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RE-AODV an Enhancement of AODV Routing Protocol for Wireless Sensor Networks

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ABSTRACT

Routing in Wireless Sensor Networks (WSNs) plays a significant role especially when mobility of nodes is introduced. Although, the introduction of the concept of mobility in WSNs has expanded their range of applications but it influences significantly the connectivity of the networks. In a mobile WSN, the topology of the network changes dynamically, roads maintained by some nodes become invalid, because of mobility of nodes. The main restriction of mobile WSN is the energy consumption. Thus, all routing protocols must consider this constraint and require an enhancement to consume less energy. In this paper we are working with Ad-hoc On Demand Distance vector (AODV) as a routing protocol, we are presenting an enhancement of this routing protocol based on residual energy of each node to optimize the energy consumption and maximize the network lifetime. We named the enhanced protocol: RE-AODV for Residual Energy-AODV.

Key words : WSN, Mobility, AODV, Residual energy, RE-AODV.

1. INTRODUCTION

Wireless Sensor Networks are considered as a special type of Ad-hoc networks. It consists of a set of sensor nodes deployed in a geographical area for monitoring of applications such as environmental habitat, healthcare, agriculture, defense applications, disaster prone areas, hazardous zones, and so on [1].

Most of precedent studies consider networks with statics nodes, while there are various applications where nodes are mobile. The advantage of allowing the sensors to be mobile increases the number of applications beyond those for which static WSNs are used. In this case, sensors can be attached to a number of platforms such as people, animals, Vehicles, etc. In fact, adding mobility to the network increases the chances of getting a variety of information. In a mobile WSN [2], life time of the sensor node is the most critical parameter. That's why energy conservation is a major challenge for monitoring applications in mobile WSNs [3]. Each sensor node consumes an amount of its battery for detection and an amount for reception/transmission of the detected data from/to other nodes of the network. The transmission/reception of data represents the operation that consumes a large part of the total energy. In this respect, many works deal with this problem by seeking to optimize the energy consumption of this operation. We are also working on this point of optimization of energy consumption.

In this paper we propose a new method to optimize the energy consumed by mobile sensor nodes which is an enhancement of AODV routing protocol. The purpose of our contribution is to transmit packets in a reliable way with minimal energy consumption in order to extend the life time of the network. The proposed method consists of taking into account the metric of energy in the process of establishing roads. For this goal, we propose a mechanism that considers the residual energies of the mobile nodes when making routing decisions.

In this work, we use NS2 simulator to compare the performance of simple AODV and the enhanced version of AODV proposed in this paper (RE-AODV) based on different metrics which are: packet delivery ratio, end to end delay and energy consumption.

The rest of the paper is organized as follows. Section 2 presents a detailed study of the AODV routing protocol and its limitations. In section 3 we present our optimization of the AODV protocol. A discussion to compare the two protocols is presented in section 4. In section 5, we present the Random Waypoint mobility model. Section 6 shows our performance evaluation and the experimental results. And in the last section, we present conclusion and some future directions.

2. AD-HOC ON DEMAND DISTANCE VECTOR (AODV)

AODV [4], [5] referred as Ad Hoc On-Demand Distance Vector is a routing protocol which is designed for wireless and mobile ad hoc network. AODV is a reactive protocol and essentially represents an improvement of the proactive protocol DSDV (Destination-Sequenced Distance Vector). AODV establishes route with destination only when it is required [6], [7]. It chooses the shortest route witch does not contain loop. It uses the principles of sequence numbers to maintain the consistency of routing information. Because of the mobility of the nodes, the routes change frequently so that routes maintained by certain nodes become invalid.

To create a path to a certain destination, AODV uses a Route Request. The source node broadcast the Route Request message (RREQ) to its neighbors to find the destination. A node receiving a packet RREQ will then send a packet Route Replay (RREP) if it is the destination or if it has a route to the destination with a sequence number greater than or equal to that of the packet RREQ otherwise it rebroadcast the packet RREQ. If a RREP is received then the operation of route discovery is complete. Otherwise, after a waiting period it rebroadcasts the message RREQ and waits for a period greater than the first. In the absence of a RREP, this process can be repeated. If there is still no response after three attempts, the route search process is aborted. And a new route request will be initiated after 10 seconds. Once the source has received the RREP packets, it can begin sending data packets to the destination. If, later, the source receives a RREP containing a sequence number greater or equal, but with a smaller number of hops, it will update its routing information to that destination and start using the best route. A route is maintained as long as it continues to be active, that is, as long as data flows between source and destination. The link expires when there is no more data in transit on the link and after a delay called ACTIVE_ROUTE_TIMEOUT. In the event of a link break, the end node sends a Route_Error (RERR) packet to the source node to warn that the destination is now unreachable. If the source node still wants to get a route to that destination, it must restart the route discovery process [8], [9].

2.2 Limitations of AODV

In the AODV protocol, the routes are established according to the "minimum number of jumps" (the shortest way). However, if the number of communications increases, the principle of the shortest path is no longer the optimal criterion of choice of routes [10], it is better than to use other metrics that have a significant effect on the connectivity and the lifetime of the network. In addition, energy is a very important constraint in WSNs. If a node, which participates in the process of establishing roads, has a very low energy, the road can be disconnected very quickly; this can have a detrimental effect on the lifetime of the network. To deal with this problem, the energy metric should be taken into account in the route establishment process. To this end, we propose a mechanism that considers the residual energies of mobile nodes when making routing decisions.

3. AODV OPTIMIZATION: RESIDUAL ENERGY-AODV (RE-AODV)

Taking into account the different limitations and constraints described above, we propose an enhancement of AODV routing protocol that we named RE-AODV. Our proposition aims to maximize the network lifetime and improve the performance obtained by the AODV basic routing protocol in terms of energy consumption, packet delivery ratio and end to end delay.

The principle of RE-AODV is to choose a routing path to destination that contains nodes that have the highest residual energy. Based on this routing principle we ensure the durability of the network life, as well as the arrival of packets to their destination.

3.1 Operation of RE-AODV

```
Source node;
Destination node;
liste<Node> listeNeighborsNodes; Source node; Destination node;
liste<Node> listeNeighborsNodes;
Map<Node , Number> listDistanceNeighborsNodes;
For every NeighborNode in listNeighborsNodes do
listDistanceNeighborsNodes.add(Node,
CountDistanceNodeDestination(NeighborNode,
Destination));
End For;
NextNode=Max(ListDistanceNeighborsNodes);
```

A. Calculation of distance to destination

The distance to the destination will be calculated as follows:

$$\text{Distance} = \sum \text{Energy of Nodes}$$

Where $\sum$ Energy of nodes is considered as the sum of the energy of nodes that constitute a path to the destination.

4. DISCUSSION

In this paragraph we use two figures to show how the two protocols react in the phase of selecting the route to the destination.

As shown in Figure 1. AODV chooses the shortest route with a smaller number of hops while the RE-AODV protocol chooses the most powerful path in terms of energy to guarantee a durability of the network life.

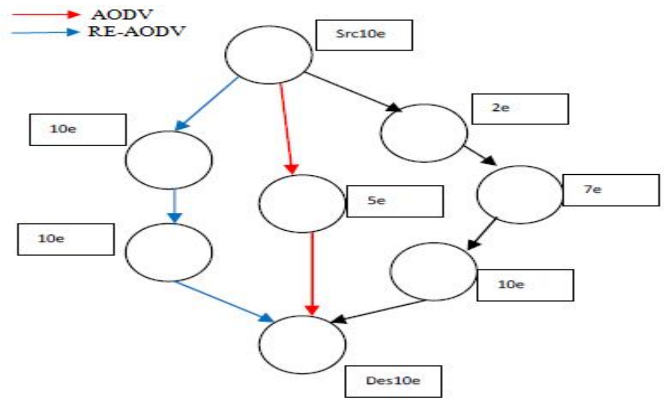

Figure 1: AODV and RE-AODV Path Discovery Process

Figure 2. shows an example of selecting the path to the destination according to the algorithm of the proposed protocol RE-AODV.

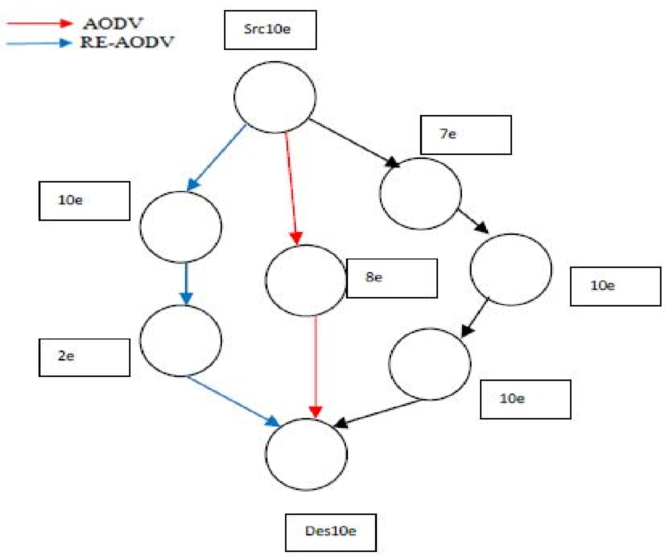

Figure 2: Example of selecting the path to the destination

Distance of the bleu path = 12;
Distance of the red path = 8;
Distance of the black path = 27;

In this example the RE-AODV chooses the black path as the best path to reach destination because it represents the most powerful path in terms of energy.

5. MOBILITY MODEL: RANDOM WAYPOINT

Random Waypoint mobility model is a basic model which describes the movement pattern of independent nodes by simple terms. In this mobility model nodes move directly along direct line segments from one waypoint to the next. The waypoints are assumed to be distributed independently and uniformly in the Random Waypoint movement domain. The Random Waypoint is a widely used mobility model.

In this model [11]: Each node moves randomly from one waypoint to the next. At the start of each step a random velocity is chosen from [0, Vmax]. The nodes stop for a duration (pause time), when they reach each waypoint before continuing on the next step, where durations are independent and identically distributed random variables. The velocity and direction of a node are chosen independently of other nodes.

In the Random Waypoint model, the maximum velocity and the pause time are the two parameters that define the mobility behavior of nodes. Figure 3. shows an example of the movement trace of a node.

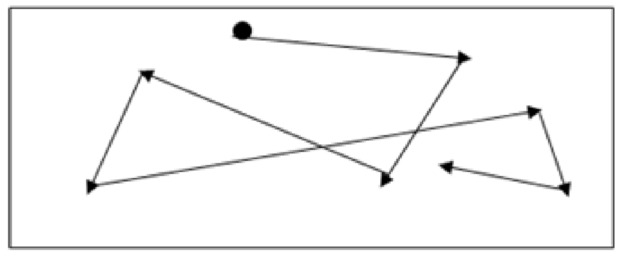

Figure 3: Node movement in the Random Waypoint Mobility Model

6. SIMULATION PARAMETERS & RESULTS

In this research work we choose to work with the simulation tool NS2. This simulation study focuses on the performance of routing protocols studied in previous paragraphs which are AODV and RE-AODV.

Table 1. shows the simulation parameters that are used for our simulations. Initially, nodes are randomly distributed in the simulation area (1000m × 1000m). We use random waypoint mobility model for simulations to model nodes movement.

Tableau 1: Simulation parameters

Simulation parameters	Values
Simulation area	1000m*1000m
Mobility model	Random Way Point
speed	5 (m/s)
Simulation time	100 s
Number of nodes	100; 200; 400; 600; 800; 1000
Packet size	512 bytes
Mac type	IEEE 802.11
Antenna type	Omni-Antenna
Radio propagation method	Two Ray Ground
Traffic type	CBR
Protocols	AODV; RE-AODV

To compare the performance of AODV and RE-AODV we focus on three performance metrics which are quantitatively measured: Packet delivery ratio (PDR), the Average energy consumption and End to end delay (EED).

Packet delivery ratio (PDR): the ratio of the data packets delivered to the destination. A high packet delivery ratio shows better protocol performance.

End to end delay (EED): the time taken for a packet to be transmitted across a network from source to destination.

Average energy remaining in each node: the gain in terms of energy conservation. The average energy consumption impacts significantly the network lifetime. The protocols that show low average energy consumption provides longer network lifetime.

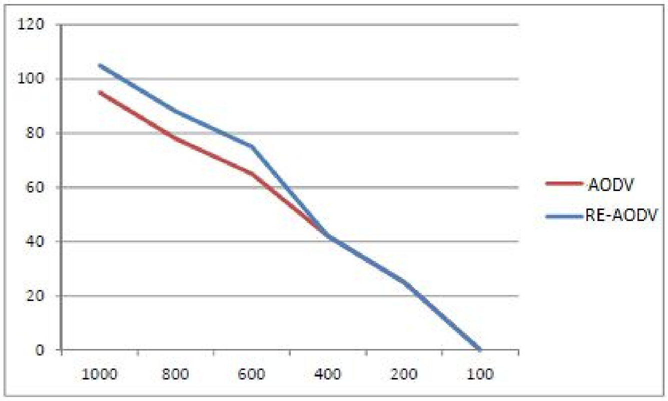

Figure 4 : Packet delivery ratio Vs. Number of nodes

In figure 4. the packet delivery ratio of the two protocols is represented for different number of nodes, we note that the number of packets delivered by the RE-AODV protocol is more interesting than that delivered by the AODV protocol. So we can see that the RE-AODV shows better performance in term of packets delivery ratio in networks with a high number of nodes.

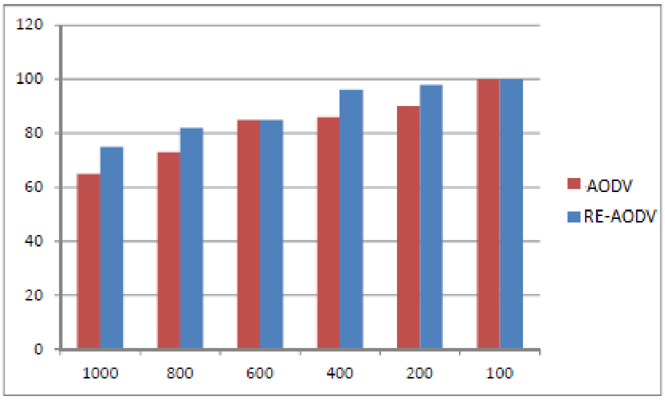

Figure 5 : Average energy remaining in each node Vs. Number of nodes

Figure 5. shows the average energy remaining in each node after the end of the simulation, it can be seen that the power consumption for the RE-AODV protocol is low compared to the AODV protocol.

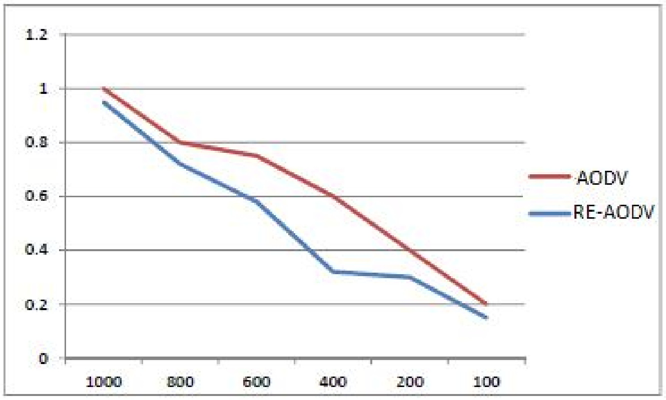

Figure 6 : End to end delay Vs. Number of nodes

Figure 6. shows the end-to-end delay for RE-AODV and AODV protocols, it can be seen that the EED is lower for the RE-AODV protocol and this is due to the fact that the RE-AODV chooses the strongest route in term of energy.

7. CONCLUSION

In this paper, RE-AODV protocol has been proposed as an improvement of AODV routing protocol. The proposed protocol applied a new technique of path selection based on the energy remaining in each node.

The purpose of this work is to improve the performance of the AODV protocol specifically at the level of energy consumption.

As shown in our simulation experiments did with the network simulator NS2, RE-AODV show high packet delivery ratio, low end to end delay and better energy consumption.

REFERENCES

1. J. Yick, B. Mukherjee and D. Ghosal, **Wireless sensor network survey**, Journal of Computer Network, vol.52, pp.2292–2330, 2008. https://doi.org/10.1016/j.comnet.2008.04.002
2. V. Manikandan et al., **Energy Efficient Dynamic Routing in Wireless Sensor Networks**, International Journal of Advanced Trends in Computer Science and Engineering, vol8,pp. 2189–2193, September- October 2019. https://doi.org/10.30534/ijatcse/2019/51852019
3. S. Ganesh and R. Amutha **Efficient and Secure Routing Protocol for Wireless Sensor Networks through SNR Based Dynamic Clustering Mechanisms**, Journal of Communications and Networks, vol.15, 2013. https://doi.org/10.1109/JCN.2013.000073
4. A. hinds **A Review of Routing Protocols for Mobile Ad-Hoc Networks (MANET)**, International Journal of Information and Education Technology, vol.3, 2013. https://doi.org/10.7763/IJIET.2013.V3.223

5. V.P. Patil, **On-demand and table –driven routing protocol energy efficiency performance evaluation in mobile ad hoc networks**, International Journal of Computer Science and Management Research, vol.1, 2012.
6. V. Bharathi and T. Poongkuzhali **A Performance Enhancement of an Optimized Power Reactive Routing based on AODV Protocol for Mobile AD-HOC Network**, International Journal of Technology And Engineering System(IJTES), vol.2, pp.39-44, 2011. https://doi.org/10.1109/ICRTIT.2011.5972262
7. A. Miran et al. **Enhancing AODV routing protocol to support QoS**, International Journal of Advanced Trends in Computer Science and Engineering, vol.8, pp.1824–1830, September - October 2019. https://doi.org/10.30534/ijatcse/2019/04852019
8. G.S. Mamatha and Dr. S. C. Sharma **Analyzing MANET Variations, Challenges, Capacity and Protocol Issues**, International Journal of Computer Science and Engineering Survey (IJCSES), vol.1, pp.14-21, 2010.
9. G. Jayakumar and G. Ganapathy **Performance Comparison of Mobile Ad-hoc Network Routing Protocol** , Proc. of International Journal of Computer Science and Network Securit (IJCSNS), vol.7, pp.77-84, 2007.
10. P. Sharma et al., **Resource Provisioning for various network applications in adhoc networks**, International Journal of Advanced Trends in Computer Science and Engineering, vol. 8,pp. 2653- 2659,September-October 2019. https://doi.org/10.30534/ijatcse/2019/119852019
11. V. Vasanthi, M. Romen Kumar, N. Ajith Singh. and M. Hemalatha **A detailed study of mobility models in wireless sensor network**. Journal of Theoretical and Applied Information Technology, vol.33, 2011.