Dynamic and Optimized Routing Approach (DORA) in Vehicular Ad hoc Networks (VANETs)

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***Abstract*—Vehicular Ad hoc Networks (VANETs) are one of the significant areas of research and this is also a subfield in Ad Hoc Networks. This is mainly focused on improving the safety of roads and reducing the total number of accidents. There is no central coordination to this network, nodes are mobile, dynamic topology, the routing process is a big challenge, and this is most responsible for the delivery message to the small overhead and delay. Routing is a tedious task that occurs huge changes in network topology and delivers the data packets in a limited period. In VANETs many existing routing protocols are introduced to overcome various issues but these are not efficient to overcome all the issues in routing. Routing shows a huge impact on other parameters such as data transmission rate (DTR), packet delivery ratio (PDR), Packet Drop Ratio (PDRatio), Average Propagation Delay (APD) and throughput. In this paper, the dynamic and optimized routing approach (DORA) is introduced in VANETs to overcome the various issues and improve the performance of IP by measuring the DTR, PDR and PDRatio. Comparisons among the Ant Colony Optimization (ACO), improved distance-based ant colony optimization routing (IDBACOR), and DORA is shown.**

Keywords—Data transmission rate (DTR); packet delivery ratio (PDR); packet drop ratio (PDRatio); throughput

I. Introduction

A vehicular ad hoc network (VANET) plays a major role in communication between the vehicles become smarter [1]. This network consists of two architectures as Vehicle-to-vehicle communication (V2V) ensures the communication between vehicles and Vehicle-to-infrastructure (V2I) which swaps the data between vehicles. VANET is one of the dynamic topologies that give the regular disconnected network. This contains limitless storage of battery, and the nodes in this network have the limitation of power. The transportation region should be improved with safety, this network ensures the development of many safety applications to prevent accidents, to improve the road capacity the applications are maximized and avoid traffic congestion, and real-time applications are used to access the internet.

From the past many years, huge data is created and transmitted through the network every time, which is called the explosion of data. Several approaches are developed and designed to fulfill the requirements of the users from all over the world. Due to the heavy traffic in the network and its high usage in wireless networks, all systems are facing technical issues such as delay in the messages, huge packet drop ratio, throughput is very low, and communication cost is very high, and effect of these huge issues gives the overhead in the network.

VANETs are specifically the branch of MANETs. Compared with MANET, VANETS present with fast motion in vehicles which is fastly and dynamically changing the topology is extra advantage to the VANETS.

All these nodes are managed by the default roads layout. In VANETs, several levels control the node velocities such as limited speed, level of congestion, and traffic management systems such as traffic lights and top symbols, etc. In future, these nodes are used for high transmission ranges, storage of data, and all the energy sources are restored. These networks are more powerful to store and process the energy capacities that make workable and more reconcilable by measuring huge tasks [2, 3, 4, 5, 6].

Routing plays a significant role in this network based on the available properties of vehicles. Many existing approaches are incapable of deciding the optimal routes based on the inefficient communications among the VANETs. This will show an impact on packet delivery among the vehicular nodes. At this time, the local optimum situation may occur. The mobility nodes are facing traffic density on the streets and they are unable to find the nearest nodes. In this situation, the packets are kept in buffer by the nodes for long time.

If the data packets are in buffer for more time then the live path is terminated. This may show impact on network and leads to the end-to-end delay and packet delivery ratio (PDR). If the data packets are in buffer for more time then the live path is terminated. This may show impact on network and leads to the end-to-end delay and packet delivery ratio (PDR). Thus the proposed approach dynamic and optimized routing approach (DORA) in this paper is focused on solving these issues more effectively. DORA provides the optimal routing path based on multiple streets, and also proposed the intelligent packet delivery system based on other parameters such as data transmission rate (DTR), packet delivery ratio (PDR), Packet Drop Ratio (PDRatio), Throughput.

Fig. 1 shows the VANET network based on the vehicles movements at the junctions.

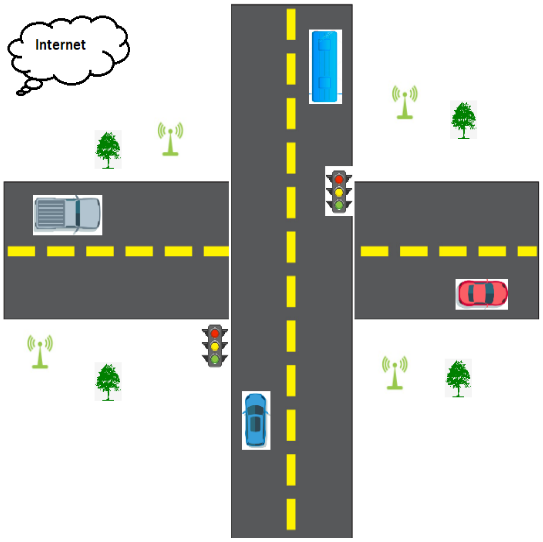

Fig. 1. VANET Networks.

II. Literature Survey

Lo et al., [7] introduced a routing protocol called Enhanced Hybrid Traffic-Aware Routing (EHTAR) which is integrated with VANET in the urban platform. In this network, the functional nodes are placed at every junction which is used to observe the real-time vehicular and collect the traffic information for every road segment. This is called a Junction-Tracker. This is used to improve the communication and transmission among the nodes. Gazori et al., [8] proposed a unique model which utilizes the traffic lights as bridges for the help of routing in place of utilizing the mobile vehicles. In the route selection process this will prevent network failures. This protocol is mainly focused on swapping the data packets between bridge nodes. Among these, the path with the smallest hop count and the huge connection is selected. Wang et al., [9] introduced the Named Data Network (NDN) which is a new routing protocol. This is an improved routing protocol which is adopted the distance parameter to prevent defects in hop-count.

Nahar et al., [10] proposed the protocol integrated with cosine similarity-based selective broadcast routing protocol (CSBR). In this protocol, clustering plays a significant role in finding the suitable path to transfer the data to a destination. The proposed approach increases the packet delivery fraction (PDF) 5-10% and minimizes the average delay by 25%.

Brendha et al., [11] proposed the advanced VANET to improve road safety and minimize overall accidents. Because of the high mobility nodes, the routing is a difficult task, which causes a high impact on the topology to transfer the packets in very little time. Several existing approaches are discussed in this paper which is not reliable to solve the issues in routing.

Nazib et al., [12] study about various routing protocols in VANETs. These are divided into seven groups based on the implementation and developed concepts. Several advantages and disadvantages are also discussed by the author.

Qin et al., [13] study several VANETs routing protocols and introduced the new routing protocol is introduced to influence both densities of the vehicles and traffic lights based on network connectivity. The proposed approach follows the unicast packets to improve the traffic flow. Cardenas et al., [14] introduced the new protocol called probabilistic multimetric routing protocol (ProMRP) which is more suitable in VANETs. ProMRP is mainly focused on estimating the probability of every neighbor carrying the packet and successfully sending the packets to the destination. This is mainly calculating the four metrics such as distance to destination, the position of the nodes, node bandwidth and density, etc. Thus the author proposed the improved system called EProMRP. This shows the improved results based on the packet delivery.

Nazib et al., [15] introduced the reinforcement learning (RL)-based routing approaches that improve the quality-of-service (QoS) parameters in the VANETs routing. QoS parameters such as bandwidth, end-to-end delay, throughput, control overhead, and PDR. The proposed approach performed better compared with the existing approaches. Khan [16] proposed the new WSN which integrates the MANETS, VANETS, and other wireless networks that develop the intelligent transportation system which is focused on road safety and accurate vehicle movements according to the route change. Thus the performance improved. Zhenchang Xia et al., [17] discussed about various VANET approaches that are performed better. Several challenges such as low security, less reliability are to be overcome. R. Hussain et al., [18] discussed about the trust implementation in the VANET platform. The author mainly focused on providing the privacy and security for the data that is transmitted among the source and destination. H. Fatemidokht et al., [19] discussed about issues and overcome the issues by using Unmanned Aerial Vehicles (UAVs). This approach mainly worked on multiple tasks to increase the performance of proposed approach. N. B. Gayathri et al., [20] introduced the efficient scheme in the VANETS. This scheme mainly focused on implementing the pair-free platform that improves the transmission and computational efficiency. This approach also supports the batch checking that reduces the calculation overhead in VANETs.

III. Dynamic and Optimized Routing Approach (DORA)

DORA is the dynamic and geographic routing approach that selects the nodes dynamically. The selection of paths can be done by analyzing the traffic and density of the vehicles in the junctions to select reliable routes in the network. The maps are used to find the actual positions of the nearest junctions. Based on the score given by the density of vehicles in traffic and distance among the metric curves are used to selects the next destination, then the junction is selected. This works better on dense traffic platforms. The efficient selection of path is selected based on the packet travels. Every node in the network gives the information to the server (gateway) if it goes to its communication range. The gateway develops a various set of paths among itself and each node.

The algorithm is focused on various factors such as route discovery, route recovery, dynamic routing and maintaining the constant power at all the vehicles. The DORA develops the route by using the request of the route from the base stations (BS). The BS gives the route reply by using the messages. To find the efficient route, the distances between two vehicles are to be calculated. Distance factor plays the main role to measure the distance among the nearest vehicles are measure by using Euclidean distance is represented in (1).

$$\mathrm{Dist} = \sqrt{(\mathrm{a1} - \mathrm{a2}) + (\mathrm{b1} - \mathrm{b2})} \quad (1)$$

Equation-1 (a1, b1) represents the neighbor nodes, and (a2, b2) represents the spatial region of the destination node. The data is sent to the destination node from source to find the accurate route. Various factors shows the huge impact on finding the route such as constant, lifespan and availability of buffer are measured. These factors are merged with reply packets to other general information. DORA is adopted with fitness function improves the more constant route, this results in increasing data PDR. This will also reduce the packet loss and more routes are added.

$$\mathrm{route(l)} = \mathrm{packets(transfer\ until\ the\ availability\ t} + \mathrm{Predict\ (P)_t|available\ t)} \quad (2)$$

$\mathrm{Predict\ (P)_t}$ predicted time for the

link availability among two vehicles Va, Vb.

The reliability (R) is expressed as:

The link is available at the time. Hence $\mathrm{L_{ab}}$ the distance between two vehicles are represented in

$$\mathrm{L_{ab}} = \sqrt{(\mathrm{a_1} - \mathrm{a_2})^2 + (\mathrm{b_1} - \mathrm{b_2})^2} \quad (3)$$

Hence, this will maintain the constant link among the vehicles and discover the accurate route and improves the performance of communication.

Algorithm Steps:

 # Input: Nodes (Vehicles) 95 with the initialize values at Nodes (N): 5 Joules

Functions (Route_Creation R_c, Route_Recovery $R_{recovery}$, Route_Diversion $R_{diversion}$, Mobility, Speed of Vehicles, vehicles position change)

$\mathrm{N} = \{\mathrm{N_1}, \mathrm{N_2}, \mathrm{N_3} \dots\dots\dots \mathrm{N_n}\}$

Step 1: Select Source Node N_s and Destination Node N_d.

Step 2: Calculate the distance between two nodes using equation-1.

Step 3: If the N>1 //total nodes
Message ("Node Mobility and Communication started")
Else
Message ("Node Mobility and Communication not started")

Step 4: If N_s >1
Message ("Source Node transmits the data to destination node N_d)
Else
Message ("No transmission from source to destination node N_d and data loss occur)

Step 5: Now calculate the routing path duration from N_s to N_d

- Path duration is based on probability density function (pdf)

Step 6:

$\mathrm{L_1, L_2, L_3, \dots . L_{E_H}}$ defines the duration of links of $1,2,3, \dots\dots \mathrm{E_H}$ nodes

$\mathrm{E_H}$ − Represents the average number of nodes required to reach the $\mathrm{N_d}$.

Step 7: Path is expressed as: $T_{path} = Min(\mathrm{L_1, L_2, L_3, \dots . L_{E_H}})$

Step 8: Apply Bayes' theorem for *pdf* of T_{path} is $f(T_{path}) = \mathrm{E_H} * \mathrm{E_Z} * \mathrm{C_T^{E_H-1}}$

Step 9: Based on the average duration the path is changed.

Step 10: Now data reached.

IV. Simulation

The following simulation parameters (Table I) are given below:

TABLE I. SIMULATION PARAMETERS

Simulation/Scenario	
Simulation Time (Sec)	120-140
MAC protocol	IEEE 802.11p
Range of Transmission	260 m
Total vehicles	95
Date packet sending rate PDR	4.5-14.5 packets/s
Data packet size	512 Bytes

V. Evaluation Results

To implement this protocol, the NS3 simulator is used to show better simulation and comparative results are shown by using ACO and IDBACOR routing protocol. The proposed approach DORA shows the high performance than other VANET protocols. This simulation consists of 95 vehicles. In general, the VANETS have a dynamic nature, with several fluctuations obtain in terms of data rates, speed of vehicles, etc. The initial value of each vehicle is 'Zero' and the mobility of the network is 120 km/h. Due to the boundless size of the network, huge mobility, and active topology. The proposed approach is more flexible to accept the variations in the vehicles. The experiments are conducted by using 95 vehicles and algorithms such as ACO, IDBACOR, and DORA. The simulation NS3 proves that the proposed model improves the performance in terms of DTR, PDR, PDRatio, APD, and throughput. Fig. 2 shows the vehicular network created by the NS3 simulator. Fig. 3 shows the communication among the nodes by sending request messages.

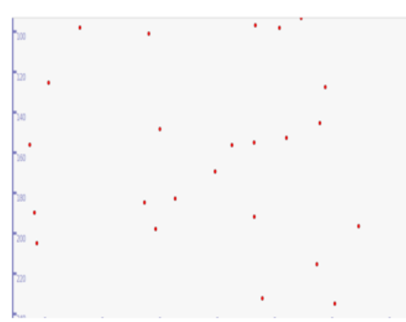

Fig. 2. Network with 95 Nodes. The Red Color nodes are considered as Vehicles.

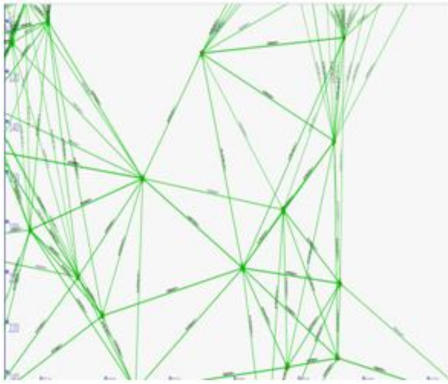

Fig. 3. Communication between 95 Nodes (Vehicles).

VI. Performance Metrics

The efficiency and performance of DORA is shown with the comparison among the ACO and IDBACOR. The evaluation is calculated by using data transmission rate (DTR), packet delivery ratio (PDR), Packet Drop Ratio (PDRatio). Table II shows the performance of proposed approaches and existing approaches by showing the parameters:

A. Data Transmission Rate (DTR)

This parameter plays the major role in routing in VANETs. This defines the transmission time of the message to forward the vehicle to destination. This parameter shows the impact on various metrics such as traffic, collisions and mobility.

B. Packet Delivery Ratio (PDR)

PDR mainly focused on delivering the packets successfully to the destination. The PDR is calculated by using Eq. (4).

$$PDR = \frac{\sum_{a=1}^{k} \text{Packets Received}}{\sum_{a=1}^{k} \text{Packets originated}} \quad (4)$$

C. Packet Drop Ratio (PDRatio)

Packet Drop Ratio (PDRatio) is the fraction of the total transmitted packets that were not received at the destination. The PDRatio is calculated in Eq. (5) as follows:

$$PDRatio = \left(\sum_{a=1}^{k} \text{No of packets Sent} - \sum_{a=1}^{k} \text{No of packets received}\right) * 100 \quad (5)$$

TABLE II. Performance of Algorithms based on Parameters

Algorithm	PDR (Bytes)	DTR (Bytes)	Packet Drop Ratio (Bytes)	Average Propagation Delay (APD) (Sec)	Throughput (Packet/Sec)
ACO	87.59	425.79	12.41	5.92	83.08
IDBACOR	90.25	455.25	9.75	5.43	87.14
DORA	91.96	493.19	8.04	5.02	88.47

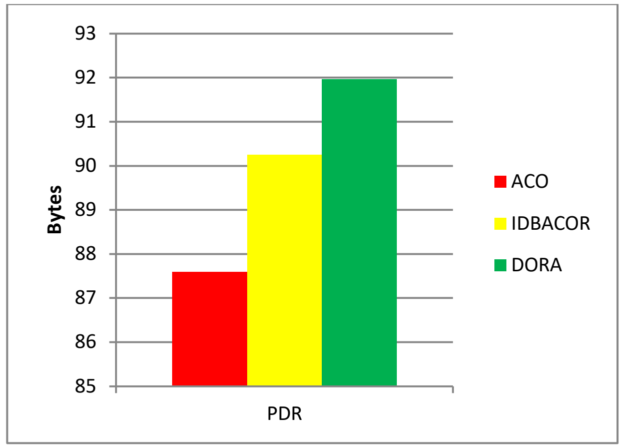

Fig. 4. Performance of Algorithms ACO, IDBACOR and DORA by showing PDR.

In Fig. 4 and Fig. 5 shows the performance of PDR by showing bar and line graphs. Compare with the existing approaches DORA performed better by transmitting data between nodes. DORA improves the CTP also for maintain the cumulative power according to the requirement at the nodes.

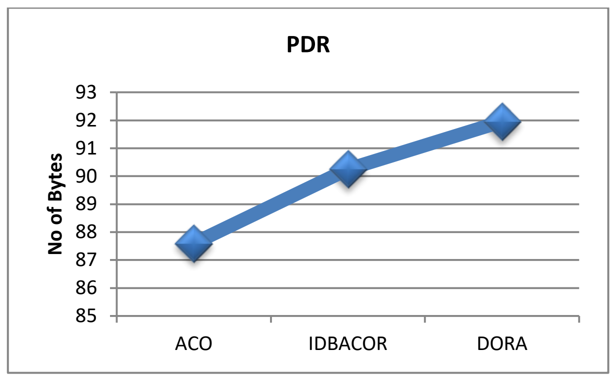

Fig. 5. Performance of Algorithms based on ACO, IDBACOR, and DORA by showing PDR.

In Fig. 6 and Fig. 7 shows DTR performance by calculating the transmission time for every message. This measures the transmitting time from source to destination.

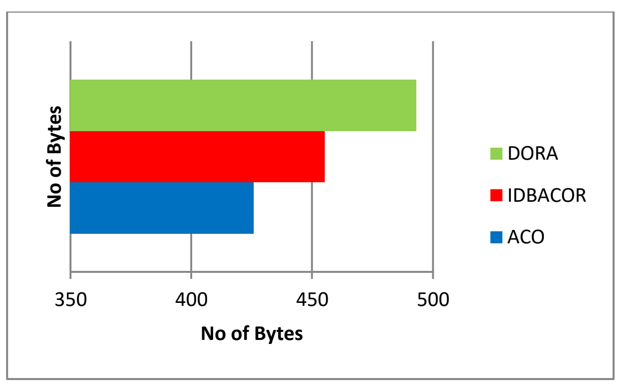

Fig. 6. Performance of Algorithms ACO, IDBACOR and DORA by showing DTR (Bytes).

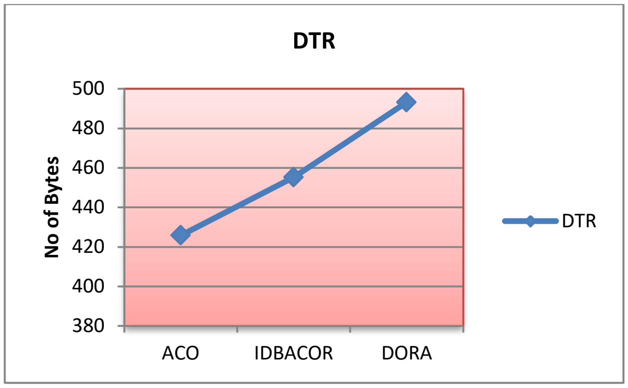

Fig. 7. Performance of Algorithms ACO, IDBACOR and DORA by showing DTR.

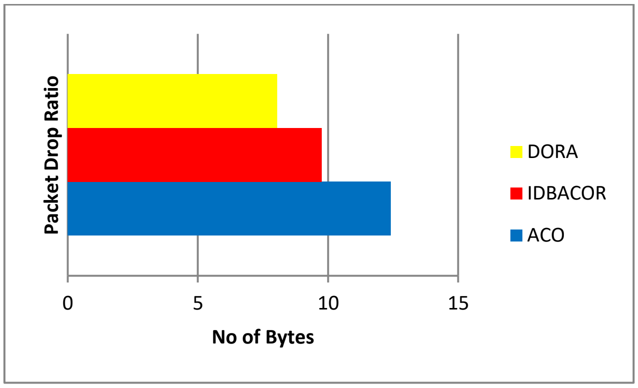

Fig. 8. Performance of Algorithms ACO, IDBACOR and DORA by showing Packet Drop Ratio represented by Line Graphs.

In Fig. 8, 9 show the packet drop ratio is measured. Compare with existing approaches DORA shows the very less drop rate. This is also based on the PDR.

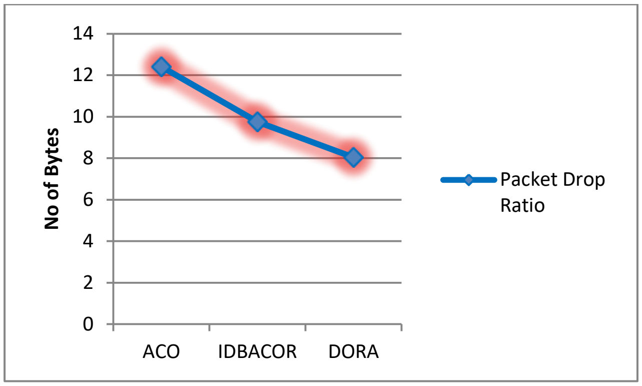

Fig. 9. Performance of Algorithms ACO, IDBACOR and DORA by showing Packet Drop Ratio.

In Fig. 10, Fig. 11, Fig. 12 and Fig. 13 shows the performance of APD and throughput represented in the form of bar graphs and line graphs. The APD is reduced in DORA compare with existing approaches. The throughput is increased compare with ACO and IDBACOR.

The APD is used to measure the delay for the data transmission from source to destination. Compare with other approaches DORA shows the low APD.

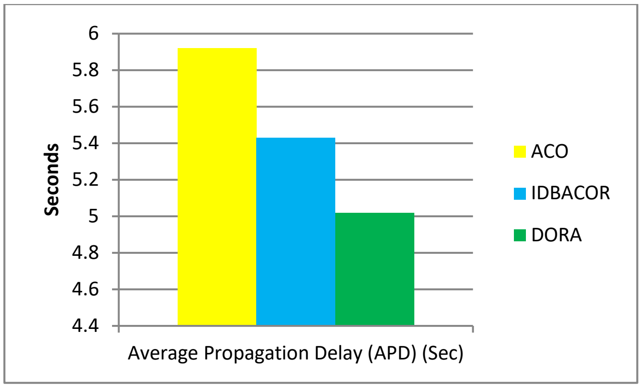

Fig. 10. Performance Representation of APD by using Bar Graphs.

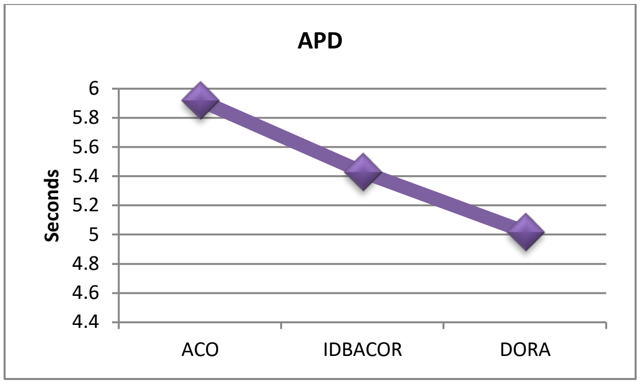

Fig. 11. Performance Representation of APD by using Line Graphs.

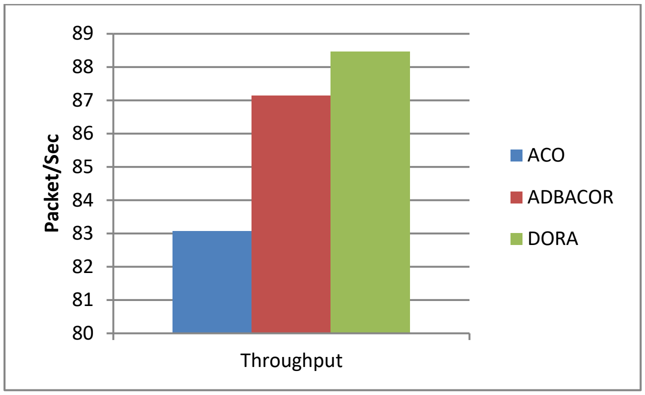

Fig. 12. Performance Representation of throughput by using Bar Graphs.

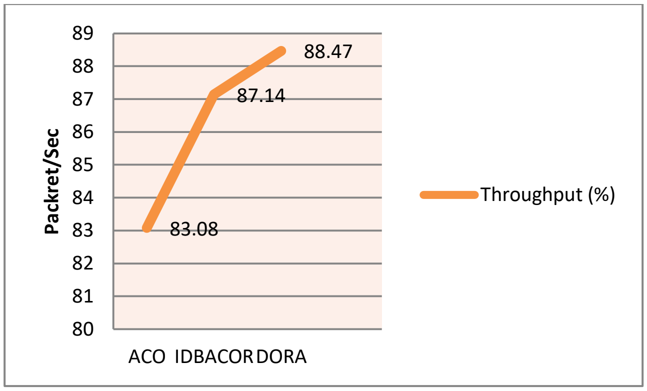

Fig. 13. Performance of Throughput.

VII. Conclusion

In this paper, dynamic and optimized routing approach (DORA) is developed to overcome the several issues such as dynamic routing in VANET's network. The proposed approach shows the optimal path from source to destination. This approach also overcomes very less packet loss which didn't show any impact on output. The DORA focused on data transmission and communication between the nodes (vehicles) in VANETs. DORA improves the performance by measuring the parameters such as DTR, PDR, PDRatio, APD and throughput. The experiments are conducted on 95 nodes (vehicles). The performance of the proposed approach achieved the better results compare with existing approaches such as ACO, IDBACOR. The performance of DORA is achieved the results such as PDR-91.96, DTR-493.19, PDRation-8.04, APD-5.02, throughput-88.47. In future, an improved simulation approach is to be developed to overcome the several obstacles present in dynamic routing.

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