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Survey on Weighted Load Balanced Routing Protocol and Energy-Aware Routing Protocol for MANET

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Abstract- AODV is a prominent routing protocol for MANET that uses hop count as a path selection metric. However, AODV has no means to convey traffic load on current route. In this paper we will survey protocols for load-balancing and energy-aware routing on MANET . This protocol is used for Internet gateway broadcasting route, and it evaluates route with node's residual energy and transmission load. With this protocol node accessing Internet can find a shortest route and avoid low-power node and busy node. The routing strategy in this paper focuses on distributing the traffic on the routes consisting of nodes with comparatively longer life and have less traffic to pass through. Aggregate Interface Queue Length (AIQL), to deal with traffic issue. The weight of a route is decided by three factors: the aggregate interface queue length, the route energy and the hop count. The route with highest weight value is selected for further data transmission.

Keywords- Ad hoc networks, Load balance, Aggregate Interface Queue Length, Normalized routing load, End-to- end delay.

1. INTRODUCTION

A mobile ad hoc network is defined as a collection of mobile platforms or nodes where each node is free to move about arbitrarily. Each node logically consists of a router that may have multiple hosts and that also may have multiple wireless communication devices [1]. The routing protocols in MANET can be categorized in to three different groups: Global/Proactive, On demand/Reactive and Hybrid routing protocols [2]. In global routing protocols, each node stores and maintains routing information to every other node in the network. In on-demand routing protocols, routes are created when required by the source node, rather than storing up-to-date routing tables. Hybrid routing protocols combine the basic properties of the two classes of protocols mentioned earlier. In practice, some routes get congested, while other routes remain underutilized. This results in poor performance of mobile ad hoc networks. Therefore, the need for balancing the load distribution among various routes becomes more important.

" The aim of this paper is to provide a characteristic comparison for a number of proposed load balanced ad hoc routing. We suggesting routing protocol i.e. WLBR routing protocol using performance metrics like normalized routing load and end to end delay.

The rest of this paper is organized as follows. Section 2 discusses the background and characteristic comparisons of currently proposed load balanced ad hoc routing protocols. This section ends with a table that compares the proposed routing protocols that balance the load, on the basis of factors like metric used advantages and disadvantages. Finally section concludes the paper.

2. RELATED WORK

Load balancing deals with improving the performance of the system by transferring the jobs from overloaded nodes to underloaded or idle nodes. By doing so, the total time to process all jobs may reduce considerably and also makes it sure that no node sits idle while some jobs are waiting to be processed. Routing protocols are vital for the proper functioning of ad hoc networks. A major drawback of all existing ad hoc routing protocols is that they do not have provisions for conveying the load and/or quality of a path during route setup. Hence they cannot balance the load on different routes[3]. Also, both proactive and reactive protocols choose a route based on the metric, the smallest number of hops to the destination. But it may not be the most significant route when there is congestion or bottleneck in the network. It may cause the packet drop rate, packet end-to-end delay, or routing overhead to be increased

particularly in the cases when the traffic is concentrated on a special node like a gateway through which mobile nodes from ad hoc network can connect to Internet. There are various proposed algorithms for load balancing. A comparative study of some of the load balanced ad hoc routing protocols is given in the Table 1.

Accessing Internet needs an Internet gateway, which cans forwards packets between Internet and MANET. Most Internet applications run in CIS mode, servers provide information and services; users' computers use these services like terminals. Most computers link to several servers, and servers needn't access users' computer actively. In most situation nodes in MANET don't work as a server, so they needn't static IP addresses. Then Internet gateway often has a responsibility to assign a dynamic IP address to MANET node.

In MANET research field there is a very important issue - routing protocol. Since MANET is a movable and easily changeable network, its route is not stable as wired network.

This paper analyzes actual situation and requirement of MANET nodes accessing Internet and proposes a routing scheme using in this situation. The routing scheme considers load balancing and energy consuming factors to make route to Internet more reliable and get better performance.

Present protocols of MANET categories:. Provocative protocols are derived from wired network, one node should know the route to all other nodes and stores the route information in route table. When it wants to send message to another node, it look up record in its route table. With this type of protocols nodes should update route to all nodes frequently, including the nodes it wouldn't communicate to. Since provocative protocols waste much bandwidth to transmit route information, it doesn't fit MANET. Reactive protocols needn't maintain route information. When a node wants to access another node, it send route request to find correspondent node. Routing overhead of this type of protocols is little, so reactive protocols is more feasible in MANET than provocative protocols.

TABLE 1: CHARACTERISTIC COMPARISON OF LOAD BALANCED AD HOC ROUTING PROTOCOLS

S. No.	Routing Protocol	Metric Used	Disadvantages	Advantages
1.	Load Balanced Ad hoc Routing (LBAR) [6]	Degree of nodal activity	Mainly intended for connectionless applications	Responds quickly to link failures caused by topology changes
2.	Dynamic Load Aware Routing (DLAR) [7]	Intermediate node routing load	Interface queue length doesn't give a true picture of actual load	Routes are reconstructed dynamically in advance of congestion
3.	Load Sensitive Routing (LSR) [21]	Summation of number of queuing packets at mobile host and at neighboring hosts	No consideration for burst traffic or transient traffic	The source node can quickly obtain the route information and quickly responds to calls for connections.
4.	Weighted Load Aware Routing (WLAR) [8]	*Traffic load	Overhead of route request packets	Avoids the influence of burst traffic.
5.	Load Aware Routing in Ad hoc networks (LARA) [9]	Contention at the MAC level for non-TCP source Number of hops and traffic cost of the route for TCP source	Condition of the route is not considered, once it has been selected for data transmission	Uniformly distributes the load among all the nodes in the network, leading to better overall performance
6.	Correlated Load-Aware Routing (CLAR) [10]	Traffic load through and around neighboring nodes	More useful for high load network with low mobility	improves packet delivery ratio and reduces average end-to-end delay by keeping track of the average queue size at an interface
7.	Simple Load-balancing Ad hoc Routing (SLAR) [11]	Forwarding Load	Mobile nodes may deliberately give up forwarding packets to save their own energy	Reduces message overhead
8.	Simple Load-balancing Approach (SLA) [12]	Own Traffic Load	A reliable server node called Credit Manager (CM) is required which manages nodes' Credit Database (CDB)	Reduces message overhead
9.	A Workload-Based Adaptive Load-Balancing Technique for MANETs[16]	Interface queue occupancy and workload	Determining the appropriate threshold value	Reduces message overhead
10.	Multipath Routing Protocol with Load Balancing (MRP-LB) [13]	Total number of congested packets on multiple routes	Additional fields in the packet are introduced resulting in high overheads	Gives N disjoint routes and uniformly distributes traffic on these routes.
11.	Ad hoc On-demand Distance Vector Routing with Load Balancing (LB-AODV) [14]	Balance Index	Techniques that provide good estimation of network size and topology in dynamic MANETs need to be investigated	Reduces unnecessary routing traffic.
12.	Protocol to enhance path reliability and realize load balancing in MANETs [15]	Node-disjoint routes	As routes used are node disjoint hence the reliability of a highly reliable link cannot be utilized	A mobile host can recover faster in case of route failures.
13.	Load Balancing and Resource Reservation in Mobile Ad Hoc Networks [4]	Bandwidth	The bandwidth reserved for alternate routes is predetermined and not dynamic	In case of node movement source route is reused as much as possible while rerouting the packets on an alternate route

14.	Delay-based Load-Aware On demand Routing (D-LAOR) protocol [17]	Total path delay and hop count	Routing overhead is comparatively high.	increases packet delivery fraction and decreases end-to-end delay in a moderate network scenario in comparison to AODV and other LAOR protocols.
15.	Busy Node Avoidance Routing (BNAR) protocol [`18]	**Busy rate	High traffic environment is required to properly study its characteristics. Also It doesn't give shortest path in terms of hop count	Outperforms routing protocols using hop wise shortest route in a high traffic environment.
16.	BNAR_with_Netw-ork Allocation Vector (BNAR_with_NAV) [19]	**Busy rate	High traffic environment is required to properly study its characteristics. Also It doesn't give shortest path in terms of hop count	Can disperse traffic more in comparison to BNAR and outing protocols using hop wise shortest route.
17.	Energy Consumption Load Balancing (ECLB) [20]	Energy consumption rate	Energy consumption rate of each node is to be calculated after every t time interval	Improves the function of route discovery by adding energy factor and in case of link breakage, data are transmitted through existing alternative path without re-performing source-initial route discovery.

But for Internet gateway, provocative protocol is better, because gateway should broadcast its existence to all nodes. So routing protocol proposed in this paper is provocative, gateway broadcasts route information, and nodes save them into route table. When nodes want to link to Internet, it can fetch gateway's route information from route table instead of sending route request packets to network.

Nodes in MANET are always portable devices powered by battery. Energy consuming also should be considered in routing in MANET. If one node in the route has low power, the route maybe break sometime later because this node's shutdown on account of power exhausting. So selecting a route with long lifetime should avoid low-power node

3. Weighted Load Balanced Routing Protocol for MANET

The aim of the protocol (WLBR) suggested in this paper is to distribute the traffic in MANETs by using the information available in the network. The basic idea is to select a routing path that consists of nodes with higher energy and hence longer life in order to reduce the routing overhead and end-to-end delay by distributing the packets over the path which is less utilized. Before we introduce the proposed routing protocol algorithm, we first define the route determining parameters, as follows:

1. Route Energy (RE): The route energy is the sum of energy possessed by nodes falling on a route. Higher the route energy, lesser is the probability of route failure due to exhausted nodes.

2. Aggregate Interface Queue Length (AIQL): The sum of interface queue lengths of all the intermediate nodes from the source node to the current node.

3. Hop count (HC): The HC is the number of hops for a feasible path.

3.1 Route Discovery

The route discovery procedure is similar to that of Ad hoc On-demand Distance Vector (AODV) routing protocol. A source node initiates the route discovery process whenever it wants to communicate with another node for which it has no routing information in its table.

The source node initiates route discovery by broadcasting a route request (RREQ) packet to its neighboring nodes[5].

When a node receives a RREQ, it checks its routing table for a route to the destination node. If routing table contains a route to the destination node, its sequence number is checked to determine whether it is at least as great as that contained in the RREQ packet. If the two conditions are satisfied, then the intermediate node sends a route response along the reverse path back to the source node. Otherwise, the node increments the hop count by one, adds its own interface queue length and energy and rebroadcasts the route discovery packet. When the destination node fmds a suitable path, a RREP packet is sent back towards the source node.

Algorithm 1 [Route discovery process]. Source node N, wants to find a path to destination node Nd. Suppose that z is the number of mobile nodes and N is the set of mobile nodes, i.e.,
N = {N1, N2, ... , Nz}, where Ns, Ni, Nd, N, 1 <= s, d, i <= z and s != d. We assume that node Ni, is an intermediate node that receives the RREQ packet.
if (node N, is the destination node Nd){

1. Destination node Nd analyzes route energy (RE),aggregate interface queue length (AlQL), and hop count (HC) along each feasible path.

2. Destination node Nd calculates weight values of each feasible path and selects the route with maximum weight value as primary routing path.

3. Destination node then sends a RREP packet to source node Ns-
4. Source node N, starts sending the data.
}
else
Node Ni forwards the RREQ packet to the neighboring node.

4. A LOAD-BALANCING AND ENERGY-AWARE ROUTING PROTOCOL FOR MANET

Nodes in MANET want to accessing Internet must know gateway's existence first and gateway should tell them that. Gateway broadcasts GRP (Gateway Route Packet) to all its neighbor nodes periodically, neighbor nodes received GRP stores the information to route table and update GRP adding its own information and forward it to their neighbors except the node get GRP from until all nodes received it. A field in GRP named Broadcast ID informs its time sequence.

Energy awareness GRP includes two fields about energy information.
One is average power residual percentage, which records average power remainder information of all nodes in the route. Another is minimum power residual percentage, which records lowest power information in the path. Load balancing For load balancing GRP should includes load information. We evaluate load of nodes by ratio of cache utilization. The ratio IS high means the node's communication task is strenuous. Since one node in the route with huge task lead to the whole route's poor efficiency, one field storing the worst node's load information in GRP is enough. When nodes select route, they should choose the route with light load.
Energy and load are two important factors in MANET routing protocol. There is another important factor-hop. In MANET nodes are movable, so route is not stable. A route composed of more nodes it is more instable. Choosing a route should evaluate the three factors complicatedly, so it is a key issue in this routing protocol of MANET nodes accessing Internet. To solute this question, a new parameter RIUD is suggested in this paper.

Definition 5:RIUD (Route Integrated Usable Degree) is an indicator of route usability. It considered both energy situation and load situation of the route and used as a basis to select route. It is calculated by following equation:

$$RIUD = \frac{i \times APRP + j \times (100 - MCUR)}{n}$$

In the equation n means hops; i and j are coefficients, which indicate weights of energy and load of the route.
i+j=I , for example, we can set i=O.4; j=O.6,which means importance of load balancing is bigger than that of energy in design.

5. CONCLUSION

Weighted load balanced routing (WLBR) protocol for mobile ad hoc networks. WLBR selects a routing path by maximizing the weight among the feasible paths. There are three parameters in WLBR that are used to calculate the weight of the feasible path: the aggregate interface queue length, the route energy, and the hop count. Route selection is based on the weight value of each feasible path. In a feasible path, the higher the weight value, the higher is its suitability for traffic distribution. Simulation results show that the proposed WLBR outperforms AODV especially in an environment with moderate mobility.

A load-balancing and energy-aware routing protocol for MANET accessing Internet is suggested in this paper. Since nodes of MANET are movable and Energy is limit, route in MANET is instable. The protocol can find a shortest route without low-power nodes and high loaded nodes to Internet gateway to avoid instable route most probably.

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