Analytical Simulations for Proactive, Reactive and Position based Routing Protocols using OMNeT++ via INet Framework

Mohamed M. A. Elgazzar, Ahmad Alshareef

Abstract: Vehicular ad-hoc networks VANETs has become one of the great research topics related to automotive industry, as they are the suitable way to describe the real scenarios of the car movement through our daily life. Routing protocols used in the network description of a vehicular ad-hoc network are to balance between the responsiveness of the network to the rapid change of the topology and bandwidth efficiency. Different approaches for routing protocols are introduced to address the routing strategies to be followed in the constructed vehicular ad-hoc network considering its perspective of the routing algorithm to be followed. Each approach is consists of different routing protocols that inherits the main theme of the parent approach. Evaluating the measurements for each approach is very important for the developer of the network through network simulation prior to the expensive direct implementation of the vehicular ad-hoc networks. In this paper, we will discuss three main routing approaches: reactive, proactive and position based routing protocols, discussing the main theme for each approach followed by analytical simulations for three different protocols representing the three approaches. Ad-hoc on demand vector AODV representing the reactive approach, destination-sequenced distance vector DSDV representing the proactive approach and greedy perimeter stateless routing GPSR representing the position based approach.

Keywords: VANET, MANET, Routing, Proactive, Reactive, Position based, AODV, DSDV, GPSR, Simulation, OMNeT++, INet.

I. INTRODUCTION

Choosing the best routing protocol is one of the important decision, when constructing vehicular ad-hoc network as the routing protocol is responsible for selecting the best path for the messages to be communicated between different nodes of the network. Vehicular ad-hoc networks are characterized by the dynamic nature, where there is a rapid change in the network topology. Consequently, the selection of good routing protocol is necessary in order to increase the robustness of the network. There are many constraints in designing routing protocols in VANETS, which are multi-hop paths, node mobility, huge network, device heterogeneity, congestion and bandwidth [1]. In addition, quality of service is initially dependent on the routing protocol. Maximum throughput, minimum packet loss and controlled overhead are the major objectives of constructing a routing protocol [2].

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Routing protocols in vehicular ad-hoc networks are important to have good V2V communication during runtime, hence many researches is being ongoing to reach the best routing protocol.

The early researches classified the routing protocols into two types topology based and position based and classified each type into two or three other types, where the topology based protocols are classified into proactive and reactive protocols. However, there are many other types rather than topology and position types as cluster based, geo cast and broadcast routing protocols [3].

II. ROUTING PROTOCOLS APPROACHES

1.1. Proactive Routing protocols

Proactive protocols are building up the link information in a periodic way in the background, while the system is running, this is performed in a periodic behavior whatever there is a request for communication between nodes or not. The main advantages of ready link information is the low latency [3] in the real time operation as the link information is already prepared and ready for use, also proactive protocols have no route discovery phase during operation that speedup the initiation of the communication process without any latency.

2.1.1Destination Sequenced Distance Vector protocol

Destination sequenced distance vector (DSDV) protocol is representing the proactive routing protocol that uses routing tables for packet transmission through the network. Each node of the network has its own routing table that is build up periodically by receiving the updates coming from the neighbor nodes of the network. Each node of the network maintain its sequence numberthat is updated based on any change in the network received from the neighbor nodes, this sequence number is used to get loop free network and to differentiate between new routes and old ones. Upon any change in the network, each node propagates this change to its neighbor nodes so that all node should be informed with the updates. Routing tables updates are propagated periodically between nodes upon any change in the routing tables as link breaks. The exchange of many routing tables may lead to high traffic control, to solve this problem two strategies of propagating routing tables are introduced; full dump and incremental change, where full dump involve all routing table information, while incremental change involve only the changed information from the last full dump occurred. DSDV is doing better performance in low dense networks [4] with low number of nodes, and by increasing number of nodes; the packet collision ratio is highly increased.

It has minimum end-to-end delay than the reactive protocols [5] as the routing information is kept updating in periodic way. Proactive protocols perform better in network with low to moderate mobility of nodes and with few number of nodes.

1.2. Reactive Routing protocols

Reactive routing protocols are type of topology based routing protocol that using link information in the package forward process, but it is different from the proactive type in the phase of building up the routing tables. Reactive routing protocols building up the link information only based on a valid communication request not in a periodic way, they are also called as on demand protocols [3]. The main advantage of reactive routing protocol is that no route maintenance except for the requested route, also this leads to less memory required for each participating nodes in the system. Reactive routing protocols have the advantage to be working in large-scale ad-hoc network with good response to link failure.

1.2.1. Ad-hoc On demand Distance Vector routing protocol

Ad-hoc on demand distance vector routing protocol (AODV) is representing the reactive on demand protocols that builds up its routes eventually based upon request not in a periodic strategy. This protocol use bidirectional links between source and destination through the intermediate nodes, it provides unicast communication and multicast communication. Route discovery and route maintenance are the two major functions of the protocol, where route discovery phase to start directly based on a valid communication to propagate data from a source node to a destination node by sending and receiving RREQ and RREP messages between the only interested nodes of this data exchange. Flooding of control package technique is used in the route discovery phase that introduces overhead over the transmission of packets. Route maintenance phase to start upon any failure detected in the active routes between source and destination, this failure is detected by receiving RERR message from an intermediate node to inform the source that the route is no more valid for communication. Hello messages approach between the nodes of the network is periodically sent to detect any route failure for the active routes. The network discards all unused active routes after the expiration of the life time for each active route.
AODV is doing better performance in high dense networks [6] with higher number of nodes, it has high throughput [7] due to the dynamic response of updating the routing information, however it faces high end-to-end delay [6] as it requires time to establish and find the best route. Reactive protocols perform better in network with low rate of packet transmissions as high rate of packets cause high overhead.

1.3. Position Based Routing protocols

Position based routing protocols are the protocols that don't use the link information during the package exchange and forwarding, they uses the geographic position of the nodes instead, when a node wants to communicate with another node it forward the package and exchange the data using the position of the destination node. Position based routing protocols gets the geographical destinations of all other nodes of the system using the global positioning system (GPS), which means that no need for link information between all nodes and no building routing tables.

1.3.1. Greedy Perimeter Stateless routing protocol

Greedy perimeter stateless routing (GPSR) is representing the position based routing protocols that uses the geographic position in packet forwarding, they use the vehicle-to-vehicle (V2V) concept to forward the package to the next state using the greedy concept. Position based greedy protocols are using beaconing method to find out the exact locations of the neighbors nodes in the system. GPSR uses the right hand rule perimeters [8] where the next propagation is the next counterclockwise node calculated based on the direction of the previous hop of the packet, this perimeter mode improves the reachability results of the nodes.

III. EVALUATION AND RESULTS ANALYSIS

3.1 The network

The network under test isbuilt and simulated in OMNeT++ network simulator via INet framework. It consists of a source node and a destination node who are far away from each other with no direct communication between them. Seven intermediate moving nodes are moving through the network constructing the routing paths between the source and the destination applying the fundamentals of ad-hoc on demand distance vector (AODV) routing protocol.
There are many factors affecting the behavior of the network; number of nodes, area of the network, speed of moving nodes and transmission power.

General Parameters	Value
Number of nodes	7
Speed of nodes	25 mph
Nodes movement strategy	Linear
Area of the network	1600m2
Transmission power	1mW

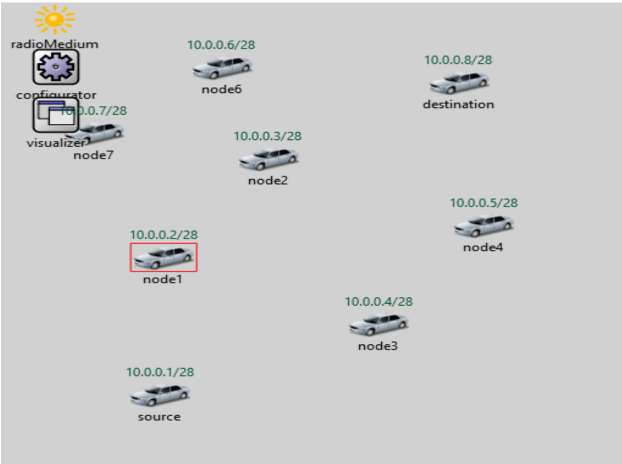

Figure 1: The network used to evaluate AODV protocol

3.2 Results analysis

3.2.1 DSDV

By fixing the general parameters and the route lifetime parameter while varying hello-message interval time, the following results are obtained by checking a specific node in all simulations.

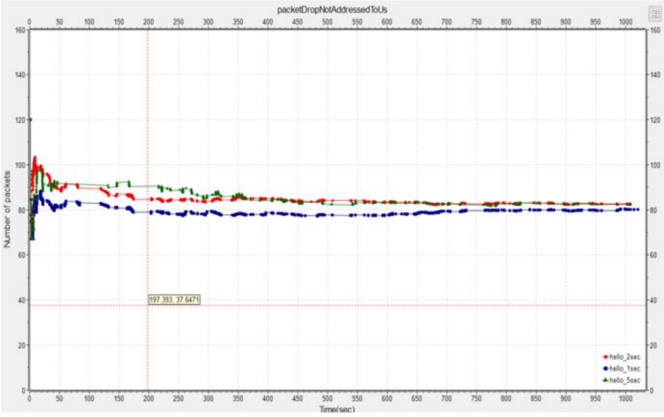

Figure 2: Mean of number of Packets drop not addressed to specific node

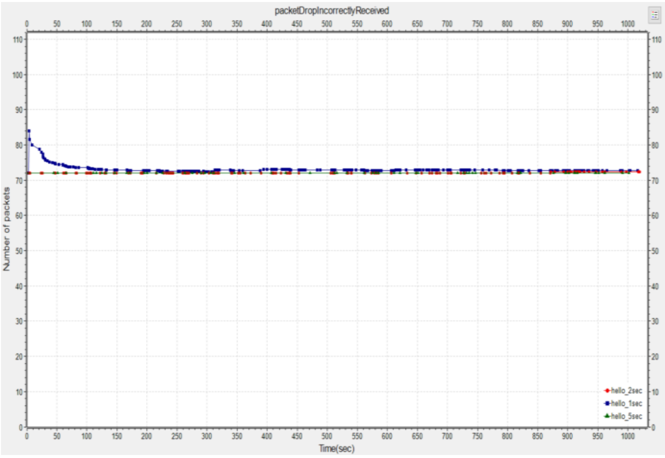

Figure3: Mean number of packets drop incorrectly received to specific node

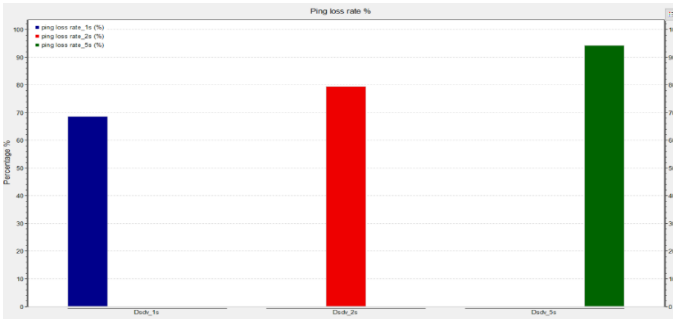

Figure4: loss rate of sent packages

For DSDV the two main parameters are hello-message interval time and the route lifetime, the results show that by increasing the hello-message interval time we got high packet loss rate and this rate is decreased by decreasing the value of this parameter. The loss rate is slightly affected by the route lifetime proportionally but the effect is not big in the percentage. By getting the hello-message interval time and the route lifetime too low, we got good results in terms of packet loss rate, but the overhead is highly impacted through the nodes as too many messages are sent periodically.

3.2.2 AODV

By fixing the general parameters and varying active route timeout and delete period of routes, the following results are obtained by checking a specific node in all simulations.

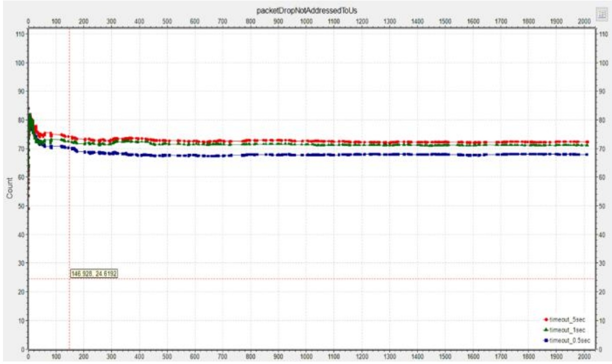

Figure 5:Mean of number of Packets drop not addressed to specific node

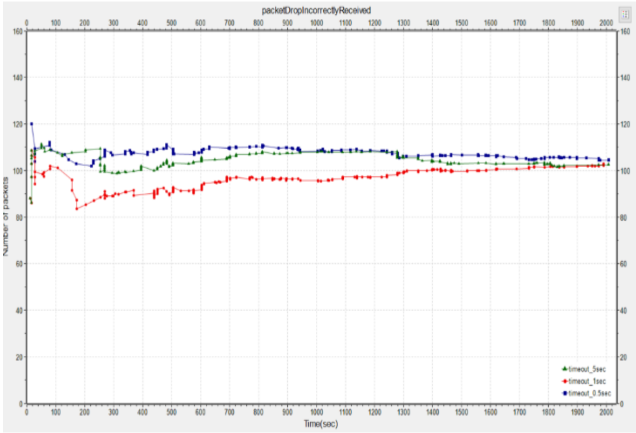

Figure6: Mean number of packets drop incorrectly received to specific node

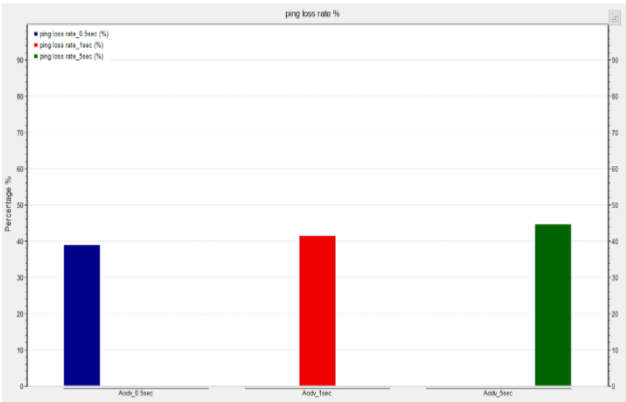

Figure7: loss rate of sent packages

For AODV the two main parameters under test are active route timeout and the period of deleting valid routes, the results show that by increasing these values we got high packet loss rate and by decreasing the values we got lower packet loss rate. However, by getting too low for parameters active route timeout and the period of deleting valid routes, the overhead is increased for each node.

3.2.3 GPSR

By fixing the general parameters and varying the transmission power value, the following results are obtained by checking a specific node in all simulations.

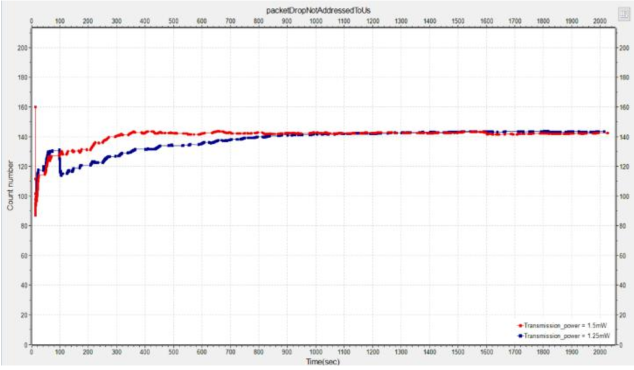

Figure8: Mean of number of Packets drop not addressed to specific node.

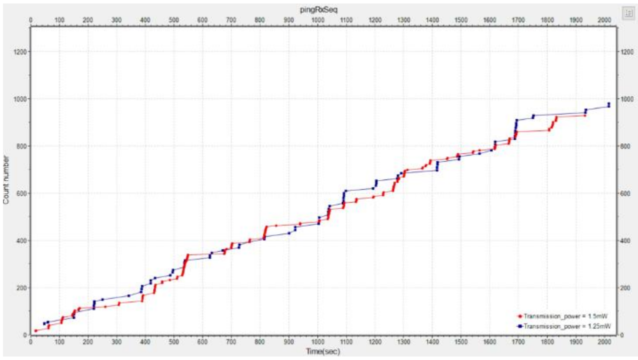

Figure9: Mean of number of packet received sequence.

By fixing the general parameters and varying the speed of the moving nodes in the network, the following results are obtained by checking a specific node in all simulations.

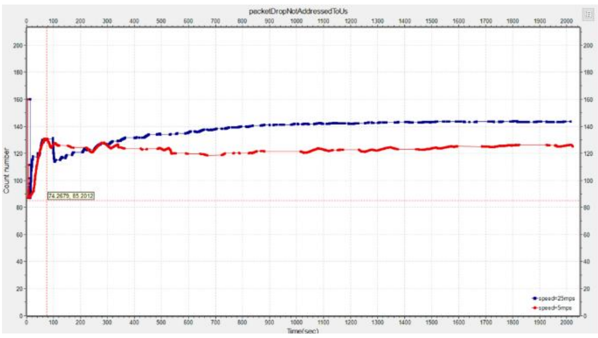

Figure10: Mean of number of Packets drop not addressed to specific node.

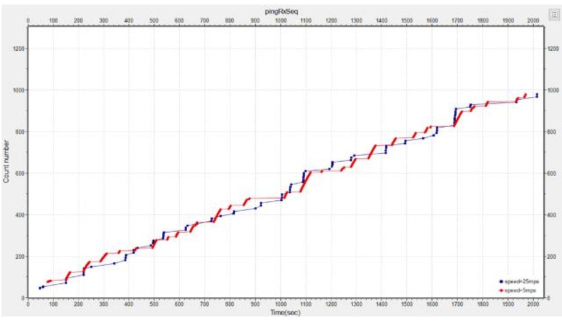

Figure11: Mean of number of packet received sequence.

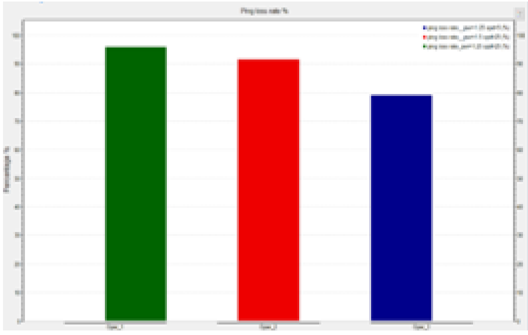

Figure12: loss rate of sent packages for three different scenarios

For GPSR the transmission power value and the speed of the moving nodes are the two main parameters to affect the performance of the protocol. The results shows that by increasing the transmission power of the nodes in the network, the packet loss rate is decreased obviously and it is decreased as well by decreasing the speed of the moving node. However, increasing the power transmission value could highly affect the cost of the network and decreasing the speed of the moving node is dependent on the nature of the network.

IV. CONCLUSION

In this paper, the behavior of three different routing protocol types is measured through fixed network by applying the three proactive, reactive and position based routing protocols on this network. Ad-hoc on demand distance vector AODV is chosen to represent the reactive routing type, destination-sequenced distance vector DSDV to represent the proactive routing type and greedy perimeter stateless routing GPSR to represent position based type.

The results shows that DSDV is do better when adjust the hello interval-time parameter and the route level with low values, however getting the values of these parameters too low may lead to high overhead that makes the network to do badly in high dense networks. AODV protocol is the most powerful protocol in high dense networks by increasing the active route timeout and the period of deleting valid routes, however increasing these parameters value may leads to some overhead in the nodes route information and many invalid routes may lead to decrease the packet delivery ratio. GPSR is the protocol with lowest performance especially in high-speed networks that leads to very high packet loss rate, however it performs very well when the area of the whole network is not very big. Each protocol can be modified by changing the effective factors of the protocol to get different results and performance for the same protocol. The most important factor to decide the parameters of each network is the nature of the network and its requirements of operation, where the designer can choose the suitable protocol algorithm and the suitable parameters of the desired protocol as well.

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