LOAD BALANCING IN MANET BY LIGHTENING THE CNETER NODE

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***Abstract*—**Mobile ad hoc network is a collection of wireless mobile nodes, which are connected over a wireless medium. There is no pre-existing communication infrastructure (no access points, no base stations) and the nodes can freely move and self-organize into a network topology. Such a network can contain two or more nodes. Hence, balancing the load in an Ad hoc network is important because the nodes have limited communication resources such as bandwidth, buffer space and battery power. MANETs require an efficient routing protocol that achieves the quality of service (QoS) mechanism. Routing protocol should be fully distributed; Adaptive to frequent topology change, Easy computation & maintenance, Optimal and loop free route optimal use of resources, Collision should be minimum. MANET consider the shortest path with minimum hop count as optimal route without any consideration traffic and thus degrading the performance of the network Therefore it is very essential to consider load balancing issue in routing mechanism. This Paper mainly focuses on survey of various load balanced Routing protocols for efficient data transmission in MANETs.

Keywords*—MANETs, Adhoc Networks, Load balancing, Qos, Delay, Network Traffic, throughput, performance, battery powercomponent.*

I. INTRODUCTION

Mobile ad hoc network is a type of wireless network which contains of mobile nodes having the capability to deploy anytime anywhere without or minimum infrastructure. The applications for mobile ad hoc networks are wide open such as disaster management, emergency operations, rescue operations and many more. One of the major application outcomes of mobile ad hoc network is vehicular ad hoc network. Some important characteristics of mobile ad hoc networks are dynamic topology, peer-to-peer fashion during data transfer, mobility of nodes and in real-time such networks are heterogeneous. The nodes that are present in the mobile ad hoc network moves arbitrarily that leads to frequent topology changes. Due to this, data transfer suffers from channel loses and reliable transfer is becoming a challenging task. Hence several routing protocols are developed. The protocols that are designed and developed for mobile ad hoc networks can be classified into three major divisions such as proactive or table-driven, reactive or on-demand and hybrid. In proactive routing protocols the routes to all the destination nodes are determined at the start up, and maintained by using a periodic route update process. The proactive routing protocols are DSDV [1], WRP [2], GSR [3], FSR [4], STAR [5], DREAM [6], MMWN [7], CGSR [8], HSR [9], OLSR [10], TBRPF [11]. In reactive protocols, routes are determined when they are required by the source using a route discovery process. The reactive routing protocols are AODV [12], DSR [13], ROAM [14], LMR [15], TORA [16], ABR [17], SSA [18], LAR [19], RDMAR [20], ARA [21], FORP [22], CBRP [23]. Hybrid routing protocols combines the properties of the first two classes of protocols into one. Hybrid routing protocols are ZRP [24], ZHLS [25], SLURP [26], DST [27], DDR [28]. That is, they are both reactive and proactive in nature. Each group has a number of different

II. ADHOC NETWORK

MANET consists of mobile hosts equipped with wireless communication devices. The main characteristics of MANET is, it operate without a central coordinator Rapidly deployable, self configuring, Multi-hop radio communication, Frequent link breakage due to mobile nodes ,Constraint resources (bandwidth, computing power, battery lifetime, etc.) and all nodes are mobile so topology can be very dynamic. So that the main challenges of routing protocol in MANET is , it should be Fully distributed, Adaptive to frequent topology change ,Easy computation & maintenance, Optimal and loop free route, Optimal use of resources, It provide QoS and Collision should be minimum.

Classification of routing protocols in MANET:- The routing protocols in MANET are classified depending on routing strategy and network structure. According to the routing strategy the routing protocols can be categorized as Table-driven and source initiated, while depending on the network structure these are classified as flat routing, hierarchical routing and geographic position assisted routing Based on the routing strategy the routing protocols can be classified into two parts:

Proactive (Table driven) routing protocol:- Each and every node in the network maintains routing information to every other node in the network. Routes information is generally kept in the routing tables and is periodically updated as the network topology changes. DSDV and WRP are the examples of proactive protocols.

Reactive (On-Demand) routing protocol:- This protocols, don’t maintain routing information or routing activity at the network nodes if there is no communication. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. DSR[29], AODV[30] are the examples of reactive protocols.

Hybrid routing protocol:- This is combination of best features of above two protocols. Node within certain distance from the node concerned, or within a particular geographical region, are said to be in routing zone. For routing within zone, proactive approach and for routing beyond the zone, a proactive routing protocol is used.

III. LOAD BALANCED ROUTING PROTOCOLS IN MANET

Chai Keong Toh et al. (2009) "Load Balanced Routing Protocols for Ad Hoc" [3] , Various Load balanced ad hoc routing protocols are on-demand-based protocols; i.e load balancing strategies is combined with route discovery phase[31].

In a broader context, the term load can be interpreted as: **Channel load**: Represents the load on the channel where multiple nodes contend to access the shared media.

Nodal load: Relates to a node's activity. Specifically, it refers to how busy a node is in processing, computation, and so on. **Neighboring load:** Represents the load generated by communication activities among neighboring nodes.

load metrics:- Load balanced ad-hoc routing protocols are based on different load metrics.

Active path: This refers to the number of active routing paths supported by a node. Generally, the higher the number of active routing paths, the busier the node since it is responsible for forwarding data packets from an upstream node to a downstream node.

Traffic size: This refers to the traffic load present at a node and its associated neighbors (measured in bytes).

Packets in interface queue: This refers to the total number of packets buffered at both the incoming and outgoing wireless interfaces.

Channel access probability: This refers to the likelihood of successful access to the wireless media. It is also related to the degree of channel contention with neighboring nodes.

Node delay: This refers to the delays incurred for packet queuing, processing, and successful transmission.

Delay-based Load-Aware On-demand Routing (DLAOR) J-H. Song et al. (2003), "Load Aware On-Demand routing (LAOR) Protocol for Mobile Ad hoc Networks" [14], which uses the optimal path based on the estimated total path delay and the hop count as the route selection criterion. The delay of each node is calculated based on packet arrival time and packet transmission time. The average delay at node includes the queuing contention and transmission delays. Then total path delay is calculated by sum of node delay from source to destination. Dp = k (k=1…n) (1) Where Qk is the node delay. In route discovery process, the RREQ packet carries hopcount, and the total path delay Dp of a path P. On receiving the RREQ packet the destination node send RREP packet back. If the duplicate RREQ packet has a minimum total path delay and hop count than the previous one, the destination sends a RREP packet again to the source node to change the route immediately. Delay based Load Aware On-demand Routing (D-LAOR) protocol is an extension of the AODV. 1)D-LAOR allows the intermediate nodes to relay duplicate RREQ packets if the new path (P') to the source of RREQ is shorter than the previous path (P) in hop count, and DP' is smaller than DP (i.e., DP' < DP). 2) Each node updates the route entry only when the newly acquired path (P') is shorter than the previous path (P) in hop count, and DP' is smaller than DP (i.e., DP' < DP).

Associativity Based Routing (ABR) Route is selected based on nodes having associativity states that imply periods of stability [32]. ABR defines a new metric for routing known as the degree of association stability. It is free from loops, deadlock, and packet duplicates. In ABR, a route is selected based on associativity states of nodes. In this manner, the routes selected are likely to be long-lived and hence there is no need to restart frequently, resulting in higher attainable throughput. Load balancing is employed during the route discovery phase. A source first sends a broadcast query (BQ) message in search of nodes that have a route to the destination. All intermediate nodes receiving the query append their addresses and associativity ticks with their neighbors along with the route relaying load (RRL) information into the query packet. In this way the query packet arriving at the destination node contains associativity ticks and relaying load information of nodes along the route. The destination node thus knows, at an appropriate time after receiving the first BQ packet, all the possible routes and their qualities. ABR then considers acceptable routes with nodes that do not exceed the maximum allowable RRL. From among the acceptable routes, the destination node chooses the most stable route and sends a reply back to the source node via the route selected. If multiple paths have the same overall degree of association stability, the route with the minimum number of hops is selected. In this way ABR avoids congested nodes.

Alternative path routing (APR):**-** M. R. Pearlman et al. (2000) "On the impact of alternate path routing for load balancing in mobile ad-hoc networks" [33], suggested to balance the load by routing the traffic over the set of disjoint route. But due to, overlapping radio-coverage of neighboring nodes it can result in, strong interdependence between alternate routes which limits APR's benefits to particular MANET topologies and channel access techniques. Channel have a significant impact on APR performance, due to "route coupling". Two routes that have nodes or links in common are considered highly coupled. However, route coupling may occur even if two routes have no common nodes or links. In the case of multiple-channel spread spectrum networks, transmission across a link may result in degraded quality for a simultaneous transmission on a neighboring link. In single-channel networks, a transmission can block transmission across neighboring links.

Dynamic Load Aware Routing (DLAR) S. J. Lee et al. (2001) "Dynamic Load Aware Routing in Ad Hoc Networks" [34], it uses the number of packets buffered in the interface as the primary route selection criteria. There are three algorithms in selecting the least loaded route. DLAR scheme 1 adds the routing load of each intermediate node and selects the route with the least sum. If there is a tie, the destination selects the route with the shortest hop distance. DLAR scheme 2 uses the average number of packets buffered at each intermediate node along the path. DLAR scheme 3 considers the number of congested intermediate nodes as the route selection metric. In DLAR protocol only the sum of the lengths of instantaneous interface queues are considered but the instantaneous queue length doesn't give exact traffic at a node.

Load Aware Routing in Ad-hoc (LARA):- Vikrant Saigala et al. (2004)," Load balanced routing in mobile ad hoc networks" [35], uses traffic density and traffic cost because thus, the time required to gain access to the shared medium is directly proportional to the traffic at the neighboring nodes.

Load-Balanced Ad hoc Routing (LBAR) H. Hassanein et al. (2003), "Load-aware destinationcontrolled routing for MANETs" [36], is on-demand routing protocol intended for delay-sensitive applications. It finds out route with least traffic and load so that data packets can be routed with least delay. This algorithm proposes four stages: Route Discovery; Path Maintenance; Local Connectivity Management; Cost Function Computation. In Route Discovery there are two stages, forward and backward. In forward phase setup message is broadcasted which carry cost information, seen from the source to the current node. In backward phase the ACK message is send via the selected path (active path). Due to mobility if the path breaks, destination pick up alternative best-cost partial route and send the ACK message in Path Maintenance phase. In local connectivity management phase, each node send 'Hello' message to neighbor to check the path breakage.The best path is calculated based on minimum traffic load in transmission and minimum interference by neighboring nodes. To find out minimum traffic load, activity (number of active path passes through node i) i.e Ai and also Traffic interference (sum of activities of neighboring node) is calculated i.e TIi . Whereas the cost of route is sum of Ai and TIi . Path is chosen which has minimum cost.

Load Sensitive Routing (LSR) protocol K. Wu et al. (2003), "Load Sensitive Routing for Mobile Ad Hoc Networks" [37], is based on the DSR. This protocol utilizes network load information as the main path selection criterion. The way to obtain network load information in LSR does not require periodic exchange of load information among neighboring nodes and is suitable for any existing routing protocol. Unlike LBAR and DLAR LSR does not require the destination nodes to wait for all possible routes. Instead, it uses a re-direction method to find better paths effectively. The source node can quickly respond to a call for connection without losing the chance to obtain the best path. Based on the initial status of an active part, LSR can search dynamically for better paths if the active path becomes congested during data transmission. In route discovery we use a redirection method similar to we developed in Multi path routing to forward Route Reply (RREP) messages. This method can let the source node obtain better path without an increase of flooding cost and waiting delay in the destination nodes. In LSR, they adapt the active routes in a route in a different context, by using network load information. When a used path becomes congested, LSR tries to search for a lightweight path. The source node continues to send data traffic along the congested paths until a better path is found. Route adaptation strategy is based on the initial status and current status of an active path.

Weighted Load Aware Routing (WLAR) Dae In Choi et al. (2003), "Design and Simulation Result of a Weighted Aware Routing (WLAR) Protocol in Mobile Ad Hoc Network" [38], is an extension of AODV, it distribute the traffics among ad hoc nodes through load balancing mechanism. They have used total traffic load, as a route selection metric. Queue size and sharing nodes (those avg. queue length is greater than threshold value) are used to find the total traffic. The total traffic is the product of average queue size and number of sharing nodes. Total traffic load in node is defined as its own traffic load plus the product of its own traffic load and the number of sharing nodes. Path load is defined as sum of total traffic loads of the nodes which include source node and all intermediate nodes on the route, except the destination node. In route discovery phase, when RREQ messages come at intermediate node, it rebroadcast it based on its own total traffic load so that the flooded RREQ's which traverse the heavily loaded routes are dropped on the way or at the destination node. Destination node will select the best route and replies RREP.

Simple Load-balancing Approach (SLA) Y. Yoo et al. (2004), "A Simple Load-Balancing Approach in Secure Ad Hoc Networks" [39], each node to drop RREQ or to give up packet forwarding depending on its own traffic load. Meanwhile, mobile nodes may deliberately give up forwarding packets to save their own energy. To make nodes volunteer in packet forwarding we also suggest a payment scheme called ProtocolIndependent Fairness Algorithm (PIFA) for packet forwarding. It's a credit based schema where the node can earn the credit when it can forward the packet, this solution is used to avoid selfness of node, which drop the packet to save its own battery power. There is server node called Credit Manager (CM), which manages nodes' Credit Database (CDB). Other MANET nodes periodically report to CM on the number of packets they forwarded in each time interval in MANETs using PIFA, nodes can originate packets only when they have enough credits which can be earned by forwarding others' packets. Also PIFA detect the malicious node which tries to cheat with other on the number of forwarding packets to acquire more credits than it should actually receive.

Correlated Load-Aware Routing (CLAR) Kyungshik Lim et al. (2004), "A Correlated Load Aware Routing Protocol in Mobile Ad Hoc Networks" [40] that consider the traffic load, through and around neighboring nodes, as the primary route selection metric. Traffic load is based on traffic passing through this node and neighboring node. The destination node selects the best route among multipaths. When the RREQ reaches the destination node, it selects the route with minimum traffic load as a best route. If there are one more routes, which have same traffic load, the destination selects the route with the shortest hop distance. When there are still multiple paths that have the least load and hop distance, the earliest path arrived at the destination is chosen.

Energy Consumption Load Balancing (ECLB) The nodes in MANETs are typically powered by batteries which have limited energy reservoir and sometimes it also becomes very difficult to recharge or replace the battery of the nodes. Hence, power consumption becomes an important issue. The power consumption rate of each node must be evenly distributed to maximize the lifetime of ad hoc mobile networks, and the overall transmission power for each connection request must be minimized.The routing protocols are designed in such a way that the paths are computed based on minimizing hop count or delay. Thus, some nodes become involved in routing packets for many source-destination pairs. The energy resources of these nodes get depleted faster than other nodes. H. K. Cho et al. (2005), "A Load-balancing Routing Considering Power Conservation in Wireless Ad-Hoc Networks" [41], makes balanced energy consumption available by calculating energy consumption rate of each node and choosing alternative route using the result to exclude the overburden-traffic-conditioned node in route directory.

Prediction based Adaptive Load Balancing (PALB) Shouyi YIN et al. (2005), "Adaptive Load Balancing in Mobile Ad hoc Networks" [42], it distributes traffic load among multiple disjoint paths based on the measurement and prediction of network traffic. PALB protocol is associated with node disjoint multipath routing like NDMR [43]. Source node periodically predicts the crosstraffic of each node in the multiple disjoint paths and adjusts traffic distribution across multiple disjoint paths. PLAB consist of different models like filtering, distribution, load balancing. Data packets first enter into packet filtering model whose objective is facilitate traffic shifting among multiple paths in a way that reduces the possibility that packets arrive at the destination out of order. The packet distribution model then distributes the traffic out from packet filtering model across the multiple paths. The distribution of traffic is based on load balancing model which decides when and how to shift traffic among the multiple paths. The load balancing model operates based on evaluation of paths stability and measurement of paths statistics. The network traffic is predicted by analyzing the traffic data collected in mobile ad hoc network testbed [44]. This load balancing approach can distribute traffic properly and reduces the end-to-end packet delay and packet dropping probability and balances the energy consumption of the network.

Workload-Based Adaptive Load Balancing (WBALB) Y. J. Lee et al. (2005), "A Workload-Based Adaptive Load-Balancing Technique for Mobile Ad Hoc Networks" [45], In traditional on demand routing algorithm the node that respond to RREQ message are considered as intermediate node on route. In WBALB, RREQ messages are forwarded selectively according to the load status of each node. Overloaded nodes do not allow additional communications to set up through them so that they can be excluded from the requested paths within a specific period.Each node begins to allow additional traffic flows again whenever its overloaded status is dissolved. Each node maintains a threshold value, which is a criterion for decision of whether or not to respond to a RREQ message. The threshold value dynamically changes according to the load status of a node based on its interface queue occupancy and its workload within a specific period.

Traffic Size Aware Routing (TSAR) Altalhi et al. (2004), "Load-Balanced Routing through Virtual Paths: Highly Adaptive and Efficient Routing Scheme for Ad Hoc Wireless Networks" [46], load balancing based on the traffic size in number of packets. Measuring the load by the number of packets is inaccurate since the size of the packets may differ. A more accurate method is to measure the traffic size in bytes. Node can maintain an entry for every active virtual path it services. This entry contains the time at which the entry was created, the number of packets, and the size of the traffic that was routed using that entry. Then the load metric is calculated which is the sum of all the traffic that is routed through all the hops that make up that path.

Node Centric Load balancing routing protocol Amjad Ali et al. (2012), "Node Centric Load Balancing Routing Protocol for Mobile Ad Hoc Networks" [47], suggested that each node avoid the congestion in greedy fashion. This algorithm uses the alternative route towards the destination to avoid new routes forming through congested node. Each node finds the current status of interface queue size, where node considers 60 as maximum queue size. Queue size 50 is considered as congestion threshold. When a node notices that the congestion threshold has been reached, it automatically starts ignoring new RREQ packets so as to not allow any new routes passing through it. They have used the concept of Terminal nodes (those nodes that are connected to the rest of the network through only a single link, in other words, they have only one neighboring node). There are few situations, If a source is a terminal node and its neighboring node is currently congested. In this case the source node broadcasts a modified RREQ message to indicate that the source has no other neighbors to forward this broadcast through. Hence exempting terminal node's RREQ from being suppressed by congested nodes. Another possible scenario is when a node that has two or more immediate neighbors but both or all of them are congested and not allowing RREQ messages from non terminal. The congested nodes temporarily buffer the RREQ packets and waits for a retransmission. If a retransmission for the same RREQ message is received the node assumes that there are no alternative routes to the destination and hence the RREQ packet is put in priority queue and subsequently broadcasted.

IV. CONCLUSION

In this paper we have discussed some important issues related to the load-balanced routing protocols for mobile ad hoc networks (MANET). Nodes in MANET have limited bandwidth, buffer space, battery power etc. So it is essential to distribute the traffic among the mobile host. There are different metrics used for the route selection. Load balancing algorithms are delay based, traffic based or hybrid based. In MANET, to improve the performance, it is very essential to balance the load. Load balancing is used to increase throughput of the network. Also it is possible to maximize nodes lifetime, packet delivery ratio, and minimize traffic congestion and load unbalance, as a result, end-to-end packet delay can be minimized, and network energy consumption can be balanced.

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