IOP Conf. Series: Materials Science and Engineering **333** (2018) 012108 doi:10.1088/1757-899X/333/1/012108

Wireless Sensor Network Quality of Service Improvement on Flooding Attack Condition

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Abstract. There are two methods of building communication using wireless media. The first method is building a base infrastructure as an intermediary between users. Problems that arise on this type of network infrastructure is limited space to build any network physical infrastructure and also the cost factor. The second method is to build an ad hoc network between users who will communicate. On ad hoc network, each user must be willing to send data from source to destination for the occurrence of a communication. One of network protocol in Ad Hoc, Ad hoc on demand Distance Vector (AODV), has the smallest overhead value, easier to adapt to dynamic network and has small control message. One AODV protocol's drawback is route finding process' security for sending the data. In this research, AODV protocol is optimized by determining Expanding Ring Search (ERS) best value. Random topology is used with variation in the number of nodes: 25, 50, 75, 100, 125 and 150 with node's speed of 10m/s in the area of 1000m x 1000m on flooding network condition. Parameters measured are Throughput, Packet Delivery Ratio, Average Delay and Normalized Routing Load. From the test results of AODV protocol optimization with best value of Expanding Ring Search (ERS), throughput increased by 5.67%, packet delivery ratio increased by 5.73%, and as for Normalized Routing Load decreased by 4.66%. ERS optimal value for each node's condition depending on the number of nodes on the network.

1. Introduction

There are two ways to establish communication using wireless media. First is to build a base station (infrastructure) [1-2]. The problem that arise on the type of network infrastructure is limitation of space to build all of the physical infrastructure of the network and also the cost factor. Secondly, builds an ad hoc network between users who communicate each other. In an ad hoc network, each user must be willing to submit data from source to destination so that the communication occurs [2].

In the ad hoc wireless network is often called MANET (Mobile Ad hoc Network), network design is structured. Each node can communicate with each other in a certain transmission range. To be able to communicate with each node needs help another node, the node in MANET can act as terminals and routers [3-5].

MANET research concerned at the moment are the routing protocol, the security aspect, limited bandwidth and power consumption [6]. There are two routing protocols that have been set as the

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standard to the ad hoc network by the Internet Engineering Task Force (IETF), routing protocol that is both proactive and reactive [6][7][2].

Overall, MANET routing protocols has weak level of security [9]. There is also security weaknesses on AODV protocol that is in the process of finding a route for transmitting data. In AODV protocol, searching for a route is begin with sending a route request (RREQ) addressed to the destination node [10]. The problem that arise in AODV is the process of sending RREQ that is broadcast. It can be used by third parties to attack and immobilize MANET network.

2. Experimental

This study uses Network Simulator 2 (NS2) software as a tool to perform ad hoc network simulation to test the performance of AODV protocol that has been modified.

The research process to be conducted determine the optimal threshold value of TTL which provides a major influence on the value of the parameter packet delivery, average end-to-end delay, throughput, and normalized routing load. The flow of the research is shown in Figure 1.

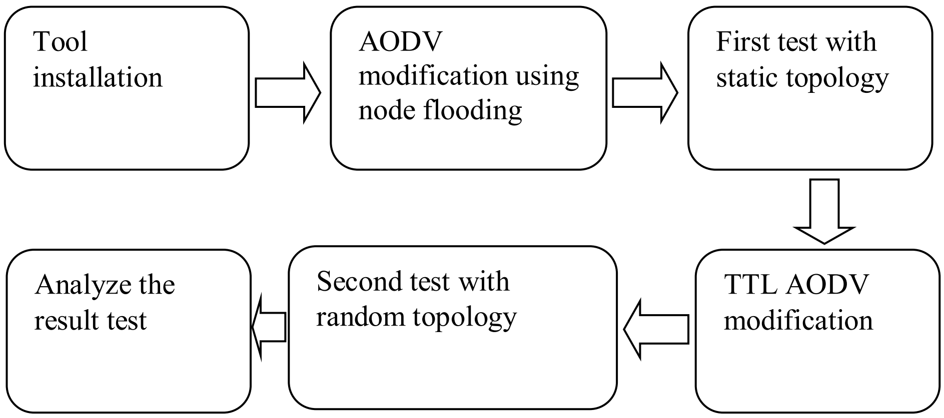

Figure 1. Research process

In routing search, a node will first perform RREQ delivery where RREQTTL delivery is highly influence so RREQ data packet does not become a packet flooding. AODV TTL influenced by three parameters, namely TTL_START, TTL_THRESHOLD, and TTL_INCREMENT as shown in Figure 2 :

```
/* Various constants used for the expanding ring search */
#define TTL_START     5
#define TTL_THRESHOLD 7
#define TTL_INCREMENT 2
```

Figure 2. ERS parameter

Default value of AODV of TTL_START with 5 hops, TTL_THRESHOLD with 7 hops and TTL_INCREMENT with 2 hops.

2.1. RREQ submission prior changes

Submission RREQ on AODV default first shipment has reached the five-layer or the network layer, it can be facilitate for attackers to immobilize MANET networks that have been built. The illustration shown in Figure 3.

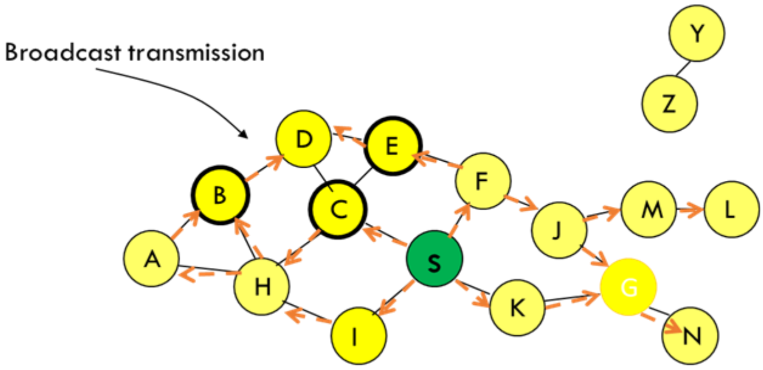

Figure 3. RREQ AODV default delivery process

Figure 3.3 shows that S node transmit RREQ. RREQ, as indicated by the red arrows, in one RREQ delivery will spread throughout the network. It is not effective when the destination node is in the area close by. The process is also used by third parties to immobilize network. Due to shipping RREQ RREQ once it has been flooded throughout the network.

2.2. Proposed RREQ submission

Submission of proposed TREQ is with the delivery layer by layer node, can be illustrated in Figure 4.

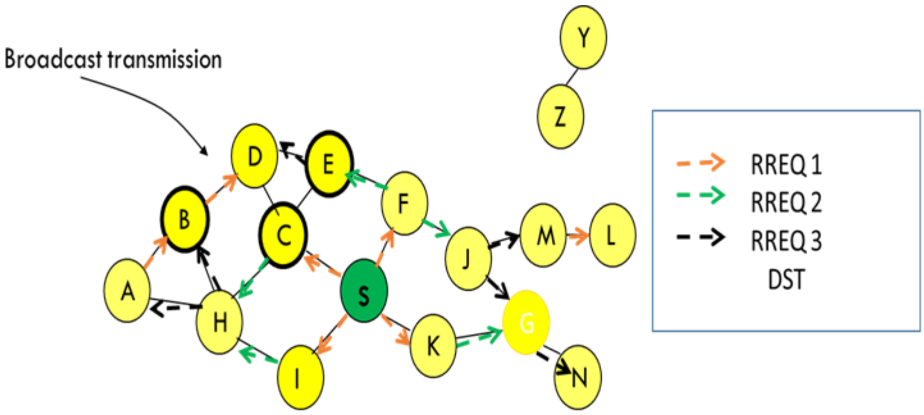

Figure 4. Proposed RREQ AODV delivery process As seen on Figure 3.4, RREQ is sent layer by layer to secure from flooding.

3. Results and Discussion

This chapter discuss the routing protocol AODV with changing to the ERS and also the condition of the network in case of flooding. The discussion includes trial details, details and implementation scenarios, test results and analysis.

3.1. Test scenario on static network

Parameter test to demonstrate the performance of a protocol in this test is throughput and average delay.

The test result indicates that the variation affect the results of the simulation time parameters of throughput and average delay of the data obtained. Value throughput and average delay is beginning to stabilize at simulation time of 500 seconds or above. This indicates that the next simulation is recommended using simulation time above 500 seconds. Next test is using parameter simulation time of 700 seconds.

At the time of 700 seconds with a variation simulation conducted ERS, ERS value with the value of the highest throughput parameter is the ERS ERS 2 and 6 with the same throughput on both the ERS is 258.87 Kbps, the value of ERS ERS 2 and 6 also have value parameter average delay is the lowest compare to the other ERS is 0.85 ms. With the value of detail ERS ERS 2 and 6 can be seen in Table 1.

Table. 1 Optimun ERS value from first test

ERS Parameter	*TTL start*	*TTL increment*	*TTL threshold*
ERS 4	1	1	6
ERS 6	1	2	16

3.2 Optimum ERS test on mobile random network

The next test is to get an optimum value of ERS on mobile random network with flooding network condition. The test will use wifi 802.11a standard.

For an optimum ERS testing on mobile random network, parameter used as a reference are Throughput, Packet Delivery Ratio, Delay and Average Normalized Routing Load. With ERS threshold values that varied from 1 to 12 and the value of the ERS AODV default.

Testing with 25 nodes in the network, mobile random and flood condition network with 4 node flooding, showed that the best value of ERS is ERS 3 with ERS TTL_start 3, TTL_increment by 1 and TTL_ threshold value is 3. Details of the results as follows:

1. Throughput parameter increases 7.49% compare to AODV ERS default.
2. Packet Delivery Ratio parameter increases 7.6% compare to AODV ERS default.
3. Average Delay paremeter decreases 4.17% compare to AODV ERS default.
4. Normalized Routing Load parameter increases 6.74% compare to AODV ERS default.

From the result of test, value obtained is ERS 3 as the optimal value compare to ERS default. With ERS value of 3, the next test will be the variation of the number of nodes.

3.3 Optimum ERS testing on several condition

From the previous test, the optimum value of ERS is ERS 3 with parameter of ERS TTL_start, TTL_increment by 1 and TTL_ threshold value of 3. From the ERS value, the test will conduct by varying the amount of network nodes compare to ERS value AODV default.

From the test results, with node variation will obtain Throughput and Packet Delivery Ratio parameter as seen on Figure 5.

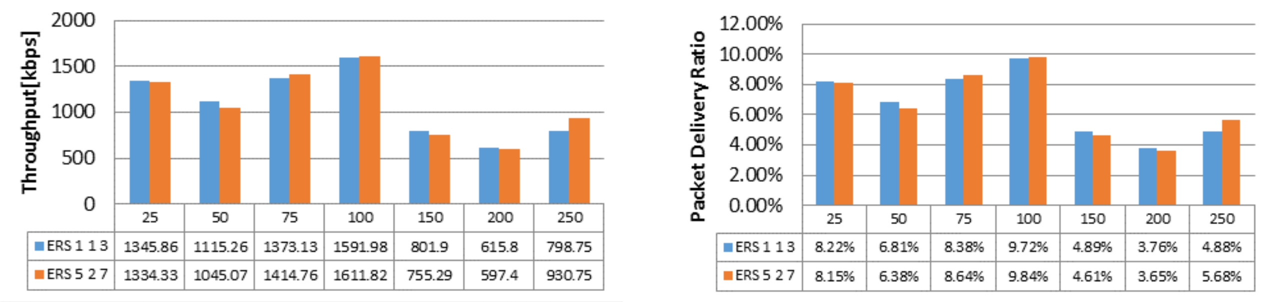

Figure 5. Throughput and Packet Delivery Ratio parameter test result

Test result with Average Delay and Normalized Routing Load parameter test can be seen on Figure 6.

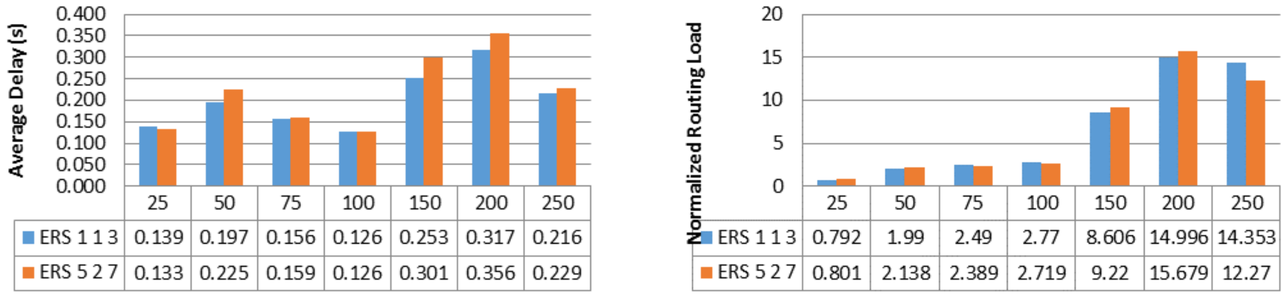

Figure 6. Average Delay and Normalized Routing Load parameter test result

T-Test results conducted on all data results indicate that the critical value of t> t Stat which means Ho is accepted and H1 is rejected. It can be concluded that changes on the ERS 3 and ERS default AODV does not provide changes to the parameter Throughput, Packet Delivery Ratio, Delay and Average Normalized Routing Load.

Testing with a variety of nodes on optimal ERS compare to ERS default AODV will result an optimum ERS can not applicable in general to the different number of nodes.

3.4 Optimum ERS searching on number of node variation

The test is then performed on searching optimum ERS with node variation. Node variations tested are 25, 50, 75, 100, 125 and 150. From the test results, an optimum throughput parameters, Packet Delivery Ratio and Normalized Routing Load shown in Table 2.

Table. 2 Optimum test result from Throughput, Packet Delivery Ratio and Normalized Routing Load parameter

Number of nodes	Throughput [kbps]	Packet Delivery Ratio	Normalized Routing	TTL Star	TTL Increment	TTL Threshold
25	1222,79	7,47%	0,846	1	1	3
50	1416,73	8,65%	1,586	1	1	3
75	928,72	5,67%	3,673	1	1	5
100	1143,02	6,97%	3,891	1	1	6
125	1252,27	7,64%	4,649	1	1	7
150	851,97	5,20%	8,042	1	1	8

From the results of the parameters in Table 2, a pattern of increasing the value of ERS on the number of nodes on the network shown on Figure 7.

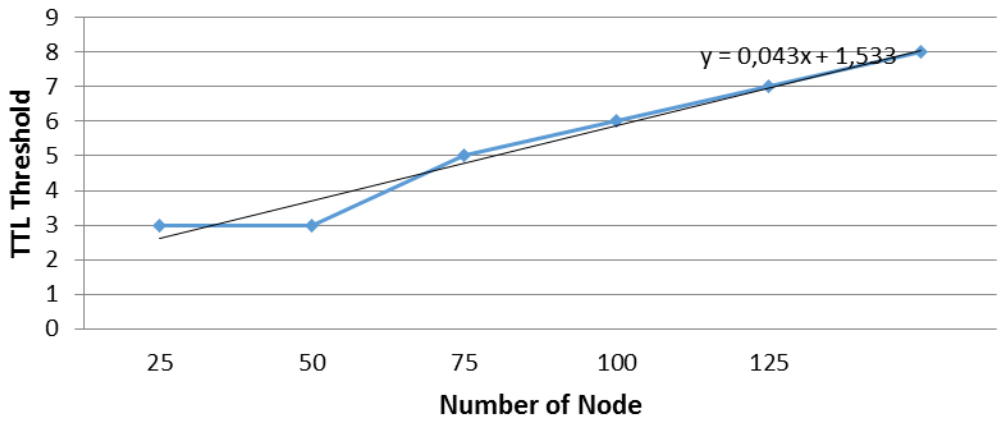

Figure 7. Relation between number of node with ERS parameter (TTL Threshold)

Relation between TTL Threshold and the number of nodes in the network will obtained an equation:

$$TTL_{Threshold} = (0{,}043 \ \text{x number of node}) + 1{,}533 \quad (1)$$

4. Conclusions

From the research that has been done on ERS optimization on flooding attack condition, some conclusions can be drawn based on the research objectives and the results achieved:

By applying an optimum ERS (TTL threshold) in AODV protocol, the protocol has increased within the parameters of throughput, packet delivery ratio and Normalized Routing Load, compare to the AODV protocol default with one data sender and one data receiver. Throughput parameter increased by 5.67%, packet delivery ratio parameter increased by 5.73%, and Normalized Routing Load decreased by 4.66% with one data sender and one receiver data. An optimum ESR value in some number of node conditions with single data sender and single data recipient, relation between ERS on TTL threshold parameter with the number of nodes shown as follow equation:

$$TTL_{Threshold} = (0{,}043 \ \text{x number of node}) + 1{,}533$$

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