1S-05

MANET Topology Control based on the remaining energy of nodes

Wan Norshahriman Bin Saharudin † Michiko Harayama ‡

† Graduate school of Engineering, Gifu University 1-1 Yanagido, Gifu-shi, Gifu, 501-1193 Japan

‡ Faculty of Engineering, Gifu University 1-1 Yanagido, Gifu-shi, Gifu, 501-1193 Japan

E-mail: † t3128031@edu.gifu-u.ac.jp, ‡ harayama@gifu-u.ac.jp

1. Introduction

Mobile Ad hoc Networks (MANET) are self-organized networks where the networks are dynamically created and maintain to communicate with each other and independent from base station or fixed infrastructure [1]. It proves useful when can be applied fast and easy to maintain in the disaster zones or remote areas where there is no other communication means are available. However, the drawback is the mobile nodes have the limited battery supply so the MANET requires that the routing protocols utilize power efficiently to maximize the network lifetime [2].

Therefore, we focused on the topology control method based on the nodes remaining energy itself. In this study appropriate functions of remaining energy that express the transmission power are investigated.

2. Related Work

There are various existing methods to maximize the power efficiency while maintaining the communication stability. Mainly, there are 3 methods that have been proposed widely which will be discussed below.

2.1 Selective routing path base on remaining energy or energy consumption

In [3], the authors proposed the Energy Conscious Dynamic Source Routing (ECDSR) protocol. During the route discovery phase, a path is selected between the nodes that having higher remaining battery power instead of the least hops count method in DSR. The results are the nodes energy consumption is distributed fairly and maximized the overall network lifetime. However, energy are consumed not only data delivery but also exchange of hello and routing packets.

2.2 Reducing the nodes energy consumption by the time interval.

In [4], the authors proposed to make each node randomly make asleep for a while with gossip probability *p*. When the value of *p* is small enough the network stays connected. The routing is simpler and scalable without need to maintain information between the nodes. However, since nodes are chosen randomly, nodes which haves much energy are not always selected to sleep.

2.3 Topology control by controlling the transmission power.

In [5], the authors proposed to control the transmission power and the threshold of energy detection based on the number adjacent nodes (node degree). The main advantage of this method is the network quality can be maintain even in a dense environment while reduce the energy consumption. However, energy saving effect of this study is a sub-effect and doesn't directly save nodes that energy are short.

Furthermore, the method [3] need to share information between the nodes thus burden the packets load to carry the extra information. The routing protocol also needs to be changed a lot thus create the comparability problem with other nodes that have another routing protocol. In contrast, topology control method [5] doesn't need to share the information between the nodes and reduce the packet load.

Between the time's intervals methods that isolate nodes (sleep node) from the network without the circumferences, nodes remaining energy based is more reliable to control the transmission power.

3. Proposed Work

3.1 Formula

We investigate the several formula to control the transmission power ($\tilde{P}_T$) based on the remaining energy ($\tilde{E}_R$) which is mentioned below.

Here $\tilde{P}_T$ and $\tilde{E}_R$ are normalized values of P_T and E_R

$$\tilde{P}_T = \tilde{E}_R^a (a>0)$$

For the power factor a, we choose 0.01, 0.05, 0.5, 1.0, 2.0 and 4.0 to investigate the results.

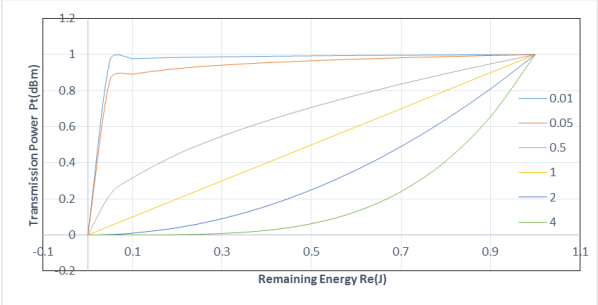

Fig.1 $\tilde{P}_T$ vs $\tilde{E}_R$

From Fig.1, as the normalized remaining energy decline, the transmission power also reduced based on the power factor of a. The power factor of a, changes the declining rate of $\tilde{P}_T$.

4.Simulation

This section describes the simulation tool and parameters chosen to simulate the proposed data transfer. Here, the Ubuntu Operating System in a VMWare environment was used. For simulation software, Network Simulation 3(NS3.24.1) was used as the simulator to evaluate the performance of the topology control based on $\tilde{E}_R$. We used IEEE802.11b for MAC protocols with 2Mbps bandwidth and UDP traffic model based on AODV MANET routing protocol.

Each packet size contains 512 bytes and packets are sent between 0.05s interval. Each node is placed by random within 300mx300m field and assumed to move based on a random walk model in two-dimensional space. The movement speed was assumed based on an average adult walking speed 1.5m/s. After traveled for 100m, it would then move to another random location.

Energy consumption was based on RN-174wifi module which is the maximum transmission power is 12dBm, idle and Rx current is 40mA.Tx current is 190mA.Maximum battery capacity was set to 40 J.

20 nodes, 40 nodes and 60 nodes scenarios were chosen to evaluate. Simulation time took placed in 120s for 10 times and averaged.

Fig.2~4 below are the simulation results.

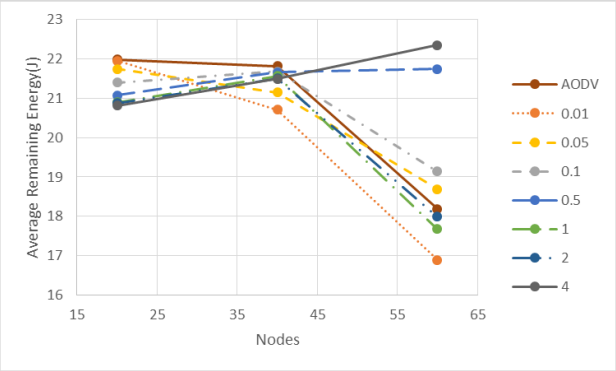

Fig.2 Avg.Remaining Energy

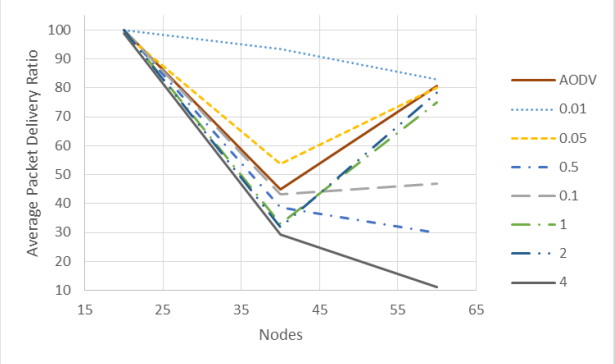

Fig.3 Avg. packet deliver ratio

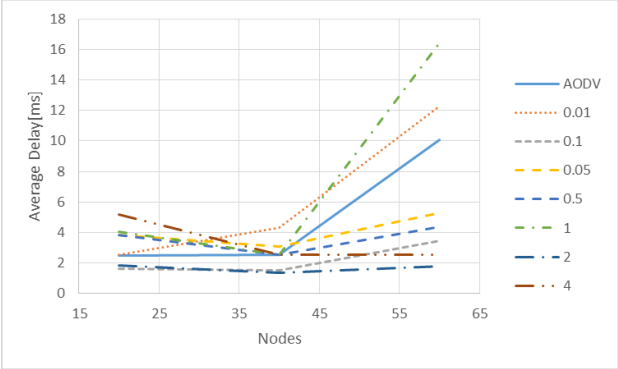

Fig.4 Average delay

From Fig.2 AODV remaining energy was getting smaller as the nodes increased while the proposed increasing. Meanwhile, the packet delivery ratio for MANET is better than proposed for overall. However the average delay experienced by a packet from the source to destination is much better for proposed work than the AODV.

7. Conclusion and Future Work

For this work, we investigated the relationship between the remaining energy and the topology control.

We can conclude that we can choose between the proposed works or AODV depend on the situation to take priority for remaining energy or the packet delivery performance.

For future work, we hope to refine the proposed work's formula to enhance the packet delivery performance.

References

[1] Michel Barbeau and Evangelos Kranakis "Principles of Ad hoc networking," Wiley, 2007.

[2] Shilpa Bade, Meeta Kumar, and Pooja Kamat, "A reactive Energy-Alert Algorithm for MANET and its impact on Node Energy Consumption," International Journal of Computer Applications, vol. 71, no. 18, pp.1-6, 2013.

[3] Namita Agrawal, Nitin Choubey, Prashant Mishra, "Optimized Route Selection with Energy Constraint in MANET," International Journal of Advancements in Research & Technology, Vol. 3, Issue 4, pp.139-145, 2014.

[4] Xiaobing Hou and David Tipper,"Gossip-based Sleep Protocol (GSP) for Energy Efficient Routing in Wireless Ad Hoc Networks", WCNC 2004, pp.1305-1310, 2014.

[5] Yukinari Hayashi, Michiko Harayama,"MANET Topology Control Based on the Node Degree and Energy Detection Threshold", ITA15, pp.41-46. 2014.