (MANETs) - the spontaneous creation of a wireless network for data exchange - to the domain of vehicles. They are a key component of intelligent transportation systems (ITS).

2.1 VANET Characteristics

Though Vehicular network share common characteristics with conventional ad-hoc sensor network such as self organized and lack of central control. VANET have unique challenges that impact the design of communication system and its protocol security [1]. These challenges include:

2.1.1 Potentially high number of nodes

Regarding VANETs as the technical basis for envisioned Intelligent Transportation System (ITS) we expect that a large portion of vehicles will be equipped with communication capabilities for vehicular communication. Taking additionally potential road-side units into account, VANET needs to be scalable with a very high number of nodes [1].
2.1.2 High mobility and frequent topology changes

Nodes potentially move with high speed. Hence in certain scenarios such as when vehicle pass each other, the duration of time that remains for exchange of data packets is rather small. Also, intermediate nodes in a wireless multi-hop chain of forwarding nodes can move quickly [1].

2.1.3 High application requirement on data delivery

Important VANET applications are for traffic safety to avoid road accidents; potentially including safety of-life. These applications have high requirements with respect to real time and reliability. An end-to-end delay of seconds can render safety information meaningless [1].

2.1.4 No confidentiality of safety information

For safety application the information contained in a message is of interest for all road users and hence not confidential [1].

2.1.5 Privacy

Communication capabilities in vehicles might reveal information about the driver/user, such as identifier, speed, position and mobility pattern. Despite the need of message authentication and non-repudiation of safety messages, privacy of users and drivers should be respected in particular location privacy and anonymity [1].

2.2 VANET Infrastructure

Pure vehicle to vehicle ad hoc network (V2V) communication is a first type of communication in VANET, in which vehicle communicates to another vehicle [2].

In second type of communication vehicles depend on permanent infrastructure for sending and receiving safety or non-safety messages, it is called vehicle to infrastructure (V2I) communication [2]. Hybrid network (V2V+V2I) communication is a third type of communication in VANET, in which vehicle communicates to another vehicle or Infrastructure [2].

3 Network Simulation

Network Simulation is a technique where a program models the behavior of a network either by calculating the interaction between the different network entities (hosts / packets, etc.) using mathematical formulas, or actually capturing and playing back observations from a production network. The behavior of the network and the various applications and services it supports can then be observed in a test lab; Various attributes of controlled manner to assess how the network would behave under different conditions.
4 Network Simulator

A Network Simulator is software that predicts the behavior of computer network. Since communication Networks have become too complex for traditional analytical methods to provide an accurate understanding of system behavior network simulator are used. In simulators, the computer network is typically modeled with devices, links, applications etc. and the performance is analyzed. Simulators typically come with support for the most popular technologies and networks in use today. In this paper, we are using following network simulators such as SUMO, MOVE and NS2.

5 ACO

5.1 Overview of Ant Colony Optimization

The ant colony optimization (ACO) [3] is a probabilistic technique which is used for solving computational problems and helps to find good path. As shown in below figure ants find the shortest path while searching for their food to nest vice versa.

![Fig 2: ANT Mechanism](image1)

This algorithm is a member of swarm intelligence methods, and it contains some metaheuristic techniques. It is based on the behavior of ants finding the shortest path between their colony and the food [3].

5.2 Application of Ant Colony Optimization:

a) Network Optimization
b) Scheduling problem
c) Vehicle routing problem
d) Assignment problem
e) Device Sizing Problem in Nanoelectronics
f) Image Processing

5.3 Ant Colony Optimization Mechanism

The foraging behavior of ants has more unique ability to find the shortest path from their nests to a food source. Some experiments which are done on the certain ants’ shows the communication occurs by depositing a substance called pheromone along the path. It also deposits the pheromone with higher concentration where there is shortest route which is known as Ant Colony Optimization (ACO) [4]. ACO has highly dynamic parameters. Most ant have very limited or no vision.

![Fig 3: FANT and BANT Agent](image2)
As shown in Figure 3 there are two types of agents in routing algorithm: forward ant agents (FANT) which is from source to destination, in its going to destination process to collect information about the quality of path; backward ant agents (BANT) which is from destination to source. The creation of new routes requires the use of a forward ant (FANT) and a backward ant (BANT). A FANT is an agent which establishes the pheromone track to the source node. In contrast, a BANT establishes the pheromone track to the destination node. The FANT is a small packet which has its unique sequence number. Nodes are able to differentiate duplicate packets on the basis of the sequence number and the source address of the FANT. Ants decide on which path they would follow based on the pheromone concentration deposited on each particular path. Those paths which have greater pheromone concentration will have higher probability of selection. Therefore, the selection among the paths is biased toward the shortest path. Each ant search for route in the network, it can according to routing information to choose path, and then can modify the routing table value, look for good path.

6 Mobility Model

Mobility models are one of the key components in VANET simulations.[5] They provide the position of nodes in the topology at any instant of time, which mainly affects network throughput and connectivity [6,7]. In other words, mobility models describe the pattern of movement of vehicles, and how their location, velocity and acceleration change over time. As the performance of any protocol is chiefly determined by the mobility patterns of vehicle, it is desirable to simulate the vehicle movement of targeted real life applications in a reasonable way. Therefore, when evaluating VANET scenarios, it is essential to choose a proper underlying mobility model [5].

6.1 Various Mobility Levels

In static or stationary networks, the nodes, users, and the monitored phenomenon have very low or negligible mobility. For instance, sun and temperature sensors placed in a room may gather appropriate information and further use it to manage motorized shades in order to keep these parameters within predefined limits. Introducing mobility in the below-mentioned three levels in wireless ad hoc network [5] enhances the static paradigm:

• **Node Level Mobility**: Nodes or vehicles are ad hoc in nature and may be moving. For example, moving vehicle or flying unmanned aerial vehicles, collecting information as their carriers continuously change their position and/ or direction.

• **Information Level Mobility**: An event or source may occur in any part of the network at any instance of time. Thus the source of information is mobile. E.g. the pollution produced by a poorly maintained automobile is moving along with the automobile. Other example may be is evolution of an oil spill that can be modeled through measurements at different buoy site.

• **User Level Mobility**: Users or destinations accessing the information collected by network are themselves moving and are mobile. Thus the information applicable to them may change over the passage of time. For example, examining the traffic conditions on the way to the nearest fuel station changes as the user is regularly changing his/her position.

6.2 Intelligent Driver Model (IDM):

In VanetMobiSim [9], driver behavior in the presence of other vehicles [10] is accounted for in an Intelligent Driver Model (IDM). In car-following models of which the IDM is an improved version, a driver does not approach a vehicle arbitrarily closely as can occur in some mobility models but will de-accelerate if another car is ahead or overtake in another lane. Therefore, we use VanetMobiSim mobility modeling, taking groups of roads that intersect at traffic lights to illustrate the findings [8].

7 Simulation work

In this paper calculate the traffic using No. of vehicle present in the coverage area. More than vehicle present in road capacity, then assume the place will be traffic accor. Then we will choose an alternate path to the destination using ACO method. The ACO method has helped to identify the alternate path to quickly reach the destination. Then road capacity calculates the following formula:

\[
\text{Road Capacity} = \text{Road Length} - \frac{\text{No.of Vehicles Length}}{} \]

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Table 1: Simulation Parameters

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Simulator</td>
<td>NS-2.35</td>
</tr>
<tr>
<td>Routing Protocol</td>
<td>AODV</td>
</tr>
<tr>
<td>Simulation Time</td>
<td>500 s</td>
</tr>
<tr>
<td>Simulation Area</td>
<td>1000 * 1000 m</td>
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<tr>
<td>Number of Nodes</td>
<td>100</td>
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<tr>
<td>DATA TYPE</td>
<td>FTP</td>
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<tr>
<td>Packets Generation Rate</td>
<td>80 kb</td>
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<tr>
<td>Packet Size</td>
<td>160 bytes</td>
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<tr>
<td>MAC Protocol</td>
<td>IEEE 802.11</td>
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<tr>
<td>Channel Type</td>
<td>Wireless Channel</td>
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<tr>
<td>Mobility Model</td>
<td>IDM</td>
</tr>
<tr>
<td>Antenna Type</td>
<td>Omni Antenna</td>
</tr>
</tbody>
</table>

Fig 4: SUMO tool graphical view for road-side – 1
Fig 4: SUMO tool graphical view for road-side – 2
Fig 5: Zoom view for traffic signal using sumo tool-1
Fig 6: Zoom view for traffic signal using sumo tool-2
Fig 7: NS2 tool simulation view for traffic
Fig 8: Finding alternate path using ACO
7.1 Analyzing Performance:

\[
\text{Throughput} = \frac{\text{Received data} \times 8}{\text{Data Transmission Period (bps)}}
\]

\[
= 249.96 \text{ bps}
\]

End-to-End Delay

\[
d_{\text{end-end}} = N \left( d_{\text{trans}} + d_{\text{prop}} + d_{\text{proc}} \right)
\]

where

- \(d_{\text{end-end}}\) = end-to-end delay
- \(d_{\text{trans}}\) = transmission delay
- \(d_{\text{prop}}\) = propagation delay
- \(d_{\text{proc}}\) = processing delay
- \(d_{\text{queue}}\) = Queuing delay

\(N\) = number of links (Number of routers + 1)

Note: we have neglected queuing delays.

Each router will have its own \(d_{\text{trans}}, d_{\text{prop}}, d_{\text{proc}}\) hence this formula gives a rough estimate.

\[
d_{\text{end-end}} = 264.451
\]

Packet Delivery Ratio:

\[
PDR = \frac{\sum \text{Number of packet receive}}{\sum \text{Number of packet send}}
\]

\[
= 99.33\% 
\]

8 Conclusion

From the criteria such as End to End delay, Throughput and ratio we analysis using AODV protocol. Based on the ACO technologies find the best path to the destination when traffic happened in road-side. In future we enhance our criterion level for comparison. We also compare some other protocols with DSR, DSDV and AODV protocols by using mobility models.

References


[8] Nadia N. Qadri et.al, “Robust P2P Multimedia Exchange within a VANET”, Published online: 23 September 2010 © Springer Science+Business Media, LLC. 2010
