Survey of Load Balancing Routing in MANET

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Abstract: A mobile ad hoc network (MANET) is a collection of wireless mobile hosts forming a temporary network without the aid of any stand-alone infrastructure or centralized administration. Mobile Ad-hoc networks are self-organizing and self-configuring multichip wireless networks where, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. Nodes in these networks cooperating in a friendly manner to engaging themselves in multihop forwarding. The nodes in the network not only act as hosts but also as routers that route data to/from other nodes in network. 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: MANET, Load balancing, Qos, Delay, Network Traffic, throughput, performance, battery power

1. INTRODUCTION

In Ad hoc networks, it is essential to use efficient routing protocols that provide high quality communication. To maintain portability, size and weight of the device this network has lot of resource constrain. The nodes in MANET have limited bandwidth, buffer space, battery power etc. So it is required to distribute the traffic among the mobile host.

A routing protocol in MANET should fairly distribute the routing tasks among the mobile host. An unbalanced traffic/load distribution leads to performance degradation of the network. Due to this unbalancing nature, few nodes in the network are highly loaded with routing duties which causes the large queue size, high packet delay, high packet loss ratio and high power consumption. This problem lead to solution of load balancing routing algorithm for MANET.

2. AD-HOC 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.

2.1 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[1], AODV[2] 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.

3. CLASSIFICATION OF 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[3].

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.

### 3.1 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.

The Routing protocols can generally be categorized into three types (based on their load balancing techniques) as shown in fig.1.

*Figure 1 Classification of load balanced routing protocol*

- **Delay-based**: Where load balancing is achieved by attempting to avoid nodes with high link delay. An example is, Load-Aware On-Demand Routing (LAOR).
- **Traffic-based**: Where load balancing is achieved by evenly distributing traffic load among network nodes. Examples is, Associativity Based Routing (ABR).
- **Hybrid-based**: Where load balancing is achieved by combining the features of traffic- and delay-based techniques. Examples are Content Sensitive Load Aware Routing (CSLAR) and Load Aware Routing in Ad Hoc (LARA).

### 4. Load Balanced Routing Protocols in MANET

#### 4.1 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.

\[ D_p = \sum Q_k \ (k=1…n) \]  

Where \( Q_k \) is the node delay.

In route discovery process, the RREQ packet carries hop-count, and the total path delay \( D_p \) of a path \( P \). On receiving the RREQ packet the destination node sends a 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 the total path delay \( D_P' \) is smaller than \( D_P \) (i.e., \( D_P' < D_P \)).

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 the total path delay \( D_P' \) is smaller than \( D_P \) (i.e., \( D_P' < D_P \)).

#### 4.2 Associativity Based Routing (ABR)

Route is selected based on nodes having associativity states that imply periods of stability [22]. 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.

4.3 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” [6], 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.

4.4 Dynamic Load Aware Routing (DLAR)

S. J. Lee et al. (2001) “Dynamic Load Aware Routing in Ad Hoc Networks” [7], 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.

4.5 Load Aware Routing in Ad-hoc (LARA)

Vikrant Saigala et al. (2004), “Load balanced routing in mobile ad hoc networks” [8], 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.

Traffic queue: - The traffic queue of a node is defined as the average value of the interface queue length measured over a period of time.

\[ q_i = \frac{\sum_{k=1}^{N} q_i(k)}{N} \]  

(2)

Where, \( q_i(k) \) is the \( k \)th sample of the queue length. \( q_i \) is the average of these \( N \) samples.

Traffic density: - The traffic density of a node \( i \) is the sum of traffic queue \( q_i \) of node \( i \) plus the traffic queues of all its neighbors,

\[ Q(i) = \sum_{j \in N(i)} q_j \]  

(3)

where \( N(i) \) is the neighborhood of node \( i \) and \( q_j \) is the size of the traffic queue at node \( j \). \( Q(i) \) is the sum of traffic queues of all the neighbors of node \( i \) plus that of node \( i \) itself.

Traffic cost: - The traffic cost of a route is defined as the sum of the traffic densities at each of the nodes and the hop costs on that particular route.

\[ C(r) = \sum_{i \in r} Q(i) + \sum_{i,j \in r, i \neq j} h_{ij} \]  

(4)

Where \( h_{ij} \) is the hop cost along \( i \) and \( j \). So that this protocol makes enhanced route selection attempt based on traffic density and traffic cost which leads to better performance than DLAR and DSR.

4.6 Load-Balanced Ad hoc Routing (LBAR)

H. Hassanein et al. (2003), “Load-aware destination-controlled routing for MANETs” [9], 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 information, seen from the source to the current node. In backward phase the ACK message is send via the selected information, seen from the source to the current node. In backward phase the ACK message is send via the selected information, seen from the source to the current node. In backward phase the ACK message is send via the selected information, seen from the source to the current node.
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 A, and also Traffic interference (sum of activities of neighboring node) is calculated i.e TI. Whereas the cost of route is sum of A, and TI. Path is chosen which has minimum cost.

4.7 Load Sensitive Routing (LSR) protocol
K. Wu et al. (2003), “Load Sensitive Routing for Mobile Ad Hoc Networks” [10], 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.

4.8 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” [11], 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.

4.9 Simple Load-balancing Approach (SLA)
Y. Yoo et al. (2004), “A Simple Load-Balancing Approach in Secure Ad Hoc Networks” [13], 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 Protocol-Independent 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 selfishness 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.

4.10 Correlated Load-Aware Routing (CLAR)
Kyunghik Lim et al. (2004), “A Correlated Load Aware Routing Protocol in Mobile Ad Hoc Networks” [15] 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 multi-paths. 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 best load and hop distance, the earliest path arrived at the destination is chosen.

4.11 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” [16], 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.

4.12 Prediction based Adaptive Load Balancing (PALB)
Shouyi YIN et al. (2005), “Adaptive Load Balancing in Mobile Ad hoc Networks” [17], 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 [18]. Source node periodically predicts the cross-traffic 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 tested [19]. 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.

4.13 Workload-Based Adaptive Load Balancing (WBALB)
Y. J. Lee et al. (2005), “A Workload-Based Adaptive Load- Balancing Technique for Mobile Ad Hoc Networks” [20]. 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.

4.14 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” [21], 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.

4.15 Node Centric Load balancing routing protocol
Amjad Ali et al. (2012), “Node Centric Load Balancing Routing Protocol for Mobile Ad Hoc Networks” [23], 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.
4.16 Load Balanced Routing Mechanisms for Mobile Ad Hoc Networks

Amita RANI et al. (2009), “Load Balanced Routing Mechanisms for Mobile Ad Hoc Networks” [24], suggested algorithm which is based on combination of following three metrics:

- hop count
- residual battery capacity and 
- average number of packets queued up in the interface queue of a node.

These metrics along with weight values decide path for data transmission. Most of routing algorithm focuses on the hop count for selection of best path, but this may degrade performance due to congestion.

The proposed algorithm is used to select the path with higher route energy (maximum batter power with each node), higher traffic queue (number of packet queued at node should be maximum) and feasible hot count.

Weight of path is calculated as,

\[ W(P_i) = W_1 \cdot \text{RE}(P_i) - W_2 \cdot \text{ATQ}(P_i) - W_3 \cdot \text{HC}(P_i) \]

Where \( P_i \) is the path, \( W_1, W_2 \) and \( W_3 \) are weight associated with each parameter, \( \text{RE}(P_i) \) is route energy of path, \( \text{ATQ}(P_i) \) is avg. traffic queue of path and \( \text{HC}(P_i) \) is hop count of path. The path having Maximum Weight is selected for transmission.

Another scheme suggested in this paper is, the weight value is adaptive instead of constant because the battery power of node is decreasing as time elapsed.

\[ W(P_i) = (1-\alpha) \cdot \text{RE}(P_i) - \alpha \cdot 2^* (\text{ATQ}(P_i) + \text{HC}(P_i)) \]

Where \( \alpha = \min(\text{RE}(P_i)) / \text{IE}; 0 \leq \alpha \leq 1 \)

That gives the proportion of battery power left.

5. COMPARISON BETWEEN THE LOAD BALANCING ALGORITHM

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Route Selection Criteria</th>
<th>Extensi on of Category</th>
<th>Single path / Multi Path</th>
<th>Advantages</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-LAOR</td>
<td>Packet buffered in queue and hop count</td>
<td>AODV</td>
<td>Delay Based</td>
<td>Multipath</td>
<td>Increases packet delivery fraction and Decreases end-to-end delay in a moderate Network scenario in comparison to AODV and other LAOR protocols.</td>
</tr>
<tr>
<td>ABR</td>
<td>Associativity states that imply periods of stability</td>
<td>DSDV</td>
<td>Traffic Based</td>
<td>Multipath</td>
<td>This protocol is free from loops, deadlock, and packet duplicates. Problems associated with stale routes are absent. And it also ensure the transmission integrity. ABR can also be used to support adaptive mobile multi-media applications</td>
</tr>
<tr>
<td>APR</td>
<td>Disjoint node</td>
<td>ZRP</td>
<td>Traffic Based</td>
<td>Multipath</td>
<td>Alternate path routing (APR) has been applied to telephone networks, ATM and the Internet to support load balancing and survivability. The potential benefits of APR make it appear to be an ideal candidate for the bandwidth limited and dynamic mobile ad-hoc networks (MANETs).</td>
</tr>
<tr>
<td>DLAR</td>
<td>Least loaded route</td>
<td>DSR</td>
<td>Traffic Based</td>
<td>Single path</td>
<td>DLAR periodically monitors the congestion status of active data sessions and</td>
</tr>
</tbody>
</table>
Table showing various routing protocols and their characteristics:

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Traffic load</th>
<th>Routed option</th>
<th>Route conditions</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARA</td>
<td>Traffic density and traffic cost</td>
<td>DSR</td>
<td>Traffic Based</td>
<td>Uniformly distributes the load among all the nodes in the network, leading to better overall performance. This protocol makes enhanced route selection attempt based on traffic density and traffic cost which leads to better performance than DLAR and DSR.</td>
</tr>
<tr>
<td>LBAR</td>
<td>Minimum traffic load and minimum interference</td>
<td>DSR</td>
<td>Traffic Based</td>
<td>Intended for delay-sensitive applications. In addition, in order to keep up with frequent topology change, LBAR provides quick response to link failure by patching up the broken routes in use, thus guaranteeing reliability of data transmission.</td>
</tr>
<tr>
<td>LSR</td>
<td>Network load information</td>
<td>DSR</td>
<td>Traffic Based</td>
<td>LSR does not require periodic exchange of load information among neighboring nodes. 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.</td>
</tr>
<tr>
<td>WLAR</td>
<td>Total traffic load</td>
<td>AODV</td>
<td>Delay Based</td>
<td>Avoids the influence of burst traffic.</td>
</tr>
<tr>
<td>SLA</td>
<td>Traffic load at node (Forwarding load)</td>
<td>AODV + DSR</td>
<td>Traffic Based</td>
<td>Minimizes the traffic concentration by allowing each MS to drop RREQ or to give up packet forwarding depending on its own traffic load.</td>
</tr>
<tr>
<td>CLAR</td>
<td>Traffic load of node and neighboring nodes</td>
<td>AODV</td>
<td>Traffic Based</td>
<td>Better suited for the heavy load networks with low mobility.</td>
</tr>
<tr>
<td>ECLB</td>
<td>Energy</td>
<td>DSR</td>
<td>Delay</td>
<td>Mobile hosts have limited</td>
</tr>
</tbody>
</table>
6. 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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