ENERGY AWARE ROUTING FOR ADHOC NETWORKS USING DYNAMIC PATH SWITCHING

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ABSTRACT

Ad hoc networks are self-configuring networks and each node executes routing functionalities by itself; they are powered by battery, which is prone to decrease with time. In this paper, a power aware routing algorithm called Dynamic path switching is proposed which attempt to extend the lifetime of network in MANET. It creates a new path based on the energy level of the nodes. Along with DPS the Transmission power control technique is incorporated which varies the transmission power based on the distance. It reduces power consumption further. The proposed techniques are incorporated in Zone Routing Protocol (ZRP) and simulated by using NS-2 simulator to obtain the QOS parameters.

KEYWORDS

MANET, ZRP, Dynamic path switching, Packet Delivery ratio, Energy Efficient Routing.

1. INTRODUCTION

The Ad hoc networks are most preferred these days since it does not need an infrastructure; moreover the nodes themselves act as routers. The network is a constantly changing structure forming different routes to the destination. The battery power tends to deplete cause of this feature. Preserving battery power is an important aspect as it increases the duration for which the network exists. Complete draining of battery in a node will lead to node failure. Node failure will lead to decrease number of intermediate nodes to reach the destination, thereby decreasing the network lifetime. Designing a routing algorithm which prevents node failure is the main objective of this paper. The routing Strategy of the network is changed as to get to destination with frequent change in paths instead of using a single node for a longer duration. We incorporate power aware routing techniques in a MANET to effectively reduce energy consumption. Based on the behavior of routing, the routing protocol is primarily classified into three types as given below.

1. Pro Active routing protocol (Table Driven Approach)

Each node will pro-actively maintain a table which keeps the information needed for the routing process by periodically send Beacon messages to its neighbor nodes. Examples of such protocols

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are Destination Sequenced Distance Vector routing (DSDV), Optimized Link State Routing (OLSR) etc.

2. Reactive Routing protocol (On demand Routing Protocol)

Nodes do not maintain an updated routing table at every instant of time. It establishes a network link whenever the connection is needed. Examples of such protocols are AODV, DSR, etc.

3. Hybrid routing protocol

This routing protocol comprises of both the pro-active and reactive mechanism. Examples of such protocols are ZRP, CEDAR, etc.

2. RELATED WORKS

The technique of effective routing has been done in previous works; all the techniques have their unique way of managing power. Switching modes [1] concentrate on switching the nodes between active and sleep mode, the node goes to sleep mode based on the battery level of the node. In active mode, a node may transmit data at any time. In power-save mode, a node is inactive most of the time and comes to active mode occasionally. Switching between active and sleep mode is accomplished by keeping alive timer. This technique fails to provide an alternative for the transmission of the packet.

Power-Aware Routing [2], [3] deal with avoiding node with a low battery level this technique also serves as a power saving technique. This technique saves power by eliminating nodes with minimum power for transmission of packets. Omitting nodes will consequently lead to minimize in the number of intermediate nodes for transmission. Maintaining a drain rate [4] in this technique when overall network power is reduced to a certain level the source establishes a path with nodes which has a minimum battery left. This increases the vulnerability of link breaking since data is transferred with nodes with minimum energy.

Even power distribution [6] technique deals with distributing power evenly to all nodes for transmission of data. The technique concentrates on the fact that no node should get maximum energy for itself so that power shortage may occur for other nodes. Even distribution of power may result in inadequate power if the destination is far from the source.

In conclusion all previous [10] - [16] works deal with power management effectively, but all of them lack in the fact that change in route is not an instantaneous process. Dynamic path switching [17] overcomes this drawback it provides an alternate path the moment the node gets a low battery level. This unique feature of DPS makes it an effective routing compared to all other techniques. Moreover, all other techniques work on the fact saving power alone, while DPS deals with node failure, which is a good way of preventing link breakages. The Dynamic path switching technique is implemented in zone routing protocol.

3. ZONE ROUTING PROTOCOL

The Zone Routing Protocol (ZRP) is a hybrid protocol, which combines both proactive and reactive protocols. ZRP [8] seem to overcome the disadvantages in the proactive and reactive protocol.

There are two types of routing in ZRP.1. Intra zone routing: In intra zone routing [8] the node transmits data within its radius by proactive mechanism by maintaining a routing table within the zone. 2. Inter zone routing: In inter zone routing [9] node transmits outside its zone radius by reactive mechanism of establishing a path by route request and route reply.

It sets a zone for each node and acts proactively within that zone and operates reactively when transmission is to occur outside the zone. Energy conservation in the Zone Routing Protocol is very efficient as it saves power by transmitting data through peripheral nodes. Transmission through peripheral nodes reduces energy consumption of intermediate nodes while transmitting data. Moreover maintaining route update is confined to a small zone instead of maintaining route updates of the entire network.

The nodes of Zion are classified as peripheral and interior nodes. Node inside the zone is called interior nodes where the peripheral nodes are outer node whose minimum distance with central node is equal to zone radius. In Fig. 1 nodes A-E are interior nodes, the nodes F-J called peripheral nodes. Nodes K and L are outside the zone of S. Node S is the source node with a radius of 2. Node S wants to transmit data to the nodes within its radius through a proactive mechanism by maintaining a routing table by IARP. If not found, it uses IERP. The request is forwarded by bordercast to the peripheral Nodes. Data forwarding to K and L occur reactively by Border casting technique. This helps in establishing a link between nodes S and K

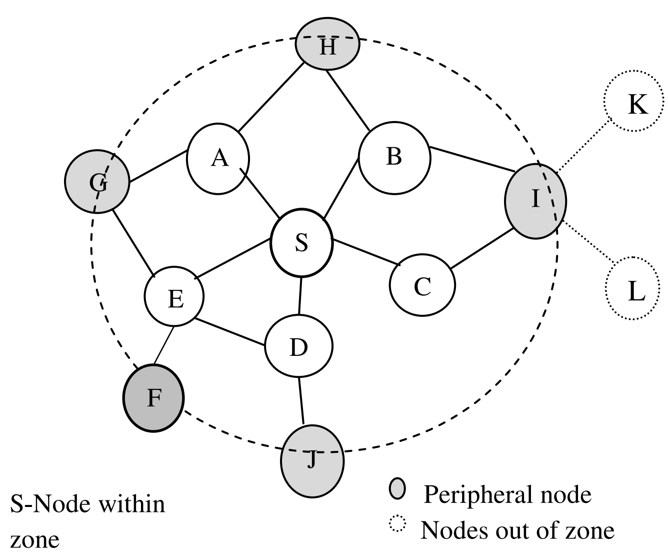

Fig. 1: Zone routing protocol

3.1 Dynamic Path Switching

The Dynamic path switching (DPS) technique is a protocol which tends to extend the lifetime of the network. In this, making the intermediate overloaded nodes into sleeping mode based on the conditions without disturb the transmission. It uses an alternate path if the energy of a node goes below the specified threshold. It saves remaining energy by making transition to sleep mode. DPS technique makes the node transmit for a longer duration than usual time as it prevents complete drain of energy. It is bound to certain conditions for transition to sleep mode and to switch path.

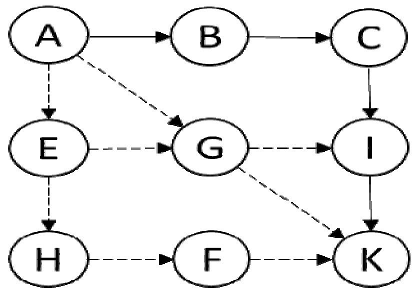

Fig. 2: Dynamic path switching

In Fig. 2, Node A wants to transmit data to node K, it checks the neighbor routing table by using IARP. If fount route node A forwards data packets to K. if not found it invokes IERP. The Solid line indicate original path, the dotted line represent the alternate path from node A to K. If energy level of the intermediate nodes B, C and I reach threshold, it goes to sleep mode and node A can take the alternate paths A-E-H-F-K, A-G-K and A-G-I-K to reach node K. DPS technique changes the path from source to destination very often so that the link does not get broken. This feature of changing paths instantaneously makes DPS technique an efficient and preferable routing technique. The following conditions are used for changing the path in DPS.

The conditions are

1. If node is participating for long duration

2. If battery goes below the given threshold

$$\frac{r(n)}{i(n)} > \beta$$

β represents the threshold value.

i (n) is the initial energy level
r (n) is the remaining energy level.
n is an intermediate node

DPS uses the above conditions for changing the path while intermediate nodes go below the threshold. Initial energy i (n) set for all the nodes in network. Nodes start forwarding the packets, energy Will depleted. The intermediate nodes check the remaining energy r (n). If r (n) if below the energy threshold, it switches the path to an alternate path. DPS mainly focuses on conserving the energy of the network and prevents node failure in a network. The flow diagram of DPS clearly depicts the working principle of DPS technique.

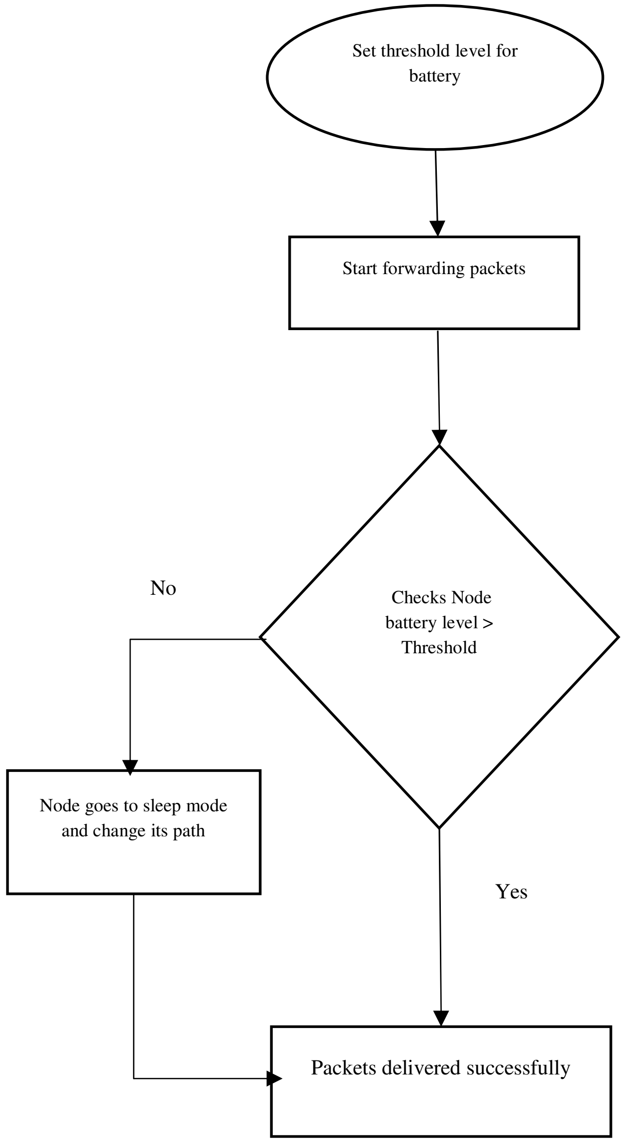

Fig. 3: DPS flow diagram

3.2 ZRP With DPS

The power aware DPS technique is incorporated in ZRP. It operates as per the routing mechanism of proactive and reactive protocol. It switches the path based on the conditions for changing path. If battery power of node inside the zone gets low it changes path with help of the updated routing table, which possess all the routing information. When the battery level of a node which is outside a zone gets low the DPS changes path reactively through border casting.

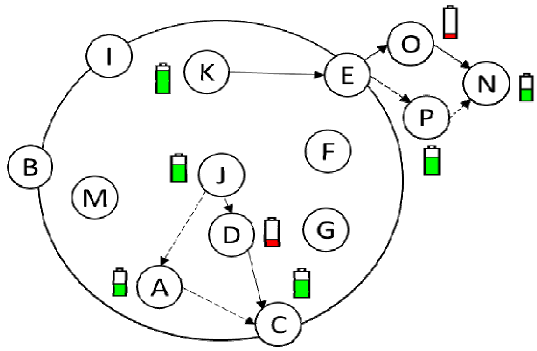

Fig. 4: ZRP with DPS

Fig. 4 represents incorporation of DPS in ZRP protocol. First case: Node J wants to transmit a Packet to node C and uses the path J-D-C in normal conditions. Node D is a forwarding to node C and also DPS complaint node .Based on conditions the node D energy goes below threshold it goes to sleep mode and the source node J changes the path to J-A-C which is an alternate path to reach node C. This occurs under proactive condition. Consider another scenario were packet forwarding is to occur between nodes K and N. For this scenario transmission occur reactively as N is outside the zone K first reaches the peripheral node E and then reaches to destination, here the original path is K-E-O-N whereas the alternate path is K-E-P-N. The source takes an alternate path if O's battery goes below the threshold. The incorporation of DPS in ZRP effectively decreases the energy consumption.

4. TRANSMISSION POWER CONTROL

Transmission power control is a technique which adjusts the transmission power level based on the distance. It saves Power, since power consumed for nodes with shorter distance is reduced. The node adapts itself for different distance from the source node. Power level for various distances are predefined. The energy is not dissipated unnecessarily and reduces total energy consumption.

The distance between the source and the destination is calculated by finding out the nodes position. From Fig. 5, we have assigned node A as source node and node E as destination node. The destination node (Node E) is nearer to the source node(A) and the distance between node A and node E is almost less than 30 m, so the transmission power of the source node is adjusted based on the pre-defined power 0.07 J as given in table 1. At initial we have assigned transmission power of 0.2J to all the nodes.

DISTANCE (METERS)	**POWER (Joules)**
10-30	0.07
30-60	0.14
60-80	0.18
100	0.2

Table 1: Power allocation for various distances

Table 1 represents power allocated for transmission of data for various distances. If a node is at distance of 100 meters 0.2 joules are used if it is below 100 meters the predefined power is used.

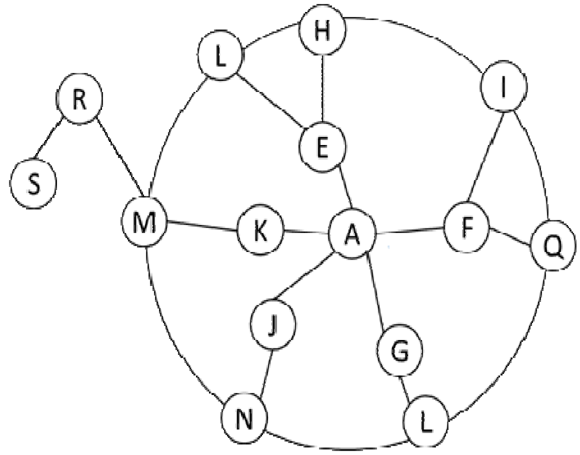

Fig. 5: Transmission power control

In Fig. 5, source node A sends data to M for that minimum power is used (0.18 J). In another scenario for transmission to R it takes more power (0.2 J) as it is far from source A.

5. SIMULATION SETUP

Simulation is carried out with Network simulator-2 tool. We consider all the parameters required for the simulation. Our simulation takes on a communication link between node 7 and 16.

The initial energy set by node is 100 j

Size: The simulation environment is of size 1000x1000 m^2

Transmission range: Range of transmission is 100 meters

No of nodes: 20, 30, 40, 50, 60, 70. The node density varies from 20 to 70.

Routing protocol: Zone routing protocol, ZRP is a hybrid routing protocol. It is chosen since energy conservation can be done effectively

Transmission power: The transmitting power is chosen to be 0.2 joules.

Mobility: random way point model with speed of 5 m/s

Receiver power: The receiving power is 0.1 joules.

Battery threshold: Battery threshold is 30 joules.

Simulation time: The total simulation time is 200 seconds

Packet size: The packet size is 2000 Kbps

6. RESULTS AND DISCUSSIONS

The use of Dynamic path switching has influenced the improvement of the network. The network performance parameters are compared with the performance of the ordinary ZRP. The results reveal that the new network DPSZRP is better than ZRP. The parameters which have been compared are Energy, Throughput, Packet delivery ratio, Packet loss and delay. All the parameters are found to perform better compared to the normal ZRP. The incorporation of DPS improves the overall network performance moreover the network exists for a longer duration compared to the existing one. DPS also reduces the link breakages in a network which improves the reliability of packet transmission.

6.1 Energy

Fig. 6 shows that Energy consumed by DPSZRP is 30% lower, when compared to ordinary ZRP this is due to DPS incorporation in ZRP. Switching to sleep mode when nodes battery goes low, it conserves the energy. Energy consumption leads to extending the lifetime of the network.

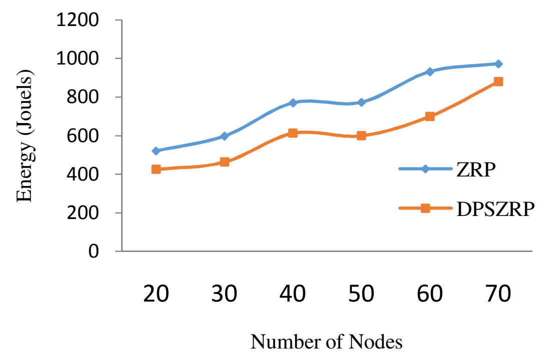

Fig. 6: Energy comparison

6.2 Packet Delivery Ratio

Fig. 7 shows that there is an increase of 5% in PDR when using DPSZRP. Since the possibility of link failure and node failure has been reduced to a considerable extent, which results in more number of packets being delivered to the destination without any packet loss in the network.

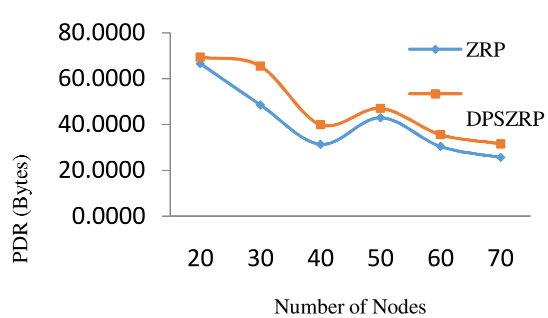

Fig. 7: Packet delivery ratio Comparison

6.3 Throughput

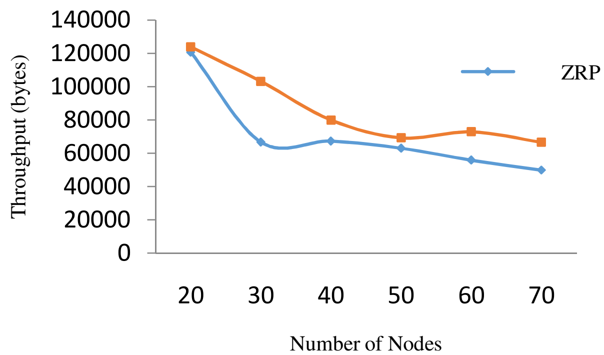

Fig. 8: Throughput comparison

Fig. 8 shows that Throughput of the proposed network is higher compared to the existing one. The incorporation of DPS has improved the number of successful packets delivered to the destination.

6.4 Packet loss

Fig. 9 shows that packet losses in transmission are also reduced by implementing DPS in ZRP. The packets are get delivered to the destination without getting dropped since DPS prevents complete node failure and finds an alternate path if the battery goes low.

6.5 Delay

Fig. 10 shows that delay in proposed DPSZRP is slightly higher when compared to ordinary ZRP. The reason is that it takes time when switching between nodes.. The delay effect is very insignificant.

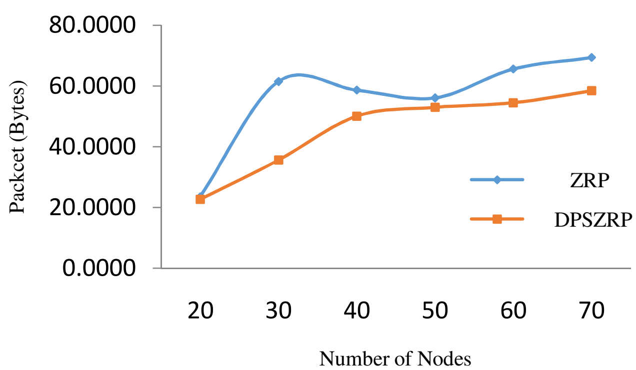

Fig. 9:Packet loss comparison

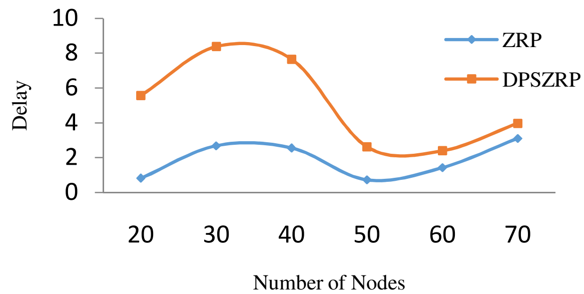

Fig. 10: Delay comparison

However the primary objective of conserving energy is accomplished even with the presence of delay. Hence DPSZRP is found to be an efficient network which produces the desired results.

7. CONCLUSION

In this paper, we proposed a new approach to minimize the energy consumption using ZRP protocol, named DPSZRP and analyzed our proposed routing algorithm with various parameters and its performances for different number of nodes. The proposed DPSZRP technique with transmission power control has better overall network performance. It enhances the performance of the network by changing paths based on the battery level of a node. The power is also varied based on the distance. The proposed DPSZRP design is found to be more efficient compared to ZRP. It makes network to exist for longer duration.

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