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Modeling and Simulation of VANET performances using various Routing Algorithms

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Abstract

Vehicular communications have been one of the hottest research topics for the last few years. Many routing protocols have been proposed for such kind of networks. Most of them try to exploit the information which may be available at the vehicle by the time that a routing decision must be made. In addition, some solutions are designed taking into account the particular, highly partitioned, network connectivity in vehicular settings. Despite the great variety of approaches which have been proposed, we found that there is a set of issues which are common to many vehicular ad -hoc routing protocols in this paper, we perform a simulation-based analysis of VANET by describing the communication between the nodes with various routing algorithms such as LEACH and MLEACH. We have shown simulation results which support our VANET communication. Moreover, solutions to solve every presented problem are outlined. The paper is concluded with some future prospects which may motivate the person to further works for the advancement in the field of VANET using various Routing Protocols.

Keyword: - VANET (Vehicular Adhoc Networks), Routings Protocols, LEACH (Low-energy adaptive clustering hierarchy), MLEACH.

Introduction and Motivation

Recent advances in wireless communication technologies are enabling new vehicular networking scenarios. In Vehicular Ad hoc Networks (VANET), vehicles can communicate wirelessly through multihop paths. That is, vehicles use other intermediate vehicles as relays to reach the final destination of data messages [1-3]. The routing protocol has the responsibility of finding a path between the source and the destination. Thus, many research efforts have been devoted during the last years to design VANET-specific routing protocols which take advantage of additional information available to vehicles (e.g. geographic positions, digital maps or planned routes). Additionally, some protocols address the inherent dis-connectivity problem of vehicular scenarios. Since vehicles tend to travel forming groups, the VANET actually consists of disconnected clusters of vehicles. In order to route data messages between clusters, the store-carry-forward paradigm typical is adopted by some vehicular routing protocols [4-6]. In this paper, we have simulated two different routing protocols specifically designed for vehicular networks. By thorough study, we have detected several problems which are common to the protocols and which cause unnecessary message drops and temporary loops. So, we show that VANET protocols Led to the loss of the data depending upon the storage available to Each node [7].

We describe in detail every issue and support our conclusions with simulation results. Moreover, we propose solutions for each problem and draw some guidelines which should be taken into account when designing effective VANET routing protocols [8]. This article may help prospective protocol designers to avoid common past errors, in order to develop new routing protocols more effective for the vehicular environment.

This paper is divided into the following sections. Section A introduces to VANET its description and its meaning. Section B. summarizes the different routing approaches which have been proposed in VANET routing. The simulation environment employed for our project is described in Section C. The parameter specifications which affects the routing protocols has been enlisted in the Section D. Section E describes the simulation output in response to the different protocols i.e. simulator output. Finally in Section F the conclusion is represented and also some future prospects are specified. And then in Section G. the references are specified.

Routing In Vehicular Ad-Hoc Networks

Vehicular ad hoc networks exhibit different characteristics from classical ad hoc networks [10]. First, the mobility of vehicles is restricted by the road layout, other vehicles' movements and traffic rules. It is also affected by external factors like weather conditions or the timeframe under consideration [11]. In addition, different scenarios such as cities or highways lead to distinct distributions of vehicles maybe the most salient feature derived from vehicular mobility patterns, vehicles tend to move in groups forming clusters. Thus, the network becomes highly partitioned and an end-to-end path between source and destination might not exist at the time of sending a data message. All these factors make traditional ad hoc routing not to be a very appropriate solution for vehicular settings. Because of the great number of vehicles which may participate on a VANET, routing protocols need to be localized to ensure their scalability [11-12]. That is, vehicles make routing decisions solely based on information locally available in their close vicinity. Therefore, exchanging information with neighboring vehicles via beacon messages is a fundamental part of protocols [13].

Usually, vehicles can obtain position information from systems like GPS. Hence, many protocol designers have employed geographic routing as the basis for VANET-specific solutions. By using greedy heuristics, the protocols such as LEACH choose as next hop the neighbor which provides greater advance towards the destination's position (i.e., the one which is closer to the destination). However, there are known problems associated to geographic routing protocols in VANET scenarios. So, there is need for everyone to adapt traditional geographic routing to the singularities of vehicular scenarios. Other protocols try to improve the performance obtained with geographic routing by means of using digital maps.

In this way, the map provides information about topology of streets. This is employed by the source node to compute a list of junctions which the data message must traverse to get to the destination. In order to reach each junction, the protocols apply geographic routing along each street. GSR and A-STAR are examples of geographic-based VANET routing protocols that employ map information [15-16]. However, up to here we have shown the basic routing in the VANET. It consists of storing the message coming from the different nodes and forwards the packets to the final destination that require the information [16].

Simulation Setup

In order to evaluate the strengths and weaknesses of VANET routing, we have implemented The Network Simulator NS-3. These protocols such as LEACH, PEGASIS, and MLEACH etc. cover the variety of routing approaches depicted in the previous section. In order to generate the simulation scenario and the vehicular mobility patterns, the simulator has been employed. In this way, we have been able to simulate realistic vehicular movements by showing the movements of the nodes in straight line and also in an ad-hoc manner and they stop at the desired point. Here, we consider a large number of traffic of node transfer of the data is shown in the form of the packet flow. The flow of the packets from different nodes in shown in different colors depending upon whether they are using the TCP/UDP for the connection for the transfer of the data .The transfer of the data as FTP is shown.

The Parameter Specifications

The parameter specifications include the following [16-18]:

1. Time of simulation.
2. Routing protocols.
3. Number of nodes.
4. Network interface.
5. Bandwidth.
6. Traffic type.
7. Max packet in queue.
8. Area size.
9. Packet size.
10. MAC protocol type.
11. Max packet in queue.

Time of simulation	10.0
Routing protocol	MULTICASTING
Number of nodes	100
Network Interface	Phy/Wireless Phy
Bandwidth	11 Mb
Traffic Type	CBR
Max Packet in queue	50
MAC protocol type	MAC/802.11
Packet size	1500 bytes
Area size	1000*1500

TABLE 1. Values of the various Parameters

Above are specified the parameters for the communication between nodes. Since our objective is to obtain insight onto the routing protocols and their associated problems [19-20], we must carefully design the simulation scenario. Once these parameters are set the communication in the network starts and nodes starts sending the packets and receiving the packets and thus the whole scenario of the network results in state, where the simulation lasts as many time as set by the simulation.

The Simulation Output

Simulation of the routing protocols on the ideal trans- mission range is shown , in a way that two vehicles *u, v* can directly communicate with each other if *distance*(*u, v*) $\leq$ *r*. However, in real scenarios, even static networks do not reveal such notion of transmission range because of different factors which affect the propagation and decoding of wireless signals (fading, interference, collisions, etc.). In fact, the probability of reception decreases as the distance from the transmitter to the receiver increases. In this section, we analyze the implications of the ideal transmission range assumption.

The routing protocols under consideration use greedy heuristics to select the next hop for a given message. Below figure showing the data transfer.

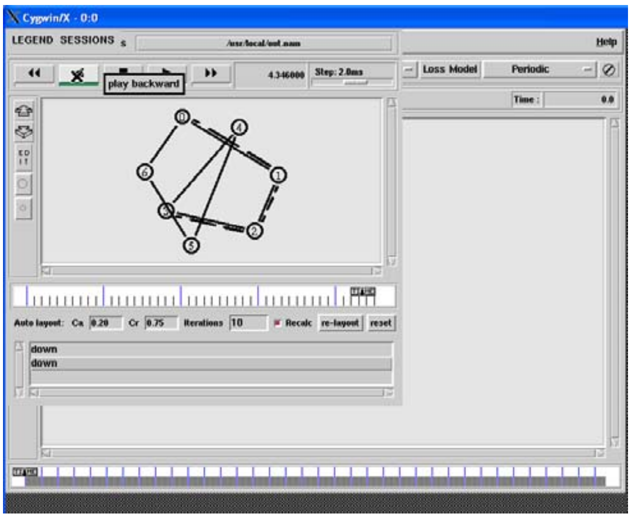

FIGURE 1- Topology of various nodes

The data transfer between the nodes results in the overflow of the packets when it overcomes the size of the queue size. The movements of the nodes in a straight path as well as in random.

Here the nodes are shown as sink and source i.e. which transmit the data is called as source and which receives the data is called as sink. The transfer of packets is shown in colors.

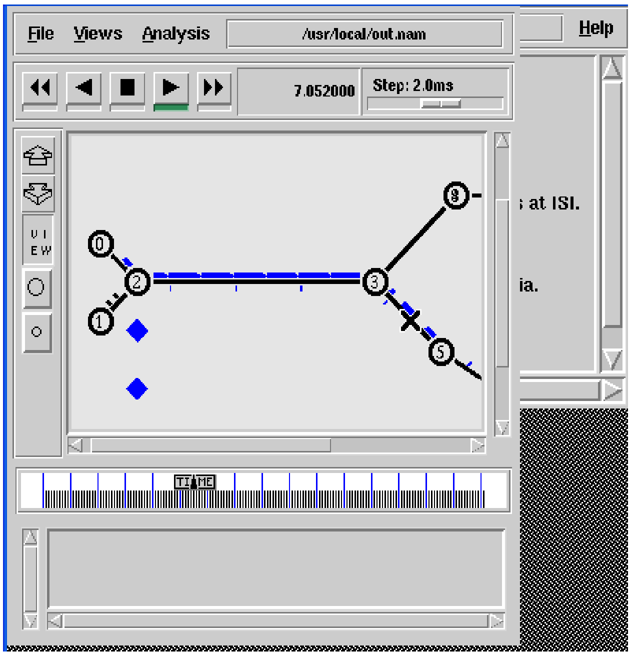

FIGURE 2. Transferring of the data among nodes

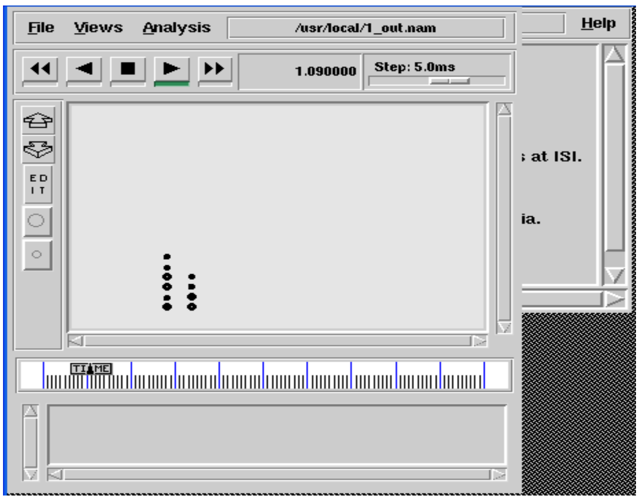

FIGURE 3. Packets Receive and drops

The movement of the nodes shown in the above figure illustrates the movement along a straight path however we have also implemented the movement in random path. Here the data transfer between the nodes takes place in a more random manner as compared to the previous links. In the figure above shown we have also control the data rate to prevent the overflow of the data from the queue of the nodes and also have established the link in such a way that there is minimal congestion in network depending on the parameters listed in table shown above. We have specified each and every parameter individually to have a better control over the flow of traffic in the network .So by defining the parameters in an efficient way we can have a better control over the traffic in the network and hence it is good to have an analysis of these parameters before using them in the implementation. In the above table mentioned we have specified the parameters carefully.

TABLE-2 Performance of LEACH Protocol on Various Numbers of Nodes in the VANET

No of Nodes	PDF	E2Edelay	Throughput	Normalize routing role
50	1.062	6.4502	46756.05	0.92
100	2.133	5.5757	98428.40	0.495
150	3.1967	5.5724	149133.68	0.500
200	4.0802	5.5708	196798.24	0.497
250	4.7314	5.5523	248336.90	0.500

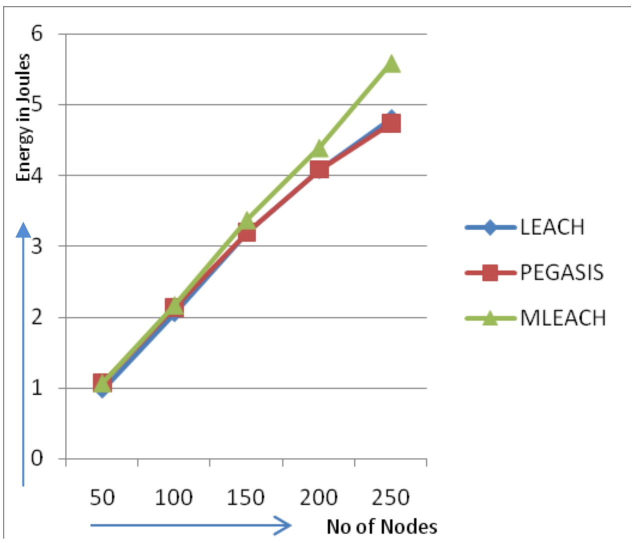

Figure 3: Comparison of Total Energy Left in Various Protocols

In the above graph, the comparison between the LEACH, PEGASIS and MLEACH is made. The Energy consumption by PEGASIS is more as compared to LEACH and MLEACH. Using the proposed algorithm much more energy id consumed as compared to LEACH and PEGASIS, which gives the better results.

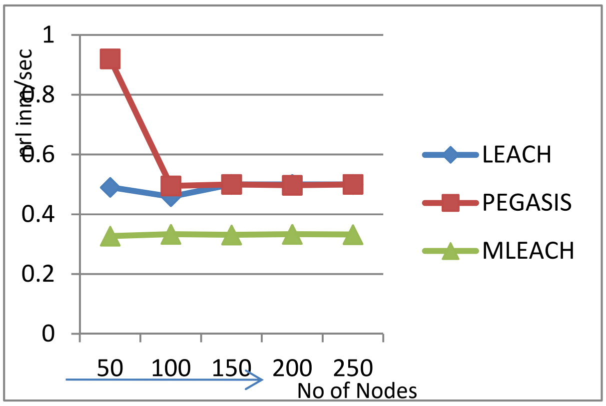

Figure 5: Comparison of Normalized Routing Load in various protocols

The above graph shows the comparison of NRL in various protocols which shows that MLEACH sends the data packet in a linear manner while other protocols sends the data having discrepancies i.e. PEGASIS sends data packet in large number then suddenly fall in data packets, similar happens with LEACH also.

The graphical and the tabular comparison between various protocols show that MLEACH performs better as compared to the LEACH and the PEGASIS protocol. The total amount of energy left after transferring the data to the base station is greater in MLEACH as compared to LEACH and PEGASIS. It means MLEACH consumes less amount of energy as compared to the LEACH and PEGASIS. The energy saving get increased with the increase in number of nodes as number of clusters increases and energy gets saved. The E2Edelay is also reduced in the MLEACH protocol as direct communication consumes greater energy and sometimes packet may not deliver to destination results in increase in the E2Edelay. The Throughput of MLEACH is not approximately equal to the LEACH or somewhat less. The normalized routing load of MLEACH is less as compared to other routing protocol due proper routing data packet.

Conclusion

Low-Energy Adaptive Clustering Hierarchy (LEACH) is one of the most popular cluster-based routing protocols for VANETs. The LEACH minimizes energy dissipation by dividing VANETs into clusters to reduce the number of message and restrict direct communications between micro-sensor nodes and BS. The main drawback of LEACH is that cluster head transmit direct to the base station. But the cluster head may be at large distance from the base station. It consumes a lot of energy due to large distance covered by the data packet. The proposed system reduces the energy consumption by introducing a chain system between the VANETs cluster heads. In the proposed system, the cluster head closest to base station is known as chain leader. The cluster head farthest from the base station will transmit its data to its closest neighbor cluster head. The process goes on until data is reached to the chain leader. The chain leader transmits the data to the base station. The existing LEACH as well as the modified LEACH implemented using the NS3; and their performance is compared. The modified LEACH shows better performance as compared to the existing LEACH in terms of energy consumption as well as the routing load.is definitely something to lookout for in the future. A lot of theoretical work has been put into realizing these networks and few experiments has been performed to validate this theory as cost of setting up this architecture is high, but more such efforts can be expected in near future. A successful vehicular network will open up a plethora of services to a huge number of audiences which will turn out to be life saving as well as fun. The goal of this work was to present and discuss recent advances in the development of vehicular inter-networking (VANET) technologies.

Here we have implemented the nodes ad-hoc network up to a certain extent between the nodes over i.e. data transfer between the nodes over, movement of the nodes in a directed as well as in random path using Routing Protocol "Leach".

Three major classes of applications possible in VANET are safety oriented, convenience oriented and commercial oriented. Safety applications will monitor the surrounding road, approaching vehicles, surface of the road, road curves etc. They will exchange messages and co-operate to help other vehicles out under such scenario. Though reliability and latency would be of major concern, it may automate things like emergency braking to avoid potential accidents.

Convenience application will be mainly of traffic management type. Their goal would be to enhance traffic efficiency by boosting the degree of convenience for drivers. Commercial applications will provide the driver with the entertainment and services as web access, streaming audio and video.

In the extreme cases of very light or very heavy traffic, the adaptive broadcast protocol has a limited impact on the reception rate.

While communication between vehicles is frequently mentioned as a target for ad hoc routing protocols, there have previously been not many studies on how the specific movement patterns of vehicles may influence the protocol performance and applicability. Typically the behavior of routing protocols for mobile ad hoc networks is analyzed based on the assumption that the nodes in the network follow the random waypoint mobility model. In this model each node randomly selects a waypoint in the simulation and moves from its current location to the waypoint with a random but constant speed. Once a node has arrived at the waypoint it pauses for a random amount of time before selecting a new waypoint.

Since this movement pattern of nodes has no similarity to the behavior of vehicles, the random waypoint model seems to be inappropriate to investigate the characteristics of Vehicular Ad hoc Networks (VANET) or to determine which routing protocols are suitable for VANET.

So, we had to look for a car traffic flow simulator with a very good model. It should include elements such as vehicle characteristics (e.g. a car has a different movement pattern than a truck) and driver behavior (e.g. when a driver decides to change lanes). The traffic simulator should be able to produce a movement scenario with many different situations with a large number of cars in different areas, with various car densities on different road types. Based on these movement patterns, profound analyses of the characteristics of the dynamic topology, formed by the mobile nodes, should be possible.

Vehicular traffic simulations can coarsely be classified into microscopic and macroscopic approaches. When following a macroscopic approach, one focuses on system parameters like traffic density (number of vehicles per kilometer per lane) or traffic flow (number of vehicles per hour crossing an intersection) in order to compute a road's capacity or the distribution of traffic in a road net. In general, vehicular traffic is viewed from a macroscopic perspective as a fluid compressible medium and, therefore, is modeled as a special derivation of the Navier-Stokes equations. In contrast, with a microscopic approach the movement of each individual vehicle is determined. In order to generate vehicle movement patterns for ad hoc routing experiments one clearly has to follow a microscopic approach, because the position of each individual vehicle is needed. Nevertheless, one also has to take care that a microscopic simulation does not result in unrealistic macroscopic effects. As a 'pre-process' generates the vehicle movements and complexity is therefore a minor concern, a driver behavior model for the microscopic traffic simulation would be preferable.

Such models not only takes the characteristics of the cars into account but it also includes a model of the driver's behavior, like lane changing and passing decisions, traffic regulation and traffic sign considerations, or decreasing speed in curves, to name only a few. Driver Behavior Models are known to be highly accurate and are therefore used by vehicle manufacturers, e.g. to determine the lifetime of certain parts of the car.

The goal is to provide a powerful simulator that is capable to simulate all public and private traffic in a larger area of 10 million people over 24 hours. For this purpose they developed a multi-agent traffic simulator. This simulator surprisingly enfolds many things.

The people act as linked individuals. For example, assume a classical family with a husband going to work by car early in the morning, two children walking to school and a wife going shopping for their family. The individuals in the simulation choose time of travel and means of transportation by their needs and environment. For example the husband, mentioned above, would take a tramway instead of a car if he lives in the city and if it is much faster. With this simulator one could simulate the consequences of building sites, road modifications up to price changes for public and private transport.

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VANET present a very active field of research, development, standardization, and field trials. Throughout the world, there are many national and international projects in government, industry, and academia devoted to VANET. The creation of high-performance, highly reliable, highly scalable, secure, and privacy-preserving VANET technologies presents an extraordinary challenge for the wireless research community. A high degree of communication reliability is needed under unfavorable conditions. Clearly, the specificity of vehicular inter-networking in terms of mobility behavior, applications scenarios, and application requirements makes VANET research an exciting and demanding application- and purpose-driven sub-discipline of wireless networking.

Future Scope

In the extreme cases of very light or very heavy traffic, the adaptive broadcast protocol has a limited impact on the reception rate. On the other hand, the adaptive protocol shows promising results such as MLEACH etc. when the network traffic is moderate. The proposed additions to the broadcast protocol are not resource intensive or difficult to implement, as a result, implementing the suggested changes provides of increasing the performance of the 802.11 broadcast protocols for a VANET.

In addition, The modified LEACH(Modified-Low-energy adaptive clustering hierarchy) was showing better performance as compared to the existing LEACH in terms of energy consumption as well as the routing load. A lot of theoretical work has been put into realizing these networks and few experiments has been performed to validate this theory as cost of setting up this architecture is high, but more such efforts can be expected in near future. A successful vehicular network(VANET) will open up a plethora of services to a huge number of audiences which will turn out to be life saving as well as fun. The goal of this work was to present and discuss recent advances in the development of vehicular inter-networking (VANET) technologies.

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