Load Balancing Congestion Control Techniques in Mobile Ad hoc Network: A Survey

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***Abstract*— Mobile ad-hoc network (MANET) is accomplished of forming a temporary network, without the required of a central administration or standard support devices available in a conventional network, thus forming an infrastructure-less network. In order to guarantee for the future, the mobile ad hoc networks establishes the networks everywhere. Congestion, the major reason for a link break is caused due to excessive load on the network, further leads to failure of nodes and topology change in the ad-hoc network. The excessive load on the nodes cause the buffer overflow that further lead to the packets being dropped. This leads to packet delay and affects the packet delivery ratio of MANET protocol. Load balancing is a solution to avoid congestion in the network. If the load is balanced then it will provide effective use of the network and reduce packet delay and improve packet delivery ratio. Transferring load of congested route to less congested routes improves overall network performance. Ad hoc On-Demand Multipath Distance Vector (AOMDV) selects a path with a lower hop count and discards routes with higher hop count. In this paper we present the survey of congestion control routing techniques to detect and avoid the possibility of congestion.**

***Index Terms*—Congestion, Multipath, Load balancing, MANET**

I. INTRODUCTION

Mobility and the lack of any fixed infrastructure make Mobile Ad-hoc Networks (MANETs) very gorgeous for new age applications. There are a lot of issues and challenges in designing a MANET network. A mobile ad hoc network (MANET) group has been formed within IETF. The primary focus of this working group is to develop and evolve MANET specifications and introduce them to the Internet standard track. The goal is to support mobile ad hoc networks with hundreds of routers and solve challenges in this kind of network. Some challenges that ad hoc networking faces are limited wireless transmission range, hidden terminal problems, packet losses due to transmission errors, mobility- induced route changes, and battery constraints. Mobile ad hoc networks could enhance the service area of access networks and provide wireless connectivity into areas with poor or previously no coverage (e.g., cell edges). Connectivity to wired infrastructure will be provided through multiple gateways with possibly different capabilities and utilization. To improve performance, the mobile host should have the ability to adapt At transport layer, end-systems can gather information about each used path: congestion state, capacity and latency. This information can then be used to react to congestion events in the network by moving the traffic away from congested paths [1].

The environment of an ad hoc network is characterized by unpredictable connectivity changes, unreliable wireless medium, resource-constrained nodes, and dynamic topology. These features make a MANET prone to numerous types of failures including: transmission errors, node failures, link failures, route breakages, and congestions. The environment of ad hoc network can be categorized into three main states: an ideal state, wherein the network is relatively stable with sufficient resources; a congested state, wherein some nodes, regions or the whole network is experiencing congestion; and an energy critical state, wherein the energy capacity of nodes in the network is critically low. Under these conditions, designing an efficient and reliable routing protocol that adapts to the current state of the network is an important and challenging task. To our knowledge none of the current routing protocols designed and evaluated for ad hoc networks in literatures has demonstrated effective operation in a wide range of network dynamics or states. . Figure 1.represents the mobile ad hoc network. The number of nodes are presents the independent connection between the sender and receiver.

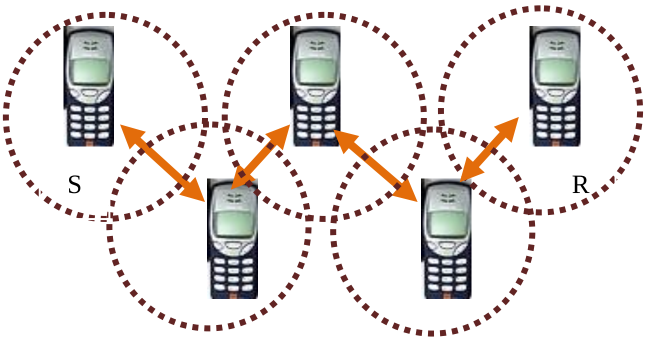

Fig.1 Mobile Ad hoc Network

Mobile Ad-hoc Networks (MANETs) is very gorgeous for latest applications. There are a lot of issues and challenges in designing a MANET network. Because active topology structure and node change every second on its position, one of the measure challenges is congestion, in MANET if sender node want to send data into the some specific receiver so very first broadcast routing packet onto the network and get destination through the shortest path (if we apply AODV) or minimum intermediate hop (if we use DSR) after getting path sender sends actual data through uni-path link but at the same time more than one sender share common link so congestion occur onto the network that is measure issue for MANET. So various researcher works in that filed for minimization of congestion from network. In this synopsis we focus congestion minimization using multipath routing in ad-hoc network and transport layer base congestion control or rate analysis base congestion control in MANET.

In multipath technique sender sends data through more than one path to receiver node that increases the performance of the network are control the single share path congestion after that we also analyze data rate of sender if sender rate greater than the receiver node so we minimize the sending rate on the bases of transport layer technique. There is a possibility of load imbalance due to that the computing/processing power of the systems are non-uniform (i.e.,) few nodes maybe idle and few will be overloaded. A node which has high processing power finishes its own work quickly and is estimated to have less or no load at all most of the time. So, in the presence of under-loaded nodes, the need for over-loaded nodes is undesirable.

Multi-path routing can balance the load better than the single path routing in ad hoc networks, where the first selective shortest paths are used for routing. This is possible only for the networks having a huge number of nodes (i.e., a large fraction of the total number of nodes in the network) between any source-destination pair of nodes. It is infeasible to build such a system it is economical for discovering and maintaining a large number of paths. Load balance is not improved by using multiple shortest path routes instead of a single path. So, for a better load balanced network distributed multi-path load splitting strategies need to be carefully designed.

Load balanced routing aims to move traffic from the areas that are above the optimal load to less loaded areas, so that the entire network achieves better performance. If the traffic is not distributed evenly, then some areas in a network are under heavy load while some are lightly loaded or idle.

II. MANET Challenges & Needs

- Autonomous- No centralized administration entity is available to manage the operation of the different mobile nodes.
- Dynamic topology- Nodes are mobile and can be connected dynamically in an arbitrary manner. Links of the network vary timely and are based on the proximity of one node to another node.
- Device discovery- Identifying relevant newly moved in nodes and informing about their existence need dynamic update to facilitate automatic optimal route selection.
- Poor Transmission Quality- This is an inherent problem of wireless communication caused by several error sources that result in degradation of the received signal.
- Network configuration- The whole MANET infrastructure is dynamic and is the reason for dynamic connection and disconnection of the variable links.
- Topology maintenance- Updating information of dynamic links among nodes in MANETs is a major challenge.

Mobile Ad-hoc network are useful for providing cost less communication

- For Intelligent transportation systems
- Mine site operations
- Battle field area
- Wildlife monitoring
- For Vehicular ad hoc networks
- For Health monitoring

III. Multipath Routing

The process of discovering multiple routes among the distinct source and single destination at the time of single route discovery corresponds to multi-path routing [1]. In MANET, the prevailing issues such as scalability, security, network lifetime, etc can be handled by the multi-path routing protocols [2]. This protocol enhances the end-to-end throughput and offers load balancing in MANETs.

A. *Multipath Routing Issues.*

Multipath routing has some disadvantages [2]:

1) Route Request Storm

A huge quantity of route request messages are created by the multipath reactive routing protocols. When the intermediate nodes requires to process the duplicate request messages, there is a chance of unnecessary overhead packets be set up in the networks.

2) Inefficient Route Discovery

Certain multi-path routing protocols avoid intermediate node from forwarding a reply from its route cache in order to determine node-disjoint or link disjoint paths. Hence the source has to wait till it gets a reply from destination. Thus the process of route discovery performed by the multipath routing protocol needs more time when compared with DSR or AODV protocols.

Mobile ad hoc environments can vary greatly in terms of the number of nodes, density of the network and bandwidth constraints. We propose and investigate the tradeoffs between two variations of the MP-AOMDV protocol:

- Node-Disjoint MP-AOMDV
- Link-Disjoint MP-AOMDV

The node-disjoint version is a more strict variation of the link-disjoint protocol and thus produces fewer alternate routes. Because the node-disjoint protocol discovers completely independent paths, each path will fail independently.

With the link-disjoint protocol, individual node movement can cause the loss of multiple paths. However, the node-disjoint approach is less useful in sparse environments where there are few node-disjoint paths. In such scenarios, the link-disjoint version will prove to be more useful, since it can produce a greater number of alternate paths. Hence, we investigate both variations in this paper.

B. Node-Disjoint MP-AOMDV

Discovery of Multiple Node-Disjoint Paths: The purpose of computing alternate paths for a source node is that when the primary path breaks due node movement, one of the alternate paths can then be chosen as the next primary path and data transmission can continue without initiating another route discovery. One way to increase the likelihood that the alternate paths themselves are valid is to make sure that the alternate paths do not have any nodes in common with each other. Two routes that do not have any nodes in common are said to be node-disjoint. Previous studies suggest that such paths typically fail independently [3].

MP-AOMDV modifies the base AODV protocol's route discovery mechanism, in a manner similar to [3], to enable discovery of multiple node-disjoint paths for a particular source node. The RREQ packet is modified to contain the address of the neighbor of the source through which it has been forwarded. The destination node uses this information to reply to only those RREQs that come from distinct neighbors of the source. Since every intermediate node forwards only one RREQ toward the destination, each RREQ arriving at the destination has traveled along a unique path from source to destination. Thus when the destination replies only to RREQs from distinct neighbors of the source, these RREPs arrive at the source via node-disjoint paths. The source node then stores, in its route table, multiple next hops for each destination. Refer to [3] for a proof of correctness of the route discovery mechanism.

IV. Congestion in MANET

When the requirements become greater than maximum capability of the communication link particularly during multiple hosts attempting to access a shared media, congestion occurs in the network. Congestion may also be caused during the following conditions.

- When the load in the link goes beyond the carrying capacity.
- When the broadcasting packets are surplus in nature.
- When more number of packets field has becomes time out and retransmitted.
- When the number of node increases.
- During standard deviation of the packet delay [4].

The congestion detected in the network can rigorously worsen network throughput [3]. It results in the packet losses, bandwidth degradation and energy expenditure [5]. When the congested network is left unattended i.e., when suitable congestion control technique is not executed, it results in congestion collapse of the network. So the data will not deliver to destined node in effective manner [3]. When the routing protocols in MANET are not conscious about the congestion, it results in the following issues.

- **Long delay:** This holds up the process of detecting the congestion. When the congestion is more rigorous, it is better to select an alternate new path. But the prevailing on-demand routing protocol delays the route searching process.
- **High overhead:** More processing and communication attempts are required for a new route discovery. If the multi-path routing is utilized, its needs additional endeavor for upholding the multi-paths despite the existence of alternate route.
- **Many packet losses:** The congestion control technique attempts to minimize the excess load in the network by either reducing the sending rate at the sender side or by dropping the packets at the intermediate nodes or by executing both the process. This causes increased packet loss rate or minimum throughput.

Moreover, in high mobility scenarios, the average end-to-end delay can be significantly high due to frequent route discoveries. Multipath on-demand protocols try to alleviate these problems by computing and caching multiple paths obtained during a single route discovery process. The performance of these protocols tends to increase with node density; at higher node densities, a greater number of alternate paths are available. In such protocols, link failures in the primary path, through which data transmission is actually taking place, cause the source to switch to an alternate path instead of initiating another route discovery. A new route discovery occurs only when all pre-computed paths break. This approach can result in reduced delay since packets do not need to be buffered at the source when an alternate path is available.

V. Literature Review

Here we are presenting survey about existing work done in the field of MANET routing protocol, congestion control.

Kezhong Liu ; Layuan Li in his work titled "Research of QoS-Aware Routing Protocol with Load Balancing for Mobile Ad Hoc Networks"[2] this paper combines the multi-constraint QoS mechanism with the load balancing scheme to search the satisfying path between the source node and destination node. The researcher main objective is to develop a load balancing strategy that could monitor any changes to the load status of the neighborhoods and be able to choose the least loaded routes with the knowledge of the surrounding load status. The AQRL protocol makes an extension on the AODV and utilizes the node's resolvable bandwidth and load information to distribute the network loads, which can prevent network from getting into the sate of congestion, and avoid the power of congested node to be exhausted.

Yi, J., Adnane, A., David, S. and Parrein, B. in his work titled "Multipath optimized link state routing for mobile ad hoc networks"[3] The algorithm gains great flexibility and extensibility by employing different link metrics and cost functions. In addition, route recovery and loop detection are implemented in MP-OLSR in order to improve quality of service regarding OLSR.Multipath routing protocols for Mobile Ad hoc Network (MANET) address the problem of scalability, security (confidentiality and integrity), lifetime of networks, instability of wireless transmissions, and their adaptation to applications.

G.Vijaya Lakshmi Dr. C.Shoba Bindhu, in his work titled " Congestion Control Avoidance in Ad hoc network using queuing model",[4] they proposed the queuing mechanism hence improves the network metrics such as overall network throughput, reduces the route delay, overhead and traffic blockage probability. The approach is generated over a routing scheme in ad-hoc network.

Vijayaragavan Shanmugam and Duraiswamy Karuppaswamy, in his work titled " An Analysis of Power Aware Congestion Control Multipath Multicast Protocol for Mobile Ad hoc Network",[5] In this paper, they propose a Power-Aware Multiple Path Multicast Adhoc On Demand Distance Vector (PAMPMAODV) for MANETs. In order to utilize the battery effectively a different strategy has been proposed for route selection. The route selection process has been designed to select multiple routes based on hop count, end-to-end delay and residual battery capacity. The PAMP-MAODV protocol has been implemented using the group learning module of VCR and compared with MAODV and MP-MAODV routing protocols for parameters such as network traffic, the node speed, the network area, throughput, control overhead, number of receivers and SD of Battery Energy Used.

S.Santhosh baboo and B.Narasimhan, in his work titled "A Hop-by-Hop Congestion-Aware Routing Protocol for Heterogeneous Mobile Ad-hoc Networks", [6] In this paper, they propose to develop a hop-by-hop congestion aware routing protocol which employs a combined weight value as a routing metric, based on the data rate, queuing delay, link quality and MAC overhead. Among the discovered routes, the route with minimum cost index is selected, which is based on the node weight of all the in-network nodes.

Makoto Ikeda, Elis Kulla et. al. "Congestion Control for Multi-flow Traffic in Wireless Mobile Ad-hoc Networks" [1] In this paper, researcher deal with congestion control for multi-flow traffic in wireless mobile ad-hoc networks (MANET) using OLSR routing. This approach done through OLSR routing they also apply multi flow in AODV routing approach.

Tuan Anh Le, Choong Seon Hong, Member, IEEE, Md. Abdur Razzaque et. al. in his work titled "An Energy-Aware Congestion Control Algorithm for Multipath TCP" [7] In this paper, they develop ecMTCP. ecMTCP moves traffic from the most congested paths to the more lightly loaded paths, as well as from higher energy cost paths to the lower ones, thus achieving load-balancing and energy-savings. This paper focus congestion control with the help of energy base load balancing mechanism, this work also modified via multipath routing technique for end-to-end delay minimization.

Jingyuan Wang, Jiangtao Wen et. al. in his work titled "An Improved TCP Congestion Control Algorithm and its Performance" [8] In this paper, they propose a novel congestion control algorithm, named TCP-FIT, which could perform gracefully in both wireless and high BDP networks. The algorithm was inspired by parallel TCP, but with the important distinctions that only one TCP connection with one congestion window is established for each TCP session, and that no modifications to other layers (e.g. the application layer) of the end-to-end system need to be made. This work done only transport layer congestion control via TCP improvement method but congestion also occurs in routing time so that work enhance through routing base congestion control technique.

M. Ali, B. G Stewart et. al. In his work titled "Multipath Routing Backbones for Load Balancing in Mobile Ad Hoc Networks" [9] this paper presents a new approach based on multipath routing backbones for enhanced load balancing in MANETs. Nodes in MANETs greatly differ with each other in terms of communication and processing capabilities. In the proposed approach, multiple routing backbones are identified from source to destination using intermediate nodes that have better communication and processing capabilities to take part in the mobile routing backbones and efficiently participate in the routing process. This work use multipath technique but not execute multipath simultaneously that case use alternative base load balancing technique.

S.Karunakaran et al [10] proposed a "cluster based congestion control (CBCC) protocol that consists of scalable and distributed cluster-based mechanisms for supporting congestion control in ad hoc networks". The clusters autonomously and proactively monitor congestion within its localized scope. The present approach improves the responsiveness of the system when compared to end-to-end techniques. After estimating the traffic rate along a path, the sending rate of the source nodes is adjusted accordingly. Thus this protocol look forward the injection of dynamic flows in the network and proactively adjusts the rate while waiting for congestion feedback.

S.Venkatasubramanian [11] proposed "QoS architecture for Bandwidth Management and Rate Control in MANET". The proposed QoS architecture contains an adaptive bandwidth management technique which measures the available bandwidth at each node in real-time and it is then propagated on demand by the QoS routing protocol. The source nodes perform call admission control for different priority of flows based on the bandwidth information provided by the QoS routing. A rate control mechanism is used to regulate best-effort traffic, whenever network congestion is detected.

Kai Chen et al [12] proposed "an explicit rate-based flow control scheme (called EXACT) for the MANET network". In EXACT, flow's allowed rate is explicitly conveyed from intermediate routers to the end-hosts in each data packet's special control header. As a result, EXACT reacts quickly and precisely to re-routing and bandwidth variation, which makes it especially suitable for a dynamic MANET network.

Kazi Chandrima Rahman et al [13] proposed "explicit rate based congestion control (XRCC) for multimedia streaming over mobile ad hoc networks". XRCC addresses the problems that TCP faces when deployed over ad-hoc networks, and thus shows considerable performance improvement over TCP. Although XRCC minimizes packet drops caused by network congestion as compared to TCP congestion control mechanism, it still suffers from packet drops.

Hongqiang Zhai et al [14] proposed "a novel rate based end-to-end Congestion Control scheme (RBCC)". Based on the novel use of channel busyness ratio, which is an accurate sign of the network utilization and congestion status, a new rate control scheme has been proposed to efficiently and reliably support the transport service in MANET. In RBCC, a sub layer consisting of a leaky bucket is added under TCP to control the sending rate based on the network layer feedback at the bottleneck node.

Emmanuel Lochin et al [15] proposed "a complete reliable rate-based protocol based on TCP-Friendly Rate Control (TFRC) and selective acknowledgement (SACK) mechanisms". This design also introduces a flow control variable, which regulates the sender to avoid packet loss at the receiver due to a slow receiver. In this mechanism, there is no packet loss due to flow control, at the receiver, and applies a smoothness criterion to demonstrate that the introduction of the flow control inside TFRC does not alter the smoothness property of this mechanism.

Yuedong Xu et al [16] proposed "A fully distributed congestion control algorithm to balance throughput and fairness for TCP flows in multi-hop ad hoc networks". The interactions between the hidden nodes and network congestion are mainly focused. A distributed algorithm to improve the end-to-end throughput, and at the same time, provide per-flow fairness by exploiting cross-layer information is proposed. In the link layer, each node uses a proportional controller to determine the ECN marking probability for the purpose of notifying incipient congestion. Then the rate based TCP sender adjusts its sending rate according to the feedbacks from the link layer.

Yuanyuan ZOU, Yang TAO at el [17] proposed a "A Method of Selecting Path Based on Neighbor Stability in Ad Hoc Network" in this paper they studies about routing algorithm based on the stability in mobile Ad-Hoc network and presents a routing mechanism based on neighbor stability. They put the mechanism in multicast routing protocol MAODV [12] and propose a improved routing algorithm NBS-MAODV which is based on MAODV algorithm. NBS-MAODV algorithm sends data according to the neighbor stability metric in the path construction process. It can reduce the times of link fracture caused by network mobility and increase the total overhead of network.

Ashish Bagwari et al [18] proposed "Performance of AODV Routing Protocol with increasing the MANET Nodes and its effects on QoS of Mobile Ad hoc Networks" In this paper they are analyzing the performance of reactive routing protocol via enhancing number of nodes and observe how it effects to QoS of existing mobile Ad-hoc network. Here Mobile ad-hoc network are dividing into clusters. Each cluster has MANET node with CHG. From one cluster to another cluster or within the cluster we applied reactive routing protocols specifically AODV to evaluate AODV protocol behavior and performance and check what kind of effect made by particular protocol on QoS.

Vishnu Kumar Sharma et al proposed "Mobile Agent Based Congestion Control Using AODV Routing Protocol Technique for Mobile Ad-Hoc Network" [19]. In this proposal, they propose to agent based congestion control technique for MANETs. In there technique, the information about network congestion is collected and distributed by mobile agents (MA) A mobile agent based congestion control AODV routing protocol is proposed to avoid congestion in ad hoc network. Some mobile agents are collected in ad-hoc network, which carry routing information and nodes congestion status. When mobile agent movements through the network, it can select a less-loaded neighbor node as its next hop and update the routing table according to the node's congestion status. With the support of mobile agents, the nodes can get the dynamic network topology in time. And they conclude through that paper there proposed technique attains high delivery ratio and throughput with reduced delay when compared with the different existing technique.

The Split Multipath Routing (SMR) is proposed in [20]. SMR is used to construct maximally disjoint paths. Maximally disjoint paths have as few links or nodes in common as possible.

The Scalable Multipath On-demand Routing (SMORT) is proposed in [21], which establishes fail-safe paths between intermediate nodes and the destination, reducing the delay and routing overhead, while achieving higher packet delivery ratios.

In [22] Sambasivam et al propose to use periodic update packets unicast along each path which are used to measure the signal strength of each hop along the alternate paths and at any point, only the path with the strongest signal strength is used for data transmission.

In [23], Roy et al propose a New Layer that is capable of gathering Neighbor Stability information which can be used to modify the routing algorithms like AODV so as to refrain them from accepting spurious route update messages (like the route updates broadcast by nodes passing by) to avoid unstable neighbors to be identified as the forwarding node. For this purpose, a Protocol Specific Beacon has been used. In this paper, we propose to augment this beacon so that the nodes in the network can piggy-back their status information like the current fractional usage of its available bandwidth, available battery power etc.

In [24], the authors propose a scheme to calculate alternate paths such that when a link failure occurs, the intermediate node searches for an alternate path to circumvent the broken link. The basic assumption made in this protocol is that all the nodes are in promiscuous mode and that they can overhear every transmission within their range. This protocol, however, has a number of limitations. First, it assumes that several nodes are within transmission range of each other. Also, constant mobility of the nodes is not taken into account. The protocol assumes that a node that offers the alternate route around a broken link does not move away and remains within range of the two nodes between whom the link has broken. Moreover, the utilization of promiscuous mode greatly increases the power consumption of each node.

The authors propose an on-demand routing scheme, called Split Multipath Routing (SMR) [25] that establishes and utilizes multiple routes of maximally disjoint paths. In this paper, the authors attempt to build maximally disjoint routes to prevent certain links from becoming congested and to efficiently utilize the available network resources. The SMR protocol is a variation of the DSR protocol and makes use of source routing to cache pre-computed alternate routes.

VI. Research Findings

MANET (Mobile Ad-Hoc Network) is following the rule of dynamic that means uncertainty of the network topology. So every discrete time duration node change established routing path from one to another and increases the routing overhead as well as drop data packet that point diverted. To find out the reason of data drop that is following like drop through collision, route error, time out, route not exist, duplicate data packet, end of simulation etc. that all point degraded the performance of the network and generate retransmission condition and provide the reason for congestion occurrence and maximize delay. So our focus in module of congestion controls method. The protocol attempts to find multiple paths that collectively satisfy the bandwidth requirements. The original bandwidth requirement is essentially split into multiple sub-bandwidth requirements. Each sub-path is then responsible for one sub-bandwidth requirement. This protocol is on-demand and uses the local bandwidth information available at each node for discovering routes. A ticket-based approach is used to search for multiple paths. In this approach a number of probes are sent out from the source, each carrying a ticket.

It is essential to adjust the data rate used by each sender in order not to overload the network, where multiple senders compete for link bandwidth. Packets are dropped when they arrive at the router and cannot be forwarded. Many packets are dropped while excessive amount of packets arrive at a network bottleneck. The packets dropped would've traveled long way and in addition the lost packets often trigger retransmissions. This intimates that even more packets are sent into the network. And so, network throughput is still more worsened by the network congestion. There are chances of congestion collapse where almost no data is delivered successfully if no appropriate congestion control is performed.

Shared broadcast medium is used in mobile ad hoc networks. Medium capacity which is very inadequate is shared within all the nodes in a collision domain. While delivering data to multiple destinations, multicast communication is of great concern in these networks, since it helps saving resources. Group communication which is an inherent feature of many proposed applications in MANETs is added to this broadcast medium. So, it is important to avoid congestion collapse in wireless multihop networks in order to perform efficient congestion control.

Each probe is responsible for searching one path. The number of tickets sent controls the amount of flooding that is done. Each probe travels along a path that contains the necessary bandwidth. The source initially sends a certain number of tickets each containing the total bandwidth requirement. The tickets are sent along links that contain sufficient bandwidth to meet the requirement. When an intermediate node receives a ticket, it checks to see which links have enough bandwidth to meet the requirement. If it finds some, it then chooses a link, reserves the bandwidth, and forwards the ticket on the link. If no links have the required bandwidth, the node reserves bandwidth along multiple links such that the sum of the reserved bandwidths equals the original requirement. In this way, the bandwidth requirement is split into sub-bandwidth requirements equaling the bandwidths reserved along each of the links. The original ticket is split into sub-tickets, with each sub-ticket being forwarded along one of the links. Each sub-ticket is then responsible for finding a multi-path satisfying the sub-bandwidth requirement. If no links can be found to satisfy the bandwidth requirements, the intermediate node drops the ticket. Links with more available bandwidth are preferred.

Most of the existing protocols provide solutions to load balancing or congestion or fault-tolerance, individually. So a combined protocol is necessary, in order to provide solutions for all the above problems. In this study, we propose a congestion controlled multi-path routing protocol scheme to achieve load balance and avoid congestion in networks. When the average load of an existing link increases beyond a threshold and residual battery power of a node decreases below a threshold, it distributes the traffic over disjoint mutli-path routes to reduce the traffic load on a congested link. The algorithm for finding multi-path routes computes fail-safe multiple paths, which provide all the intermediate nodes on the primary path with multiple routes to destination.

VII. Discussion about Performance

The nodes are free to move randomly and organize themselves arbitrarily; thus, the networks wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. Mobile ad hoc networks are infrastructure-less networks since they do not require any fixed infrastructure, such as a base station, for their operation. In general, routes between nodes in an ad hoc network may include multiple hops, and hence it is appropriate to call such networks as ''multi-hop wireless ad hoc networks''. Each node will be able to communicate directly with any other node that resides within its transmission range. For communicating with nodes that reside beyond this range, the node needs to use intermediate nodes to relay the messages hop by hop. The ad hoc networks flexibility and convenience do come at a price. Ad hoc wireless networks inherit the traditional problems of wireless communications and wireless networking. Mobile users will want to communicate in situations in which no fixed wired infrastructure is available. For example, a group of researcher's en route to a conference may meet at the airport and need to connect to the wide area network, students may need to interact during a lecture, or fire fighters need to connect to an ambulance en route to an emergency scene. In such situations, a collection of mobile hosts with wireless network interfaces may form a temporary network without the aid of any established infrastructure or centralized administration. Because nowadays many laptops are equipped with powerful CPUs, large hard disk drives, and good sound and image capabilities, the idea of forming a network among these researchers, students, or members of a rescue team, who can easily be equipped with the devices mentioned above, seems possible. Such networks received considerable

The first and most serious challenge is that centralized controlling usually is not available in MANET due to the lack of infrastructure support. Without perfect coordination, collisions could take place when several nodes simultaneously access the shared medium. They may also result from transmissions hat are multiple-hop away. Second, due to hardware constraints, a node cannot immediately detect collisions during its transmission, which leads to channel inefficiency. Third, as every node in the network is mobile, the network topology may change from time to time. Accordingly, each node may experience different degree of channel contention and collision. At the same time, the attendant route changes also affect the interaction between the MAC layer and higher layers. Finally, several important issues like energy efficiency, fairness, or quality of service (QoS) provision need to be carefully considered when designing MAC protocols for MANET.

On the other hand, the objective of load-balancing in MANETs is different from that of wired networks due to mobility and limited resources like bandwidth, transmission range and power. In mobile ad hoc networks, balancing the load can evenly distribute the traffic over the network and prevent early expiration of overloaded nodes due to excessive power consumption in forwarding packets. It can also allow an appropriate usage of the available network resources. The existing ad-hoc routing protocols do not have a mechanism to convey the load information to the neighbors and cannot evenly distribute the load in the network. It remains a major drawback in MANETs that the nodes cannot support load balancing among different routes over the network. The performance are measured on the basis of given performance metrics

A. Metrics:

We use the following five metrics to compare the performance of the multi-path routing protocols.

1. *Routing overhead.* The routing overhead is measured as the average number of control packets transmitted at each node during the simulation. Each hop is counted as one separate transmission.

2. *Average number of paths.* The average number of paths is the amount of paths that are discovered per route request.

3. *Data packet delivery ratio.* The data packet delivery ratio is the ratio of the total number of delivered data packets at the destination to the total number of data packets sent.

4. *Average end-to-end delay of data packets.* The average end-to-end delay is the transmission delay of data packets that are delivered successfully.

5. *Load balancing.* Load balancing is the ability of a routing protocol to distribute traffic equally among the nodes. We capture this property by calculating the deviation from the optimal traffic distribution.

VIII. CONCLUSION

The major problem of node failure is congestion. The Survey has notify about, if we reduce congestion by choosing non congested routes to send RREQ and data packets and to transfer the load to higher hop count alternate paths if the nodes or route turn out to be congested. The different techniques are proposed for that related with rate, alternate path, and detection and provide multipath. AOMDV came up with the advantage of multiple routes being discovered and the route carrying the minimum hop count value is selected but again suffered with the disadvantage of source running the route discovery on node failure. These protocols will avoid congestion on routes by carrying a good route discovery technique, balance load on account of congestion that would definitely to an extent avoid node failures and has improved packet delivery ratio, throughput, reduced packet delay and packet drop performance metrics.

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