Probability based Method for Node Selection in MANET

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Abstract

In Mobile Ad hoc Network, the mobility of node is unpredictable and possibly mobile in the network is among characteristic of the wireless network. The energy constraint of the nodes is an important issue that must be considered in designing a routing protocol. Every node in MANET is typically battery powered as well as limited in storage and processing capabilities. Moreover, they may be situated in areas where it is not possible to re-charge. Thus, how to reach the optimal routes path connection in order to prolong network lifetimes. In order to address this problem, the Probability based Method for Node Selection scheme be proposed to select a node in the path discovery. The scheme combines the concepts of energy level with distance factor on routing protocol, and reservation as well as consumption of energy on nodes.

Keywords-component; Energy constraint; Residual energy; Node selection.

1. Introduction

Mobile ad hoc networks (MANET) consist of wireless nodes that form a communications network without fixed infrastructure. Topology changes occur in MANET also due to node mobility or node breakdown as a result of running out of power, which will cause the network connection is broken. Concept of MANET, nodes act to function as a router to connect to a remote node of the source. Connection between nodes in the network requires an effective routing mechanism to ensure QoS. However the fitness of node also becomes an important issue to be considered in the selection of a node routing due to limited resources not to be depleted during packet forward.

2. Background

Maintaining optimized lifetime of routing path in a network that consists of nodes with limited energy is a very challenging task. It is clear of node in MANET is power/energy constrained according on its battery's size, model, property, capacity etc. Node's activities, i.e. transmission, reception, and overhearing, will decrease the energy of the battery [1]. Reduction of energy will cause increase in transceiver delay and overhead cost. Therefore, the node will die when the energy runs out. The network lifetime can be maintained longer with efficient management of nodes' energy. Efficient energy management can be achieved using appropriate techniques of node selection, energy conservation and minimizing energy consumption on the nodes. To achieve optimum network lifetime, the node selection process must concerns in the first phase of the route discovery process. Many algorithms and techniques in routing protocol have been introduced and they have contributed to QoS in routing protocol. However, there are some drawbacks found in the current routing protocols, in particular during route discovery sessions. Moreover, when the weak nodes with limited energy strength are allowed to involve in forming a route, the nodes' energy will drain earlier and eventually caused the path connection to break.

The rest of this paper is organized as follows. Section III provides an overview of routing concept. Section IV characterise energy power on node (constrain). Section V explains the previous work on power-aware. Section VI describes the design consideration of the proposed scheme and Section VII concludes this paper.

3. Routing protocol in MANET

The routing protocol is the process of moving packets through an internetwork, such as the internet. Routing consist three phase: i) Node discovery with participating node ii) Route discovery involve of disjoint or non-disjoint ii) Route maintenance is to recover the route failure. Routing technique has two types, first one the single path and another is multipath routing technique. Single path is establishment of single route path from source node to destination. While the multipath technique is allows the establishment of several numbers of routes path from source node to destination and it also used to provide route suggestions or alternative route. The multipath routing effectively reduces the frequency of route discovery therefore the latency for discovering another route is reduced when currently used route is broken. Multiple paths can be useful in improving the effective bandwidth of communication, responding to congestion and heavy traffic, and increasing delivery reliability [2]. Alternatively, traffic can be distributed among multiple routes to enhance transmission reliability, provide load balancing, and secure data transmission.

4. Characteristic of Node with Constrain Energy

Each node in MANET serves as host and router which are supplied with battery power. Depletion the battery power of nodes involved in the routing path make the network lifetime drop off. Since of difficulties in charging or replace the battery of node, the energy management and energy consumption is vital to ensure the lifetime node can be extended. The limitation of energy source on nodes in MANET is the most challenging problems [3] [4]. Nodes in a MANET are usually battery powered predetermined time making capabilities. It is not practical for the modification of adding capacity. To achieve optimizing it's via developing an efficient routing algorithm scheme.

Nodes use energy when periodically it send beacon signals to the neighbor nodes to detect its existence or involved to send the data to desired destination. Mobile nodes in MANET cannot operate without energy, and the energy in mobile nodes could be highly limited due to the generally limited battery power, this can be considered one of the most important limiting factors in operating an ad hoc network. Every time a node transmits, receives or overhearing to a communication medium, it consumes energy. The standard IEEE 802.11 protocol, developed for wireless network, that operation on wireless network with a little traffic, much energy is wasted due to the following causes: Idle listening, collision, overhearing and protocol overhead.

In describe the energy constraint with the limited battery lifetime imposes a severe constraint on the network performance. Thus, the residual energy at nodes is significant in determining the selection to extend the network lifetime. Nodes in the minimum route quickly drained of energy will impact the network connection when they fail. Therefore, the design factors are most important protocol is associated with the node selection algorithm based on residual energy.

5. Related work on Power-Aware routing protocol

Several protocols have been proposed that the energy in the node is a significant problem in maximizing the network lifetime. There are a few protocols have been proposed as Distance-based Energy Aware Routing (DEAR) [5], MAP [6], WSN [4].

DEAR in [5] was proposed routing algorithm based on route setup route maintenance. In route setup phase, it using the distance of source node to sink node (d_n) compare with source node with direct transmission to destination (if $d_n \leq 100$) it will use direct transmission or else, multi-hop routing will be used. This algorithm can also determine the number of nodes involved as a relay node, and also can determine which node will be the node closest to the direct link from n to the sink node as possible.

However, DEAR algorithm is not measuring residual energy available to a selected node to ensure that the selected node does not run out of energy in the operational.

The author in [6] was make analysis and it states, using a short range communications and non-distance communication between sensor nodes because of the power transmission is required to give as the following figure 1.

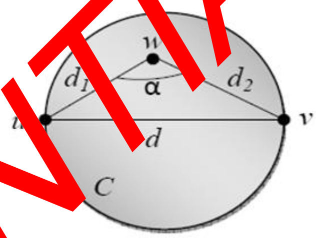

Figure 1. The case for multi-hop communication [6]

Suppose node *u* must send a packet to node *v*, which is at distance *d*. Node *v* is within *u*'s transmitting range at maximum power, so direct communication between *u* and *v* is possible. However, there exists also a node w in the region C circum scribed by the circle of diameter d that intersects both *u* and *v*. let δ(*a*,*b*) be the distance between nodes *a* and *b*, respectively. Since δ(*u*,*w*) = *d1* < *d* and δ(*v*,*w*) = *d2* < *d*, sending the packet using *w* as a relay is also possible. But the author does not take into account the case if node *w* is outside C and if w node is not taken as a relay node, *u* direct transmission to *v*, it will use high energy transmission and transmission distance was limited.

The author in [7] was propose the distance-based energy efficient sensor placement (DBEEP) for lifetime maximization, and jointly optimize the load balance, communication range and network size in a time-driven linear WSN. It described the traffic load balancing is a critical issue that must be addressed at each node in a balanced flow of traffic on a particular node can increase the network lifetime. They come with the energy model with assume that nodes only relay data to the next node in the direction of the radius except that the next node is lost. In this model was configuring with arrangement of node relate on distance deployed along the radius adjacent node have *d1>d2…>dn*, the connected coverage of the nodes inside will be ensured. Identical in [8] the author was describe the control of energy consumption by controlling the optimum router location. By identifying the number of nodes involved and taking into account the communication costs and the shortest route.

Based on the consideration of literature have been investigated, that the techniques of Energy-Aware or the proposed has helped improve the network connection of the network lifetime. The node discovery selection based on node energy and distance few other considerations that can helped towards that (DEAR, MAP, WSN, ect). However there is lack of attention to the energy possessed by an individual node. In the proposed technique have them take into account the energy consumption as based on distance to radius front next node on be relay the transmission to destination. This did not reflect the accurate value of the node capacity of its own.

6. Probability based Method for Node Selection

To the best of our knowledge, we propose probability based method for node selection routing schemes that consider the energy distance factor to be optimize network lifetime and also considering the residual energy at the nodes. To describe our proposed route based on the findings, we propose a node discovery based on energy aware with distance factor of node routing protocol for MANETs. The aim is to ensure improved performance of the path lifetime while remaining central to the energy options based on multiple threshold level on nodes in the route discovery. Node selection technique based on residual energy with distance factor is to ensure that the node is participating in the way of residual value of the equal capacity on the path routing. The energy cost on nodes wills accumulation of path selection which is owned by the path that better reflect the realities. Unlike other techniques, that uses the threshold value but does not reflect the cost of energy capacity at each node. This will surely to become an early break down route path.

Node participating

It is common for each node in the network to have a different battery level from other nodes. Initially power on the nodes often referred to size, model, property capacity and etc due to different battery manufacturing techniques that yield different capacities and decay rate. Each node has an energy source, it work on reachable zone related to energy level. All nodes within reach are tier 1, 2, 3...according to energy strange as illustrate in figure 1.2. A nodes main task that involves communicating with other nodes is to participate in route discovery and maintenance.

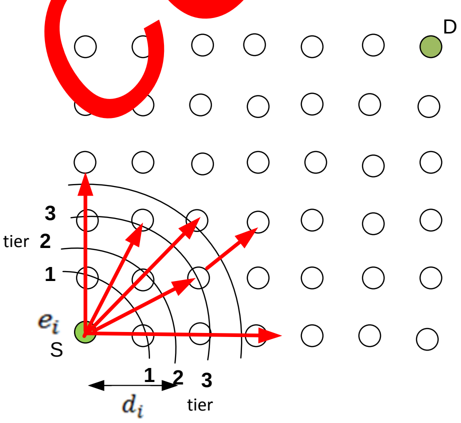

Figure 2: Energy reachable zone

e_i : energy level of node i

d_i: distance between the source node and node i

ρ_i: energy-distance factor of node i

The energy-distance factor (ρ_i) is computed as follows. Figure 1.3 shows the representative block diagram.

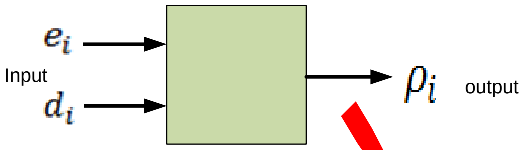

Figure 3: Representative Block Diagram of the model

If the energy level and the distance of the node i are given by e_i and d_i respectively.

energy-distance product of node i (m_i) = $e_i * d_i$ (1)

energy-distance factor of node i $(\rho_i) = \frac{e_i d_i}{\sum_{i=1}^{n} e_i d_i}$ (2)

Where, n – number of nodes in the tier 1

Properties of energy-distance factor

i. ρ_i lies between 0 and 1 for all i

Proof:

Consider the extreme case of no other nodes in the vicinity of the source node. Then $e_i = 0$.

Thus $\rho_i = 0$

The other extreme case is only one node in the vicinity of the source node with energy level e and at a distance d.

Energy-distance product $(m) = ed$

Energy-distance factor $(\rho) = \frac{ed}{\sum ed} = \frac{ed}{ed} = 1$

For all other cases where there are more than one node in the vicinity of the source.

Energy-distance product of node i $(m_i) = e_i d_i < \sum e_i d_i$

Hence, Energy-distance factor of node i $(\rho_i) = \frac{e_i d_i}{\sum e_i d_i} < 1$

Thus for all cases,

Energy-distance product of node i is $0 \leq \rho_i \leq 1$

i. $\sum \rho_i = 1$

Proof:

Consider that there are n nodes in the tier 1 of source node S.

Let $\sum_{i=1}^{n} e_i d_i = e_1 d_1 + e_2 d_2 + \ldots\ldots.. + e_n d_n = c$

$$\rho_i = \frac{e_i d_i}{\sum_{i=1}^{n} e_i d_i} \quad (3)$$

$$\sum \rho_i = \sum \frac{e_i d_i}{\sum_{i=1}^{n} e_i d_i}$$

$$\sum \rho_i = \frac{e_1 d_1}{c} + \frac{e_2 d_2}{c} + \ldots\ldots. + \frac{e_n d_n}{c}$$

$$\sum \rho_i = \frac{c}{c} \quad (4)$$

$$\sum \rho_i = 1$$

Thus, ρ_i behave like a probability

Since ρ_i behaves like a probability and identifies the node with the highest energy level at the farthest distance possible, it may be used to select the next hop node for forwarding the packet towards the destination. The node possessing the largest ρ value may be preferred to all other nodes as the next hop in the direction of the destination.

Energy Behaviour of the Intermediate Node

The Energy required to forward a packet of data to the next node is given by [5]:

$$E_{Fx}(l,d) = E_{Tx}(l,d) + E_{Rx}(l)$$

$$= \begin{cases} 2l \,. E_{elec} + l.\varepsilon_{fs}.d^2 , \; if d < d_0 \\ 2l \,. E_{elec} + l.\varepsilon_{mp}.d^4 , \; if d \geq d_0 \end{cases} \quad (5)$$

$$d_0 = \sqrt{\frac{[illegible]}{e_m[illegible]}}$$

$$d_0 = \sqrt{\frac{10}{0.0013}} = 87.71 \text{ m}$$

Hence, when selecting an intermediate node, it is necessary to consider both free space transmission as well as multipath transmission.

SIMILATION

The energy behaviour of the intermediate nodes was investigated using simulations. A simulation environment was setup using GNU Octave 3.2.4 software. Figure 4 and 5 shows the residual energy of the intermediate node after transmitting a packet of unit size. The experiment has been setup with three intermediate nodes between the source node and the destination located at different distances but having the same energy levels. Locating the nodes at different distances create different energy-distance factors for the nodes though they possess the same level of energy. Residual energy has been computed by dividing the energy consumed by the initial energy using Formula (6) and the angle of deviation is the deviation of the intermediate node from the line connecting the source and destination nodes.

$$E_R = \frac{E_C}{E_I} = \frac{E_I - E_L}{E_I} \quad (6)$$

Where E_R – residual energy
E_I – initial energy
E_C – energy consumed
E_L – energy left

Figure 4: Residual Energy in the Intermediate Node – Free Space Transmission

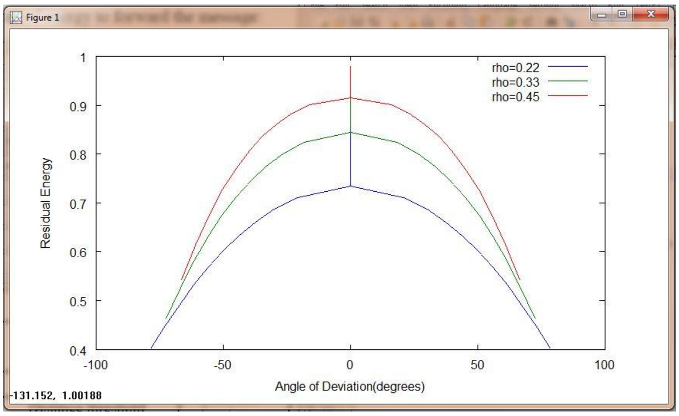

Figure 5: Residual Energy in the Intermediate Node – Multi Path Transmission

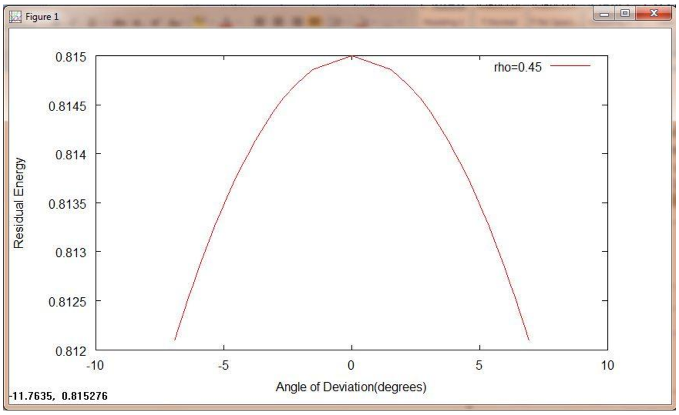

Figure 6: Residual Energy in the Intermediate Node – Narrower Angle of Deviation

Figure 6 shows the same information but confined to a narrow angle of deviation. Figure 6 has been plotted specially to clarify the confusion created in Figures 5 and 6 near the origin (0^o). From Figure 6, it can be clearly seen that the sharp rise in the residual energy is due to data point concentrating near 0^o only and apart from that it clearly follows the general trend. From these figures, it can be seen that the residual energy increases as the angle of deviation reduces towards origin. This is due to the fact that as the angle of deviation reduces so does the distance between the intermediate node and the destination node. The energy consumption by the intermediate node reduces drastically with the reduction of distance as they are related through higher orders of the distance as shown in Formula (2). These figures also show that the node with highest energy-distance factor (ρ) has the highest residual energy meaning that the intermediate node has consumed lowest energy compared to other intermediate nodes.

Figures 7 and 8 show the results of the experiment that has been set up using intermediate nodes with different initial energy levels but located at the same distance.

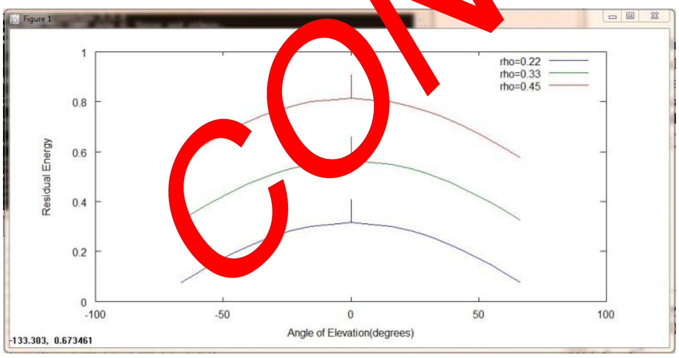

Figure 7: Residual Energy in the Intermediate Node – Free Space Transmission

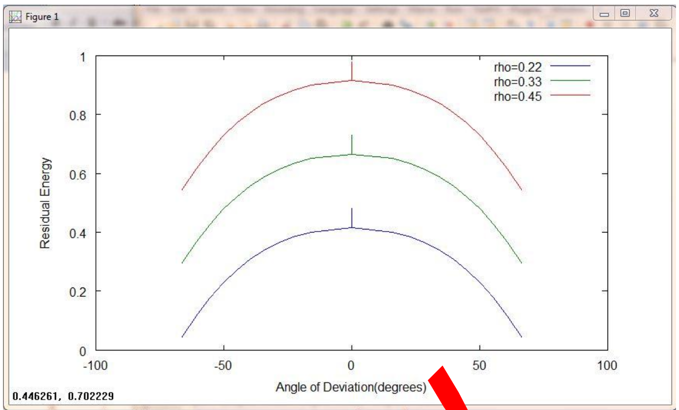

Figure 8: Residual Energy in the Intermediate Node – Multi Path Transmission

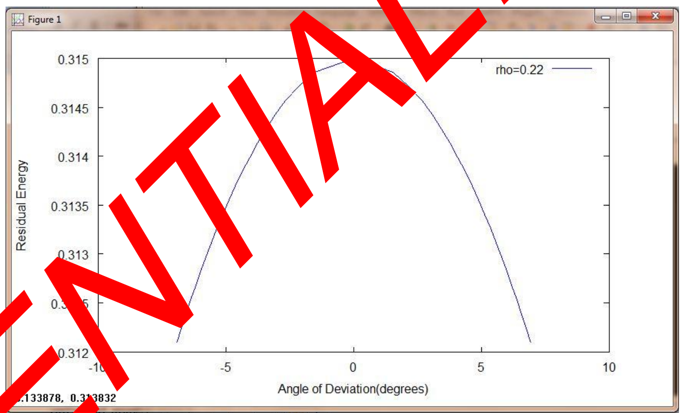

Figure 9: Residual Energy in the Intermediate Node – Narrower Angle of Deviation

Figures 7 and 8 show that the intermediate node with the largest ρ has the highest residual energy level compared to the other nodes. This result is similar to the results shown in Figures 4, 5, and 6. In both cases the node with the largest ρ provides the highest residual energy meaning that it has more energy left after the transmission of a data packet. This information is very important for selecting the intermediate node that could provide a stable route in terms of node life time. If a node with low residual energy was chosen for transmission, it would not have sufficient energy left for future transmission forcing the nodes to rearrange the routes through other nodes. Hence it can be concluded that the node with the largest energy-distance factor (ρ) provides the best intermediate node for the transmission of data towards the destination. From the results it can also be seen when the energy-distance factors are arranged in a descending order they provide the intermediate nodes' residual energy from highest to lowest meaning that the energy-distance factors can be used to select the best node as well as the backup nodes with an order of preference in times of node failures due to other reasons such as node mobility.

7. CONCLUSION

The concise discussion in this paper shows that, despite the large efforts of the MANET research community and the rapid progress made during the last years, many issues that affect the energy at the node still has space improvements, particularly involving the routing protocol. The algorithm of nodes selection based on residual energy is the one of the essential to improve the lifetime of network nodes by considering the individual energy. Residual energy level at the node and the distance factor can be used to determine the probability of intermediate node to be select as relay node to destination. This algorithm can prevent the early failure of a node and reflected to reliability of route path. The node with the largest ρ provides the highest residual energy meaning that it has more energy left after the transmission of a data packet. This will extend the route path connection in the entire network path.

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