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Energy Efficient Multipath Routing Protocol in Mobile Ad-Hoc Networks

Mrs. J. Nandhini*
Asst Prof. ECE,
Velalar College of Engineering and Technology, Erode
638012, India
nandhoosaran@gmail.com

Dr. D. Sharmila
Prof & HOD EIE,
Bannari Amman Institute of Technology, Sathyamangalam,
Erode – 638401, India
hodei@bitsathy.ac.in

Abstract: In this paper we introduce Energy Efficient Multipath Routing Protocol (EEMRP) by using Load distribution approach and Sleep/Down mode approach. Each mobile node uses signal power strength from the received packets to predict the link breakage time, and sends a warning to the source node of the packet if the link is soon-to-be-broken. The load distribution approach is to balance the energy usage of all mobile node by selecting a route with underutilized nodes rather than the shortest route. Experimental results are simulated by using NS-2 tool to demonstrate the effectiveness of algorithm.

Key words: Energy, Sleep mode, Load distribution, Adhoc networks.

I. INTRODUCTION

Communication has become very important for people to exchange information anytime from and to anywhere. Mobile Ad hoc Networks, called MANETs, are becoming useful as the existing wireless infrastructure is expensive and inconvenient to use. They are going to become integral part of next generation mobile services. A MANET is a collection of wireless nodes that can dynamically form a network to exchange information without using any pre-existing fixed network infrastructure. The abilities of ad hoc networks are recognized and it is used for security-sensitive operations, although there is a trend to adopt ad hoc networks for commercial uses due to their unique properties.

MANETs are dynamically created and maintained by the individual nodes comprising the network. They do not require a pre-existing architecture for communication purposes and do not rely on any type of wired infrastructure; in an ad hoc network all communication occurs through a wireless median.MANET comprises a special subset of wireless networks since they do not require the existence of a centralized message-passing device. Simple wireless networks require the existence of access points or static base stations, which are responsible for routing messages to and from mobile nodes within the specified transmission area.

Ad hoc networks, on the other hand, do not require the existence of any device other than two or more MNs willing to cooperatively form a network. Instead of relying on a wired base station to coordinate the flow of messages to each mobile node, the individual mobile nodes form their own network and forward packets to and from each other.

This adaptive behavior allows a network to be quickly formed even under the most adverse conditions.

A. Routing In Mobile Ad Hoc Networks:

Developing support for routing is one of the most significant challenges in ad hoc networks and is critical for the basic network operations. Certain unique combinations of characteristics make routing in ad hoc networks interesting.

First, nodes in an ad hoc network are allowed to move in an uncontrolled manner. Such node mobility results in a highly dynamic network with rapid topological changes causing frequent route failures. A good routing protocol for this network environment has to dynamically adapt to the changing network topology.

Second, the underlying wireless channel provides much lower and more variable bandwidth than wired networks. The wireless channel working as a shared medium makes available bandwidth per node even lower. So routing protocols should be bandwidth-efficient by expending a minimal overhead for computing routes so that much of the remaining bandwidth is available for the actual data communication.

Third, nodes run on batteries which have limited energy supply. In order for nodes to stay and communicate for longer periods, it is desirable that a routing protocol be energy-efficient as well. This also provides also another reason why overheads must be kept low. Thus, routing protocols must meet the conflicting goals of dynamic adaptation and low overhead to deliver good overall performance.

B. Categories of Routing Protocols:

a. Table Driven or Proactive Protocols:

In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the famous table driven or proactive protocols are: GSR , WRP, ZRP, STAR etc.

b. On Demand or Reactive Protocols:

In On Demand routing or reactive protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure [1]. The route remains valid till destination is achieved or until the route is no longer needed. Some famous on demand routing protocols are: DSR, RDMAR, AODV

c. Hybrid Routing Protocols:

Hybrid routing protocols are proposed to combine the merits of both proactive and reactive routing protocols and overcome their shortcomings. Normally, hybrid routing protocols for mobile ad hoc networks exploit hierarchical network architectures. Proper proactive routing approach and reactive routing approach are exploited in different hierarchical levels, respectively [3]. Examples are Zone Routing Protocol (ZRP), Zone-based Hierarchical Link State routing (ZHLS) and Hybrid Ad hoc Routing Protocol (HARP).

II. RELATED WORK

A. *Snr/Rp Aware Routing Model:*

This approach include a cross-layer design (CLD) to improve information sharing between network and physical layers. We present a model that allows the network layer to adjust its routing protocol dynamically based on signal noise ratio (SNR) and received power (RP) [2] along the end-to-end routing path for each transmission link to improve the end-to-end routing performance in MANET.

In technicality, information from the transmission links, such as Signal to Noise Ratio (SNR) and Received Power (RP) [5], can furnish valuable information to the source node about the transmission paths as far as routing is concerned. Each wireless node can communicate with any other node within its transmission range, which depends on SNR and RP at the receiver node.

a. *Modification in AODV and DSR (Reactive routing):*

In case of DSR and AODV, the new mechanism will work as follows: when the route request packet arrives at the destination or an intermediate node with a route to the destination, a route reply packet will be generated. This reply packet is then sent back to the source node following the reverse route contained in the route request packet. Each intermediate node will update the SNR and RP values if its link values of SNR and RP lower than the existing recorded values in the route reply packet. If SNR/RP values of its link are greater than recorded value, the node will not update the value. The process will continue until the route reply packet reach the source node. Now, at the source node there are many of available routes with different values of SNR and RP. The Source node will select the route based on the value of best of worse available values of SNR or RP.

b. *Modification in OLSR (Proactive routing):*

Original OLSR uses hello and Topology Control (TC) messages to discover and exchange link state information throughout the network. Nodes compute next hop destination by using topology information received by neighbors considering shortest hop forwarding paths. OLSR makes use of "Hello" messages to find its one hop neighbors and its two hop neighbors through their responses. The sender node can then select its MPR based on the one hop node that offers the best routes to the two hop nodes. In this SNR and RP model, they modified the selection process of MPR and makes nodes select MPR based on the SNR and RP values of each link connected to those MPR instead of the shortest paths. Modified OLSR constructs routing table for each node using the SNR/RP to guarantee the quality of service in the network.

B. *Preemptive Routing In Ad Hoc Networks:*

In this work, when a path is likely to be broken, a warning is sent to the source indicating the likelihood of a disconnection. The source can then initiate path discovery early, potentially avoiding the disconnection altogether. A path is considered likely to break when the received packet power becomes close to the minimum detectable power. Care must be taken to avoid initiating false route warnings due to fluctuations in received power caused by fading, multipath effects and similar random transient phenomena. Experiments demonstrate that adding proactive route selection and maintenance to DSR and AODV (on-demand ad hoc routing protocols) significantly reduces the number of broken paths, with a small increase in protocol overhead.

a. *Preemptive Route Maintenance:*

With preemptive maintenance, recovery is initiated early by detecting that a link is likely to break and finding and using an alternative path before the cost of a link failure is incurred. This technique is similar to soft-handoff techniques used in cellular phone networks as mobiles move across cells. When extended with preemptive maintenance, an on-demand routing algorithm consists of two components: (i) detecting that a path is likely to be is connected soon; and (ii) finding a better path and switching to it. Note the similarity to pure on-demand protocols: path failure is replaced with the likelihood of failure as the trigger mechanism for route discovery. Note that it is possible to add preemptive maintenance to table-driven protocols as well to avoid the cost of detecting a path failure.

b. *Generating the Preemptive Warning:*

The preemptive warning is generated when the signal power of a received packet drops below a preemptive threshold. The value of this threshold is critical to the efficiency of the algorithm – if the value is too low, there will not be sufficient time to discover an alternative path before the path breaks. Conversely, if the value is too high, the warning is generated early with the following negative side-effects: (i) unnecessary discoveries: the frequency of the recovery action and the associated overhead increase; (ii) early switches to lower quality path: we may be forced to accept a path of a lower quality than the one we are currently using; and (iii) increasing the preemptive threshold effectively limits the range of the mobiles – a smaller range is now acceptable without generating a preemptive warning. If the threshold is too high, false network partitioning can also occur. Generating the preemptive warning is complicated due to fading that can cause sudden variations in the received signal power. The remainder of this section derives the criteria for selecting good threshold values under ideal conditions, then addresses link state estimation in the presence of channel fading and other random transient interferences.

C. *A Prediction-Based Link Availability Estimation:*

Routing is difficult in MANET since mobility may cause radio links to break frequently. When any link of a path breaks, this path needs to be either repaired by finding another link if any or replaced with a newly found path. This rerouting operation costs the scarce radio resource and battery power while rerouting delay may affect quality of service (QoS) [9] for applications and degrade the network performance. To reduce rerouting operation, selecting an optimal path in such networks should consider path reliability more than some metrics used in wired networks such as path cost and QoS etc. The reliability of a path depends on the availability of all links constituting this path. However, most routing schemes in the literature focus mainly on the procedure of information exchange for finding and/or maintaining a path between two nodes, and often use 'shortest path' (measured in terms of the number of hops or links that a path goes through) as the major routing metric. How to measure link availability properly in order to quantify a routing metric in terms of path reliability has not been addressed adequately.

In this method 'associativity' is defined as a new routing metric for link reliability. This metric tries to reflect the degree of the association stability between two mobile nodes through the connection stability of a node with respect to another one over time and space [6]. Each node generates a beacon to signify its existence periodically. Upon receiving a beacon, the receiver increases the value of its associativity with the beaconing node and both signal stability and location stability are used to quantify the reliability of a link. With the signal stability, each node classifies its neighbors as either 'strongly connected' or 'weakly connected' according to the signal strength of received beacons generated periodically by its neighbors.

The location stability is measured in terms of the period of time that a link has existed. Accordingly, the routing metric biases the selected path toward the one consisting of strong channels which have been in existence for a time greater than some threshold. A common weakness of the above two pure measurement-based criteria for link reliability is that they cannot reflect possible changes in link status happening in the future. That is, the reliability of a link measured as 'better' based on past and/or current information on link status may become worse with time than that of those currently measured as 'worse' due to the dynamic nature of mobile environments. This possible misjudgment to link reliability would affect the network performance especially in a high mobility environment.

a. Drawbacks in Existing System:

Most of the existing Mobile Ad hoc Network (MANET) protocols optimize hop count as building a route selection. However, the routes selected based on hop count alone may be of bad quality since the routing protocols do not ignore weak quality links which are typically used to connect to remote nodes, hence higher frame error rates and lower throughput.

Routing in Ad hoc networks is a challenging problem because nodes are mobile and links are continuously being created and broken. Existing on-demand Ad hoc routing algorithms initiate route discovery only after a path breaks, incurring a significant cost in detecting the disconnection and establishing a new route or when a path is likely to be broken, a warning is sent to the source indicating the likelihood of a disconnection. Then source will initiate path discovery again.

III. ROUTING TECHNIQUE

In our proposed protocol, all nodes wishing to communicate with other nodes within the ad hoc network are willing to participate fully in the protocols of the network. Each node participating in the network should also be willing to forward packets for other nodes in the network [4]. We refer to the minimum number of hops necessary for a packet to reach from source to destination .When a Source want to communicate to destination, the source have to find the primary and back-up route. If any problem the primary path while communicate, the source can change the path to back-up (secondary path) to communicate destination.

A. Finding Primary (Active) Path:

First the primary path which is used to communicate with the source and destination is found. All the source node sends the RREQ(Route Request) message to its neighbor and if the destination is in the range of source then RREQ is directly sent to destination and the destination will send the RREP(Route Reply) [7] to source and the route will be established. Otherwise the source sends the RREQ to its neighbor node which is called as intermediate node. The intermediate nodes receive the RREQ packet and retransmit the RREQ to its neighbor nodes by increasing the hop count and appending its ID in the route record of the RREQ. Each and every intermediate node will do the same process until the RREQ reach the destination. If the destination finds two or more RREQ from the same source, it will find the two best routes based on the hops count and energy. In that two routes which will have least number of hops count will take as a Primary (active) path.

B. Finding Secondary (Back-up) Path:

We know that the destination selects the two best routes based on the hops count and energy. In that two routes , the destination selects the best route as a primary route. Then another route will be selected as Secondary (back-up) path. The destination will send the RREP by both primary and secondary path. Each RREP packets contains the primary as well as the back-up route information. When the source node receives the RREP packets, it treats this as a primary route and it communicates to the destination through the primary route.

C. Changing of Path from Primary to Secondary:

It is clear that, in the MANET the source found two paths to communicate destination. Upon that two paths it selects the best path as primary path and communicate to the destination. Any problems like, the intermediate node will move out of range by mobility or the intermediate node's battery power will go down[8]. In such cases the intermediate node in primary path will sends the message like "Path likely to be disconnect" . whenever the source gets the warning message like this from any intermediate node in the primary path, the source start using the back-up path along with primary path. Whenever destination node receives the data packets from the source node through two different paths (Primary + Backup), it sends acknowledgement through both the paths. If source node receives an acknowledgement from the destination node through the Backup route, it makes preemptive switch over to the Backup route.

D. Performance Evaluation:

By using this method we can able to reduce the total number of dropped data packets up to 25% and able also reduce the path discovery time for every time.

IV. ENERGY EFFICIENCY

In this work the Over-all energy consumption in the Routing paths and also transmission time is reduced. First the possible paths (here we use three) to destination is selected then the priority is given based on the energy level and its hop-count. By that path the Data is simultaneously sent to the destination. By this method the particular path energy consumption is reduced and energy consumption is distributed to another two available paths. So the dead node occurrence will stop. To reduce the overall network energy consumption sleep/power down mode approach is used.

A. Sleep/power Down Mode Approach:

The sleep/power-down mode approach focuses on inactive time of communication. Since most radio hardware supports a number of low power states, it is desirable to put the radio subsystem into the sleep state or simply turn it off to save energy.

However, when all the nodes in a MANET sleep and do not listen, packets cannot be delivered to a destination node. One possible solution is to elect a special node, called a *master*, and let it coordinate the communication on behalf of its neighboring slave nodes. Now, slave nodes can safely sleep most of time saving battery energy. Each slave node periodically wakes up and communicates with the master node to find out if it has data to receive or not but it sleeps again if it is not addressed.

V. SIMULATION RESULTS

A. Throughput:

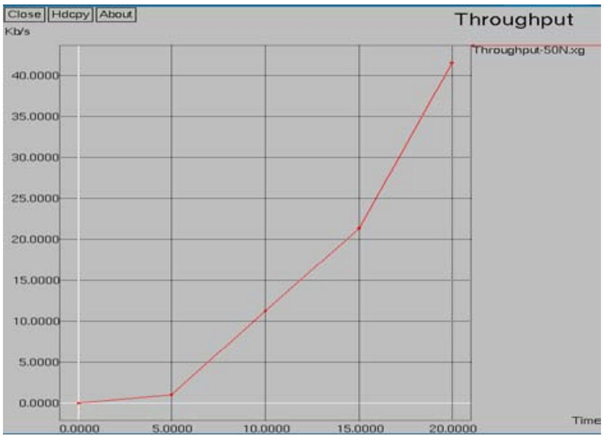

Figure.1. Result of Throughput

Fig. 1 shows the simulation result obtained for Time vs Kb/s which depicts the increase in throughput.

B. Packet Delivery Ratio:

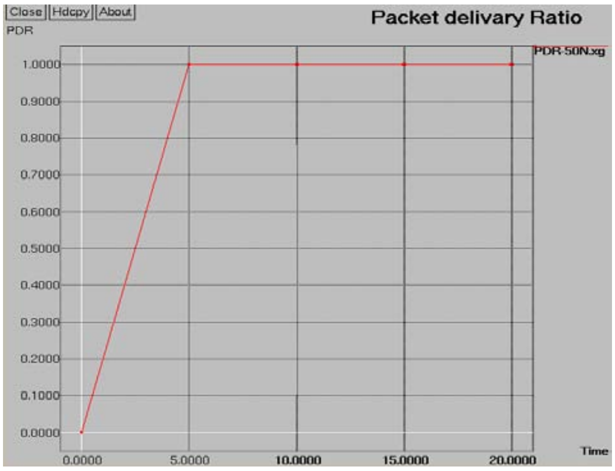

Figure. 2. Result of Packet Delivery Ratio

Fig. 2 represents the Packet Delivery Ratio which increases by this method

C. Drop Ratio:

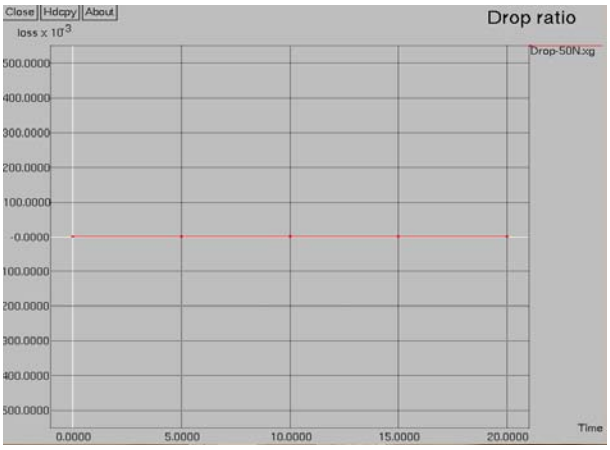

Figure. 3. Result of Drop Ratio

Fig. 3 shows Drop ratio is zero hence there is no drop in this method

VI. CONCLUSION

EEMRP mechanism reduces the energy consumption by using load distribution approach and sleep/power down approach. Most of the routing algorithms initiate route discovery only after a path breaks, it has significant control overhead for detecting the disconnection and re-construction of a new route. EEMRP mechanism detects early about the link that is likely to break soon, and hence it uses a backup path before the existing link fails. Furthermore, it will improve the communication reliability between the source and destination node even if the mobility is high.

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