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Traffic Management in Ad-Hoc Network by Selection of Suitable Routing Protocol

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Traffic Management in Ad-Hoc Network by Selection of Suitable Routing Protocol

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Abstract. The need for traffic management has risen at the same pace as the number of cars has changed dramatically. Even though VANET and MANET have seen tremendous growth, traffic management is still essential. There is a demand for effective traffic management among the vehicles, which necessitates their communication ability. Routing protocols facilitate the transmission of data between vehicles. There are several routing protocols in a MANET, and choosing the optimal one is challenging. The IEEE802.11p standard is used for data transfer via routing protocols in the current operational environment. C-V2X is a developing technology superior to IEEE802.11p in terms of efficiency. Qualcomm is the creator of C-V2X. AODV, AMODV, and MDART are some appropriate routing protocols for evaluation. The Average End-to-End Delay, Average Throughput, and Packet Delivery Ratio of each protocol are analyzed. The Network Simulator 2.35 (NS2) simulates these routing protocols. This article concludes that the performance of C-V2X using AOMDV protocols is superior to that of IEEE802.11p. This research claims that AOMDV's architecture might be improved to provide more accurate figures for the average end-to-end latency.

Keywords. AOMDV, AODV, MDART, C-V2X, NS2 and ITS.

1. Introduction
Mobile Ad-hoc networks (MANET) [1] use a wireless network to send data across the network. MANET employs the IEEE802.11p protocol for data transmission. IEEE 802.11p operates on the OSI Model's data connection and physical layers. MANET nodes serve as routers and hosts, allowing them to relay packets to all other nodes and execute user programs. MANET is essential to the Intelligent Transportation System (ITS). The Vehicular Ad-Hoc Network (VANET) [2] is a subtype of MANETs that offers wireless communication services between automobiles, vehicles, and roadside infrastructure. The VANET nodes function as both cars and roadside infrastructure. VANET offers efficient V2V and V2I connections [3]. Mobile Ad-hoc Networks are classified as multi-hop routing protocols to convey effective communications between vehicles or nodes. In VANET, there are several routing protocols for data distribution.

1.1. VANET and MANET
MANET or Mobile Ad-hoc Network, also called the ad-hoc wireless network, is a connected wireless device connection used to analyze network traffic flow. Ad-hoc networks are multi-hop infrastructure that uses wireless communication for transmission. An- hoc network [5] is easy to set up as it does not require additional access points. It can be in any small or temporary network. Each node forwards the packet to another node without any central guidance because each node acts as a router to send data and a receiver to receive data re-. The nodes in the ad-hoc network instantly form a connection whenever the communication is established. Each node in a connection uses radio waves. It uses the IEEE802.11 protocol.
VANET is a sub-division of MANET. VANET comprises V2V, V2I and hybrid infrastructure. Vehicle to Vehicle communication is also known as Intelligent Transportation Systems (ITS). ITS is an actual application of VANET. [6] comprises real-time route discovery, blind crossing, prevention of collision, control of traffic flow, monitoring the traffic flow and many more. VANET also provides internet connectivity to moving vehicles to send mail and download music or games for the back seat passenger. VANET build- IEEE 802.11p and IEEE 1609 WAVE provide ing blocks.

1.2. VANET routing protocols
VANET provides many services to the user like accident alarm, traffic management, auxiliary driving, communications between other vehicles, internet and so on. So, for the proper communications between the vehicles, we need routing protocols. Routing is a critical element of a VANET. There are different routing protocols [7], i.e., routing protocols based on topology, cluster, geographical location, position-based and broadcast-based. Fig 1 defines various routing protocols.

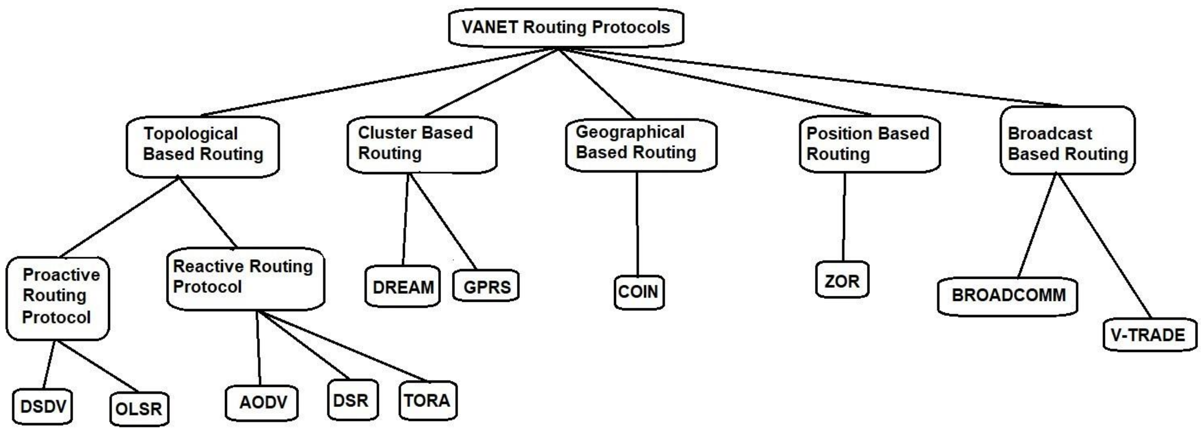


Figure 1. Various VANET routing protocols

2. Routing Types

2.1. Ad-Hoc routing
An Ad-Hoc Routing protocol is a method in the VANET system to transfer the information or messages to other cars or to the roadside unit [19]. In Ad- hoc networks, nodes decide where to send the information in the computing device in the MANET network. An Ad-hoc network connection is established when sending the data is needed. Otherwise, they don’t communicate. Each node gets its neighbour node's information and keeps it to itself, and when someone asks for details, it forwards it to that direction. The hierarchical type of routing also comes under Ad-Hoc Routing. AODV, AMODV and MDART all are types of Ad-hoc Routing protocols.

2.2. Ad-Hoc on-demand vector routing (AODV)
The information is sent through the On-Demand routing protocol only when it is specifically requested. Ad hoc The On-Demand Vector routing (AODV) [22] protocol supports both unicast and multicast [20],

and it may create routes to the destination on demand. AODV will only construct pathways if the source nodes specifically ask it to do so. There are two packets in AODV: The request packet and the Reply Packet. Request packets broadcast the message to all the other nodes for the information, and when the particular nodes are found, those nodes send the reply packet through unicast to the node that has asked for information. A node that gets all the messages keeps the route to the entry of the following desired node so that it can send the temporary notification to the requesting node.
The node that asked for information will forward the request containing the least number of hops. The entries not in the routing table are recycled after some time. If the message is not delivered to the destination, it will send the routing error to the sender's node.

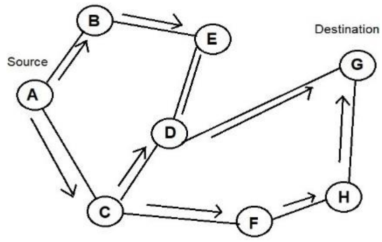


Figure 2. RREQ broadcast

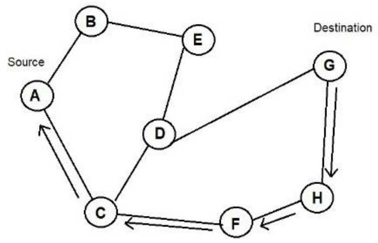


Figure 3. RREP forwarded path

Fig 2 and 3 show how the message is broadcasted and unicasted in the Route request packet (RREQ) and Route reply packet (RREP), respectively.

2.3. Ad-Hoc on-demand multi-path-vector routing (AOMDV)
The Ad-Hoc On-Demand Multipath Vector routing protocol, also known as AOMDV, is often implemented in mobile ad hoc networks as well as vehicle ad hoc networks. This protocol is an extension of the AODV protocol and it is a single-path routing mechanism. AOMDV creates transmission lines that do not include any loops and provide discontinuous alternate routes. AOMDV performs better than AODV because its efficiency in delivering packets is much higher than AODV's. [8].
When there is a requirement for the source to convey the data to some destination, AOMDV kicks into gear and generates a route request packet. After the route request packet has been broadcasted or flooded to all of the nodes in the network, the destination node will create the route reply packet, which will then be uni-casted back toward the source node. Once the node has been discovered, the route reply packet will be sent. This aspect of AOMDV operates in exactly the same way as AODV. In this situation, the source destination receives all of the potential combinations that may be used to reach the destination node, but in the case of AODV, it only retains the most efficient path. Other ones are thrown out, but in AOMDV, it preserves every single alternative path that may be taken.AOMDV performs better than AODV in terms of packet delivery fraction and average end-to-end delay [16]. AOMDV can improve transmission rates, save energy, and reduce frequent routing updates.

2.4. Multipath dynamic address routing (MDART)
Multipath Dynamic address routing (M-DART) [10] is founded on the Distributed Hash Table (DHT) based routing technology and the Dynamic Address Routing (DART) protocol. M-routing DART's table employs a multipath data forwarding approach. It utilizes a hop-by-hop routing strategy. The primary distinction between DART and M-DART is that M-DART records every route for siblings, while DART stores just a subset of ways for siblings. In M-DART, as the routing information increases, the node does not contain overhead delay by relying on DART's routing information.
In M-DART, the packet is forwarded from source to destination with a suitable and most efficient path, but if some node is changed or the link is broken, it delivers the package through a more efficient approach than it has discovered. The route in the M-DART is featured by a hierarchical method, it compares the siblings and then keeps the node or path in an entry.

2.5. Cellular vehicle to everything (C-V2X)

Cellular-Vehicle to Everything or C-V2X [21] means every vehicle connected to every other cellular thing. C-V2X offers an alternative solution for IEEE802.11p. C-V2X is an evolving technology that uses wide range of vehicle connectivity. The vehicle connectivity and safety is a huge mar- ket. Safety is the major concern of traffic management. After the development of V2V and V2I technology in VANET system, C-V2X is an emerging technology with the main problem of increasing safety, throughput, reliability, lower latency and better communication. In this vehicle will also be connected to the pedestrian. C-V2X will play a significant role or challenging role in safer autonomous driving.

3. Related Work

Amirhossein Moravejosharieh et al. [9] perform analysis on various routing protocols in vehicular ad hoc networks: AODV, DSR, DSDV and AOMDV. Their paper's main idea was to attain vehicle connectivity through V2V or V2I communication. In this, they have examined all these protocols based on routing performance. Routing performance is calculated through vehicle velocity and vehicle density. In this paper, they have used two types of routing protocols that are proactive and reactive They concluded that in MANET and VANET if vehicle velocity and vehicle density increase, then the performance of both types of routing protocols has dwindled.

Rendong Bai and Mukesh Singhal et al. [4] define new routing protocols named Waypoint Routing (WPR), which maintain a hierarchy for active routes; in this routing protocol, the intermediate node is selected as a waypoint, and then the different routes are divided into a segment by the waypoint. In this model, source and destination are considered a waypoint. Here the desirable benefit is that if the path or route does not reach the goal, it does not discard the whole path rather this protocol tries to find another path from the discarded waypoint.

D. Helen and D. Arivazhagan et al. [5] have discussed the advantages, challenges and applications of Ad-Hoc Networks. As Ad-Hoc does not require any significant network to forward the information, if nodes get the information, it simply forwards the data to an adjacent node. The advantage of an Ad-Hoc network is its flexibility, robustness and mobility. Due to all these benefits, an Ad-Hoc network is essential to future computing networks.

Rakesh Kumar et al. [7] describe comparative studies between various routing protocols in VANET. This paper describes the pros and cons of various routing protocols. Comparison is done based on traffic flow, infrastructure requirement, forwarding method and different scenarios.

Nadilma C.V. N. Pereira et al. [12] analyzed the AODV route discovery mechanism. They investigate the behavior of AODV protocol if one of the links is broken due to the mobility of vehicles. And based on this they take out the throughput, message overhead, and end-to-end delay.

Ammar Zahary et al. [16] discuss multipath routing in Mobile Ad-Hoc networks. In this paper they give the organized review for the multipath routing. They compared two multipath algorithms, AOMDV and MRAODV against long established algorithm DSR and TORA. They simulated all the proto- cols on NS2. DSR and TORA outperform the AODV protocol. They are estimated the re- sults based on routing overhead, throughput and packet delivery fraction.

Azzedine Boukerche [17] here he has discussed about the performance of various routing protocols in MANET. For evaluating, the following routing protocols are selected AODV, CBRP, DSR, DSDV and PAODV (preemptive AODV). Different scenarios, workload, mobility, load and different size of ad hoc network is simu- lated on NS2. On the basis of Simulation, he gave the various outputs.

4. Motivation

As we have seen many experiments and implementations of VANET in the previous section, they tell us that traffic management and controlling messages flow be- tween the vehicles is complex. So, we need a definite solution to manage a proper traffic management and the proper communication between the cars. Many routing algorithms transmit the data successfully, but those all-routing protocols don't always give the best output. It means still we cannot rely on them. There are many routing protocols like proactive routing protocol, cluster-based, reactive routing protocol and many more.

Reactive routing protocols or Ad-Hoc protocols, they only send the information when they are asked to. Some examples of reactive routing protocol is AODV, AMODV, TORA and many more. So sending the information to another vehicle with the help of these protocols is beneficial. This protocol also has some cons but works quite effectively in many scenarios. These all proto- routing cols use IEEE802.11p for communication between the vehicles. IEEE802.11p does have a good range, but its maximum transmission range is 300m. And it also fails when the vehicle is moving pretty fast means it sometimes fails to transmit the information at high speed.
C-V2X is the uprising technology far better than IEEE 802.11p and is more effective. Its transmission range is just double of IEEE 802.11p. And it can cope with the vehicle moving up to 500km/hr.

5. Problem Statement

This study examines which reactive routing technique will be the most effective. Select appropriate routing protocols and differentiate them based on Average End-to-End Delay, Average Throughput, and Packet Delivery Ratio. C-V2X, a new preferred technology, is used to transfer data between nodes. On Network Simulator, C-V2X technology and IEEE 802.11p standards are measured and simulated (NS2).

6. Simulation Setup

Implementation of work is done on NS2 software. There are various scenarios for different no. of nodes. 10,20,30,40 & 50, for varying pause time 50sec, 100sec, and 150sec. The transmission range of the node is also changed from 250m to 500m. combining all the possible scenarios we have to run it around 180 times.

Table .1 Experimental setups for Simulation

Parameter	**Value**
Experimental Protocol	AODV, AOMDV, MDART
Number of Nodes	10, 20, 30, 40 & 50
Simulation Time	50s, 100s,l50s
Link Layer	Logical Link Layer
Antenna T:y-pe	Omni Antenna
Simulation area	320X320
Packet Size	512 bytes
Data T:y-pe	CBR
Data Rate	llmbps
MAC protocol	IEEE 802.11p
Simulator	NS 2.34

Table 1 shows the experimental data setup simulation details in NS2 for all the protocols.
Fig 4 (a) shows the NAM screenshot, Simulation of AODV protocol with 50 nodes and transmission range of node is 250m.(b) shows the trace file for AODV protocol generated after the Simulation.

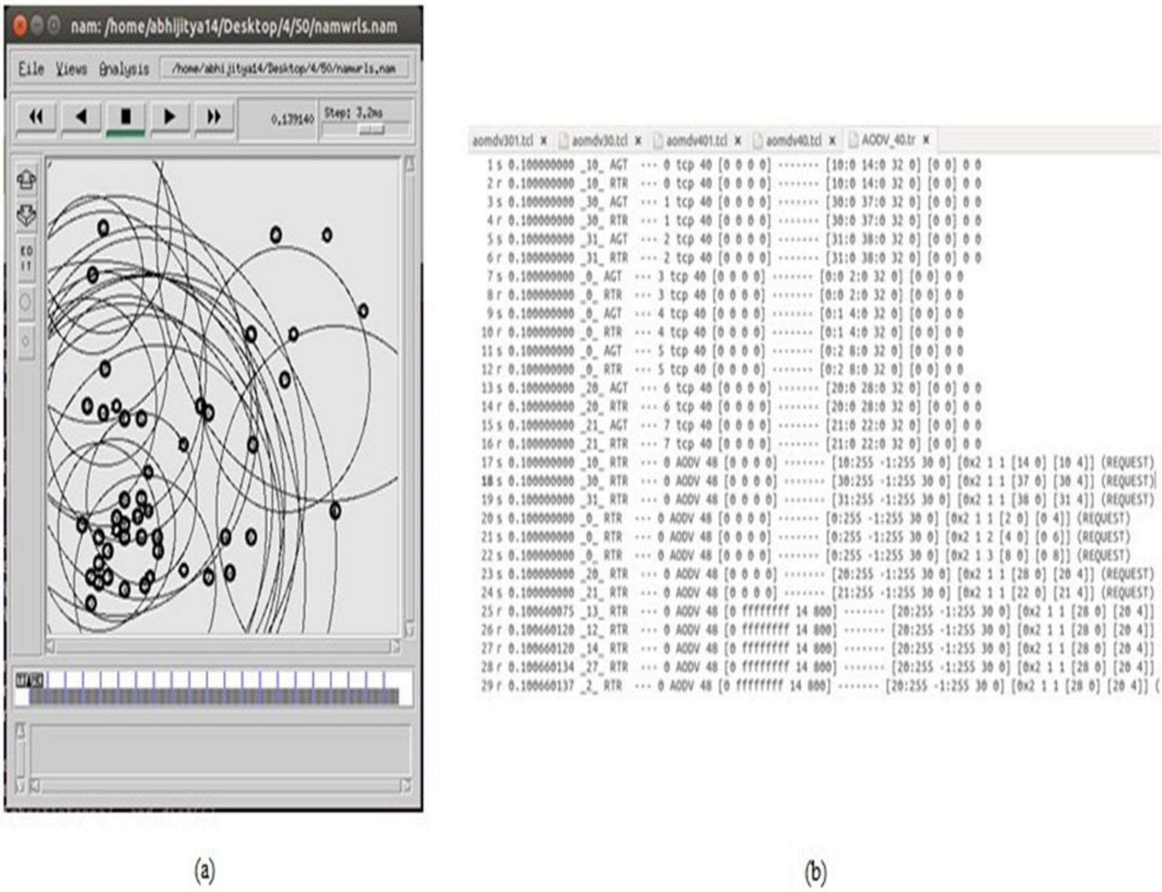


Figure 4. (a) For 50 nodes AODV protocol and 250m transmission range
(b) Trace file format for AODV

6.1. Delay

Average End to end latency refers to the amount of time that elapses between when a packet is sent from its source node to its final destination node. In its most basic form, it refers to the amount of time that must pass before a message may arrive at its intended location. A packet's end-to-end latency describes how it moves over the network, the amount of time it takes to send the packet, the amount of time it takes for the packet to propagate, and the amount of time it takes to process the data. The end-to-end latency of a network is measured between two locations that operate in synchronous fashion.

$$d_{end\text{-}end}= N[\, d_{trans}+d_{prop}+d_{proc}+d_{queue}]$$

Where:

$d_{end\text{-}end}$= *end-to-end delay* d_{trans}= *transmission delay* d_{prop}= *propagation delay* d_{proc}= *processing delay* d_{queue}= *Queuing delay*
N= number of links (Number of routers - 1)

6.2. Throughput

Throughput in data transmission is how much data is transmitted per unit. Here it means how many packets are delivered to the receiver in a particular unit of time. Throughput measurement unit is bits per second (bps) or megabits per second (mbps). The more throughput is more beneficial for the network. The protocol is more effective when throughput is high.

$$\text{Throughput} = \frac{\text{Number of delivered packets*packet size*8}}{\text{Total duration of simulation}}$$

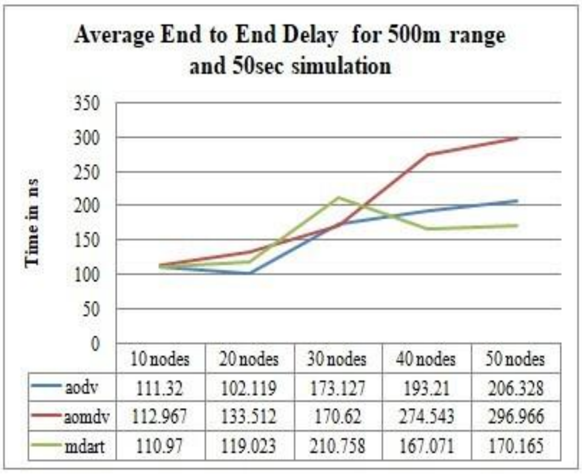
6.3. Packet delivery ratio

PDR, which stands for "Packet Delivery Ratio," is a key performance statistic for networks. The ratio of the total number of data packets provided to the total number of data packets received is the definition of it. It is possible to express it mathematically as:

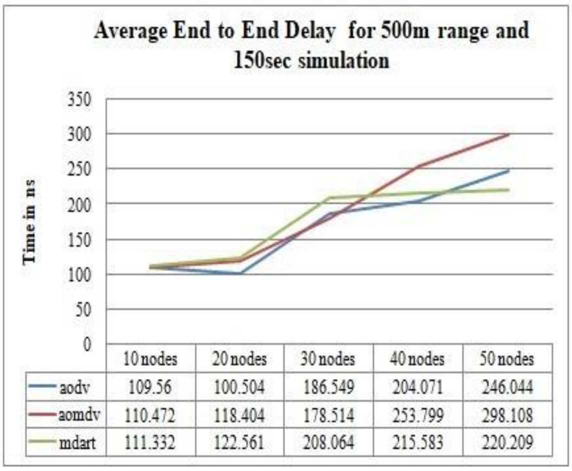
PDR = Total data packets received / Total data packets sent

7. Results and Analysis

Average End to End delay Vs No. of Nodes



(a)



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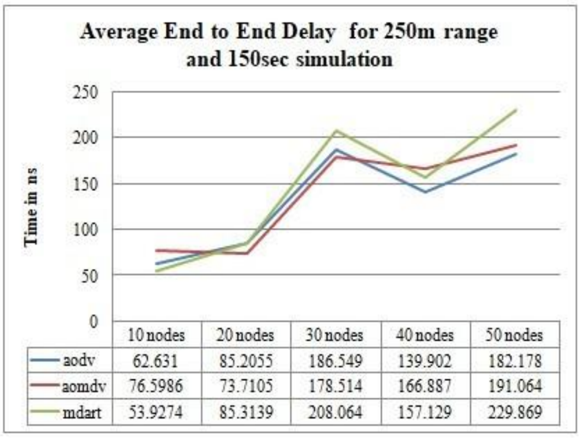

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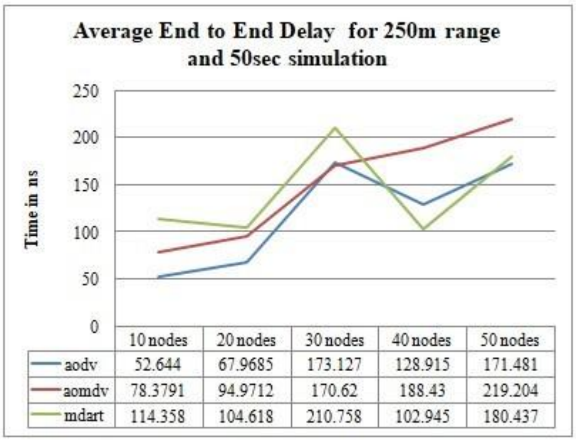
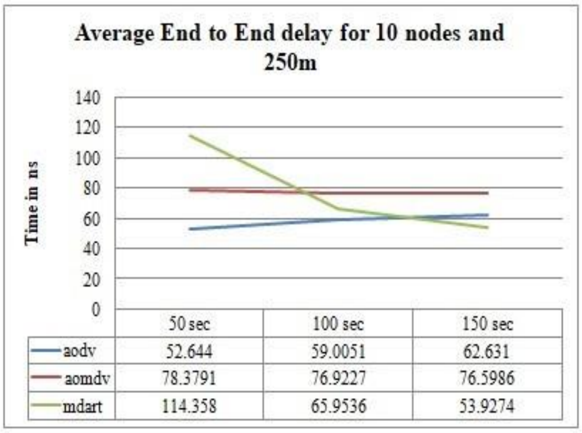


(d)

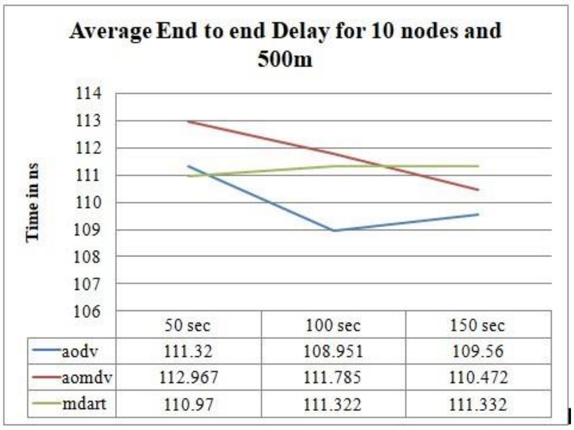
Figure 5. (a) The average end-to-end delay for a range of 500 meters and 50 seconds (b) The average end-to-end delay for a range of 500 meters and 150 seconds (c) The average end-to-end delay for a range of 250 meters and 150 seconds (d) The average end-to-end delay for a range of 250 meters and 50 seconds

Figure 5 illustrates that there is a correlation between the number of nodes and the rise in the average end-to-end delay. Nearly every graph displays progress in a linear fashion. The graphic shows that the performance of the MDART protocol improves as the number of nodes in the network increases. The AOMDV protocol has the worst Average End-to-End Delay of all the protocols. The average end-to-end delay tends to rise in proportion to the length of the node's transmission range. Because of this, it does not provide a great deal of benefits. When the MDART transmission range is enlarged, it will ultimately hit the threshold of saturation.

7.1. Average end to end delay vs simulation time



(a)



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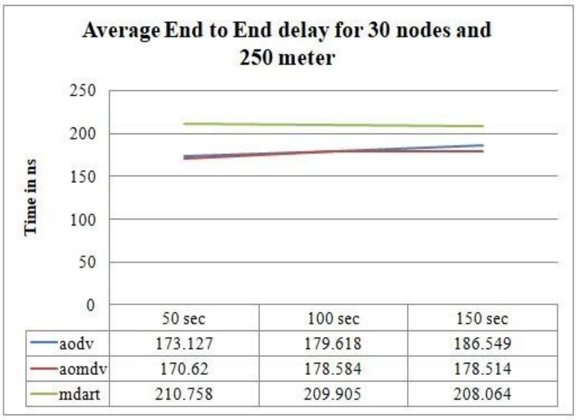

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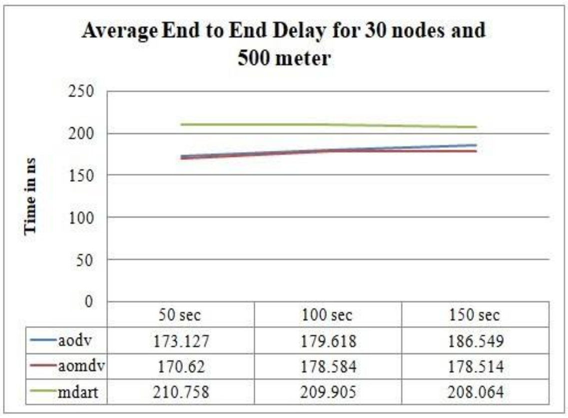

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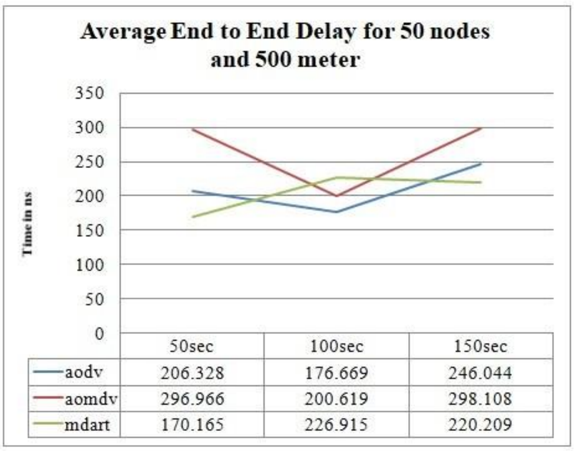

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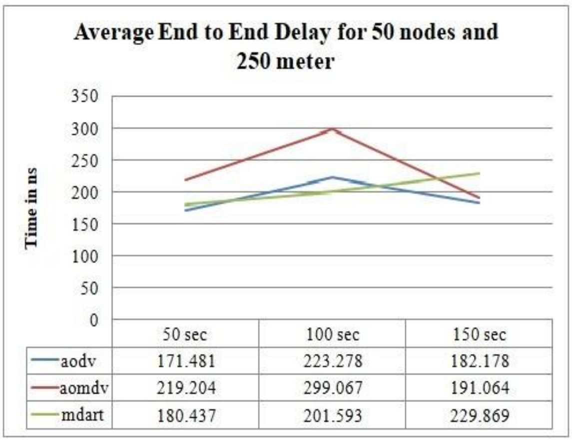
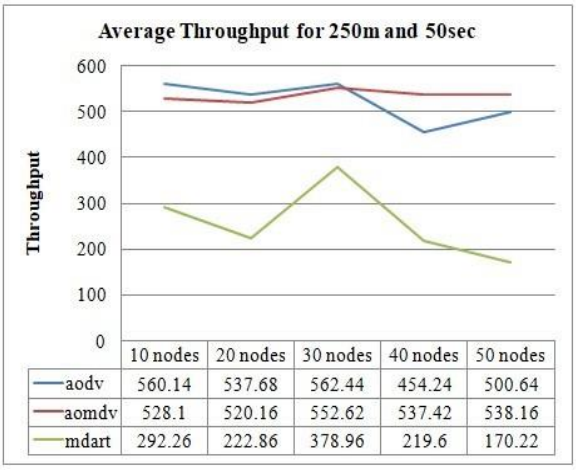


(f)

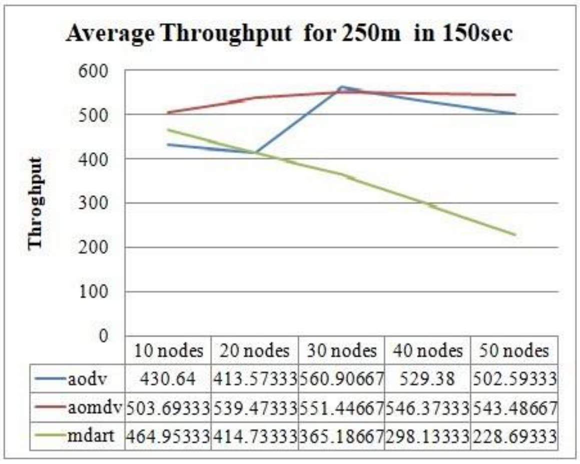
Figure 6. (a) End-to-End Delay Average for 10 Nodes and 250m (b) End-to-End Delay Average for 10 Nodes and 500m (c) End-to-End Delay Average for 30 Nodes and 250m (d) Average End To End Delay for 30 nodes and 500m

It is clear from this that the calculations used to determine the Average End-to-End Delay are derived from graph timing simulations. When compared to graph Fig. 6, it is clear that an increase in transmission range takes place whenever the Average End-to-End Delay is increased. In this scenario, the MDART protocol has superior performance in all aspects, regardless of the number of nodes involved (ten, twenty, or fifty). As the length of the simulation extends, there is often a reduction in the typical end-to-end latency. The average end-to-end latency becomes proportionally worse as the number of nodes in the network grows. There are situations in which the Average End-to-End Delay remains the same across all protocols, although with some very little differences. AOMDV performs badly in the vast majority of scenarios.

7.2. Average throughput vs no of nodes



(a)



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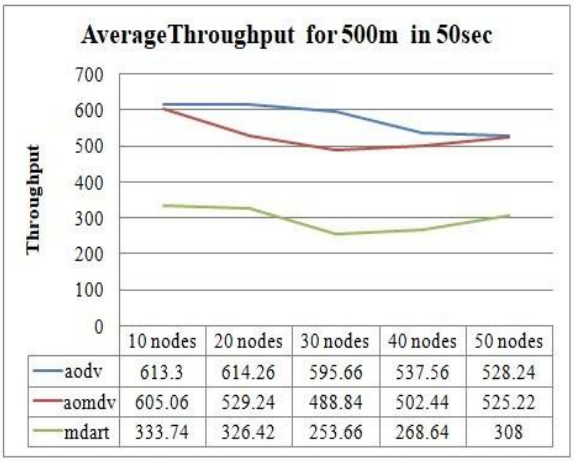
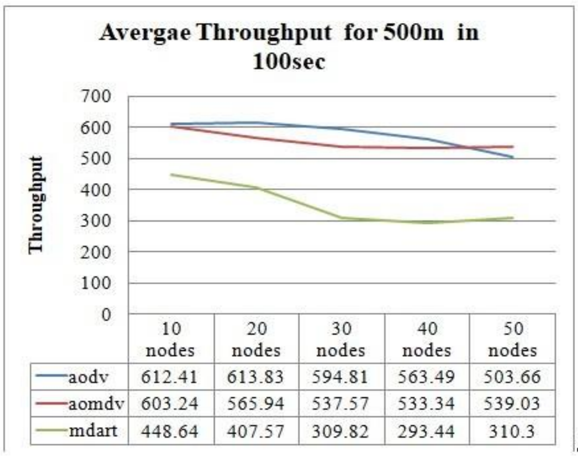


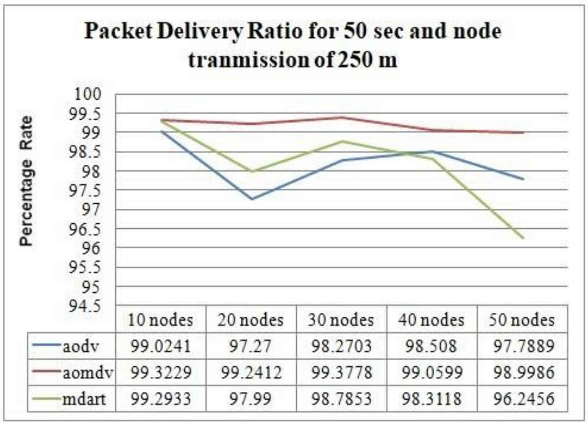


(c) (d)

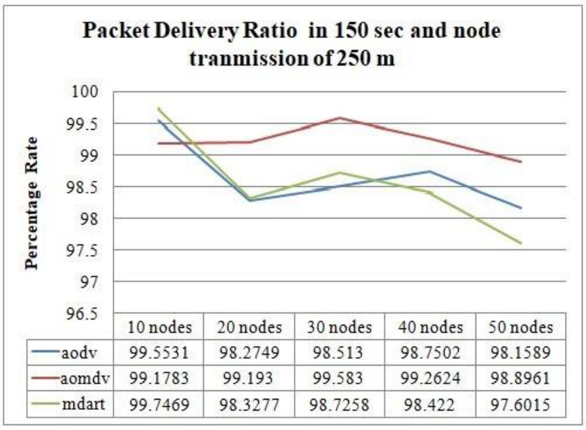
Figure 7. (a) Average Throughput for 250m and 50s (b) Average Throughput for 250m and 150s (c) Average Throughput for 500m and 50s (d) Average Throughput for 500m and 100s

From the Fig 7 graph, average throughput is observed based on no. of nodes. The average Throughput of AODV & AOMDV is higher than the MDART protocol. And also, as the transmission range of the node is increased, the average throughput of the protocols increases. Here AOMDV performs better in the entire scenario.

7.3. Packet delivery ratio vs no. Of nodes



(a)



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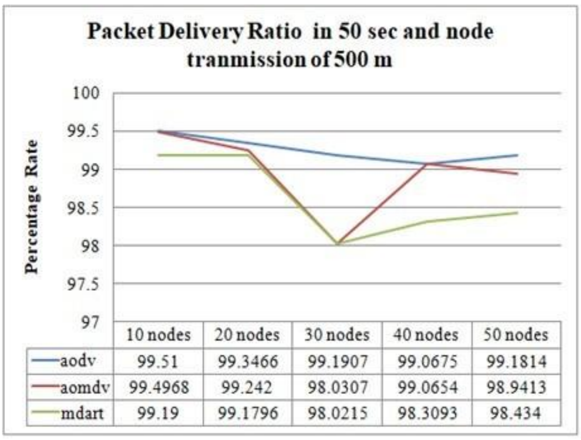

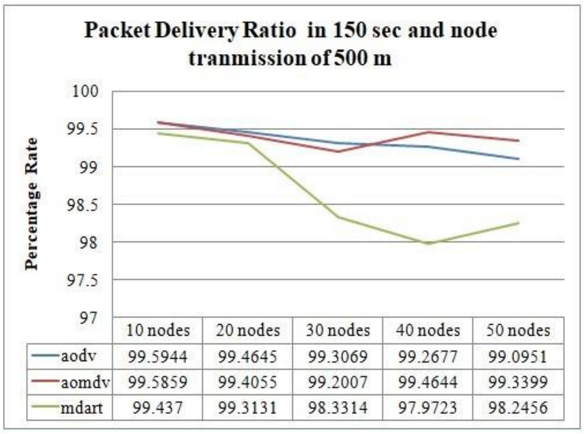

(c) (d)

Figure 8. (a) Packet Delivery Ratio for 50s and 250m (b) Packet Delivery Ratio for 150s and 250m (c) Packet Delivery Ratio for 50s and 500m (d) Packet Delivery Ratio for 150s and 500

The graphs in Fig. 8 demonstrate that the Packet Delivery Ratio drops to a lower value as the number of nodes grows. When the transmission range of the nodes is expanded, the Packet Delivery Ratio (PDR) also rises, which results in improved operational effectiveness. In comparison to the other three protocols, AODV, AOMDV, and MDART, the Packet Delivery Ratio that is achieved with AOMDV is the highest possible, while MDART achieves the lowest possible level.

8. Conclusion and Future Scope

This paper presents simulation research that was conducted using AODV, AOMDV, and MDART as its three different protocols. The performance of these protocols is evaluated using three different metrics: their average end-to-end latency, their average throughput, and their packet delivery ratio. The results of this simulation indicate that an increase in a node's transmission range leads to an increase in both the packet delivery ratio and the average throughput. Because of this, C-V2X will result in an increase in both throughput and Packet Delivery Ratio. In the same vein, increasing the

node's transmission range is not beneficial when considering the average end-to-end delay. Although it has the greatest average throughput and the highest average packet delivery ratio, the AOMDV protocol has the lowest average end-to-end latency. MDART has a lower average end-to-end latency than other solutions, but it has poor performance in other contexts. Based on this study, the researchers came to the conclusion that AOMDV needs certain design improvements in order to offer better numbers for Average End-to-End Delay, which is another major component.
When the C-V2X technology and its benefits are taken into consideration, it is feasible to operate with a different level paradigm in a variety of contexts. Additionally, more than three protocols may be used for the sake of future endeavors. There is a significant amount of worry over the confidentiality of the data as the VANET continues to grow in size. During the next year, the primary focus of routing algorithms will be on ensuring passenger safety.

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