International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

A Congestion Control Technique for Improving Multipath Routing in MANET

Rubeena Ansari[1], Professor B. L. Rai[2]

[1]*M. Tech. Scholar,* [2]*Professor, Department of Computer Science & Engineering, Organization – Jai Narain College of Technology, Bhopal, M.P., India*

rubeenaa76@gmail.com[1], blrai3021@gmail.com[2]

***Abstract*— The Mobile Ad Hoc Network path has been chosen by multi-hop contact. The communication spectrum of a node is restricted in this network and not all nodes can communicate directly with each other. Nodes are expected to transfer packets on behalf of other nodes in order to promote connectivity across the network. In the mobile ad hoc network (MANET), congestion is one of the most significant constraints that impairs the efficiency of the whole network. Multipath routing allows multiple routes to be formed between a single source and a single destination node. The Route establishment uses a system that discovers multi-hop contact between source and destination. Multipath routing can better balance the load than a single path routing in ad hoc networks, thereby reducing congestion by splitting traffic into many routes. This study introduces the modern method of Multipath Load Balancing with AOMDV routing protocol and Link reliability congestion management system to prevent congestion in network traffic flows. In this scheme, the storing and forwarding capacity is improve by changing incoming data. The efficiency of the AOMDV protocol is also improved to improve the expiration period of the link after the current network connection has failed. The new relation is defined on the basis of the new link expiry time value, which also minimizes the probability of link loss in AOMDV. This means that the multi-path routing efficiency in this technique improves the time of expiration associated with the vibrating queue length process. There is no question that multipath routing is easier than unipath routing and balancing the load by proving the alternate route if the already defined path is congested. However the efficiency of AOMDV increases after the proposed scheme has been added. The efficiency of the standard AOMDV is calculated on the basis of the load handling capacity of the nodes in the network and the performance matrices. The simulation of all routing techniques is conducted in the ns-2 simulator.**

***Index Terms*— Multipath, AOMDV, Congestion, Load, Routing, MANET, C-AOMDV**

I. INTRODUCTION

A core challenge in the architecture of ad hoc networks is the creation of stable routing protocols that provide high quality communication.

MANET nodes, such as bandwidth, buffer space, battery power, etc., have limited connectivity choices. MANET's power restrictions require the right distribution of traffic between mobile hosts. In MANET, the routing protocol will distribute the routing operations around the mobile host similarly. Unbalanced data traffic distribution can lead to power exhaustion on heavily loaded hosts. By more hosts being shut down, the connectivity of the network will be limited, leading to more hosts. Call malfunctions due to partitions in the network. In contrast, a large queuing wait and a high packet loss ratio are required to provide nodes with strong routing obligations. As a consequence, for connections using such nodes, the end-to-end latency and the packet loss ratio are high. Load balancing is now emerging as a main strategy to allow MANET resources to be used effectively and improve MANET performance. With Load Balancing, by minimizing end-to-end packet latency, maximizing the life of mobile nodes, and balancing network energy consumption, MANET can reduce traffic congestion and load variance. Ad hoc routing protocols do not have functionality for load balancing. The only downside to all modern ad hoc routing protocols is that they assume the optimal route to any given destination to be the road with a minimum number of hops. However, during route setup, there is no provision in this technique for conveying the load and the continuity of the direction. When the smaller innermost nodes become the backbone of most traffic, the medium access control layer (MAC) in these nodes adds to traffic congestion. In fact, this can lead to high packet delays, as unwanted loads can be carried by some nodes. The use of the route cache in certain protocols further aggravates this problem. This may result in a high likelihood of packet drops due to the TCP's output being impaired by congestion. It is also predicted that highly loaded nodes will incur heavy power consumption. As it decreases the battery's power, this is an undesirable situation. As a result, the demand on the multiple routes cannot be managed, thereby reducing efficiency by creating extreme mobile node problems such as congestion, power exhaustion, and queuing delays.

A routing protocol that adjusts the constraints of dynamic topology, leading to the difficulty of routing, is the most demanding of mobile ad hoc networks. The concentrate on load balancing has been on many routing protocols for MANET for many years. The key purpose of load balancing is to redirect traffic from the nodes and the congestion network route that occurs. The rise would be postponed if there is no load handling systems. Most of the routing protocols that they deem to be chosen for a high-performance route are load balancing indicators.

Paper are divided into multiple section, in section I describe about introduction, section II provide the literature survey, section III describe about our proposed work, section IV define the result discussion and section V describe about conclusion of proposed approach.

II. Literature Survey

In this section discuss the existing work which uses to secure the wireless ad hoc network by various type of attack. Those works helps to provide new way to security of mobile ad hoc network.

Nan Wang and RishikaDatla [1] "A Neighbor Coverage Multipath DSDV Routing Protocol for MANETs" This research study will investigate A Multipath DSDV Neighbor Coverage as a possible solution to data loss by seeking alternative routes to the destination when a connection is broken. A mobile ad hoc network is a collection of mobile nodes through which data from all nodes is distributed wirelessly. Network topology varies constantly due to the mobility of wireless nodes. As a consequence, routing protocols used in ad-hoc mobile networks must be flexible. Reactive, pragmatic, and hybrid protocols are grouped into routing protocols that allow data transfer inside MANETs. Proactive routing protocols are table-driven protocols, such as the Destination Sequenced Distance Vector, that use stale paths in the event of broken links, causing network data loss.

Dr. P. K. Suri, and Satmeetkaur [2] "Load balancing algorithm survey in MANET" In this title, 'MANET Load Balancing Algorithm Survey' (Mobile Ad-hoc Network) is an infrastructure-less network composed of dynamic nodes capable of exchanging their wireless networking capability with neighbouring mobile nodes. Load balancing will become one of the most important research fields in the field of MANET, since MANET does not properly have unified load management control. Load Balancing is a method for optimizing parallel and distributed network efficiency by redistributing loads between different nodes.

It degrades performance by causing network congestion, error, and power failure if the network is completely loaded without any load balancing capability. Several algorithms that follow these requirements have recently emerged and have been successfully applied to highly loaded issues.

Amita Rani and Mayankdave [3] “Load Balanced Routing Strategies for Mobile Ad Hoc Networks” This helps to maintain load equilibrium and extend the entire life of the network. Simulation results indicate that the proposed load balancing systems greatly improve the performance of the network and outperform one of the most common ad hoc routing protocols for AODV and previously proposed ad hoc routing protocols for load balancing, such as DLAR and LARA, in terms of average latency, fraction of packet transmission and jitter.

In this title, Mobile Ad Hoc Network is a wireless array of high-mobility mobile nodes that are connected via wireless media such as mobile phones, laptops, etc.

Behra Rajesh Umashankar[4]' Comparative study of latency, traffic and hybrid load balancing routing protocols in mobile ad hoc networks' One of the principal problems of mobile ad hoc networks is the implementation of high-reliability routing. Therefore, network load balancing and latency are critical challenges in the ad hoc mobile network, a number of activities and routing development has been proposed. For the suggested protocol, the separate calculations depend on traffic loads for the movement of loads between their network nodes. We need to pick acceptable metrics to maximize the network's performance. We have to try to achieve load balancing during the routing period to minimize extra overhead routing.

Ashwini.B.Patil [5] "MANET Load Balancing Routing Survey" is primarily related to node versatility in this title. In these networks, nodes cooperate to engage in multi-hop transmission cooperatively. Not only do the nodes on the network act as servers, but also as routers that route data from other network nodes. To accomplish the quality of service (QoS) process, MANETs need an efficient routing protocol. Routing protocol the energy consumption should be minimal for the collision, flexible to normal change in timing and topology, ease of computing & management, optimal and loop-free path. The topic of load-balancing in the routing scheme is therefore very important to consider as being the optimum route for MANET without regard to traffic the shortest path with minimum slump count and thereby reducing network performance. It mainly focuses on the analysis for effective MANET transmission of data through different load- balanced routing protocols.

MadhviSaxena, K.J. Mathai[6] This article provides for an improved Mobile ad hoc routing algorithm, modifying current ad hoc on-demand distance routing (AODV) by measuring loads based on parameters including minimization number hop, remaining energy node and motion node in different routes. It is proposed that the concept be implemented to enhanced load balanced and energy efficient Ad-hoc on-demand routing algorithm.

"Comparative Study of Delay-Oriented and Hybrid Load Balancing Routing Protocols in Mobile Ad Hoc Networks" We are researching load balancing metrics for each protocol. Bahram Najafpour, *ET. al.* [7]] "Comparative Study of Delay-Oriented and Hybrid Load Balancing Routing Protocols in Mobile Ad Hoc Networks" a comparative study of load balancing using two load balancing routing protocols and the results shown in the tables are shown for each load balancing technique.

BehzadMahdavi, *ET. al.* [8]' "An Overview of Traffic-Oriented Load Balancing Routing Protocols Focused on Several Metrics in Mobile Ad Hoc Networks' "In this title, we look at the load balancing metric for several discussed routing protocols and say that by selecting a multi-path routing structure and selecting the required metric.

Sanjeev Jain, *ET. al.* [9]' In this title, we propose a delay-conscious load balancing routing protocol for wireless mesh networks by creating a combined route metric for Delay-aware Load Balanced Routing Protocol for IEEE 802.16 Wireless Mesh Networks.' Initially, the traffic disruption metric (TIM) that calls the traffic load of neighbors for intrusion is determined. Next, by using the average time spent on transmitting all packets awaiting transmission through a connection, we calculate the end-to-end service delay (EDM) metric. In terms of current network loads, this calculation can be used to select the path with the lowest end-to-end operation delay. We define a combined route metric for effective route selection using these two metres. A route discovery mechanism is proposed that, along with the planned communication delay and load value, broadcasts packet request. Based on the lowest routing metric value, the route needed is selected. A route control framework is often recommended to ensure the network's stability. This can be used to stop repetitive pathway shifts and improve transmission efficiency. The findings of the simulation show that by increasing the average packet delivery ratio compared to the existing protocols, the new protocol reduces latency and overhead.

Natarajan Meghan than and Leslie C. Milton [10]' A Performance Analysis of Mobile Ad Hoc Networks Stability, Load-Balancing and Power-Aware Routing Protocols' is a detailed simulation-based performance comparison in this title of three distinct classes of mobile ad hoc network routing protocols: stability-based routing, power-aware routing, and load-balanced routing. As part of the stability-based routing, load balancing, and power-aware routing protocols, we choose the Flow-Oriented Routing Protocol (FORP), the Load Balancing Routing (LBR) based traffic disruption protocol, and the Min-Max Battery Cost Routing (MMBCR). FORP has the least number of route transfers out of the three routing protocols, while LBR has the smallest hop count and the lowest end-to-end delay per data packet. Energy per node, led closely by LBR, is the least consumed by MMBCR.

Sujata V. Mallapur, *et. al.* [11] This title suggests an efficient routing strategy called a multi-path load balancing technique for congestion control (MLBCC) in MANETs to efficiently handle load across multiple paths by reducing congestion. MLBCC incorporates a congestion control system and a load balancing mechanism throughout the data transfer process. By using the incoming rate and the outgoing rate at a fixed time interval T, the congestion control system senses congestion. Using the link cost and the path cost to efficiently distribute the load by selecting the most appropriate paths, the load balancing method decides the gateway node. A node availability degree standard deviation parameter is added to provide an optimum flow of distribution.

III. Proposed Security Scheme

Networks have limited channel bandwidth and require a few hops to exchange information with every other node on the network. Packets travelling over mobile networks are frequently influenced by radio interference from nearest neighbors. Topological transformation due to mobility and decreased battery power of the nodes must be managed without causing long interruption periods. Congestion is the primary trigger of a broken relation. Excessive loading of nodes causes the buffer overflow, which causes the packets to be destroyed. This causes packet delay and affects the packet delivery ratio of the MANET protocol. Load balancing C-AOMDV is a solution for avoiding network congestion.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

If the load is balanced, effective network consumption and packet delay can be minimized and the delivery ratio of the packets increased. Present protocols provide several paths, but they do not avoid congestion and have load balancing. AOMDV sets multiple routes to a destination, selects a single route with a low hop count, and discards higher hop count routes. In the case of a failure of the link, these roads can be used as alternate routes. In order to make efficient utilization of the network, the load must be transferred to these paths.

Establish an AOMDV base load balancing and base congestion control in the MANET sense to ensure reliable and stable connectivity in this strategy. In this step, we use the AOMDV routing protocol to implement multipath routing on the network. After the route discovery process, the AOMDV routing protocol can establish multiple disjoint routes between the sender and the recipient. The sender uses these separate paths to relay data to the receiver, thus helping to balance the load on the network. Now, if the sender has to transfer data, it requires multiple paths and any time it measures the end-to-end delay as well as the normal time (without congestion) to realize the delay gap and store it. We are now creating a second situation in which a number of senders and receivers share identical mobile nodes, resulting in network interference, which is unavoidable, so that each sender compares the current recognition delay distance with the previous recognition delay discrepancy. If the sender discovers that the delay is increasing from the time previously recorded, the data rate will rise (minimum from previous). This Bandwidth Estimation method, by way of acknowledgement delay distance, is applied to each sender node and, due to it, each sender node adjusts its basic data transfer rate and minimizes network congestion.

The second approach for congestion reduction is the dynamic queue management technique in this dynamic queue technique that is extended to each node of the network to minimize congestion due to the overflowing of the queue.

Both technical bases minimize congestion and maximize the volume of data received in the network as well as reduce average network latency.

Proposed Algorithm:

Proposed neighbor identification based security (NISB) technique detect and secure the network from blackhole attack under MANET. In this section formally describe the algorithm which provide reliable and secure communication.

Algorithm: Congestion Control Technique for Improving Multipath Routing in MANET (C-AOMDV)

Step1: Build a mobile node = M.

Step2: Set routing protocol = AOMDV;/for routing and routing. Load balancing

Step3: Set sender = S // S ε M

Step4: Set Destination = D // D ε M

Setp5: Intermediate Node = I // I ε M

Step6: AOMDV: Routing Protocol

Step7: Initialize the radio range = 550m

Step8: Set MAC = 802.11 // Medium access control

Step9: Sender B RREQ to next-> neighbor // Initiate C-AOMDV procedure

Step10: While (next->neighbor <= 550 & Next->neighbor! = Destination)

```
{
        I← Accept the route requested packet
        Forward B_RREQ to the nearest neighbor
        If (next->neighbor == Destination)
        {
        Create a Route table of routes
        Check for more than one route
        Send (R ACK to sender node)
        More than one way)
        }
        Else
        {
Check the time period of the path request
If (RRLT>= Time of Route Search)
{
Exit 0
}       }               }
```

Measures for Congestion Recognition and Management

Step1: Sender S sends data packets along the shortest path to destination D

Step2: Find the complete incoming and outgoing data from each node;/value from the trace file

Step3: Get a drop packet of data from each node

Step4: Get the justification to drop from the trace file

Step5: If (drop-reason == "COL" || "Congestion"

```
        {
        Set the queue on that node
        If (Q > Max-Val)   // if there is a queue overflow
        {
        Calculate the coming and going data rate
        If (rate > available)/incoming packet rate and available power
        {
        Apply ACK approach to data rate control
        }               }               }
```

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

Bandwidth or throughput in a packet network typically means the amount of data the network can transfer per unit of time. The calculation of the overall usable bandwidth for an end-to-end link is key to the congestion management systems used in transport protocols and directly affects the performance of the program. The bandwidth of the link varies from the bandwidth of the end-to-end line, which consists of a series of consecutive connections along the path. The proposed C-AOMDV is able to handle the congestion in network. In communication networks, connections typically refer to point-to-point links in a data link layer called segments. At a network layer, ties can consist of one or more segments linked to data link layer devices, such as switches or bridges, which are called hops. An end-to-end connection from a source to a destination may be made up of a series of hops. A data link layer usually offers a steady bit rate of transmission.

IV. Result Description

A. Simulation Parameters

Table 1 are represents the following simulation parameters to make the scenario of routing protocols. The detailed simulation model is based on network simulator-2 (ver-2.31), is used in the evaluation. The NS instructions can be used to define the topology structure of the network and the motion mode of the nodes, to configure the service source and the receiver etc.

Table 1:
Simulation Parameters

Parameters	Configuration Value
Simulation Tool	NS-2.31
Routing Protocol	DSDV, MDSDV,C-AOMDV
Simulation Area	1000m*1000m
Network Type	MANET
Number of Nodes	10,60,100
Physical Medium	Wireless, 802.11
Mobility Speed	Random
Mobility Model	Random Waypoint
Simulation Time (Sec)	100Sec
Transmission Range	550m
MAC Layer	802.11
Antenna Model	Omni Antenna
Traffic Type	CBR, FTP
Propagation radio model	Two ray ground

B. Result Analysis

The results analysis in case of proposed congestion control tecnhiue are mentioned and observe that the C-AOMDV provides better resultas compare to DSDV and MDSDV routing in MANET.

1. Packet Delivery Ratio

Packet Distribution Ratio (PDR) is the ratio between the number of packets received and the number of packets delivered to the network. This efficiency metric is essential to analyze the percentage of packets obtained successfully in the network. The efficiency of the proposed C-AOMDV routing protocol in this graph is higher than the normal DSDV and MDSDV routing protocol. Here, in the case of standard DSDV routing, the packet delivery fraction is about 83(max) percent at the end of the simulation, whereas in the case of the proposed approach it is about 87 (max) percent at the end of the simulation. The difference in delivery of packets in the case of the previous and proposed scheme is not same and the difference in reception is more in C-AOMDV scheme. The performance of rest of scenarios is mention in table 2.

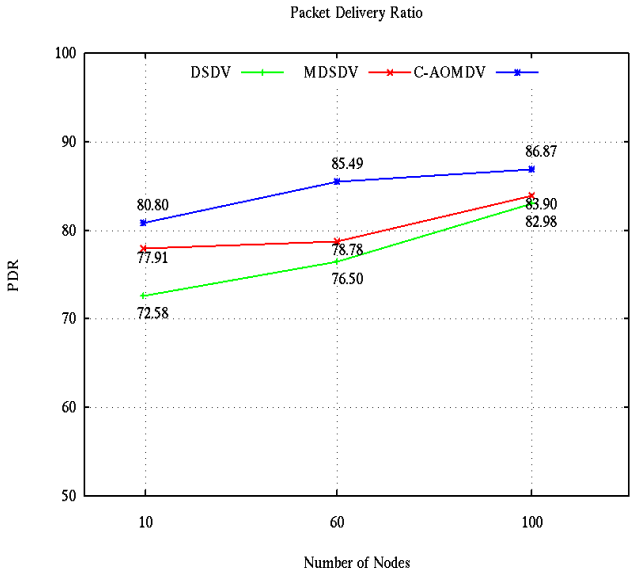

Figure 1: PDR Performance

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

Table 2
PDR Analysis

Packet Delivery Ratio (%)			
No of Nodes	DSDV	MDSDV	C-AOMDV
10	72.58	77.91	80.80
60	76.50	78.78	85.49
100	82.98	83.90	86.87

2. Routing Overload

The routing load is specified in terms of the number of routing packets to be sent to the network to be linked to the receiver. Routing packets are often referred to as 'Hello' packets. In this table, the routing load in the case of the proposed C-AOMDV scheme is less than the previous MDSDV scheme and the decreased routing load benefit increases the performance of the network. Here, in the case of the proposed scheme, the number of routing load is about 0.59(max) in network but in the case of the previous scheme it is about 0.50 routing packets are delivered in the network. The higher routing load is the excessive flooding in the network and also increases the routing performance of the C-AOMDV protocol by optimizing the routing mechanism. The performance of rest of scenarios is mention in table 3.

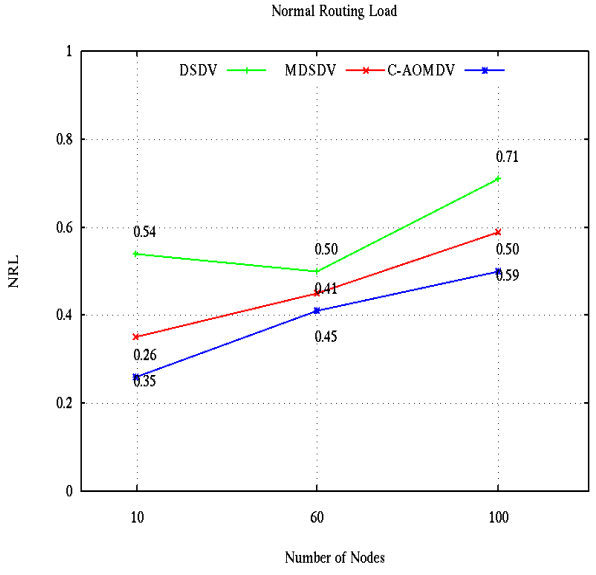

Figure 2: Routing Overhead Performance

Table 3
Overhead Analysis

Routing Overhead			
No of Nodes	DSDV	MDSDV	C-AOMDV
10	0.54	0.26	0.35
60	0.50	0.41	0.45
100	0.71	0.50	0.59

3. End to End Delay Analysis

Delay in network is occur because of not maintaining a secure link between the sender and the recipient, but they also consume node resources, and if fewer data packets are sent to the network. This graph shows the delay analysis of DSDV, MDSDV and proposed C-AOMDV. The delay of DSDV is about 0.24milliconds (ms) (max) in 100 node density scenario and after that the 0.23ms of MDSDV protocol is evaluated. The performance of C-AOMDV is better as compare to rest of the two protocols. The performance of rest of scenarios is mention in table 4.

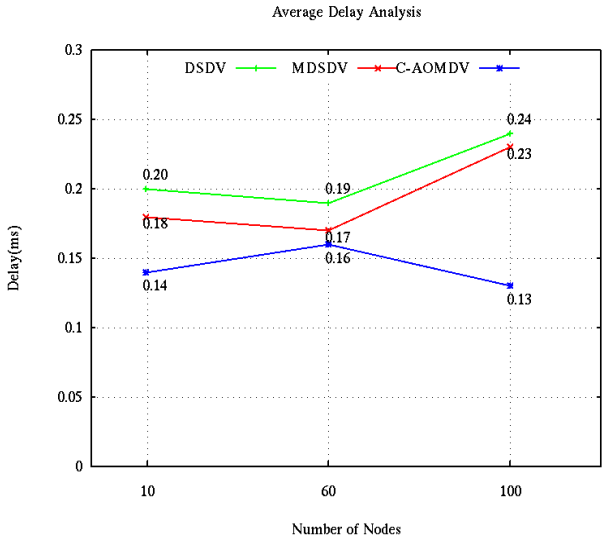

Figure 3: End to End Delay in [ms]

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

Table 4
Delay Analysis

End-to-End Delay (ms)			
No of Nodes	DSDV	MDSDV	C-AOMDV
10	0.20	0.18	0.14
60	0.19	0.17	0.16
100	0.24	0.23	0.13

5. Throughput Analysis

The throughput reflects the number of packets transmitted and received per unit of time. In this table, the throughput for previous MDSDV routing is less than the proposed C-AOMDV routing. In this proposed C-AOMDV routing strategy, multipath rotation is simplified and the efficiency of the multipath routing protocol is increased. Here the throughput of the MDSDV is significantly less than 13Kbpsas compare to C-AODV. After that the throughput of the proposed routing protocol is steadily improved to the end of the simulation. Standard multipath routing offers an alternative route, but the load distribution does not take place so the efficiency of multipath routing is decreased and the planned load distribution means that the efficiency of multipath routing is improved. The performance of rest of scenarios is mention in table 5.

Table 5
Throughput Analysis

Throughput (Kbps)			
No of Nodes	DSDV	MDSDV	C-AOMDV
10	384.99	377.28	394.42
60	395.68	384.71	401.20
100	399.20	391.38	404.15

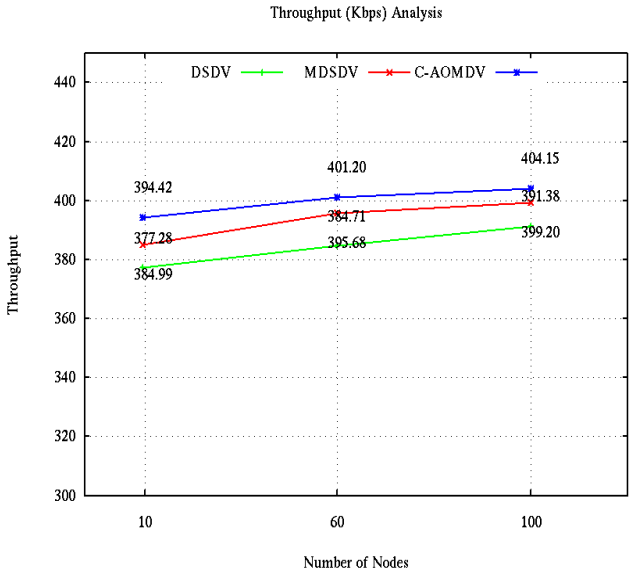

Figure 4: Throughput Performance

6. Packet Receive Analysis

This graph describes the number of packets receiving analysis in the network in the case of a C-AOMDV and previous MDSDV and DSDV scheme in network. The reliability of packet analysis is calculated whether the network is a better for transmitting the data to the network. Load balancing is effective if nodes in the network are capable of managing nodes that ensures that fewer packets are lost in the network so that more packet numbers are collected in the network. In this graph, in the case of the previous MDSDV routing, about 16000 packets are received in the network, but in the case of the proposed C-AOMDV, about 18000 packets are received in the network, it means that less packets are lost in the network because the strong connections are used for communication. The performance of rest of scenarios is mention in table 6.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 3, March 2021)

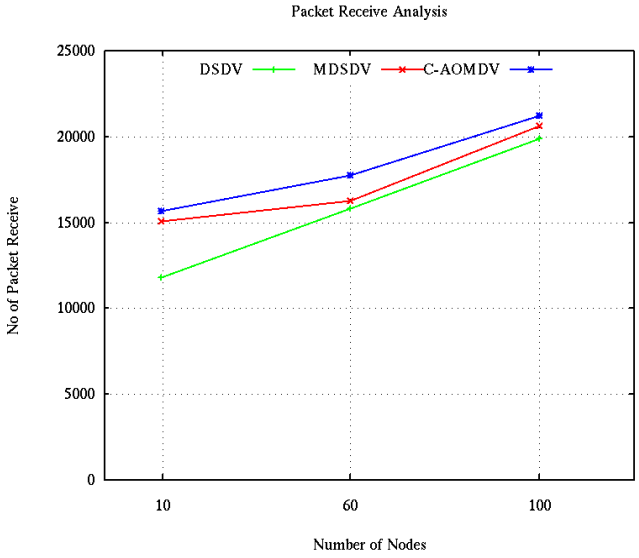

Figure 5 Packet Receive Analysis

Table 6
Packet Receive Analysis

Analysis of Packet Receive			
No of Nodes	DSDV	MDSDV	C-AOMDV
10	11780	15099	15669
60	15792	16254	17751
100	19903	20603	21247

V. Conclusion And Future Work

The routing protocol in MANET can equally spread the routing activities between the mobile host. Unbalanced allocation of traffic/load leads to a decline in the efficiency of the network. Due to this unbalancing design, few nodes in the network are heavily loaded with routing tasks that cause large queue size, high packet latency, high packet loss ratio and high power consumption. In this research proposed a load balancing C- AOMDV routing algorithm for MANET. The benefits of load balancing would be optimum network utilization, higher throughput and lower routing overload. The load may also be unevenly spread over several connections by varying the expense of the route involved. MANET consists of mobile hosts fitted with wireless networking equipment.

The performance of C-AOMDV is compare with DSDV and M-DSDV. The key features of MANET are that it runs without a central coordinator, quickly deployable, self-configuring, multi-hop radio connectivity, periodic connection breakage due to mobile nodes, restriction resources (bandwidth, processing capacity, battery life, etc.) and all nodes are mobile such that topology can be very complex. In order to meet the key challenges of the routing protocol in MANET, fully distributed, Scalable to regular change of topology, Fast computing & maintenance, Optimal and loop-free path, Optimal use of route in C-AOMDV and Collision should be a minimum. The routing protocol is needed in the network to transport packets from source to destination and the multi-path routing that provides a load balancing principle but does not effectively spread the load in the network because the valuable source of communication, i.e. the capacity, is affected by packet loss.

The multipath approach is really effective for better communication. In future try to work on Zone Routing Protocol (ZRP) and try to establish communication with multipath routing approach in MANET.

REFERENCES

[1] Nan Wang, Rishika Datla, "A Neighbour Coverage Multipath DSDV Routing Protocol for MANETs" 2019 IEEE 11th International Conference on Communication Software and Networks.

[2] Dr. p.k.suri, professor, sat meet kaur, “a survey of load balancing algorithms in manet” IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.2, No. 3, June 2012.

[3] Amita RANI, Mayank DAVE “Load Balanced Routing Mechanisms for Mobile Ad Hoc Networks” Int. J. Communications, Network and System Sciences, 2009, 7, 627-635.

[4] Behra Rajesh Umashankar “A Comparative Study of Delay, Traffic and Hybrid Based Load Balancing Routing Protocols in Mobile Ad Hoc Networks” International Journal of Advance Research in Computer Science and Management Studies Volume 2, Issue 4, April 2014.

[5] Mrs.ASHWINI.B.PATIL “Survey of Load Balancing Routing in MANET” IJETTCS Volume 1, Issue 3, September – October 2012.

[6] Madhvi Saxena, K.J. Mathai “Improved Load Balanced & Energy Efficient Ad hoc on demand routing Algorithm” International Journal of Computer Science and Information Technologies, Vol. 5 (6) , 2014, 7088-7092.

[7] Bahram Najafpour, Behzad Mahdavi, Vahab Ashrafian, Narges Latifi Avid, Mehdi Sadeghzadeh, “Comparative Study of Delay-Oriented and Hybrid Load Balancing Routing Protocols in Mobile Ad Hoc Networks’. Basic. Appl. Sci. Res., 3(2s) 498-502, 2013.

[8] Behzad Mahdavi, Bahram Najafpour, Hadi Mojez, Hamed Masoomi, Feridon Babazadeh "An Overview of Traffic-Oriented load Balancing Routing Protocols Based on the Multiple Metrics in Mobile Ad Hoc Networks" J. Basic. Appl. Sci. Res., 3(2s) 751-755, 2013.

[9] Sanjeev Jain, Vijay Shanker Tripathi and Sudarshan Tiwari "Delay-aware Load Balanced Routing Protocol for IEEE 802.16 Wireless Mesh Networks" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 6, No 1, November 2012.

[10] Natarajan Meghanathan, and Leslie C. Milton, "A Performance Comparison of Stability, Load-Balancing and Power-Aware Routing Protocols for Mobile Ad Hoc Networks" Vol 1, No 1 (June 2010) .

[11] Sujata V. Mallapur, Siddarama R. Patil, Jayashree V. Agarkhed "Load Balancing Technique for Congestion Control Multipath Routing Protocol in MANETs" Springer 09 Aug 2016.