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Multipath Routing for Internet of Vehicles using Master of Controller in Road Awareness (MRMOC-IOV)

Piyush Chouhan

Department of Electronics Engineering, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, India.
pchouhan06@yahoo.com

Swapnil Jain

Department of Electronics Engineering, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, India.
swapniljain76@gmail.com

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Abstract – Internet of Vehicles (IOV) is the recent advancement in the field of transportation which contains smart devices to make transportation easy and reliable. Road awareness also makes use of the internet of vehicles with the help of a master of control, so it needs a secure routing approach to provide the scalability to the architecture and to increase the flexibility of the system as well. This work proposed a multipath routing with extension (MDR-Ext) approach for road awareness by making use of the master of control (MOC) for establishing the network of vehicles. The system works by getting the frequent information of the vehicle details in the network by the brink controller (BC). The BC receives this data from vehicles that proceed to the MOC controller to calculate the shortest path for communication between vehicles with data packets. The path is interpreted by the MOC controller and path updating is done by the values receiving from BC at a regular interval. The proposed approach works well and the shattering of the network due to mobility is overcome through the BC. In this proposed approach packet delivery ratio could be achieved up to 95.7% better throughput up to 4244.456 kbps, low normalized routing overhead up to 8.88 bytes with less energy consumption up to 31.38 joules for multipath routing with extension approach. It is clear that MDR-EXT for MOC with the brink controller gives better performance as compared to TDR-Ext and DODR-Ext.

Index Terms – Internet of Vehicles (IOV), Road Awareness, Master of Control (MOC), Brink Controller (BC), Extension and Regional Controller.

1. INTRODUCTION

Nowadays every aspect of the human life of the whole world revolves around the internet, the same is the case with transportation. WHO has stated the bad traffic conditions and less service for connectivity causes over 3400 deaths per year and it is noted that millions are injured or disabled [1], Transport has been included in the network for the better communication and service providence, The growth in the technologies in the transport system has put the researchers on

a stage to create novel approach with the combination of various technologies [2]. The Internet of Vehicles (IOV) is the category of such network which contains vehicles which can communicate with each other because of interconnection through vehicular ad hoc network [3]. IOV provides the facility to interact with the drivers, other vehicles, or pedestrians in the real-time system [4]. IOV has been seen in working with different ways that are Vehicle to vehicle, vehicle to infrastructure, vehicle to cloud, and vehicle to personal device [5, 6]. These ways deal in a different format to provide the services. IOV system provides the facility to communicate and exchange information in between these four ways of connections which are shown in Figure 1. The previously applied algorithms like PSO, ABC, ACO was somewhere unable to provide proper services in the IOV network [7]. Currently, the companies working with government organizations on IoT development are Apple, Google, IBM, Intel, Microsoft, etc. [8].

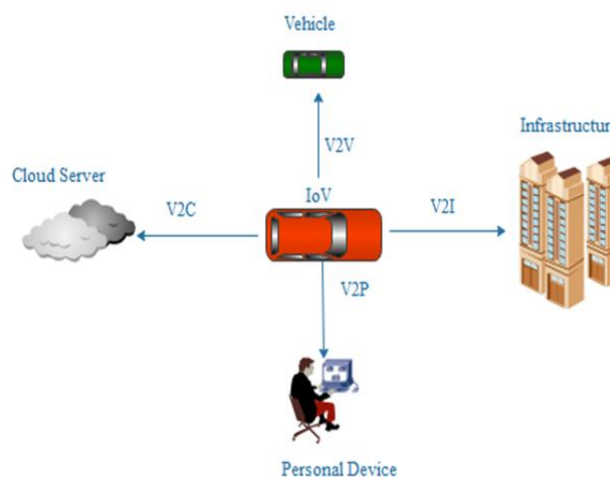


Figure 1 IOV in Different Services

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In this paper, while working for the IOV Master of Control is used, which is one of the approaches which provides the flexibility and services to design and implement any network for making the experiment of anything over it. In MOC, we have a central controller over the network and the programming can be explored to an extent. The MOC works in a manner that, helps us with the central view of the distributed network by the separation of the data plane from the control plane of the network [9, 10].

In this proposed approach the MDR-Ext with the combination of MOC and IOV is used to build a network for communication between vehicles. The proposed approach designs a routing protocol for working in the IOV. The proposed MOC with the internet of vehicles is shown in Figure 2.

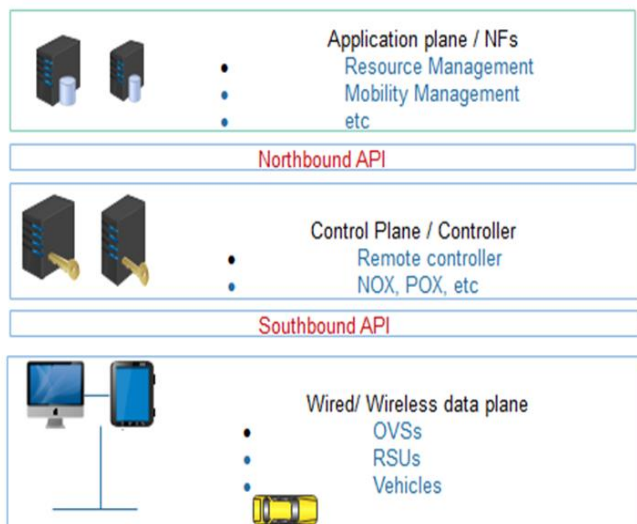


Figure 2 MOC along with Internet of Vehicles

The system comprises a proposed routing protocol that works in the IOV environment with flexibility and scalability and to implement this approach MOC is used. The proposed protocol works with the cellular network where the control messages which are having lower latency can be relayed whether they are coming or going to the controller. The brink controller here is applied to define the topology of the system in real-time. The failure of the created path in the given network can also be reduced [11] with the help of the brink controller.

The entire proposition is sorted out as pursues, section 2 contains a writing study. Countless papers are investigated in this area. Based on that examination the issue is characterized. It additionally contains foundation and related work. Depicts why successive thing set mining is required. A prologue to various wordings is likewise given. 3 contains the proposed arrangement. Improved proficient continuous thing set mining method is depicted. The last 2 sections contain outcome

examination with the commitment of the proposed work in information mining.

2. BACKGROUND DETAILS

Here authors have worked on a routing mechanism for the multi drone system which works for the delivery of the parcel to the homes. Authors have worked on the increment of the service’s accuracy in the unmanned aerial vehicle, for this, they have proposed a hybrid algorithm for routing which works on the genetic theorem. The hybrid genetic algorithm cooperates with the ground vehicle for the accurate delivery of the parcel. They have achieved higher efficiency than the existing algorithms [12].

The intelligent transportation system has gained a lot of attention from researchers and to work with the infotainment services. Here the author has worked on the routing protocols for this ITS infotainment services, they have used the QoS based routing for this system. The survey on the QoS based routing protocols have done in this paper, and they have suggested the use of a proper QoS based protocol routing system [13].

The authors have worked on the improvement in the vehicle routing mechanism in the soft time window scenario. They have worked based on the improved brain storm optimization algorithm along with the ant colony optimization algorithm. Problems like local optimum can be resolved by using this algorithm also the functionalities of the ant colony optimization algorithm can be improved by the addition of the IBSO algorithm. They have obtained a decrement in the cost of the algorithm [14].

The social aware network has been helping in the data forwarding for the social IOV. Here the authors have worked on a privacy-preserving authentication protocol for the checking of the mobile nodes. The community of the mobile node is created and the neighbor nodes’ interest can only be defined when there is a similarity in the community belongings. They have analyzed the interest of the nodes and the protection of these nodes’ interest information [15].

For the social IOV, route selection has been always an important task and for this, the authors have presented a mechanism of route discovery in this paper. An algorithm named social vehicle route selection is proposed by them which works based on the past and current driving information of the vehicle. The game evolution has been used for the route calculation. They have obtained a high clustering accuracy for vehicles and there is a high reduction in the congestion of traffic in the network [16].

Another work studied, in which questions like currently available routing protocols are adequate or not for IOV is answered [17]. Here the authors have stated that the creation of protocols till now is for the 2D MANET but the future may

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work on the 3D scenario so the designing mechanism of protocols should be enhanced. So, the existing protocols which work on 2D MANET have testes in the 3D topologies for their evaluation and the challenges that are to be faced [18].

Furthermore, we have stated the existing methods that are applied to the IOV routing mechanism and the advantages and disadvantages are studied. The Table 1 gives the study of the various methods applied early for the routing in IOV.

REF. NO.	AUTHOR AND YEAR of PUBLICATION	METHOD NAME	ADVANTAGES	DISADVANTAGES
19	Chung-Ming Huang, Tzu-Hua Lin, Kuan-Cheng Tseng, 2019	On Demand Member Centric Routing and Reactive Member Centric Routing	In platoon scenario, the PDR and throughput are high	Merged nodes in RMCM has high cost
20	Ahmed Nazar Hassan, Omprakash Kaiwartya, Abdul Hanan Abdullah, Dalya Khalid Sheet, Ram Shringar Raw, 2017	IVD based protocol for routing connectivity aware routing (IVD-CAR)	This method is better than CSR and A-CAR	Impact of higher traffic parameters are not studied
21	Denghui Wang, Qingmiao Zhabg, Jian Liu, Dezhong Yao, 2019	Grid routing Protocol in wireless multimedia sensor network	QOS is higher compared to traditional techniques	QOS of TGR protocol at start is lower
22	Na Lin, Yanjun Shi, Tongliang Zhang, Xuping Wang, 2019	Order aware hybrid genetic algorithm	Average gap is .42% and time is 580.72 seconds	It is not the best algorithm for CVRP
23	Iaonan Wang, Hongbin Cheng, Deguang Le, 2018	Intra VD and Inter VD routing algorithm for IPv4 based internet	Delay is reduced by 60% and packet loss is reduced of 53%	With the evolution in technology it needs changes
24	Daxin Tian, K. Zheng, J. Zhou, X. DUan, Y. Wang, Z. Sheng, Q. Ni, 2017	Unicast routing based on attractor selecting in VANET	Self-evolution to till finding the best solution	High computing time to find path
25	Menglan Hu, W. Liu, Kai Peng, X. Ma, W. Cheng, J. Liu, Bo Li, 2018	Vehicle assisted multi UAV routing and scheduling algorithm	Have less time consumption and less distance cost	Need more accuracy

Table 1 The methods applied for the IOV Routing Protocols

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3. PROPOSED APPROACH

MOC-IOV approach is incorporated with a road aware mechanism. In this mechanism, a controller is used to get the topology of the network and the setting of rules is done. Here the vehicles that are connected are just a device that forwards the coming data. Here both the control and data traffic are sent separately to the control traffic on cellular and data on the RSU. Figure 3 shows the proposed mechanism which takes every vehicle as OVS and the table contains the rules for the flow of the data. Here in this method, the roads are split into

segments and a unique ID is provided for the data forwarding from the source to the destination. Firstly, the vehicles provide their details to the BC then the path from the source to the destination is found by the MOC and maintain it. The protocol also keeps track that the data traffic is sent via RSU for ex. V2V or V2RSU. We have worked on the basis that vehicles have WIFI for the RSU and cellular for the connection with the base station to deal with the control messages.

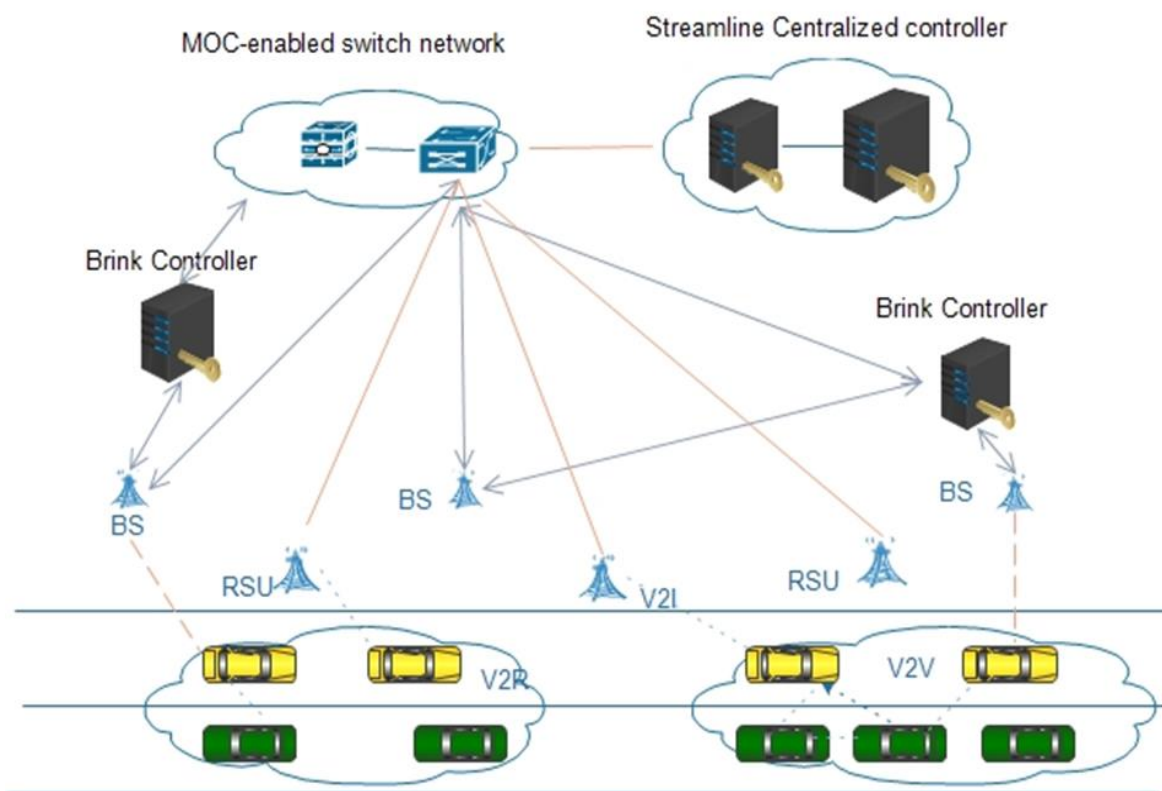


Figure 3 Proposed Architecture

3.1. Working of MOC-IOV

Working with the MOC-IOV for the routing of the data packet and finding a path of the MOC controller up to the destination is stated. Working is of two levels, which shows in Figure 3 i.e. the first one the BC takes all the details such as vehicle-ID, road-ID, position, direction, and speed of the vehicles. The connectivity of the roads is maintained by RSU and the nodes residing at the gateway. The gateway nodes are stated as those vehicles which are seen at the intersection sides of the roads. Whereas another level is having a MOC controller and it contains the MDR path. As the BC receives any information then the updating is done on the path maintained by the MOC controller. The MDR topology gives the full detail of topology to the MOC controller. The

algorithm 2 calculates the path for every segment of the road by the MOC controller. Also, the rules to be followed in maintaining the flow are in every respective segment for providing e2e connection. Now the MOC gets the shortest path by looking at the min hop count, relative velocity, and the direction of vehicles. The table stores this path with the shortest path on the top of the list. When the value of the density of vehicles is seen about 25 to 80%, then the shortest path is getting selected.

Notations:

MOC	Master of Control
Ipc	IP address of current vehicle

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Ips	IP address of source vehicle
GWV	Gateway
Pkt	Packet
RSU	Road Side Unit
Pkt_in	Input packet
Pkt_out	Output packet
CR	Current road segment
DR	Destination road segment
Nvehicle	Vehicle in neighbor
Cvehicle	Current vehicle
Svehicle	Source vehicle

1. **If**(ipc==ips) then
2. cvehicle=svehicle
3. pkt_r_queue (pkt_input)
4. **else if** (ipc!=ips) & (ipd exists_in_any_Rs) then
5. **if** (CRs == DRs) then
6. find nvehicle()
7. send pkt_to_nvehicle (pkt_out)
8. **else**
 - a. **if** (path selected has GWV) then
 - b. find nvehicle_toGWV()
 - c. send pkt_to_nGWV (pkt_out)
 - d. **else**
 - i. find nvehicle_to_RSU()
 - ii. send pkt_to_RSU (pkt_out)
 - e. **end if**
9. **end if**
10. **else**
11. find enodeb_to_MOC_controller()
12. send pkt_to_MOC_controller(pkt_out)
13. **end if**

Algorithm1 This algorithm gives the mechanism for the forwarding of packets and the rules for forwarding by the MOC controller.

The functions stated in the Algorithm1 works for the specific tasks to be carried out in the whole process for forwarding the

packets by the MOC controller. The working of functions can be understood by the definition stated below:

pkt_r_queue() : this function puts the packet in the queue for sending it to the destination

find nvehicle() : It is the function for finding the next vehicle in route

find nvehicle_toGWV() : This function finds the next vehicle that is present on gateway

send pkt_to_nGWV () : This function sends the packet to the next gateway

find nvehicle_to_RSU() : this function finds next vehicle to the road side unit

send pkt_to_RSU (pkt_out) : here the packet is sent to the road side unit

enodeb_to_MOC_controller() : this function finds enodeb for the MOC controller

send pkt_to_MOC_controller() and the packet is sent to MOC controller by this function.

i/p = in_packet_for_openflow

o/p = installation_of_rule_in_openflow

1. From database find the distance : RAR_topology_table
2. Find the paths available : RAR_topology_table
3. Calculate_the_density_in_traffic()
4. Select the paths having 30%-80% density
5. For(i=0 length(available_path)) do
6. For(i=0 to length(another_list_of_hop)) do
7. Select the vehicles that are at the edge of the range()
8. **Func** calc_lifetime_link()
9. Hop_count()
10. Relative_speed()
11. Sorting_minspeeddiffvehicles()
12. Selecting_minspeeddiffvehicle()
13. Connecting_link()
14. Duration_of_path()
15. End func
16. End For
17. End For

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18. Selecting long duration path()

19. Return writeflowOF(ing_port, eg_port)

Algorithm 2 Path Calculation by MOC Controller, Which is used for Forwarding Process of Packets. Path Calculation by MOC Controller, Which is the Supported Part of Algorithm 1 is the Second Stage Usable Algorithm after the Packet Sending Algorithm Implementation This Algorithm for the Calculation the Path is Applied.

The function used in the algorithm 2 is described here: all the functions perform a particular task.

calc_lifetime_link() : this is the function which calculates link for the lifetime and include various function inside.

Hop_count() : the function counts the number of hops present

Relative_speed() : The relative speed of the vehicles is calculated by this function

Sorting_minspeeddiffvehicles() :the min speed sorting is done by this function

Selecting_minspeeddiffvehicle() : the selection of minimum speed is done in this function

Connecting_link() : link connection is done by this function

Duration_of_path() : this function tracks the duration of path

Selecting_long_duration_path() : the function selects the path with longest duration

writeflowOF() : this is the final flow that is returned from the algorithm

3.2. Notification of Failure of Path in Network

The proposed MOC-IOV mechanism gets a notification about the failure of the path only when a path is expired or a change is seen in topology or if the path is removed. As it is seen that the MOC controller has a number of paths for every segment of the road due to MDR-Ext. On receiving the notification by BC it checks the failure type and then the table is analyzed for the new shortest path available in case if the road segment failed is below its list. In the case of the outside road segment, the request is made to the MOC controller, which is stated in Algorithm 3. When BC receives the notification of failure, then it removes all the paths with the same path ID.

Input: notification_for_failure_of_path, request_for_route

Output: installation_of_rule_in_openflow

1. If(type_of_notification == Failure_of_path)
2. Func notification_for_failed_path()
3. Road_segment_packet()
4. If(notify_fail != inner_road_segment)

5. Search new path in EC(Segment table for road)
6. Choose long lifetime path()
7. Create rule for flow()
8. Delete old entry of flow()
9. Enter new entry for flow()
10. Delete same request and ID()
11. Else if (notify_fail != outer_road_segment)
12. Request path from MOC()
13. Search new path inn MOC(RAR-topology_table)
14. Calc lifetime link()
15. Choose path with long lifetime()
16. Create rule for flow()
17. Delete old entry of flow()
18. Enter new entry for flow()
19. End if
20. End Func
21. End If
22. Return writeflowOF(ing_port, eg_port)

Algorithm 3: At the Time of Communication with Algorithm 1 and Algorithm 2, If Path Failure Occurs, then the Handling of the Failure Path by the EC and MOC Controller will Follow the Algorithm 3.

Here a function is created for the notification of the path failure i.e.

notification_for_failed_path() : this is the function we have created for getting notification of path failure.

Choose long lifetime path() : function for choosing the path with longest lifetime.

Create rule for flow() : the rules for flow are created in this function.

Delete old entry of flow() : old entry deletion is done here

Enter new entry for flow() : addition of new entry is done in this function.

Delete same request and ID() : same request id is deleted

Request path from MOC() : path is requested from the MOC controller.

Search new path in MOC() : Searching of new path in MOC controller is done in this function.

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Calc lifetime link() : This function calculated the link for lifetime.

Choose path with long lifetime() : The function chooses the path with the longest lifetime.

Create rule for flow() : The rule creation for flow is done here.

Delete old entry of flow() : deletion of old entries is done through this function.

Enter new entry for flow() : new entry is entered in this function.

writeflowOF() : this is the final flow that is returned from the algorithm.

3.3. Role of Brink Controller

The role of BC is stated with the aspect of the problem of mobility. As the VANET frequently changes its topology so the breakage of the route is seen constantly which results in the poor performance of the system. So, the mobility providence always has an issue, and here the BC is proposed to overcome this problem. The BC gets the topology information from every vehicle in real-time. BC receives information like direction, speed, position, road-ID, etc. from every vehicle in the network. When this data is received at the BC and if the change in position or topology is noted then the MOC is informed about it otherwise the BC updates the data in itself only. In this way, the routing overhead is managed easily by the MOC controller. The time interval in which the BC gets information about vehicles is 1 second, which is not fixed and can be changed. The speed of the vehicle defines the time interval of receiving the information here, we have given the mathematical expression for calculating the packet interval.

$$\text{Interval}(t) = D/S \quad \dots\dots(1)$$

$$\text{Interval}(t) = \text{MIN}(i, D/S) \quad \dots\dots(2)$$

Here S is the speed of the vehicle and D is the distance covered, i is the fixed interval. Here are two scenarios of packet receiving at BC the first in the packets are sent by vehicles at regular intervals and the other one depends on the distance covered for example 10 m, etc. Here we have calculated both the intervals eq1 gives just the interval depending on the distance covered and the eq2 gives the interval depending on the specific time of interval decided which is represented by i. In this way, the MOC controller will be able to handle the problem of mobility in the VANET.

4. RESULT AND DISCUSSION

Work has been done by the proposed approach with the simulation parameters stated in Table 2. The proposed Multipath Routing is evaluated with the extension (MDR-Ext) and with the other routing mechanism like Table Driven

Routing with the extension (TDR-Ext) and Dynamic on Demand Routing with the extension (DODR-Ext). The simulation setup is stated in Table 2.

Parameters	Value
Number of Vehicles	45
MAC Type	802.11 Ext
Simulation Area	1500*2700 m
Time for Simulation	1000s
Vehicle Speed	Random
Propagation Model	Two-ray Ground
Traffic Type	Transmission Control Protocol
Data Packet Size	Random

Table 2 Simulation Parameters

4.1. Packet Delivery Ratio

The proposed MDR-Ext has achieved higher PDR as compared to other methods. In this proposed approach 96% of PDR for a regular interval of simulation time is achieved, below Table 3 states the PDR obtained for various intervals.

Simulation Time (Sec)	MDR-Ext	TDR-Ext	DODR-Ext
200s	95.75	94.34	93.38
400s	95.63	94.51	93.98
600s	95.58	94.49	94.33
800s	95.56	94.41	94.51
1000s	95.55	94.91	94.62

Table 3 Packet Delivery Ratio

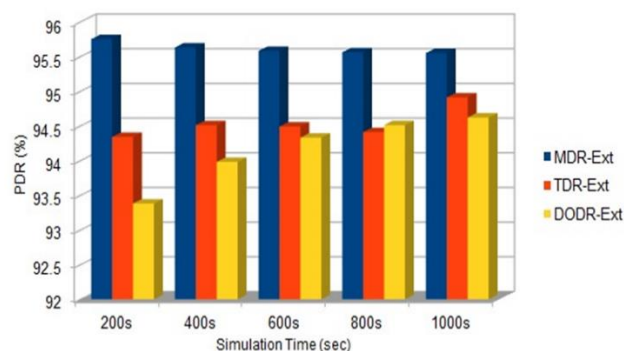


Figure 4 Packet Delivery Ratio

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From above Figure 4, MDR-Ext is providing better packet delivery ratio as compare to TDR-Ext and DODR-Ext, plainly because of three-layer structures in the proposed model is give fruitful start to finish transmission or state that packet delivery ratio and significant role in this system played by BC which legitimately backing to MOC to defeat gridlock or traffic the executives of packets in the system, BC is filling in as a scaffold between MOC and vehicles.

4.2. Normalized Routing Overhead

This parameter has also been tested for the proposed mechanism and a good drop-in NRO is obtained. So, the overhead of the normalization of routing has been lowered for the proposed approach and this phenomenon has been tested on different time intervals and the obtained values are shown in Table 4.

Simulation Time (Sec)	MDR-Ext	TDR-Ext	DODR-Ext
200s	8.9	13.2	10.8
400s	9.1	10.6	12.6
600s	9.2	10.17	13.7
800s	8.4	9.3	13.2
1000s	8.8	9	12.9

Table 4 Normalized Routing Overhead

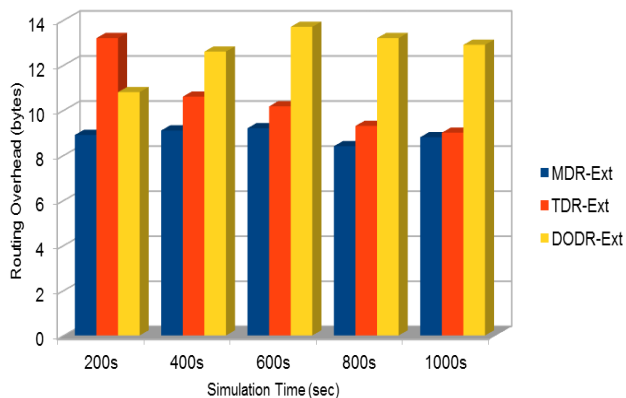


Figure 5 Normalized Routing Overhead

From Figure 5, MDR-Ext is providing compressed normalizing routing overhead as compare to TDR-Ext and DODR-Ext, it's clear that because of three-layer structures within the planned model is offer compressed normalized routing overhead and major role during this network compete by before Christ that directly support to MOC to beat tie-up or traffic management of packets within the network before Christ is functioning as a bridge for MOC and vehicles.

4.3. Throughput

The overall throughput of the system has been achieved high. The working of the system has been improved and the

performance is good at various intervals also the higher throughput is achieved. The obtained values are listed in Table 5.

Simulation Time (Sec)	MDR-Ext	TDR-Ext	DODR-Ext
200s	4331.63	4165	3739.3
400s	4253.06	4168.34	3661.32
600s	4225.33	3993.97	3633.11
800s	4211.68	4028.8	3620.71
1000s	4200.58	4033.31	3613.28

Table 5 Throughput

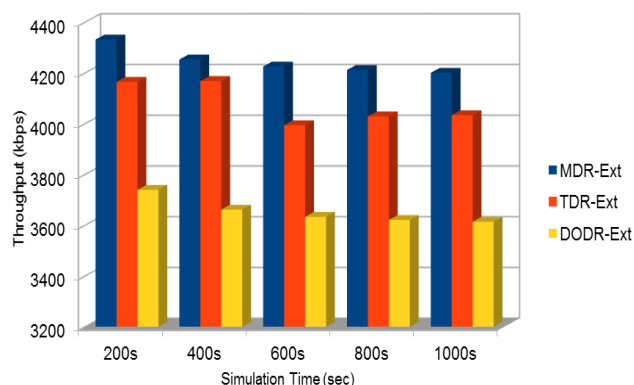


Figure 6 Throughput

From Figure 6, MDR-Ext is giving higher speed to sending data as a contrast with TDR-Ext and DODR-Ext, obviously because of three-layer structures in the proposed model is given higher throughput and significant role in this system played by BC which legitimately backing to MOC to beat gridlock or traffic the executives of bundles in the system, BC is filling in as mediator among MOC and vehicles.

4.4. Residual Energy

Residual Energy-Aware Routing. If a vehicle is capable of energy scavenging, the information regarding the availability of harvested energy can be taken into account in calculating the cost of a vehicle in addition to the residual energy of the battery. The obtained values are shown in Table 6.

Simulation Time (Sec)	MDR-Ext	TDR-Ext	DODR-Ext
200s	30.074468	28.513873	28.219522
400s	29.877706	27.378042	27.125258
600s	30.33274	28.807004	27.512728
800s	34.499823	30.05026	25.898064
1000s	32.112754	29.506564	27.66355

Table 6 Average Residual Energy

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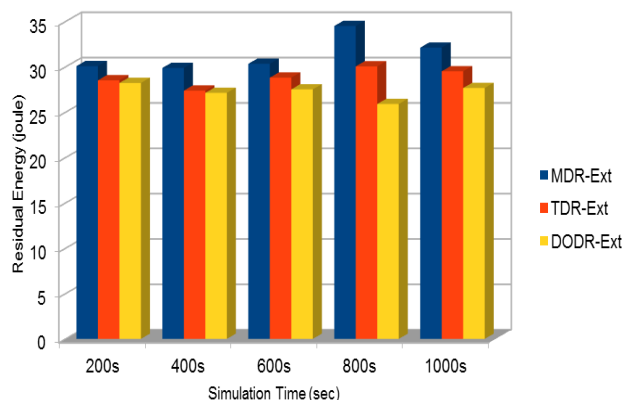


Figure 7 Residual Energy

From Figure 7, MDR-Ext is giving less energy utilization from start to finish as a contrast with TDR-Ext and DODR-Ext, obviously because of three-layer structures in the proposed model is given less energy utilization and significant role in this system played by BC which legitimately backing to MOC to conquer gridlock or traffic the executives of bundles in the system, BC is functioning as extension among MOC and vehicles.

4.5. End to End Delay

This includes delays caused by buffering of data packets during route discovery, queuing at the interface queue, retransmission delays at the MAC. The results of End to End Delay is shown in Table 7.

Simulation Time (Sec)	MDR-Ext	TDR-Ext	DODR-Ext
200s	194.508	228.097	274.135
400s	218.399	285.933	300.23
600s	237.01	359.584	267.742
800s	213.632	309.791	248.92
1000s	223.46	324.995	276.932

Table 7 End to End Delay

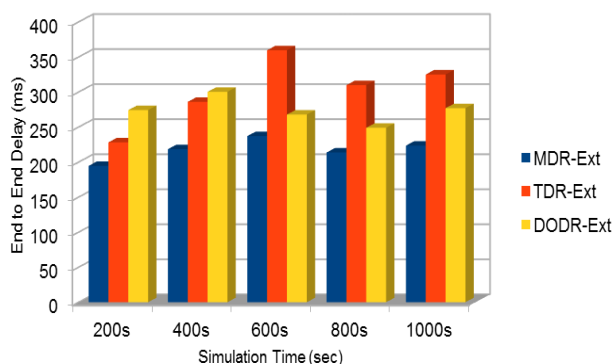


Figure 8 End to End Delay

From Figure 8, MDR-Ext is taking less time for give-up to cease verbal exchange for sending information from beginning to complete as compared to TDR-Ext and DODR-Ext, it's miles clear that because of three-layer systems in the proposed model is taking much less time from supply to destination conversation and principal position on this community played by BC which immediately aid to MOC to conquer site visitors congestion or site visitors management of packets in the community, BC is running as a bridge among MOC and vehicles.

VANET frequently changes its topography due to this reason communication and route breakage is seen continually which brings about the lackluster showing of the framework. In this way, the portability fortune consistently has an issue and here the Multipath routing proposed with VANET environment in which 802.11Ext applied to achieve enhanced Quality Service Parameter (QoS) with Brink Controller to beat this issue. The BC gets the topography data from each vehicle organizing. BC gets the data like bearing, speed, position, street ID, and so on from each vehicle in organize. At the point when this information is gotten at the BC and if the adjustment in position or geography is noted, at that point the MOC is educated about it, in any case, the BC refreshes the information in itself as it were. Along these lines, the routing overhead is overseen effectively by the MOC controller and it is clear that the experiment has achieved PDR by 96%, the throughput of 4300kbps low normalized routing overhead up to 8.88 bytes with less energy consumption up to 31.38 joules.

5. CONCLUSION

The Internet of Vehicle (IoV) has been in trend for safe and efficient transportation services. The involvement of the master of control for the creation of a network for the IOV experiment is accurate and efficient. The proposed approach worked at multipath routing with MOC-IOV for the routing of data between the vehicles. The approach also worked with the brink controller for getting the information of the vehicles within the network in a regular interval of time. This information is used by the MOC controller and the path calculation is done. The table for multiple paths is controlled by MOC, where the shortest path is set on the top of the table. This path is selected further for data transfer and the failure of the path due to changes in topology because of mobility is addressed through BC.

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Authors



Mr. Piyush Chouhan is a Phd Research Scholar in Electronics Engineering at Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore (M.P.), India. He has completed B.E. in Electronics and Communication Engineering from Ujjain Engineering College, Ujjain, M.Tech. in Electronics and Communication Engineering from Rajiv Gandhi Proudhyogiki Vishwavidyalaya, Bhopal, His research interests are Vehicular ad-hoc network, Wireless Sensor Network, Mobile ad-hoc Network and Network Security. He has number of research papers to his credit. He has 4 years of Industry experience. He has 3 years of teaching experience.



Dr. Swapnil Jain is working as Assistant Professor in Department of Electrical and Electronics Engineering at Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, India. He has completed B.E. in Electronics Engineering from Nagpur university and M.Tech. in Digital Communication from Rajiv Gandhi Proudhyogiki Vishwavidyalaya, Bhopal. He has received his Ph.D. from MGCGV, Chitrakoot in year 2016. His research interests are data and network security, Quantum cryptography, advance communication, Vehicular ad-hoc network. He has published and presented more than 20 papers in various international conferences and peer reviewed journals. He has teaching experience of more than 18 years. He is a life member of ISTE.