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# Congestion-Aware Multi-Route Establishment Routing for Mobile Ad Hoc Networks (MANET)

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**Abstract:** *This research delves into the realm of Mobile Ad-hoc Networks (MANETs), dynamic and infrastructure-less wireless communication systems that offer flexibility for deployment at any time and place. With the nodes in MANETs constrained by limited battery capacity, energy optimization becomes a pivotal design consideration. This paper comprehensively reviews prior works aimed at enhancing the longevity and various performance parameters of MANETs. A primary challenge in MANETs is congestion, arising from the restricted link capacity between nodes. To tackle this issue, the research proposes a resolution using the Ad-hoc On-demand Multipath Distance Vector (AOMDV) routing protocol, introducing alternative paths to alleviate congestion. Comparative analysis with the MEALBM scheme underscores the superior performance of the proposed approach, affirming its effectiveness in addressing congestion and contributing to the overall enhancement of MANET capabilities.*

***Keywords:-*** MANET, Queue, Load balancing, Routing, Multipath, MEALBM, Congestion.

## Introduction

The basic architecture of MANET consists of nodes that are dynamically self-organized into arbitrary and temporary network topology without any infrastructure support. The advantage of employing MANET is to offer a large degree of freedom at a minimal cost in comparison to other networking solutions. The nodes communicate with one other over a wireless link with each node acting as host and router. Because of mobility of node the topology of the network changes, thus routing becomes crucial.The protocol ensures that the available bandwidth in the network is used expeditiously by distributing traffic equally that ensures higher load balancing and congestion management. The nodes in the network can communicate with every other without a physical infrastructure regardless of their physical location. So the MANETs are open, infrastructure less and decentralized. These features enable them to work anywhere without the help of centralized authority or base stations. MANET is a promising technology and has great strength to apply in critical situations like battle fields and commercial applications. Due to the dynamic topology and other great features MANET attracts to different real world applications. Ad-hoc networks are self-organizing and adaptive features make them a perfect choice for uses such as communication and data sharing. Because of openness and decentralization features, the members of the MANETs are not able to constrain the membership. MANETs are self-organizing networks [2]. They can move independently in the network that

makes the frequent connection breakage between devices. Routing protocols [3] are responsible for efficiently establishing a reliable route between nodes so that data can be delivered between nodes in a timely manner. The efficiency of the routing protocols can dramatically affect the performance of the entire network in terms of bandwidth utilization, power consumption, and delay; therefore, the process of establishing a reliable and efficient route should be done with minimum complexity, delay, overhead, and bandwidth. Multipath routing methodology allows the establishment of multiple paths from a source node to the destination node.

A. Applications of MANET

1. Military piece of ground

- Military communication, automated battlefields

2. Emergency Services

- Search and rescue operations
- Disaster recovery – Earthquakes.

3. Educational

- Virtual classrooms or conference rooms.
- Set up ad hoc communication during conferences, meeting, or lectures

4. Home and Entertainment

- Home/office wireless networking.
- Personal Area network

B. Characteristics of MANET

1. Infrastructure-free: MANET is a self-organized network. It is independent of any established infrastructure and centralized network administration. Here each individual node plays as a router and operates in a distributed manner.

2. MULTI-HOP ROUTING: DUE TO THE ABSENCE OF ANY DEDICATED ROUTER, HERE EVERY NODE ACT AS A ROUTER AND AIDS IN FORWARDING PACKETS TO THE DESTINATION NODE. THAT'S HOW INFORMATION SHARING AMONG MOBILE NODES IS MADE AVAILABLE.

**3. DYNAMIC NETWORK TOPOLOGY: THE TOPOLOGY OF MANET CHANGES FREQUENTLY AS MANET NODES MOVE RANDOMLY IN THE NETWORK, HENCE LEADING TO REGULAR ROUTE CHANGES, NETWORK PARTITIONS, AND POSSIBLY PACKET LOSSES.**

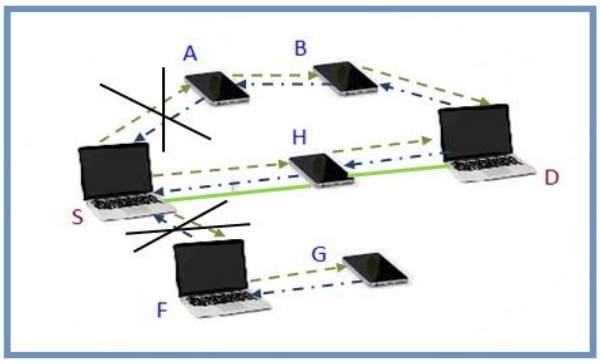


**Fig.1:** Mobile Ad hoc Network.

The communication between the nodes is mentioned in figure 1. The sender S is sends data to destination D from intermediate node H. Efficient load balancing is also essential for ensuring secure QoS for delay sensitive, time period streaming applications in MANETs [1].

This paper is organized as: in Section 1 introduces the topic of Mobile Ad-hoc Networks (MANET) with a focus on congestion control. Section 2 provides an overview of congestion in MANET, emphasizing its occurrence due to limited bandwidth and the influx of bulk data. In Section 3, the paper delves into the description of performance metrics used to evaluate previous congestion detection and removal techniques in MANET as literature survey. Section 4 is dedicated to detailing of proposed multipath routing protocols, elucidating the routing mechanisms of various protocols. Section 5 presents a simulation result analysis of the existing Ad-hoc On-demand Multipath Distance Vector (AOMDV) network, highlighting enhancements in the context of congestion and collision resolution in Enhanced Ad-hoc On-demand Distance Vector (AODV). Section 6 serves as the Results discussion. Section 7 provides a comprehensive conclusion based on the literature discussed throughout the paper, with outlines future work, describing a proposed approach for congestion control techniques utilizing multipath protocols.

## II. Congestion and Load Balancing Overview

It is essential to regulate the data rate utilized by each sender in order not to overload the network, wherever multiple senders compete for link bandwidth. Packets are loss when they reach the router and can't be forwarded. Several packets are dropped while excessive amount of packets make a network bottleneck. The packets loss would've cosmopolitan great distance and additionally the lost packets often trigger retransmissions. This intimates that even additional packets are sent into the network. And so, network throughput continues to be more worsened by the network congestion. There are probabilities of congestion collapse wherever nearly no data is delivered with success if no applicable congestion management is performed [4].

Shared broadcast medium is employed in mobile ad hoc networks. Medium capability that is extremely inadequate is shared within all the nodes in a collision domain. Whereas delivering data to multiple destinations, multicast communication is of nice concern in these networks, since it helps saving resources. Mobile nodes group communication that is an inherent feature of the many planned applications in MANETs is else to the current mass medium. So, it's necessary to avoid congestion collapse in wireless multi-hop networks so as to perform efficient congestion control [5, 6].

Load balancing is a communication methodology to distribute work across multiple mobile node, network links (wireless link), mobile node process units, memory space, or different resources, to attain optimum resource utilization like energy, link bandwidth, channel etc., to increase output, decreases latency, and avoid work.

### Load Balancing Requirement

Load balancing is a communication methodology to distribute work across multiple mobile node, network links (wireless link), mobile node process units, memory space, or different resources, to attain optimum resource utilization like energy, link bandwidth, channel etc., to increase output, decreases latency, and avoid work. [6]. There is a prospect of load imbalance due to that the computing processing power of the systems are non-uniform (i.e.) few nodes possibly idle and few can loaded. A node which has high processing power

finishes its own work quickly and is calculable to own less or no load in the least maximize time. So, within the presence of under-loaded nodes, the necessity for over-loaded nodes is undesirable [6]. Multi-path routing will balance the load higher than the one path routing in ad hoc networks, wherever the primary selective shortest methods are used for direction-finding. This can be possible just for the networks having an enormous number of nodes (i.e., a large fraction of the total number of nodes in the network) between any source-destination couple of nodes. It's impracticable to make such a system it's economical for locating and maintaining an alternative number of paths. Load balance isn't improved by exploit multiple shortest path routes rather than one path. So, for an improved load balanced network distributed multi-path load rending methods need to be rigorously designed [4]. The AOMDV [7] protocol has a capability to balance the load by providing the alternative path instantaneously in dynamic network and control the congestion. The load balancing techniques proposed by previous authors are mentioned in next section and these schemes are able to handle the congestion problem but proposed queue management scheme is more reliable and better in tem of different parameters.

## III. Literature Survey

In this paper [10] proposed technique of load balancing is Network Coding-based AOMDV routing algorithm in MANET (NC-AOMDV). It is typically proposed in order to increase the reliability of data transmission, and by applying network coding, which allows packet encoding at a relay node. Because the encoding packet is generated by a relay node, the source node does not need to encode the packets, and sends only data packets to each route. Thus, the packets transmitted by the source node are not increased. The multiple coded scheme is improves the performance in presence of receiving by removing multiple copies of data that is identified by the codes in network at destination.

In this paper [11] proposed Efficient Weighted innovative Routing Protocol (EWIRP) to Balance Load in Mobile Ad Hoc Networks (MANETs). The EWIRP proposed in this paper is a load balancing technique which can also be viewed as an efficient routing approach, improves delivery ratio, reduces end to end delay, efficiently exploits the resources like available bandwidth, node energy, queue space, without affecting the network's vital assets.

Residual energy based algorithms [12] overcome the load traffic problem. The proposed solution will not only distribute complete transmission traffic to multiple routes but will also filter out inefficient routes according to energy status. This filtration will avoid undesirable link break because of node's poor performance. First discover all possible routes from source to destination. Second to collect energy state of all intermediate nodes and calculated energy consumption of all possible routes using remaining battery charge, value of each node involved into respected route. Third is Compare the route energy state with threshold value and filter out all energy efficient possible routes.

Multipath routing protocol [14] called Heterogeneous Ad hoc On-demand Multipath Routing Based on Node Stability (HAOMDV-NS) which discovers paths based on node stability. We define the node stability by the number of one-hop neighbors, neighbor similarity between adjacent time and average received signal strength indicator. Coefficient of variation method is used to weight these three factors. The path quality is

measured by the received signal strength indicator. In this paper, every node in the network has three different radio interfaces, so there are three node stability values. Nodes broadcast the node stability by Hello packets to neighbor nodes periodically. When source node need to initiate a new route discovery process, it selects the interface with the largest average neighbor node stability value to broadcast RREQ with the path quality to the network

## IV. Proposed Congestion Control Scheme for Balancing Load

Congestion control technique is necessary for control or reduces the packet loss in dynamic network. The number of nodes in MANET The proposed approach for balancing the network load which can tackle congestion and at identical time extend network life time is proposed. Multipath load balancing overcomes the capability limitation of single path routing by distributing data traffic on to multiple ways and reducing congestion by routing traffic through lightly loaded ways. However, the benefits of multipath routing come at a worth as synchronic data transmission on multiple methods interfere with one another. Further, once network traffic starts increasing, there'll be accumulated level of rivalry among nodes let alone higher collision level consequently leading to packet drops and network level congestion. In proposed approach the route selection is based shortest path route is selected but multipath is provides the next shortest path for communication. The data is only delivering through shortest path and these shortest paths are reliable and choose the nodes having sufficient energy for communication. Congestion control is associated to controlling traffic incoming in Mobile Ad hoc Network. To avoid congestive crumple or link capabilities of the intermediate nodes and networks and to reduce the rate of sending packets congestion control is used extensively. Congestion control and dependability mechanisms are combined with buffer enhancement and AOMDV to observe the congestion control without explicit feedback about the congestion status and without the intermediate nodes being directly intermittent.

The congestion control status is required to identify the congested link and the number of relay nodes that deliver the data in same rate in network by that the congestion is heavily deployed. This proposed scheme the main point is to observe the load in each node. Here the multipath means to execute route meaning to select the multiple path in between sender to destination and how many number of nodes in them. The buffer capacity of each node is evaluated through queue length (the capacity of nodes in network to hold the data packets temporary) in a single path from multiple paths and how many numbers of nodes in single path and calculates the capacity of all nodes which are the part of multiple routes in network. The rate controlling is required to not enhance the buffer capacity to much. If the sender controls the data rate the in that case the stored packets in buffer easily leave buffer space and new arrival is too much reduced.

**Proposed Algorithm**

Step 1: Set Initial Parameter
Set node = m; // m number of mobile node
Set Sender = s; // s € m s sender that belong into m node
Set receiver = r; // r € m s receiver that belong into m node
Set protocol = AOMDV; // Routing protocol
Set rr = 550m // maximum radio range of node
Step 2: Broadcast Routing Packet for Searching Destination

```
Route_Rreq(s, r, rr)        // broadcast route request packet {
If (rr<=550 && next_hop = =”true” && nex_hop != r)
{
Record incoming and outing connection in each node’s
next hop find r-table = create route table
Work until destination search
}
Else if (nexthop = r)
{
If Find (number of paths from s to r) // all path are shortest base
{
Select more than two paths for communication
Sends data packets from one selected path
Receive ACK of successful receiving
}
}
Else
{
Receiver out of range;
}
Step3: Check each path and node load
If (any path or node drops the packets)
{
Set queue for minimizing drop;
If (Queue = = full) &&(Data_rate = = full)
{
New_length = Queue++
New_Load = Load/2
}
}
Else
{
Normal flow of data through all paths
}
}
```

## V. Result Analysis

The simulation parameters are mentioned in table 1 is considered for simulation of existing AOMDV, network in Enhanced AODV for congestion and collision resolve. The parameters are considered similar for both routing cases because similar environment in both cases gives better justification for performance

parameter. The work is done in NS-2 simulator version 2.31. The number of nodes is considered for simulation is 10,25,50,75 and 100 with random movement in a simulation area of 800m*800 m.

**Table.1:** Simulation Parameters.

| Parameters | Type |
|---|---|
| Physical Medium | Wireless Physical |
| Propagation Modes | Two Ray Ground |
| Antenna Type | Omni Directional Antenna |
| Number of Nodes | 10, 20, 30 |
| Simulation Area | 800*800 $m^2$ |
| Simulation Time | 100 seconds |
| Frequency | 914e+6 Mhz |
| MAC Layer | 802.11 |
| Routing Protocol | AOMDV |
| Queue Type | Drop tail/ Priority Queue |
| Traffic Type | CBR |
| Agent Type | TCP/UDP |
| Node Mobility | Random |

A. Packets Sending Analysis

The number of packets sends in network is measures in three different node density scenarios. The number of packets sending in proposed load balancing algorithm is more as compare to MEALBM technique in MANET. The performance of both the modules is simulated in network simulator on same parameters. The chances of delay in communication in network are controlled by proposed congestion control scheme. The congestion in network is not possible to remove from network completely but possible to reduce the congestion to improve routing performance.

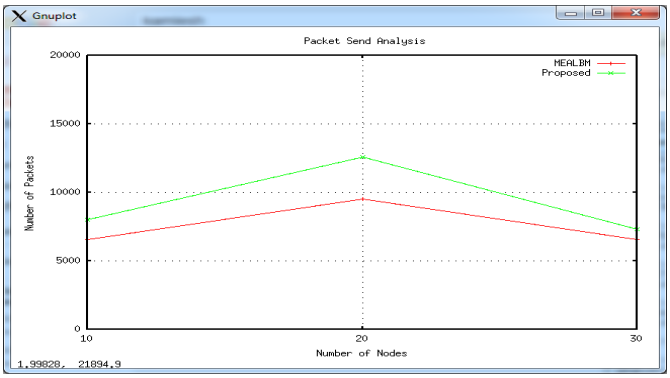


**Fig. 2:** Number of Packets Sending Analysis.

B. Packets Receiving Analysis

The number of packets receiving in network is actually decided the routing performance of multipath protocol in MANET. The number of senders is establishing the multiple paths and these paths are capable to handle the congestion in network. The performance of novel congestion control scheme is provides better data receiving in all three node density scenarios in network. The proposed scheme is able to handle congestion problem efficiently in dynamic network. The packet receiving in network is providing the better results in proposed scheme. The routing performance is improved and the congestion is controlled that improve bandwidth utilization.

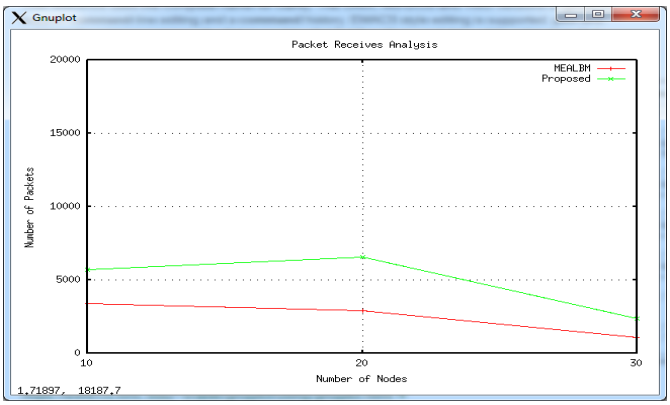


**Fig. 3:** Number of Packets Receiving Analysis.

C. Packet Dropping Analysis

The number of packets drop performance in network is measures in three different node density scenarios. The number of packets dropping is less in proposed load balancing algorithm is more as compare to MEALBM technique in MANET. The performance of both the modules is simulated in network simulator on same parameters. The packet dropping are controlled by proposed congestion control scheme to manage queue status. The congestion in network is enhancing it means the congestion is consumes the limited bandwidth and processing capability of mobile nodes. The proposed congestion control scheme is improving routing performance.

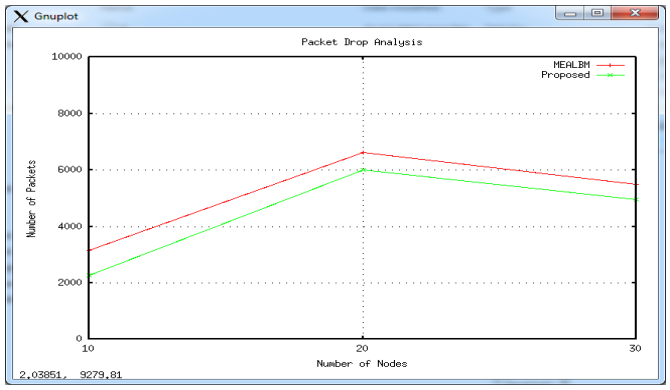


**Fig. 4:** Packet Dropping Analysis.

D. PDR Performance Analysis

Packet Delivery Ratio is the performance that provides result in the form of percentage of data receiving at destination. The congestion in network is controlled by selecting alternative path in network but this path is also not capable to handle congestion. The numbers of nodes are not able to forward data packets to next node or destination in network.

The proposed queue management scheme is handle the problem of congestion and provides better results as compare as compare to MEALBM scheme. In MEALBM are also reduce the congestion but proposed scheme is better and improve multipath routing performance. The PDR performance in all node density scenarios is better than previous security scheme and about more than 10% performance is enhanced after applying proposed approach in MANET.

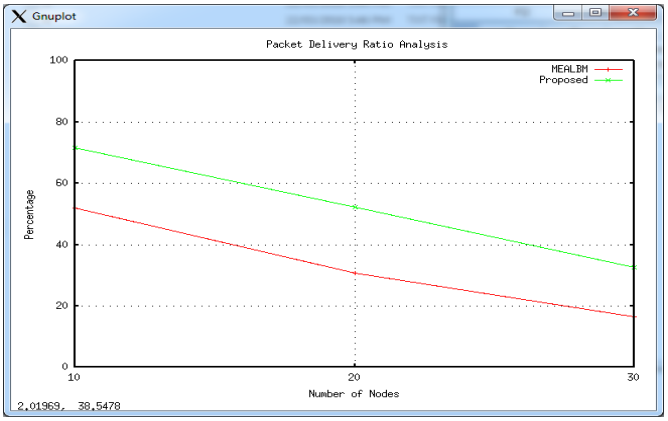


**Fig.5:** PDR Performance Analysis.

E. Throughput Performance Analysis

The kilobytes of data per unit of time receiving at destination are measures by throughput performance metrics. The numbers of sender nodes are forming multiple links through AOMDV multipath protocol. The multiple paths are stronger or able to handle load in links are measure through MEALB existing scheme and proposed queue management based congestion control scheme in MANET. The proposed congestion control scheme is provides the better throughput performance in all node density scenarios.

The better data receiving is provides better performance and improve the routing performance. The proposed congestion control scheme is control the problem of congestion and also not enhances the any overhead. The performance of proposed protocol is efficient and better as compare to MEALBM protocol in network.

**Proposed Scheme Performance Parameters**

- Node Density
- Packets Send
- Packets Received
- Packets Drop
- PDR
- Overhead

- Throughput
- Delay (ms)

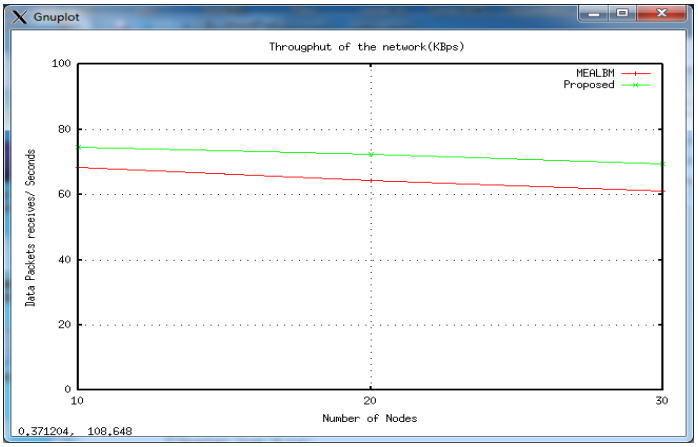


**Fig. 6:** Throughput Analysis.

F. Routing Overhead Analysis

The overhead in multipath routing is less as compare to unipath routing protocol in MANET. The flooding of packets in unipath and multipath is almost same but numbers of paths are established more or multiple paths are establish for sending data to destination. The more routing overhead is confirming the possibility of link breakage. In this graph the overhead in proposed congestion control scheme is less as compare to existing MEALBM. The packets loss in proposed scheme is reduced and the packet receiving is also more, which shows the strong link establishment. The multipath protocol is used in both the protocol for sending data but using different approach to handle congestion problem and the proposed scheme is handle more efficiently. The overhead in proposed scheme in all node density scenarios are less as compare to MEALBM protocol.

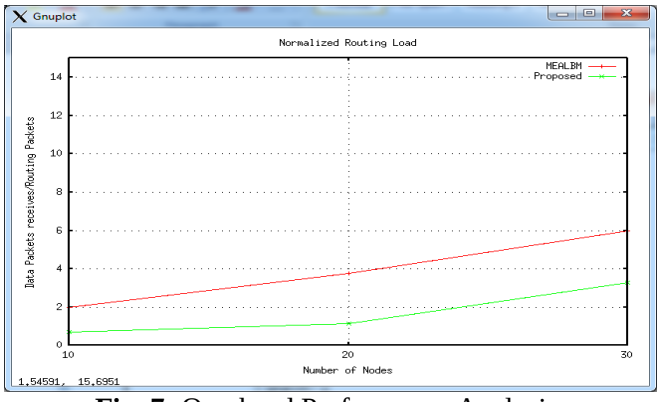


**Fig. 7:** Overhead Performance Analysis.

G. Average End to End Delay Performance Analysis

The delay problem in network is affected the packets receiving and due to that the overhead in network is also enhanced. The more packets loss due to problem of congestion is the main issue to enhance the congestion in dynamic network. The delay performance is measures in same 10, 20 and 30 node density scenarios in network. The delay is measured in milli- seconds. The numbers of senders are sends data to destination through multiple path and these paths are better or not based on the better packet delivery. The number of nodes are communicate with each other to in dynamic environment and the performance of proposed scheme is shows the less delay as compare to existing MEALBM scheme in MANET.

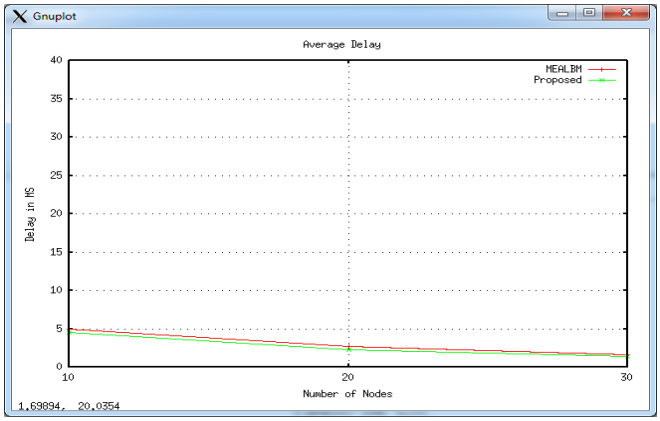


**Fig.8:** Average End to End delay Analysis.

## VI. Result Comparison

The congestion control scheme proposed in this research is reduces the packet loss and improves the packets receiving i.e. completely depends on the previous successful transmission Packet dropping due to congestion in network is degrades the network performance. The congestion control scheme proposed in this research is reduces the packet loss and improves the packets receiving i.e. completely depends on the previous successful transmission. The better data receiving as compare to MEALBM is also enhance the through and PDR performances. The mobile node has restricted computational capacities like bandwidth and buffer suspect and also not possible to enhance the available bandwidth for efficient communication but possible to manage the higher data rates by managing queue capacity. The proposed research work is based on the queue management technique to handle the load in network and this queue management technique is provides the information of heavy load and after that the alternative path is choose for sending data in dynamic network. The previous MEALBM technique are provides information of recent good work that maintain the pair of source and destination nodes using intermediate nodes which are rich and utilizes resources like bandwidth and having a capability to handle the heavy load in network that also reduces the possibility of congestion but performance of proposed scheme is more better from it. The proposed approach for balancing the network load which can tackle congestion and maintain strong link in between sender and receiver. However, the benefits of proposed multipath routing come at a worth as managed data transmission on multiple methods interfere with one another. In dynamic network multipath route establishment is not

easy to maintain strong link but proposed scheme able to provide the strong link and the link is not break due to congestion. The strong connection establishment is also reduces the possibility of link breakage and by that the overhead in network is also reduced as compare to existing MEALBM scheme in MANET.
The load balancing in the MANET is not easy but possible to modify the routing procedure. If the load in network are enhanced due to presence of attackers i.e. Resource Consumption Attack (RCA). In this attack the bandwidth and power of mobile nodes are consumed by attacker so, in future proposed the security scheme to detect and prevent the network from RCA and recover the performance of dynamic network.

## VII. Conclusion

The congestion control scheme proposed in this research is reduces the packet loss and improves the packets receiving i.e. completely depends on the previous successful transmission. The number of nodes are interconnect with other and forming a temporary link to deliver data in between sender and receiver. The packet dropping in network is reduces the network performance and in MANET due to congestion the possibility if packet dropping is more. The mobile node has restricted computational capacities like bandwidth and buffer suspect and also not possible to enhance the available bandwidth. Additionally, mobile nodes connect and depart from the network dynamically that leads to topological changes. The previous researches are provides information of recent good work that maintain the pair of source and destination nodes using intermediate nodes which are rich and utilizes resources like bandwidth and having a capability to handle the heavy load in network that reduces the possibility of congestion. Through this survey it is sure that the multipath routing protocol is provides the better performance than multipath routing but it is possible to improve multipath protocol performance. The packet loss and other metrics are shoeing the better performance than multipath routing protocol. The proposed survey is also provides the valuable knowledge about the MANET issues, application and characteristics. The strong connection establishment is also reduces the possibility of link breakage and by that the overhead in network is also reduced as compare to existing MEALBM scheme in MANET.
In future we are interested in field of congestion and load balancing with multipath protocol in MANET. The approach for balancing the network load which can tackle congestion and at identical time extend network life time is proposed Multipath load balancing overcomes the capability limitation of single path routing by distributing data traffic on to multiple ways and reducing congestion by routing traffic through lightly loaded ways. However, the benefits of multipath routing come at a worth as synchronic data transmission on multiple methods interfere with one another. Further, once network traffic starts increasing, there'll be accumulated level of rivalry among nodes let alone higher collision level consequently leading to packet drops and network level congestion. In future planning on the basis of shortest path route is selected but multipath is provides the next shortest path for communication. The data is only delivering through shortest path and this shortest path is reliable and chooses the nodes having sufficient energy for communication. If the node was having energy 10joule and another node having energy 40 joule then communication through 40 joule is the right decision for route selection. If the higher node energy node is not available then chose the path having some amount of energy on the basis of shortest path. If the existing route is break then by default performance is also showing link based energy efficient communication and improve energy utilization in MANET.

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