Design of Routing Protocol For MANET Through Energy Optimization Technique

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Abstract: A typical ad hoc network consists of nodes that are usually battery operated devices such as laptops, PDAs or sensor nodes that come together and spontaneously form a network. Energy conservation is a critical issue as the lifetime of these nodes depends on the life of the system. Research has been carried out to conserve energy at various levels i.e., at the hardware level, operating system, application level. We propose Efficient Power Aware Routing (EPAR), a new power aware routing protocol that increases the network lifetime of MANET. In contrast to conventional power aware algorithms, EPAR identifies the capacity of a node not just by its residual battery power, but also by the expected energy spent in reliably forwarding data packets over a specific link. This makes that high energy node to transmit the received packets to maximum energy node of available nodes, it may leads to successful delivery of packets on this path. Using a min-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. This protocol must be able to handle high mobility of the nodes that often cause changes in the network topology. This paper evaluates three Ad hoc network routing protocols (EPAR, MTPR, and DSR) in different network scales, taking into consideration the energy consumption. Indeed, our proposed algorithm reduces for more than 20% the total energy consumption and decreases the mean delay, especially for high load networks, to maximize the network lifetime, while achieving a good packet delivery ratio.

Keywords: EPAR, MTPR, DSR, Residual battery power

1 INTRODUCTION
An Ad hoc wireless network is a collection of two or more devices with wireless communications and networking capability. Such devices can communicate with another node that is immediately within their radio range or with the one that is outside their radio range. For the latter scenario, an intermediate node is used to relay or forward the packet from the source toward the destination. An Ad hoc wireless network is self-organizing and adaptive. This means that a formed network can be de-formed on-the-fly without the need for any system administration. The term “ad hoc” tends to imply “can take different forms” and “can be mobile, standalone, or networked”. Ad hoc nodes or devices should be able to detect the presence of other such devices and to perform the necessary handshaking to allow communications and the sharing of information and services. Ad hoc devices should not only detect the presence of connectivity with neighboring devices/nodes, but also identify what type the devices are and their corresponding attributes. Since an ad hoc wireless network does not rely on any fixed network entities, the network itself essentially infrastructure-less. There is no need for any fixed radio base stations, no wires or fixed routers. However, due to the presence of mobility, routing information will have to change to reflect changes in link connectivity. The diversity of ad hoc mobile devices also implies that the battery capacity of such devices will also vary. Since ad hoc networks rely on forwarding data packets sent by other nodes, power consumption becomes a critical issue.
1.1 Energy Efficiency

Most existing network protocols do not consider power consumption an issue since they assume the presence of static hosts and routers, which are powered by mains. However, mobile devices today are mostly operated by batteries. Battery technology is still lagging behind microprocessor technology. The lifetime of Li-ion battery today is only 2-3 hours. Such a limitation in the operating hours of devices implies the need for power conservation. In particular, for ad hoc mobile networks, mobile devices must perform both the role of an end system and that of intermediate system. Hence, forwarding packets on the behalf of others will consume power, and this can be quite significant for nodes in an ad hoc wireless network.

Energy-related metrics that have been used to determine energy efficient routing path instead of the shortest one are discussed. They are:

- energy consumed/packet,
- time to network partition,
- variance in node power levels,
- cost/packet, and
- maximum node cost.

2 PRELIMINARY STUDIES:

This section explains the literature survey various energy conservation technique the survey also extensively covers the various routing techniques.

Dongkyun Kim et al presents Untethered nodes in mobile ad-hoc networks strongly depend on the efficient use of their batteries. In this paper we propose a new metric, the drain rate, to forecast the lifetime of nodes according to current traffic conditions. This metric is combined with the value of the remaining battery capacity to determine which nodes can be part of an active route. This metric is good at reflecting the current dissipation of energy without considering other traffic measurements, like queue length and the number of connections passing through the nodes. The main goal of MDR is to extend the lifetime of each node, while prolonging the lifetime of each connection. The demerit is current dissipation of energy without considering other traffic measurements, like queue length and the number of connections passing through the nodes.

P.-J. Wan et al presents Energy conservation is a critical issue in ad hoc wireless networks for node and network life, as the nodes are powered by batteries only. One major approach for energy conservation is to route a communication session along the route which requires the lowest total energy consumption. This optimization problem is referred to as Minimum-Energy Routing. While the minimum-energy unicast routing problem can be solved in polynomial time by shortest-path algorithms, it remains open whether the minimum-energy broadcast routing problem can be solved in polynomial time, despite the NP-hardness of its general graph version. Recently three greedy heuristics were proposed in MST (minimum spanning tree), SPT (shortest-path tree), and BIP (broadcasting incremental power). At load increases the energy consumption is more.

MdNafeesRahman developed an "Efficient Algorithm for Prolonging Network Lifetime of Wireless Sensor Networks". This approach proposed a Particle Swarm Optimization (PSO). It has the merits to locate the optimal sink position with respect to those relay nodes to make the network more energy efficient. The demerit is that it only satisfies low density Network.

From the above literature survey related with the energy consumption the following things are focused:

- Minimize Energy consumed per packet: the most intuitive metric, however not optimal for maximum lifetime;
• Maximize Time to Network Partition: important for mission critical applications, hard to maintain low delay and high throughput simultaneously;
• Minimize Variance in node power levels: balance the power consumption for all the node in the network, i.e., all nodes in the network have the same importance;
• Minimize Cost per packets: try to maximize the life of all the nodes;
• Minimize Maximum Node Cost: try to delay the node

3 EXISTING PROBLEM

3.1 DSR Protocol

The Dynamic Source Routing algorithm is another innovative approach to ad hoc networking whereby nodes communicate along paths stored in source routes carried along with the packets. DSR explores the many advantages of source routing and enjoys the benefits of some of the most extensive testing and deployment of any of the protocols. It is one of the purest examples of the on demand protocol, in which all actions are taken only when the route is actually needed. It has some disadvantage also like it does not support multicasting, decreasing throughput, and increasing load of the network.

3.2 MTPR Protocol

In existing power aware methodology(MTPR), the next hop to be transmitted only chosen based on the residual energy of the next hop. Not focusing on complete path identification. Whenever the source finds next hop based on residual energy, the high residual energy nodes might not be nearer by sufficient energy nodes. This makes that high energy node to transmit the received packets to maximum energy node of available nodes. It may leads to unsuccessful delivery of packets on this path. Assuming all nodes in the network are equally important, no node should be used for routing more often than other nodes. However, if many minimum energy routes all go through a specific node, the battery of this node is drained quickly and eventually the node dies. Therefore, the remaining battery capacity of a node should be used to define a routing metric that captures the expected lifetime of a node, and so, the lifetime of the network. The limitations of this approach can be summarised are the network will be congested as the packets has to route from multiple nodes, more number of nodes has to participate in forming a routing path and it will always select its nearest neighbouring node, it does not consider overall s-d path. This protocol is that, it is not scalable to large networks and even requires significantly more processing resources than most other protocols. Basically, in order to obtain the routing information, each node must spend lot of time to process any control data it receives, even if it is not the intended recipient.

4 PROPOSED WORK

To propose an efficient power aware routing (EPAR) protocol that increases the network lifetime of MANET. In EPAR, before forwarding its packets to next hop, the source itself analyze the entire path and its ability. The source node calculates the expected energy spent over each path available and its lifetime changes if, the packet routed through each path. On analyzing the entire route path available, the source node decides not only the next hop and also the entire path to be used and route its packet as calculated. It increased Network lifetime. In EPAR, selection of path decided only based on the residual energy of full path. How about the residual energy of all intermediate nodes havetaken care in selection of next hop. It increases in life time of nodes further decreases packet loss.

5 DESIGN AND IMPLEMENTATION

To conserve energy, there should minimize the amount of energy consumed by all packets traversing from source node to destination node. i.e. we want to know the total amount of energy the
packets consumed when it travels from each and every node on the route to the next hop. The energy consumed for one packet is calculated by the equation

\[ E_c = \sum_{i=1}^{k} T(n_i, n_{i+1}) \]

where, \( n_i \) to \( n_k \) are nodes in the route while \( T \) denotes the energy consumed in transmitting and receiving a packet over one hop. Then we find the minimum \( E_c \) for all packets. The main objective of EPAR is to minimize the variance in the remaining energies of all the nodes and thereby prolong the network lifetime.

5.1 Route Discovery and Maintenance in Proposed Algorithm

EPAR schemes make routing decisions to optimize performance of power or energy related evaluation metrics. The route selections are made solely with regards to performance requirement policies, independent of the underlying ad-hoc routing protocols deployed. Therefore the power aware routing schemes are transferable from one underlying ad hoc routing protocol to another, the observed relative merits and drawbacks remain valid. There are two routing objectives for minimum total transmission energy and total operational lifetime of the network can be mutually contradictory. For example, when several minimum energy routes share a common node, the battery power of this node will quickly run into depletion, shortening the network lifetime. When choosing a path, the DSR implementation chooses the path with the minimum number of hops. For EPAR, however, the path is chosen based on energy. First, we calculate the battery power for each path, that is, the lowest hop energy of the path. The path is then selected by choosing the path with the maximum lowest hop energy.

Table 1 NETWORK PARAMETER TO BE MEASURED USING NS2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of packets</td>
<td>Defines no of packet sent</td>
</tr>
<tr>
<td>Traffic size</td>
<td>Packet size and time interval for sequential transmission</td>
</tr>
<tr>
<td>Transmit Energy</td>
<td>Require to transmit</td>
</tr>
<tr>
<td>Receive Energy</td>
<td>Require to receive</td>
</tr>
<tr>
<td>Idle energy</td>
<td>Being at ON condition</td>
</tr>
<tr>
<td>Sense power</td>
<td>Energy spent to sense packets</td>
</tr>
<tr>
<td>Energy consumed</td>
<td>No of packets transmitted x energy spent</td>
</tr>
<tr>
<td>Residual Energy</td>
<td>Initial energy – energy consumed</td>
</tr>
</tbody>
</table>

5.2 Network Lifetime

Network lifetime – Residual energy relationship

It could be classified into two conditions:

1. Non functional:

The node is simply idle and not participating in any traffic transmission at this situation residual energy will be a function of only of idle power. Since no transmission reception is carried out. Therefore, by spending idle power, how long the low power node could remain in network.
The network lifetime = The time over which the residual energy could spend on keeping the node remains in network.

(\text{Network lifetime}) \ non \ function = \ residual \ energy \\
(\text{idle power}) \ * \ \text{network lifetime} = \ \text{residual energy} \\
\text{Eg: } 0.01v \ * \ 500 \ \text{min} = 5v

2. \text{Network lifetime functional:}

In this case, the node contributes to the network and involved in handling traffic. So it would transmit power and receive power. Therefore,

(\text{transmission power} + \text{receiving power}) \ * \ \text{network lifetime} = \ \text{residual energy} \\
\text{Packet delivery ratio} = \frac{\text{No. of packets delivered}}{\text{No. of packets transmitted}}.

Figure 1 Flow Chart

6 SIMULATION SETUP AND RESULT DISCUSSION

Extensive simulations were conducted using NS-2.33. The simulated network consisted of 120 nodes randomly scattered in a 2000x2000m area at the beginning of the simulation. The tool setdestwas used to produce mobility scenarios, where nodes are moving at six different uniform speeds ranging between 0 to 10 m/s and a uniform pause time of 10s.

6.1 Node Configuration

Figure 2 Node Configuration

In Fig 2 Node Configuration is done. Node configuration essentially consists of defining the different node characteristics before creating them. They may consist of the type of addressing structure used
in the simulation, selecting the type of adhoc routing protocol for wireless nodes or defining their energy model.

6.2 Path Selection Based On Energy Calculation

In Fig 3 we calculate expected energy drain at each path calculated from path A, B, C. Among which path A expected to spent lesser energy and ensure prolong lifetime, so path A has chosen.

6.3 Average Consumed Power Versus No. Of Nodes

In Fig 4 shows that the consumed power of networks using EPAR and MTPR decreases significantly when the number of nodes exceeds 60. On the contrary, the consumed power of a network using the DSR protocol increases rapidly whilst that of EPAR based network shows stability with increasing number of nodes.
6.4 Network Lifetime Varying With Respect Network Size
In Fig 5 shows that the DSR protocol becomes inefficient when the network consists of more than 700 traffic size for low density network while for high density network becomes inefficient when the network consist more than 1000 sourcesEPAR shows the best performance with maximum network lifetime than MTPR and DSR.

6.5 Network Lifetime Varying With Respect To Network Size (Nonfunctional)

In Fig 6 shows that the node is simply idle and not participating in any traffic transmission at this situation residual energy will be a function of only of idle power. Since no transmission reception is carried out. Therefore, by spending idle power, how long the low power node could remain in network.
The network life time = The time over which the residual energy could spend on keeping the node remains in network.

6.6 Network Lifetime Varying With Respect To Network Size (Functional)

In Fig 7 shows the network lifetime as a function of the number of nodes. The life-time decreases as the number of nodes grow; however for a number of nodes greater than 100, the life-time remains almost constant as the number of nodes increases. Lifetime decreases because MANET has to cover more nodes as the number of nodes in the network size increases. We observe that the improvement achieved through EPAR is equal to 85 %. Energy is uniformly drained from all the nodes and hence the network life-time is significantly increased.

Network lifetime as a functional can be calculated as:
RESIDUAL ENERGY= (transmission power + receiving power) * network lifetime
7 CONCLUSION
This paper mainly deals with the improve the overall network lifetime of the network using a EPAR algorithm. We propose a new scheme EPAR it satisfies both medium and large size network but DSR and MTPR only used for small size network. It produces good results in terms of throughput and leads to good packet delivery ratio.

REFERENCES
[1] Internet Engineering Task Force, “Manet working group charter,”