Congestion Control and Multipath Routing Technique in MANET: A Survey

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Abstract*—In mobile ad hoc network (MANET), congestion is one of the most important restrictions that deteriorate the performance of the entire communication network. Multipath routing can balance the load better than the single path routing in mobile ad hoc network, thus reducing the congestion by dividing the traffic in several paths. The performance of the network can be improved by using a load balancing mechanism. Such a technique transfers work from heavy loaded nodes to lightly loaded nodes. The objective of this paper to presents survey of congestion control multipath routing is to improve the reliability and throughput and favor load balancing. In present approach, initially multiple loop-free and link disjoint paths are computed and then a mobile routing backbone is created based on the characteristics of mobile nodes in the communication network. AOMDV routing allows the establishment of multiple paths between a pair of source and destination node. It is characteristically proposed in order to maximize the reliability of data transmission or to provide load balancing and has received more and more attentions. Multipath On-demand protocol like AOMDV and other are try to improve these problems by calculate and caching multiple paths obtain during unipath discovery process. The recent and some other valuable approaches are also included in this paper to improve multipath protocol performance. The link failures in the primary path, through which data transmission is actually taking place, cause the source to switch to an alternate path in place of beginning another route discovery. The MANET proposed survey covers most of the portion that has possible to improve in field of congestion.

***Index Terms*—** *Congestion, AOMDV, Multipath, Load balancing, Routing, Survey*

I. Introduction

Mobile ad hoc Network (MANET) may be a group of mobile wireless nodes that type a network in self organized manner without of any centralized administration, whereas forwarding packets to each neighbour node in a multi-hop fashion [1,2]. In MANET, the communication doesn't have confidence any existing infrastructure like dedicated routers, transceiver base stations or perhaps cables. Mobile devices with wireless radio instrumentation are alleged to communicate with one another, while not the assistance of the other (fixed) devices. Mobile ad hoc networks (MANET) play a crucial role in providing ubiquitous services and are unreal to support future generation networks. Research in this field is becoming standard due to wide ranging applications supported. MANET's are characterised by quick dynamical topology, limited battery power and affected resources. MANET's enable easy readying as they do not require any infrastructure like base stations [2]. As MANET's are expected to support real time transmission services, network capability provisioning and Quality of Service (QoS) guarantees are a number of the key problems to be addressed. Multipath routing schemes are typically seen as an improved various in not solely providing parallel fail safe methods however conjointly seen as a decent selection for facilitating network provisioning and realizing QoS guarantees. Its effectiveness is providing bandwidth aggregation and load balancing is already proved in the wired networks and is now currently gaining connectedness in the context of Mobile ad hoc Networks and Mesh networks.

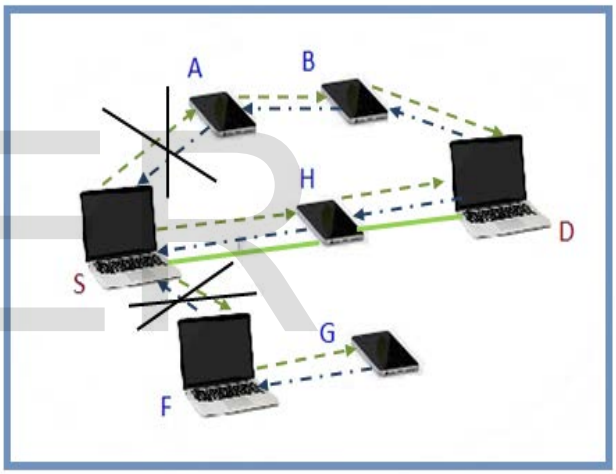

Fig. 1 Mobil Ad hoc Network

Efficient load balancing is also essential for ensuring secure QoS for delay sensitive, time period streaming applications in MANETs [1]. 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.

Section 1 is Abstract.
Section 2 is "Introduction" of MANET with congestion control.

Section 3 is about the congestion overview in MANET that occur due to limited bandwidth and bulk of incoming data

Section 4 is about the description about the performance metrics through which measures the previous congestion detection and removing techniques in MANET.

Section 5 is about the Description of multipath Routing Protocols are described the routing mechanism of different routing protocols.

Section 6 Conclusion has conclude the whole work on the basis of literature discuss in this paper.

Section 7 Future Work has described the proposed approach of congestion control technique with multipath protocol.

II. Congestion control 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 [3, 4, 6].

III. Literature Survey

Till now considerable work has been done in load balancing problem in MANETs. Several authors have done research in this domain.

This work [16] proposed a residual energy based algorithm to 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.

The unipath protocols are not support the concept of multipath routing. In these researches the only pure load balancing approach and distribution approach are highlighted. The comparison of unipath and multipath are shows the better performance in favor of multipath performance. The load and traffic balance is also observe with DSR routing protocol and at last the load is distributed to among all the paths to provides congestion free routing. In this paper [17] proposed load distribution method we compare it with another load balancing strategy that forwards traffic along one path ,found using our link quality metric and which switches over to alternate best path on route failure.

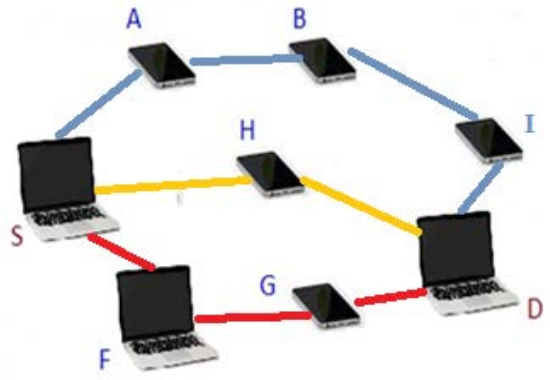

Fig.4 Multiple path Establishment

The multiple paths to destination are S-A-B-I-D,S-H-D and S-F-G-D mentioned in figure 4. In these paths the number the shortest path available is S-H-D and link in between S and H is break due to out of range of H, energy depletion of H and due to congestion in link alternative path next S-F-G-D is sending data up to destination.

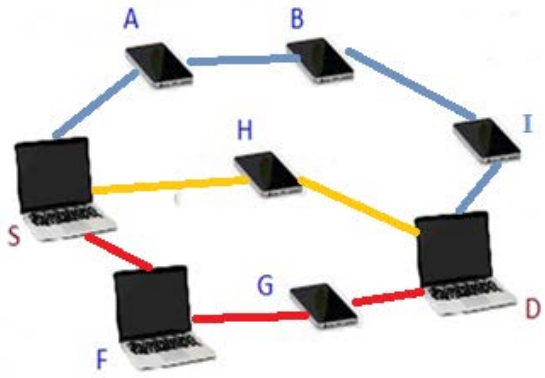

Fig.5 Data Distributed in Multipath

The data distribution in all links in multiple paths like S-A-B-I-D,S-H-D and S-F-G-D mentioned in figure 5 are distributed data in each path by that all link utilization is possible and also possible to improve energy efficiency.

Protocols considered energy constrained routing protocols and workload balancing techniques for improving MANET

routing protocols and energy efficiency. They give new routing protocol that employs adaptive load balancing technique to the MANET routing protocols with node caching enhancement. Also, they show new application of energy efficiency metrics to MANET routing protocols for energy efficiency evaluation of the protocols with limited power supply. The goal of this design is to find lightly loaded node disjoint paths with less interference and which balances the traffic over multiple paths adaptively according to the link conditions and at the same time extends the network life time.

The multipath is improves the network performance and this performance is also improve to control the sender rate and improve the nodes processing speed in network. If the network is congested then immediately call to sender to stop or slow the data sending and enhance the queue size of nodes to minimize the data dropping. The O-QMRP (Optimized Quality of Service Multipath Routing Protocol) [7] protocol establishes multiple nodedisjoint paths that will experience the lowest delay. Most delay-aware routing protocols use the current estimate of the End-to-End (ETE) delay whether it's the current queue size or the history in addition to the current experienced delay along a path. However, this is not an accurate measure of the delay that is going to be experienced by the node requesting a path, since such node will increase the total network load. Once the network load increases, ETE delay that was obtained through a Route-REQuest (RREQ) is no longer accurate. However, by introducing the projected increase in load into the computation of ETE delay, this obtained ETE delay reflects the accurate channel state. The RREQ, the node adds/updates the entry in its routing table and generates an RREP. The destination unicasts an RREP back to the source node and the *EPD* field of the RREP is initialized to zero, subsequent nodes that receive the RREP maintain their routing table according to the conditions specified, increment the *EPD (Expected Path Delay)* field of the RREP with their calculated delay, and then forward the RREP to the next hop towards the source node. Additionally, all nodes can only forward one copy of the RREP per source and per destination sequence number which guarantees node dis-jointness.

In MANET the routing is the critical issue because of the dynamic link and random motion of mobile nodes in network. For improvement of QoS of network routing improvement is necessary and improved routing minimizes the link failure in network. This paper presents [18] a novel approach called Multipath QoS Mobile Routing Backbones (MP-QMRB) for enhanced load balancing in MANETs. The method we advise works many mobile routing backbones (MRB) between a pair of source and destination nodes using in-between nodes which are rich in possessions like bandwidth, handling power, remaining energy etc. The protocol confirms that the existing bandwidth in the network is operated efficiently by allocating traffic evenly which confirms better load balancing and congestion control. AOMDV is fundamentally using the same route request (RREQ) and route reply (RREP) tool used in AODV for route finding. Each copy of the RREQ packet arriving at a node actually defines an alternate path back to the source [19]. In order to eliminate any possibility of loops, AOMDV uses the notion of an '*advertised hop-count*'. The presented hop-count of a node *i* for a destination *d* represents the extreme hop-count of the several paths for *d* existing at *i*. 'Extreme hop-count' is reflected, as then the advertised hop-count can never change for the same sequence number. The protocol only allows compliant alternate routes with lower hop counts. This guarantees loop freedom. In AOMDV, 'advertised hop-count' replaces 'hop-count' in AODV and 'route list' replaces the 'next hop' and essentially defines multiple next hops with respective hop-counts [19]. Though all next hops still have the same destination sequence number. The accessible hop-count is modified each time the sequence number is updated. Our approach finds multiple paths from source to destination using the AOMDV approach in such a way that each path so constructed will satisfy the conditions of an MRB. The path with highest routing metric is selected as the primary path and data transmission takes place though this path. In case of a route failure, the secondary path with next highest metric is selected. This avoids the route re-discovery process of single path routing thus reducing overhead

The load in network is enhanced by that the congestion is occur and packet dropping is enhanced. The load awareness is essential to improve performance. "Load Balanced Routing In Mobile Ad Hoc Networks"[15] presented a new protocol called Load Aware Routing in Ad hoc (LARA) networks protocol for efficient data transmission in mobile ad hoc networks. They also define a new metric for routing called traffic density to represent the degree of contention at the medium access control layer. During the route system, this metric is used to select the route with the least traffic load. LARA protocol needs that each node maintain a record of the modern traffic queue assessments at each of its neighbors in a table called the neighborhood table. This table is used to keep the load evidence of local neighbors at each node. This information is composed through two types of broadcasts. The first type of broadcast follows when a node tries to determine route to a destination node. This type of broadcast is called route request. The second type of propagation is the hello packet broadcasting. In the in that a node has not sent any messages to any of its neighbors within a predefined timeout period, called the hello interval, it broadcasts a hello message to its neighbors. A hello packet comprises the sender node's personality and its traffic queue status. Neighbors that receive this packet inform the equivalent neighbor's load information in their neighborhood tables. If a node does not have a data or a hello message from some of its neighbors for a predefined time, it accepts that these nodes have moved out of the wireless range of this node and it variations its neighborhood table therefore. Receiving a message from a new node is also an suggestion of the change of neighbor evidence and is handled appropriately.

This paper [20], a technique for Multipath Load Balancing and Rate Based Congestion Control (MLBRBCC) is presented. In our technique, source node forwards the data packet to the destination node through the intermediate nodes. Upon reaction of the data packet, the channel operation percentage and queue length are likely at each extreme node along the destination. Founded on these principles congestion status and likely rate

are calculated and transmitted near the destination. By checking the reorganized values from the middle nodes, the destination node determines the projected rate and it is transmitted as a response to the sender. The source node forwards the data packet to the destination through the intermediate nodes. On reaction of the data packet at the intermediate node, proportion of channel application and queue length are likely and node is verified for congestion status. This process is recurrent at every middle node, and finally the packet reaches the destination node. After the reaction of the data packet, the destination node draughts for the rate information in the packets IP header fields. Along with other important fields, estimated rate is copied to an acknowledgement packet and sent as a response to the sender. The sender performs rate control according to the estimated rate gained from the destination.

The mobile network nodes today use Drop tail queue management where packets are discarded when the queue is full. When multiple packets are dropped due to queue overflow, multiple TCP flows (to which these packets belong to) back off [21]. However, as there is a considerable amount of delay between the packet drop at the queue and the notification at the sender, large number of packets may be dropped as the sender continues sending at its current rate. Multiple flows backing off results in under utilization of the queue (no congestion). When these flows sense this (no congestion), they start increasing their sending rates as a result of which after some time the queue overflows again. This phenomenon of alternating periods of under utilization and over utilization is caused by the Drop Tail queue management policy and is called Global Synchronisation. Random Early Detection (RED) was proposed as a solution to the 'Global Synchronization' problem and this opened up a new area of research called Active Queue Management (AQM). The key aims of AQM are to prevent global synchronization, reduce queuing delays and improve resource utilization. AQM has been extensively studied in the context of wired networks. A few approaches have also studied the implications of employing AQM in the fixed wireless side (WLANs in particular) with encouraging results. However, to the best of our knowledge no approach has ever studied the implications of AQM in mobile environments. If benefits in terms of improved performance (reduced packet loss) are to be reaped by deploying AQM in MANETs, it is imperative that any such scheme should be Lightweight, Requires less memory, Processing power and energy.

AOMDV includes the AODV protocol to determine several paths between the source and the destination in every route discovery. The protocol computes multiple loop-free and link-disjoint paths. Loop-freedom is assured by using a notion of "advertised-hopcount". The proposed [23] technique of load balancing is Network Coding-based AOMDV routing algorithm in MANET (NC-AOMDV). It is typically proposed in order to rise the reliability of data transmission, and by applying network coding, which allows packet encrypting at a relay node. Because the encoding packet is produced by a relay node, the source node does not need to encrypt the packets, and sends only data packets to each route. Thus, the packets transmitted by the source node are not improved. 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. The proposed multiple link-disjoint paths are constructed, and then the source node sends packets to a neighbor node on each path. The neighbor node creates an encoded packet when it receives the necessary data packets for encoding, then the neighbor node sends the encoded packet. This multipath method delivers load balancing and avoids the ineffectiveness of AODV that needs a new route discovery during a path breaks. The fundamental of the AOMDV protocol lies in confirming that multiple paths revealed are loop-free and disjoint, and in efficiently discovery such paths using a flood-based route discovery. AOMDV route inform rules, applied close by at each node, play a key role in maintaining loop-freedom and disjointness properties.

Table 1 Comparison of Different Congestion Control Protocols

IV. Result Comparison

Most of the routing protocols that are proposed for mesh and ad hoc networks are unipath, which implies only one route, is employed between a supply and a destination node. The main goal of multipath routing is to permit the utilization of many sensible methods to succeed in destinations, not simply the most effective path. This could be achieved while not imposing excessive management overhead in maintaining such paths. The supply of multiple methods between a supply and a destination are often wont to reach the following benefits:-

- **Fault tolerance:** introducing redundancy within the network [7] or providing backup routes to be used once there's a failure sort of introducing fault tolerance at the routing level in mesh networks. to this end, some techniques could also be applied like packet salvaging [8], that consist in modifying the route of a packet if the particular route is broken.
- **Throughput enhancement:** in a very mesh network, some links will have restricted bandwidth. Routing on one path might not give enough bandwidth for a association. Therefore, using at the same time multiple methods to route data are often a decent approach to satisfy the bandwidth demand of some applications. By increasing the outturn, a smaller end-to-end delay is achieved and quality of service is improved.
- **Load balancing:** as traffic distribution isn't equal altogether links within the network, spreading the traffic on multiple routes will alleviate congestion in some links and bottlenecks.

	Protocol	Multiple Route	Overhead	Energy	Packet Delivery/ number of nodes	Throughput Data packet/per second	End to End Delay/no. of nodes	Network Life	Configuration Complexity
[15]LOAD AWARE ROUTING	LARA	NO	LOW	MOD.	0	10	10	MOD.	YES
[16] RESIDUAL ENERGY BASED	ECRP	YES	LOW	HIGH	0	5	25	HIGH	NO
[17]LOAD DISTRIBUTTION METHOD	DSR	YES	MOD.	HIGH	10	5	0	HIGH	NO
[18] MULTIPATH QOS MOBILE ROUTING	Q-PAR	YES	HIGH	HIGH	0	25	0	HIGH	NO
[19]AOMDV HOP COUNT APPROACH	AODV	NO	HIGH	HIGH	1	5	25	HIGH	YES
[20] RATE BASED CONGESTION	TCP	YES	LOW	HIGH	2	1	0	HIGH	NO
[23]NC-AOMDV	AOMDV	YES	MOD	HIGH	30	50	1	HIGH	YES
[7]MULTIPATH NO-DISJOINT	QMPR	YES	LOW	HIGH	1	0	1	HIGH	YES

The observations of research of some authors are explained below. The performance is measure through:-

The performance metrics in case of proposed profile based cluster communication is considered for performance measurement is mentioned below:-

1. **PDR(Packet Delivery Ratio)**

It is the performance to calculate the ratio of percentage of successful transmission of data in between sender and receiver in network.

2. **Residual Energy**

The energy remains in network after the completion of simulation time in given by user. The remaining energy of nodes is decided the life time of network.

3. **Routing Overhead**

Every communication in network is performing in between sender and receiver in WSN. The numbers of senders are sending routing packets for establish connection These packets are contain the route information.

4. **Throughput Analysis**

Throughput is the number of receives are receive data in unit time and this time is consider in seconds in network. The throughput is counted in bps (bits per second) but it is possible to evaluate in packets per seconds at network layer.

V. Conclusion

In MANET mobile nodes are performed as both host and router conveying traffic on behalf of other nodes in the network, which characterize MANET by simple of operation in anywhere. 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.

VI. Future Work

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 deliver through shortest path and this shortest path is reliable and choose the nodes having sufficient enrgy 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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