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The Impact of the Number of Nodes, Speed of Nodes, Speed of Network and the Network Space to the Number of Nodes Keeps Alive

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Abstract: Mobile Ad Hoc Network (MANET) is a technology that operates on portable devices such as IPAQ Personal Digital Assistants (PDA), smartphones, laptops and other mobile devices. Habitually, all these devices run on batteries; therefore, the need of sufficient power poses a critical issue in the operations of these devices in the network. This research was conducted to compare and analyse the number of nodes keeps alive in the Mobile Ad-Hoc Network (MANET) in order to find out the best way to manage the mobile devices. The NS2 simulation tool was used to conduct the experiment focused on Optimize Link State Routing (OLSR) protocol. The scenario was created based on four elements; the space of network, the different number of nodes located in the network, the different speed of nodes and the different speed of the network. The results from the experiment show that all the four elements give a significant impact to the energy usage for mobile devices. Lastly, the matrix solution table for high speed of nodes and high speed of networks is proposed. This matrix solution table can be used as a guideline for the decision maker or researcher to select the suitable elements that suite to their scenario.

Key words: OLSR, NS2, nodes keep alive, protocol, energy

INTRODUCTION

Optimize Link State Routing (OLSR) is a proactive protocol type which originated from INRIA (Institut National de Rechercheen Informatiqueet Automatique), France. It has been proposed for standardisation to the Internet Engineering Task Force (IETF) with the RFC 3626 document in October 2003. As the name implies, OLSR is a link state protocol where nodes broadcast local link information in the entire network. In OLSR, shortest routes are computed based on Dijkstra's algorithm. OLSR is widely used protocol for Mobile Ad-Hoc Networks (MANET). It addresses the high overhead problem common to proactive link state routing protocols with the introduction of Multipoint Relays (MPR) (Clausen *et al*., 2003).

There are researches that have been conducted and discussed on energy efficiency (Bergamo *et al*., 2004; De Rango *et al*., 2008; Ghanem *et al*., 2005; Kunz, 2009; Mahfoudh and Minet, 2008; Taddia *et al*., 2006) that focus on the OLSR protocol. Similarly, previous research also shows that antenna management system can also be used to save the energy (Sultana and Haque, 2014). In order to see what they are covered, it should be go all the way through all the research that have been made. Taddia *et al*. (2006) have conducted research focusing the attention on its energy efficiency. They have proposed the OLSR power controlled which is provides the optimal paths in term of minimum power needed to reach the endpoint and not as in the classic version in term of the number of hops.

The other research was conducted by Mahfoudh and Minet (2008) which is to maximize the network lifetime. Their finding are with extending the standard OLSR routing protocol with extending the path minimizing of the energy consumed in the end-to-end transmission and avoid the nodes that have less energy will give impact to energy efficiency. In conclusion, the result shows the extension of the energy efficient OLSR is the best variant maximizing both network lifetime and delivery rate. While the study that have been made by Kunz (2009) is on integrating the energy-efficiency aspect into the standard MANET routing that aiming to increase the nodes lifetime and the network performance. These researches have been made for static and dynamic scenario. He claims that the significant performance gains on dynamic topology compared to the static network. He also concludes that by changing the MPR selection criteria is not promising under any of the studied scenario.

Discussing the efficiencies of the energy, De Rango *et al*. (2008) have done the research in order to verify their effectiveness in reducing energy consumption

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and prolonging network lifetime by analyzing the behavior of different energy-aware routing metrics applied to OLSR. From their research, they found that minimum drain rate routing strategy is the better way to calculate paths between nodes in the network according to energy-saving needs, although, this metric can have some drawback in the total amount of energy consumed in the network.

A new energy power saving mechanism for mobile ad hoc network which is using OLSR was conducted by Ghanem *et al*. (2005). These researchers proposed two new mechanisms in order to allow a fair of power consumption in mobile ad hoc network. It is to introduce new MPR selection criteria that the energy capacity of nodes will take into account. From their experiment, the result shows that providing energy information are the major key for the election of MPR nodes and it stays alive for a longer period of time.

The research that have been made by Bergamo *et al*. (2004) proposed the distributed power control that aims to improve the energy efficiency of routing algorithms in ad-hoc networks. Each node in the network estimates the power necessary to reach its own neighbours. This power estimate is used both as the link cost for minimum energy routing and for alteration the transmit power, thereby decreasing interference and energy consumption). Therefore, using classic routing algorithms such as Dijkstra and Link state can provide the considerable transmit energy saving while introducing limited degradation in terms of throughput and delay.

MATERIALS AND METHODS

In directive to study the impact of these elements; network space, number of nodes and data transmission rate to the number of nodes keeps alive in high mobility which is differentiated based on different network space, different number of nodes located in the network and speeds particularly on OLSR routing protocol, it is important to create a simulation with a different scenario different data transmission rate. Network node is placed randomly in order to replicate the situation in a real-world scenario.

These experiments were conducted using different model scenario which is 400×400, 600×600, 800×800 and 1000×1000 units. The numbers of nodes for each model scenario are denoted with the number of 10, 20, 30, 40, 50 and 60 nodes. Default configurations were used during the experiments except state otherwise. The simulation experiments have made with the definite specifications that have been listed at Table 1 for simulation parameter, Table 2 for scenario parameter and Table 3 for energy model parameter.

Table 1: The simulation parameter

Propagation	Propagation/TwoRayGround
Network type	Mac/802.11
Transmission range	250 m
Mobility model	Dynamic
Queue length	50
Interface queue	Queue/DropTail/PriQueue

Table 2: The Scenario parameter

Parameters	Values
Topology area (units)	400×400, 600×600, 800×800, 1000×1000
No. of nodes	10, 20, 30, 40, 50, 60
Simulation time	350 sec
Mobility speed	22.2
Data transmission rate	45.0, 25.0, 5.0

Table 3: Energy model parameter

Parameters	Values
Initial energy (J)	1000.00
Transmission power (w)	0.60
Receiving power (w)	0.30
Idle power (w)	1.00
Sleep power (w)	0.01

RESULTS AND DISCUSSION

The investigation was conducted for three times for each sample and results are averaged. The simulation time is set for 350 sec. Figure 1-4 represent the number of nodes keeps alive of different number of nodes (i.e., 10, 20, 30, 40, 50 and 60) at different data transmission rate

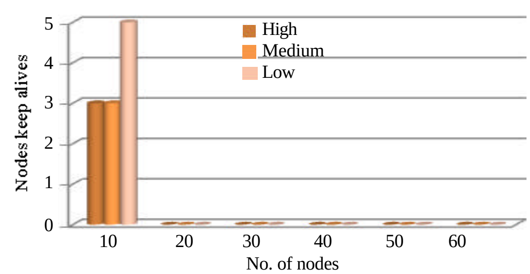

Fig. 1: The number of nodes keeps alive for high mobility speed with various data transmission rate in 400×400 unit space areas

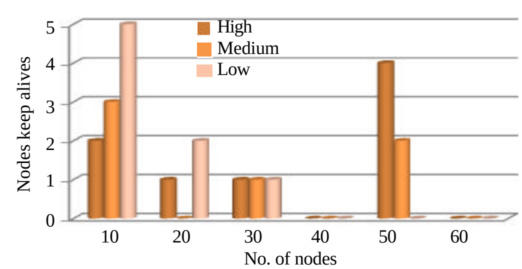

Fig. 2: The number of nodes keeps alive for high mobility speed with various data transmission rate in 600×600 unit space areas

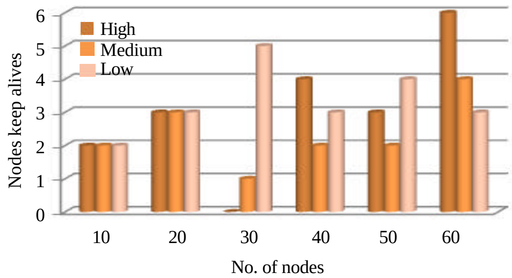

Fig. 3: The number of nodes keeps alive for high mobility speed with various data transmission rate in 800×800 unit space areas

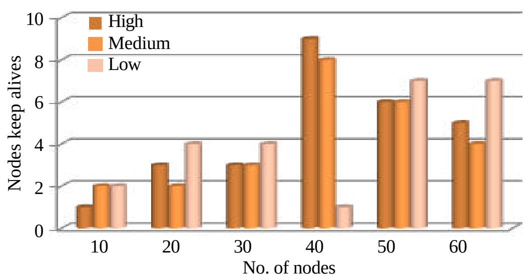

Fig. 4: The number of nodes keeps alive for high mobility speed with various data transmission rate in 1000×1000 unit space areas

(i.e., high-45.0, medium-25.0 and low-5.0) in different network space area (i.e., 400×400, 600×600, 800×800 and 1000×1000 unit).

The results in Fig. 1 show that only 5% from the total number of 210 nodes are keep alive. The nodes keep alive only exist at the number of nodes = 10 while the other number of nodes used (i.e., 20, 30, 40, 50 and 60) are dead and have no energy balance at all. It is also presented that the outcomes for high data transmission rate is similar to the results for medium data transmission rate where the number of nodes keeps alive is three out of ten nodes while five out of ten nodes are alive at low data transmission rate.

Figure 2 shows an average of the number of a live node in 600×600 unit network spaces is increasing as compared to 400×400 unit network space. It is noticeable that the existence of nodes that are keeps alive is represented in the number of nodes 10 and 30 in high, medium and low data transmission rate. The nodes keep alive for 20 nodes exist at high and low data transmission rate while for 50 nodes, it exists at high and medium data transmission rate. From that the highest number of nodes that keep alive comes from the 10 nodes with the most at low data transmission rate, approximately 50% from the number of nodes. There are no nodes keep alive for the number of nodes 40 and 60.

Table 4: The value of the number of nodes that keeps alive

Network space area	Data transmission rate	Nodes keep alive					
		10	20	30	40	50	60
400×400	High	3	0	0	0	0	0
	Medium	3	0	0	0	0	0
	Low	5	0	0	0	0	0
600×600	High	2	1	1	0	4	0
	Medium	3	0	1	0	2	0
	Low	5	2	1	0	0	0
800×800	High	2	3	0	4	3	6
	Medium	2	3	1	2	2	4
	Low	2	3	5	3	4	3
1000×1000	High	1	3	3	9	6	5
	Medium	2	2	3	8	6	4
	Low	2	4	4	1	7	7

There are no nodes keep alive for the number of nodes 40 and 60. Figure 3 shows the total number of nodes keep alive in 800×800 unit network spaces is increasing drastically. However for the number of nodes 30, there are no available nodes at the high data transmission rate, since no nodes are kept alive. The graph also depicts the result obtained at 10 and 20 number of nodes at high, medium and low data transmission rate are consistently similar with the number of nodes keeps alive which is 2 and 3, respectively. It shows that in this case (800×800 unit network space), the different type of data transmission rate has no influence on the energy usage when using 10 and 20 nodes.

Even though, the results show all nodes in the 1000×1000 unit network space are still alive, an average total number of nodes keep alive is increase if compared to other size of network space. Only 37% of all nodes are keeping alive in this network. However for 40 nodes, the high number of nodes keep alive is obvious at high and medium speed but not for the lower network speed. It shows that the communication for 40 nodes in 1000×1000 unit network space is very efficient at high and medium data transmission rate.

Table 4 summarizes the number of nodes that keep alive for all cases under high mobility speed scenario. The result shows that when the network space area increased, the number of nodes keeps alive is also increased. Similarly, when the number of nodes increased, the average number of live nodes will also be increased. The analysis focused on the number of node that exists and maintained in the network. Figure 5 shows the relation between the numbers of nodes keeps alive and the different data transmission rate. The graph shows that the number of node that alive has increase consistently for high data transmission and increasing also happen to the low and medium data transmission.

The other findings from this experiment are when it involves the additional network space area; the numbers of nodes that still alive are increase as the shown in

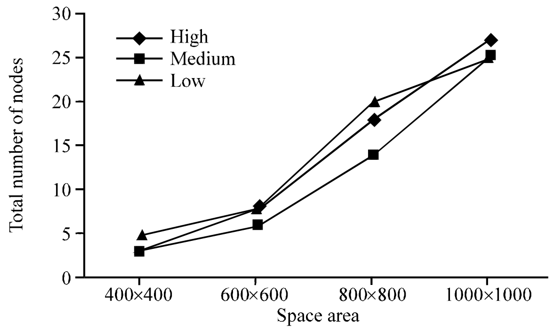

Fig. 5: The total number of nodes keeps alive for high mobility speed with various data transmission rate for different space area

Table 4 and Fig. 5. The mobility speed of nodes in OLSR network is inter-related with the network topology size and the number of nodes in terms of energy efficiency optimization.

From this point of view, it can be concluded that the data transmission rate and size of network scenario do affect each other and inter-related. It is because the traffic becomes congested if the numbers of nodes increase in the small network area. It is not conducive for the networks and also more energy is used to update the routing table and other routing information based. The network becomes stable (the number of nodes increase) when the network size increase.

CONCLUSION

The result shows that the more energy will be used when the number of nodes increases in a small size of the network (congested network) and automatically it will influence to the number of nodes that keep alive in the network. Reserchers also found that node speeds have also affected to the number of energy used in the network. This outcome can help other researcher to design the suitable configuration to suite their scenario. It also helps the authorities or policy maker when dealing with the real case scenario, especially during a war or natural disaster in order to locate an ad hoc device for their unit while doing their operation such as army, fire brigade or other rescue team either in battle field or operation site.

RECOMENDATIONS

In the future, this research can be expanded for the studies of the impact of the three elements; the different number of nodes, the different network space and the different mobility speeds to the number of nodes keeps alive for high data transmission rate environment. This study also can be tested with other protocols such as AODV and DSR.

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