Implementation of On Demand Routing Protocol to Load Balance in MANET

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Abstract*– Backbone networking provides the mechanism of load balancing in MANET which is considered to be the most vital factor in the present scenario. Many of the existing protocols are implemented with different routing methods and techniques. . In this paper, an overview of AODV protocols which are to be implemented in a Backbone networking is widely presented amidst a series of methods proposed in the past. A mobile ad-hoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless. MANET usually has a routable networking environment on top of a Link Layer ad hoc network. A backbone network or network backbone is a part of computer network infrastructure that interconnects various pieces of network, providing a path for the exchange of information between different LANs or sub networks. In an ad-hoc network, routing protocols are vital for its proper functioning. It is seen that when the network size increases per node, the throughput of an ad hoc network rapidly decreases. This is due to the fact that in large scale networks, flat structure of networks results in long hop paths which are prone to breaks. These long hop paths can be avoided by using virtual nodes concept which works as mobile backbone network (MBN). There are some specific virtual power capable nodes which are functionally more capable than ordinary nodes. To establish the structure, some of the virtual nodes are selected to act as backbone nodes (BNs), which in turn form the higher layer. In this review paper, a new routing metric is introduced to the protocol which selects the lightest loaded path which also apprehends the largest residual energy of the mobile backbone nodes for data routing. If a particular MBN is heavily loaded then select another optimal shortest path to reach the destination. Thus we assume that this new routing metric will improve the packet delivery rate and hence lowers the average delay in propagation.

***Keywords*– routing protocols, load-balancing, mobile ad hoc Networks (Manet), Mobile Backbone Node (MBN), energy aware routing.**

I. INTRODUCTION

Mobile ad hoc network (MANET) is a resource constrained randomly deployed network, in which almost all the nodes are battery constrained. Data communication in such a network is possible along multiple hops, nodes that are in communication range of each other nodes to relay the packets [1]. Routing protocols are vital for the proper functioning of ad hoc networks. Among all proposed wireless mobile ad-hoc routing protocols in the literatures, Dynamic Source Routing (DSR)[2-3} and Ad-hoc On-demand Distance Vector (AODV)[4] are the most prominent. DSR utilizes source routing in ad-hoc networks to discover routes from source nodes to destination nodes. Such type table driven protocols, although a route to every other node is always available, incur-substantial signaling traffic and power consumption. Since both bandwidth and battery power are scarce resources in mobile computers, this becomes a serious limitation to these routing protocols. Reactive routing protocols, such as AODV, maintain routes as long as they are needed by the sources.

If a source node that moves or hop on the route from the source node to the destination node becomes unreachable, route discovery from the source to the destination must be reinitiated if it still requires a route to the corresponding destination. However, none of these addresses the load balancing among the routes. In practice, some routes may get congested, while other routes remain unutilized. Since few nodes have to carry excessive loads, congestion increases, leading to undesirable effects as longer delays, lower packet delivery and higher routing overhead. This results in poor performance of mobile ad hoc network.

II. LITERATURE REVIEW

In the aspect of load balance issue, the proposed load-balancing approaches in literature can be categorized into: multi-path approaches and single-path approaches [5]. Load-balancing in multi-path routing is to find an optimal solution to the problem of minimizing the amount of traffic on each path. However, in single-path approaches, many different load balancing mechanisms were adopted in the literatures as there is only one path exists between the source node and the destination node. In [9], the authors have denoted that the most shortest-path routes pass through the center of the network and the nodes approaching the center of the network possess larger routing tables. The author in [8] has proposed a new metric which adopts the size of a node's routing table to select one among many different routes though such load-balancing mechanism can push the traffic further from the center of the network, which enhances the load distribution and significantly enhance the network performances in terms of average delay. It still has some flaws. In the heavily loaded application scenarios, all the nodes may need to communicate with each other where the difference of each node in the size of routing table is small, which create an overload in the centre of the network. This overloading scenario makes some nodes to die earlier due to the exhaustion of the battery which deteriorates in the malfunction of the network which also significantly reduces the performance.

In a general perspective Energy efficiency is the key concern in wireless networks. As a practical concern it is identified that there is a decrease in the number of participating mobile nodes due to the exhaustion of batteries in a heavy loaded nodes as these nodes are battery-powered. The network may get disconnected on the prime cause of the death of many nodes. Once a broken link is identified on the precept that many nodes have withdrawn from the network, and then it is crystal clear that an alternate route has to be discovered, incurring extra route discovery overhead and packet latency which diminishes the performance of the network.

The solution to overcome this problem is to perform a partition of the mobile nodes so as to form clusters. Each cluster in turn chose a cluster head which guides in carrying the traffic across all the clusters. Communication is possible between the nodes pertaining to the same cluster. Each local cluster can be considered as an ad-hoc network. The throughput incurred per node can be greatly improved as the number of nodes in a cluster is small.

In a MBN, the cluster heads are connected using powerful radios to form a higher-level backbone network. This backbone network is in turn another ad hoc network. Hence, per node throughput of a BN is also guarded by the number of BNs[10] .

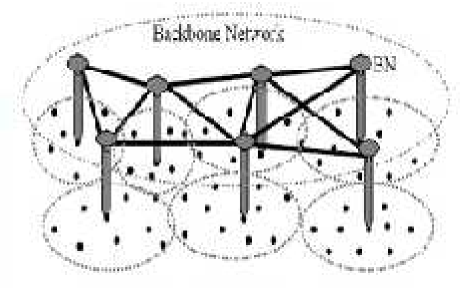

Fig. 1. General model of a two-level MBN

Hierarchical ad hoc network structure is called an ad hoc network with mobile backbones (MBN). A general picture of a two level MBN is illustrated in Fig. 1. Among the mobile nodes, some nodes, named backbone nodes (BNs), have an additional powerful radio to establish wireless links among themselves. Thus, they form a higher level network called a backbone network. The backbone network is exactly an ad hoc network that runs in a different radio level as these backbone nodes it selves move and join or leave the backbone network dynamically. Multilevel MBNs can be formed recursively in the same way. Using clustering schemes to select the BNs would be a natural choice since clustering has already been widely used to form logically hierarchical networks[11][12]. In the present routing protocols, data is transmitted after choosing the shortest path without consideration of any particular node's traffic that raises the problem of delay in transmission and unbalanced energy consumption.

Three critical issues are involved in building such a MBN, the optimal number of BNs, BN deployment and routing .Since the backbone network is also a typical ad hoc network, its capacity follows the same scaling law mentioned above. In theory, multi-level MBNs can solve this problem. However, MBNs with too many levels are not easy to operate and may suffer from hardware limitations (e.g. BNs need an additional powerful radio for each layer.). Thus, for a MBN with a few levels, we need to decide how many BNs are optimal for both the backbone network and the lower level cluster. In this paper, we give a simple theoretical analysis. After the number of BNs is decided, the second important issue is how to deploy them around the whole terrain. The main difficulties are mobility and BN failures. Using clustering schemes to elect the BNs would be a natural choice since clustering has already been widely used to form logically hierarchical networks [10[11][12]. It is ideal for partitioning the large-scale network into small groups. However, a big drawback of current clustering schemes is the instability of clusters, as indicated in many papers such as [11]. Conventional clustering schemes work effectively only in networks with very low mobility, such as the sensor network. Instability of clusters would make the hierarchy too dynamic to be operated successfully. Frequent change of BN position will waste most routing information. On-Demand routing protocol is suitable to wireless networks that has frequent mobility of nodes. When network is stable, data is transmitted after choosing the shortest path without consideration of any particular node's traffic. As the consequent step the traffic is concentrated on a particular node, which raises the problem of delay in transmission and consumption of huge energy. The occurrence of such result is determined by the routing metric which solely considers the length of the path. However other factors of the networks are ignored.

III. SUGGESTED METHODOLOGY

After continuous review and systematic process, I came to a conclusion that the same procedure can be applied for backbone nodes which reduces the time in calculating energy and routing table. Here On-Demand routing protocol is applied.

The AODV Routing protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. The major difference between AODV and Dynamic Source Routing (DSR) stems out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed. However, in AODV, the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the*RouteRequest* packet in the network when a route is not available for the desired destination. It may obtain multiple routes to different destinations from a single *RouteRequest*. The major difference between AODV and other on-demand routing protocols is that it uses a*destination sequence number* (DestSeqNum) to determine an up-to-date path to the destination. A node updates its path information only if the *DestSeqNum* of the current packet received is greater or equal than the last *DestSeqNum* stored at the node with smaller hopcount.

A RouteRequest carries the *source identifier* (SrcID), the *destination identifier* (DestID), the *source sequence number* (SrcSeqNum), the*destination sequence number* (DestSeqNum), the *broadcast identifier* (BcastID), and the *time to live* (TTL) field. DestSeqNum indicates the freshness of the route that is accepted by the source. When an intermediate node receives a RouteRequest, it either forwards it or prepares a RouteReply if it has a valid route to the destination. The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the RouteRequest packet. If a RouteRequest is received multiple times, which is indicated by the BcastID-SrcID pair, the duplicate copies are discarded. All intermediate nodes having valid routes to the destination, or the destination node itself, are allowed to send RouteReply packets to the source. Every intermediate node, while forwarding a RouteRequest, enters the previous node address and its BcastID. A timer is used to delete this entry in case a RouteReply is not received before the timer expires. This helps in storing an active path at the intermediate node as AODV does not employ source routing of data packets. When a node receives a RouteReply packet, information about the previous node from which the packet was received is also stored in order to forward the data packet to this next node as the next hop toward the destination.

It consists of two stages; route discovery and route maintain stages. In each stage, the protocol utilizes the same mechanisms as in AODV protocol except for the routing metric. The average size of route tables of all the backbone nodes (BN) along the path is minimal and the average residual power of all the nodes is maximal comparing with outer paths. The metric can be expressed as

$$Minimize\left(\frac{1}{N}\sum_{i=1}^{N}\frac{sizeof(rtb(i))}{\mathrm{Er}(i)}\right)$$

where *sizeof (rtb(i))* represents the number of entries in the routing table of a *i* backbone node among N the other backbone nodes participating in the studied route and *Er(i)* is the residual energy of Mobilenode *i*. RREQ has to be altered and an extra field will be appended representing the new metric, respectively. The energy model adopted in this paper is:

Energy = Power x Time

Energy consumption of sending or receiving a packet is decided by transmission power or receiving power and the time needed for processing the packet. The time needed for processing a packet is defined as:

Time = 8 X Packet Size/Bandwidth

Therefore

$$E_{tx} = P_{tx} \times 8 \times Packetsize / Bandwidth$$

$$E_{rx} = P_{rx} \times 8 \times Packetsize / Bandwidth$$

Where *ptx* and *prx* represent transmission power and receiving power respectively. The total energy consumption of forwarding a packet is defined as:

$$E_f = E_{tx} + E_{rx}$$

In the route discovery stage, when a sender wants to send data to destination, and there is not an already available route, the source node s send a RREQ message including the size of its routing table, residual energy and the a new metric *(Rmetric)* as its eccentricity.

The new metric is calculated by:

$$\mathrm{Rmetric(S)} = \frac{sizeof(rtb(S))}{\mathrm{Er}(S)}$$

When an intermediate *i* node receives a RREQ message, it will update above three fields of the message according to its current conditions. The update of the average table size and residual energy is expressed as follows:

$$\mathrm{Rmetric}(n+1) = \frac{n \times \mathrm{Rmetric}(n) + X_{n+1}}{n+1}$$

Where X n+1 represents the ratio of the route table size to residual energy in node 1 and n is the hop count from source node to the current node.

Finally, when the destination node D receives a lot of different RREQ messages from the possible paths. Other than choosing the shortest path, the destination node D will respond to the route with smallest new metric by sending a RREP message to the source. By now, the route between source node S and destination node D is established.

IV. Conclusion

Mobile ad hoc networks are a type of mobile network that functions without any fixed infrastructure. Continuously changing network topology, low transmission power, limited node power and available bandwidth are major challenges for routing. Designing Mobile Backbone Network with an efficient routing protocol for MANETs is a non-trivial task. This paper introduces a new routing strategy for mobile ad hoc networks. This routing strategy is referred to as Load balanced and Energy aware On Demand Routing Protocol. Backbone links are automatically selected by the routing scheme if they can reduce hop distance to remote destinations which select the lightest loaded path with the largest residual energy of the backbone nodes for data routing all of the time, thus improve the packet delivery rate and lower the average delay.

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