International Journal of Advanced Science and Technology
Vol. 28, No. 8, (2019), pp. 447-456

Ad hoc On- Demand Distance Vector (AODV)Routing Protocol InVehicular Ad Hoc Network (VANET): An Analysis Study

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Abstract: One ofvariation Mobile Ad-hoc Network(MANET) is a Vehicular Ad Hoc Network (VANET). Vanet also part of Intelligent Transportation Systems (ITS) that uses cars as nodes of a network of a mobile network . The communication types in VANET are categorized into three types which are vehicle-to-vehicle communication (V2V), vehicle-to-roadside communication (V2R) and vehicle-to-infrastructure communication (V2I) [2].The routing protocol investigated in this research is topology-based ad hoc routing protocol that is Ad hoc On- Demand Distance Vector (AODV). The routing analysis of this protocol is evaluated based on throughput and packet drop. This research investigates the latest trend of routing protocol used in VANET, evaluate the routing protocol in VANET using TWO (2) performance parameters and to implement the routing protocol in VANET in network simulator. This research was conducted using Network Simulator (NS-3) simulation.

Key words: VANET، ITS، AODV ، NS3، Routing protocol

1.0 Introduction

The evolution technology of vehicle, the improvement in vehicle and road safety, sensor and alert requirements, and access hasled to improvement ofintellelligent inter-vehicle communication (IVC) via internet connectivity. One of variation Mobile Ad-hoc Network (MANET) is a Vehicular Ad Hoc Network (VANET)and it is one component of Intelligent Transportation Systems (ITS)(Mohamed Doheir, Kadhim, Samah, Hussin, & Basari, 2014; Kumar & Rani, 2014).

Vehicular Ad-hoc Network is anindependent and self-managing wireless communication network. It provides wireless communication between Vehicle-to-Vehicle (V2V), Vehicle-to-Roadside (V2R) and Vehicle-to-Infrastructure (V2I)(Al-Razak Tareq Rahem, Ismail, Idris, & Dheyaa, 2014; Kumar & Rani, 2014). The term VANETis mostly synonymous with the term Inter-Vehicle Communication (IVC), although the focus remains on the aspect of spontaneous networking, and much less on the use of infrastructure like Road Side Unit (RSU) or cellular networks.

Intelligent Vehicular Ad-hoc Network (InVANET) is a kind of artificial intelligence that

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helps vehicles to behave intelligentlyin the event of vehicle-to-vehicle collisions, accidents and and many more. Vehicles are using radio waves to communicate with each other, creating communication networks instantly on-the-fly while vehicles are moving on the roads(Pandey, Raina, & Rao, 2015; Yaacob et al., 2017).

VANET can be classified into efficiency application and safety. VANET systems design and implementation subjected to fewproblems such as quality of services privacy, connectivity, routing and security(M. Doheir, Kadhim, Samah, Hussin, & Basari, 2014; Karp & Kung, 2000).

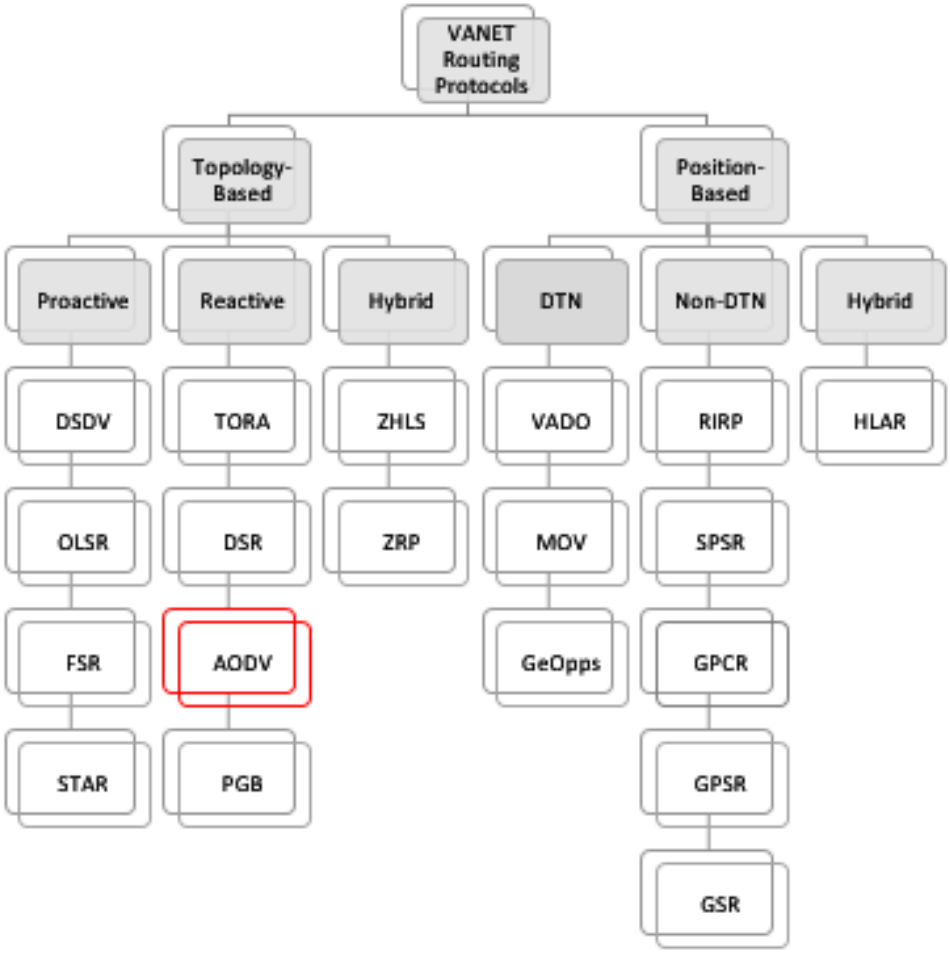

Figure1:Vanet Routing Protocols

Figure 1, shows VANET routing protocols which comprise of two sub- routing protocols namely position-based routing and topology-based routing. This research focused on Topology- Based routing protocols. It can be further sub-categorized into 3:- Proactive, Reactive and Hybrid. Finally AODV routing protocol of Reactive sub-cateqory chosen for the performance analysis of this research(S. Khan & Shah, 2003;

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Mora, Gilart-Iglesias, Pérez-Del Hoyo, & Andújar-Montoya, 2017).

2.0 Background Study

VANET - Communication Types :

The communication types in VANET are categorized into three types which are vehicle-to-vehicle communication **(V2V)**, vehicle-to-roadside communication **(V2R)** and vehicle-to-infrastructure communication **(V2I)**.

Vehicle-to-Vehicle (V2V): The vehicle-to-vehicle communication can provide data exchange platform for the drivers to share information and warning messages.
Vehicle-to-Roadside (V2R): The vehicle-to-roadside communication can communicate through enabled access point on the network.
Vehicle-to-Infrastructure (V2I): The vehicle-to-infrastructure communication can enablereal-time traffic or weather updates for drivers and provide environmental sensing and monitoring(Javed, 2003).

VANET –Characteristics(Arya & Tewari, 2013; Kumar & Rani, 2014; Pandey et al., 2015)**:**
There are differences between vehicular ad-hoc network **(VANET)** and mobile ad-hoc network **(MANET)**. Itis very tough and challenging to design routing protocols for different scenario due to single characteristic of VANET.

i. High Mobility: Vehicles have to move at different directions of Metropolitan Area Network (MAN) at high speed for communication and as a result the topology changes constantly.
ii. Frequent Disconnection: Because of changes in network as a result of fruqency disconnection and dynamic topology, the link between vehecles can easily disappear during information transmission.
iii. Mobility pattern: Depends upon various aspects such as traffic environment, structure of roads, speed, position of vehicles and driving behaviour of the driver.
iv. Too many hops: Can be wirelessly connected to each other for efficient data distribution. It is not easy for vehicles to communicate when two vehicles are requesting for the samedata packet(Mohamed Doheir, Basari, Elzamly, Yaacob, & Al-shami, 2019; R. Khan, Bilal, & Othman, 2013).
v. Inbuilt Storage: Modern vehicles equiooed with unlimited storage capacity which should have enough computing power for effective communication.
vi. Communication environment: The vehicles have to communicate among different environments such as city and highway. So the routing strategies for both cases will be different.

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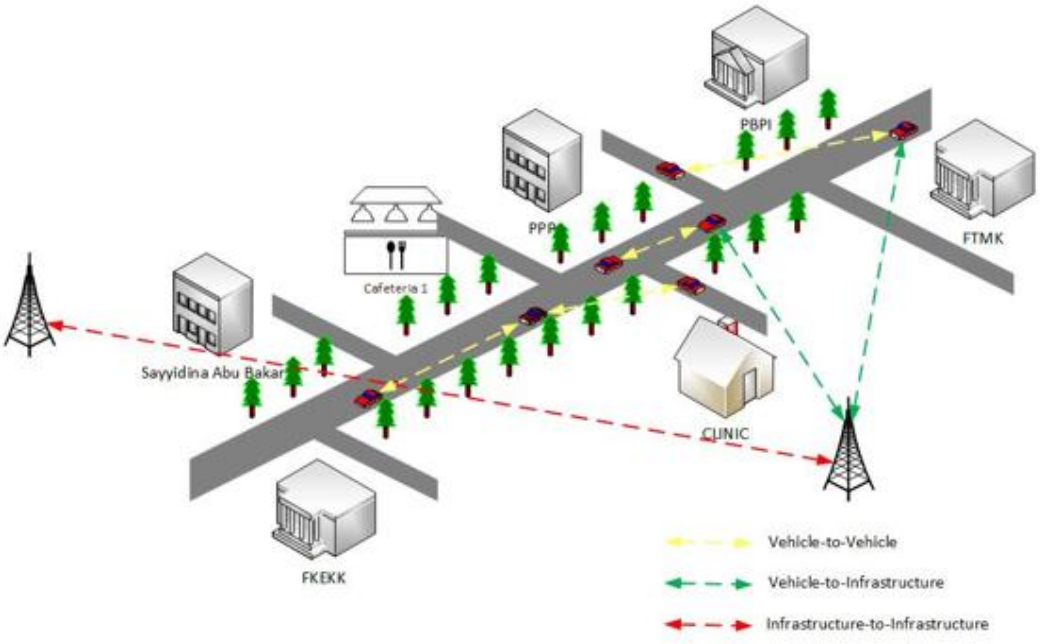

Figure2:VanetArchitechture

Figure 2, shows VANET architechture and logical design of the analysis simulation.

2.1 Routing Protocols

Routing protocol determine communication between routers, information transmitted to select specific routes available on computer network. Routing algorithms determine the specific choice of route. Each router has a priority knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, router gains knowledge of the topology of the network(Sushmitha, Reddy, & Reddy, 2015; Yaacob, Ghani, & Basari, 2013).

Ad-hoc On Demand Distance Vector Routing Protocol (AODV)

An Ad Hoc On-Demand Distance Vector (AODV) is a topology-based routing protocol designed for wireless and mobile ad hoc network (MANET). This protocol establishes routes to destinations on demand and supports both unicast and multicast routing. It also uses shared link for transferring packet from source to destination in specific manner. When the source wants to send the data to the destination through AODV it will first find the destination sequence number (DeSeqNum) from transmission. It is totally based on the shortest path. The main aim of this routing protocol is to keep the information of the neighbor nodes in form of a table. Every node has to maintain its route table for effective communication(Hassnawi, Ahmad, Yahya, Aljunid, &Elshaikh,

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2012; Kumar & Rani, 2014; Yaacob et al., 2019).

AODV Advantages (Kumar & Rani, 2014; Pandey et al., 2015; Perkins, Park, & Royer, 1999):

- Can support both of unicast and multicast packets transmission whenever nodes are in constant movement
- Can respond quickly to the topological changes that affect the actives routes because its availability to highly dynamic networks
- Has lower setup delay for connection and detection of the latest route to the destination
- Does not put any additional overhead on data packets as it does not make use of source routing
- Does not need any central administrative system to handle the routing process

AODV Disadvantages Mobile Computing Systems and Applications (WMCSA '99):

- Control packets increase the congestion in the active route
- High processing demand
- Consumes a large share of the bandwidth
- Takes long time to build the routing table

  It is possible that a valid route may have expired and the determination of a reasonable expiry time is difficult

2.2 Network Simulator 3

Network Simulator 3 (NS-3) is considered as a replacement of NS-2, not an extension. NS-3 implemented using C++.NS-3 can be developed with C++ entirely with modern hardware, capabilities times was not an issue like for NS-2. NS-3 is not a backwards-compatible extension of NS-2, it is a new simulator. The two simulators are both written in C++ but NS-3 is a new simulator that does not support the ns-2 APIs. Some models from ns-2 have already been ported from NS-2 to NS-3. The project will continue to maintain NS-2 while NS-3 is being built, and will study transition and integration mechanisms(Al-Razak Tareq Rahem et al., 2014; Yaacob et al., 2017).

3.0 Simulation And Results

Simulator and Parameters

The simulator used this project is Network Simulator 3 (NS-3) in this project.There are a few parameters used to evaluate the performance of the routing protocols. The mainly selected are throughput and packet drop performance parameter.

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Throughput

Throughput is the numbers of data packets a node can process in a given amount of time which successfully delivered on a communication network or other network node.

$$Throughput = \frac{Number\ of\ packet\ send}{Total\ time}$$

Packet Delivery Ratio

The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the sender.

$$Packet\ Delivery\ Ratio = \frac{Packet\ Delivered}{Packet\ Sent}$$

Requirement Analysis and Quality Of Data

Requirement analysis provides a better understanding of the probable behaviour of the routing protocol in VANET being investigated. The performance parameter will investigate the quality of data.There are two methods of data collection in which will determine either the objective in this project can be achieved or otherwise.

The two methodsbeing conducted are as follows:
- Measure the throughput and packet drop using NS3
- Simulate the wireless connection consistency using NetAnim

Simulation Setup and Results

The performance analysis done in scenario which is Synthetic Highway as shown in Table 1. The environment size performed in Synthetic Highway is 300 x 1500 meters and number of nodes are 40 nodes and 99 nodes. The total simulation time of nodes is 10 seconds

Table 1:Simulation Scenario

Parameter	Setting
Protocol	AODV
Network area	Synthetic Highway
Environment size	300 x 1500 meters
Number of nodes	40
Simulation time	10 seconds

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Table 2:Throughput and Packet Delivery Ratio vs Time (s) for 40 nodes

Time (s)	Throughput	Packet Delivery Ratio
1	0	0
2	6.5	12.32
3	9	12.0275
4	7	12.84
5	7.4	12.605
6	5.33	13.7175
7	6	12.69
8	5	13.0875
9	4.22	13.2375

Table 2, shows the result of the throughput and packet delivery ratio of AODV routingprotocol with respect to time.

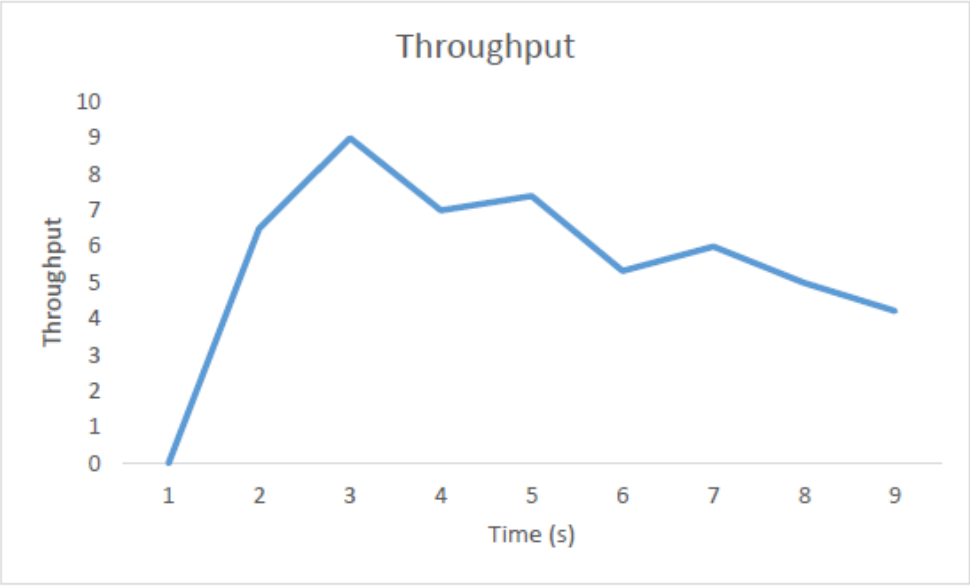

Figure3:Throughput vs Time(s) for 40 nodes

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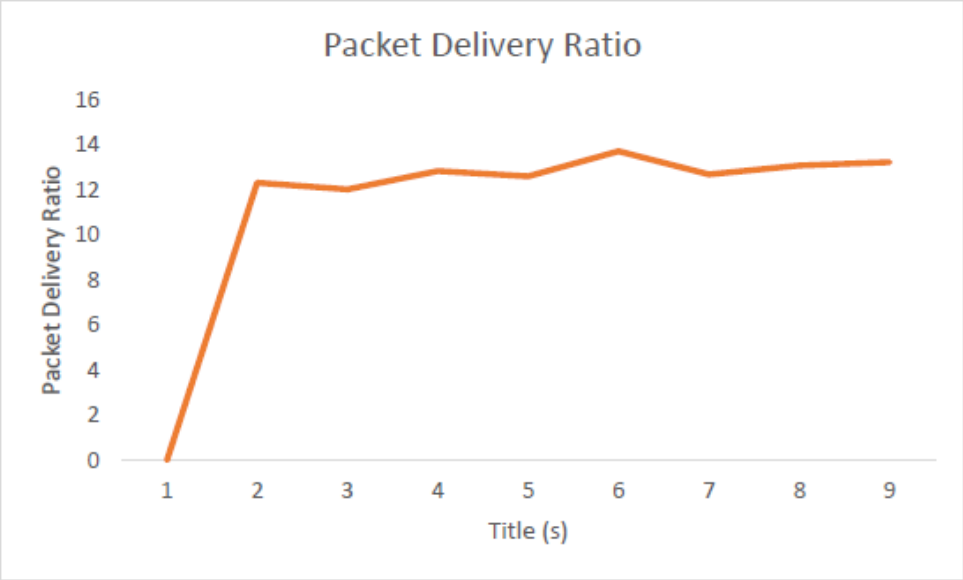

Figure4:Packet Delivery Ratio vs Time(s) for 40 nodes

Figure 3 and Figure 4illlustrates the result of the experiment extracted from table 2.

4.0 Conclusion And Future Works

The primeobjective of this research is to study variousvanet routing methods. It decribes about performance analysis of VANET routing protocol that related to certainparameterssuch as packet delivery ratio and throughput.

The result of the performance from past research could be further improved for future research as there are many types of application and software rapidly growing with the advancement of technologies such as Network Simulator (NS). The NS-3 is a discrete-event network simulator for Internet systems, targeted primarily for research and educational use for today development. The latest version of Network Simulator is Network Simulator-3 (NS-3)(Mohamed Doheir, Hussin, & Basari, 2014; Paul, 2012).

Acknowledgments

The authors would like to thank Center Of Excellence UTeM specifically Center for Advanced Computing Technology (BIOCORE) and Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka for providing facilities and financial support. Not forgotten thanks to Faculty of Engineering and Built Environment,Universiti Kebangsaan Malaysia for research opportunity given.

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