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# Improving the lifetime of Wireless Sensor Network through Energy Proficient AODV Protocol

**Vignesh Ramamoorthy H, R. Gunavathi**

***Abstract*****:** ***Wireless Sensor Network (WSN) is an emerging technology, which enables new innovative trends and equipments to resolve the issues of current and future world. The WSN is a combination of tiny sensor nodes equipped with a minimal battery power, mini processor and a RAM. The battery is non-rechargeable in nature and thus the need for energy efficiency becomes a vital task for WSN. This paper deals with improving the energy efficiency through Energy Proficient AODV protocol (EP-AODV). The proposed work utilizes minimal energy, power amplification and efficient routing technique to improve lifetime of the network. Comparison of EP-AODV with other existing schemes, EP-AODV achieves better throughput, energy efficient, First-Nod-Dies ratio and so on. Thus, the proposed EP-AODV protocol achieves better energy efficient protocol for WSN.***

***Keywords*****:** ***Amplification, AODV, Network, Processor, Protocol.***

## I. Introduction

The Wireless Sensor Network (WSN) [1,2] is an effective technology to incorporate many emerging techniques to satisfy the needs of this current world scenario. In addition, this network is an ad hoc network that can be implemented anywhere in a less time. Many applications of WSN focused in medical, home appliance, military, industrial based and so on.

Data interpretation is one of the major issue of WSN as the network can be hacked easily due to the security inability of the network [3,4]. Therefore, the security enhancement is a continuous process in WSN. Another major issue of WSN is energy utilization of the sensor node. Sensor node comprises with a non-rechargeable battery. Therefore, the lifetime of the network demands less energy utilization. Energy efficiency in WSN can obtained using better routing technique, data aggregation and other techniques [5].

Sometimes in an application like fire alarm, when the node senses the fire it should send the data to sink through robust communication. Therefore, the communication from source to destination should be robust, reliable, shortest path based and primarily energy efficient [6,7]. The routing protocol plays a vital role in establishing energy efficient network communication. Thus, the routing protocol should provide low latency, fault tolerance, fast reconfiguration and minimum consumption of energy [8]. Figure 1 shows the basic building block of sensor node.

Many routing protocols addressed the energy efficient problems and gave solutions. Most of those solutions are suitable for some situations and it suits worst to some other cases [6,8]. Therefore, the need for energy efficient protocol to adopt to most of the situation is the effective way to prolong the network lifetime. Routing protocols have critical role in most of the network activities. Mostly, location based protocols are used because the sensors does not have any addressing schemes like IP addressing to identify [8, 9, 10].

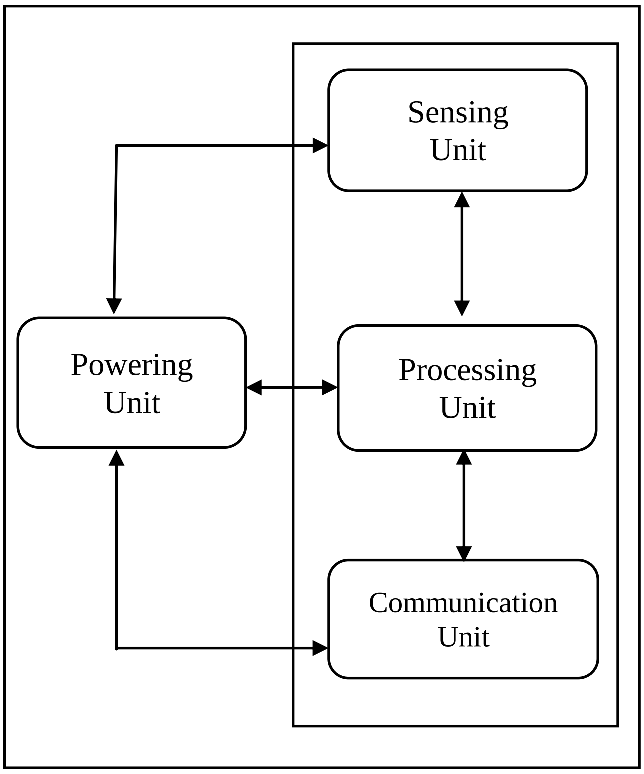


**Fig. 1. Basic building block of WSN**

The sensing unit in figure 1 integrates most of the sensor types like thermal sensor, magnetic sensor, vibration sensor, chemical, bio and light sensor. The processing unit is responsible for data collection in the environment [11]. The communication unit takes care about the forwarding the collected information to the destination or sink node.

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* Correspondence Author
**Vignesh Ramamoorthy H***, Research Scholar, Department of Computer Science, Sree Saraswathi Thyagaraja College, Pollachi, India and Assistant Professor, Department of Information Technology, Sri Krishna Arts and Science College, Coimbatore, India. Email: hvigneshram@gmail.com
**Dr. R. Gunavathi**, Associate Professor and Head, Department of MCA, Sree Saraswathi Thyagaraja College, Pollachi, Coimbatore, India. Email: gunaganesh2001@gmail.com

The location-based protocols of WSN identifies the location of the node through forwarding the data packet and counts the time to reach the destination or next hop. Through this continuous process network derives its own path for data processing. The energy consumption of a node also considered for data processing between two nodes [11,12]. One of the common protocol of this type is Ad-Hoc On Demand Distance Vector (AODV). It is a dynamic source routing protocol where the paths are not predefined. The three types of communication such as unicast, multicast and broadcast are processed in WSN. This creates a route between the source and destination whenever is needed. In addition, it also provides adding and removing of a node to the network. In AODV, the routing table maintains the routing history between each node and whenever the RREQ (Route REQuest) processed by a source node, the source node checks the routing table for path specification and follows the route [8,11,12]. After certain period, the routing table will change based on the route identification process called Packet REQuest (PREQ). AODV also has the capability of rapid dynamic link with low processing, memory overhead and network utilization. AODV also verifies the sequence number for PREQ through reverse routing (the destination forwards the packet to source). The next section, related works discuss about previous methodologies on efficient energy consumption in WSN. Section III brief on research problem identification and directions. Section IV proposed an Energy Proficient AODV Protocol (EP-AODV), for effective energy maintenance in WSN. The performance of proposed work is details through experimental results in Section V and Section VI concludes the paper.

## II. Related Work

Sudha & Kuppusamy [13] proposed a combination of LEACH and AODV protocol for effective data transmission in WSN without time delay and congestion. Clustering is formed based on LEACH protocol to avoid fictitious node transmission. So that the data transmission made faster. Through grouping and aggregation reduces the congestion in WSN. Improved AODV protocol makes more stable route and reduces the overhead in the network. Finally, it reduces the delay and improves the packet delivery ratio. Though this protocol focused in identifying the fictitious node among the nodes, the time delay and energy consumption for this process is high which automatically shrinks the performance of the network. In addition, the proposed protocol focused in cluster formation than the node identification that may makes the network insecure. Ren et al. introduced multi-path routing determination method [14]. The proposed work focused in selective forwarding attack detection in mobile WSN. The selective forwarding attack selectively drops or delivers packets when the compromised node moves into another position. This occurrence is common in WSN as the nodes are mobile in nature. Therefore, identifying the detection and rectifying the same is a precious process in saving the energy of the network. The model proposed a fog computing based system through fuzzy logic concepts to determine the multi path communication to improve the energy efficiency of the network. Proposed AODV protocol initiates the route discovery from source to destination node while the source node ready to transmit the packet to destination. The Route ERRor (RERR) packets are used to maintain the identified route path whenever, the RERR occurs the protocol identifies the path which receives the RERR is failure and reroute to newest path. In addition, the route discovery process after RERR also pulls the energy of the WSN. The multipath AODV performs a better multipath route discovery to forward the collected data to the destination; the proposed model drains the energy level of the network through identifying the routes in every round of data transmission even the network does not needs it. The multipath also does not focused in hop count from source to destination node, which may affects the network when it chooses a longer path for destination. Zhang et al. [15] introduced extended AODV method based on distributed minimum transmission for WSN. The proposed work utilizes multicasting routing technique to save the energy, bandwidth, cost and other resources of WSN. The model resolves the routing optimization problem through random load, data fusion and other factors that detains the lifetime of the network. The multicast tree structure is utilised in identifying the mobility of the node as well as the routing path of the node. Through optimization the route of the node can identified easily though the network may drops its energy when the distance between source and destination node become wider. As the mobility on sensor nodes is quite normal, the distance between the nodes of source to destination also considered to make the network energy efficient. The single path routing is a best routing than the multipath because of route discovery in multipath pulls down the energy level of the node is comparatively higher than the route discovery in single path. The routing table updation and other technical processes of multipath routing is also an energy consumption process are the setbacks of the proposed method. Galzarano et al. [16] propose gossiping-based AODV protocol for large distributed WSN. These networks have infrastructure less communication that in turn needs more security measures than the wired communication networks. In addition, large distribution in a smaller area also increases the communication interferences and collisions between the networks. Thus significantly reduces the lifetime of the network. The proposed protocol introduces "the node concentration" technique to maintain the density of the network. Therefore, the network become stable and efficiency improves. Alternatively, mobility of the node is disturbed and the functionality deceased too. The routing in gossiping also becomes another setback. The source node may out of boundary in upcoming round and if so then the destination node may also not reachable, in such situation the RERR packet may not finds its source and it collapses the total network behavior. Tong et al. [17] introduced a node-grade based AODV routing for WSN. The energy consumption is reduced based on proposed node grade technique on improved AODV protocol. The distance between the source node and sink node is identified through hop count and assigns a grade to each node based on its hop count.

The lower grade receives more packets from the source node than the higher to reach the destination or sink node faster. The RREQ of a source node is accepted and RREP is forwarded from the neighbor node when the neighbor node holds a lesser grade value than the source node if not the RREQ is rejected. This process improvise the faster communication between the node and reduces the consumption of energy to a certain level. Alternatively, the network may become overweighed for some nodes especially for lesser grade nodes and the nodes with higher grade will be idle. This reduces the overall performance of the network and distributed formation may totally collapsed. Al Balas et al. [18] proposed a genetic algorithm for multi objective approach based on AODV for WSN. Minimum hop count of AODV resembles two major problems like, unbalanced energy depletion and traffic congestion. In addition, weak link quality and short path performs better compared to high quality and long path routing in data transmission sometimes. Therefore, the proposed model tries to balance the energy depletion and path identification for better performance. The proposed genetic algorithm brings together the three major parameters such as energy, traffic and hop count. Through these groupings, a better network may avail with improved performance. The major pitfall of this proposed work is that if the nodes are mobility then the distance between the source and destination is a major factor for energy constraints [18, 19]. In addition, the network have to consider which route to be follow for each transmission (weak link and short path or high link and long path) drains the energy and without this consideration the network cannot follow the last transmission path because of the mobility feature of the network.

## III. Problem Identification and Directions

This section deals with detailing the initial process that prepared for proposed work to proceed effectively in the higher levels. Some of the assumptions made for this proposed work are,

i) The sensor nodes used in this work are mobile in nature.
ii) All sensor nodes are equipped with same level of energy.
iii) The batteries of sensor nodes are non-rechargeable.
iv) ID provided for sensors remains static.
v) All sensor nodes have a same sensing range.
vi) The distance between the node and sink node is mentioned as distance.
vii) Nodes chosen for transmission maintains amplified power still the transmission are completed.
viii) Shortest path for communication is identified based on hop count, distance between source node and destination node and residual energy of a node.
ix) Sensor nodes follows only the shortest path communication.

These are the major components for EP-AODV protocol to improve the lifetime of the network proficiently.

## IV. Proposed Energy Proficient AODV Protocol

The proposed Energy Proficient AODV protocol (EP-AODV) focused in improving the lifetime of the network through performing proficient data communication. It also focused in utilizing the minimal energy for communication and using the battery resources efficiently.

The EP-AODV shows it effectively data transmission technique in the initial stage of the network formation itself. The proposed protocol follows,

i) Hop count mechanism – source node forwards the RREQ to its neighbors and neighbors reply RREP with hop count to the source.
ii) EP-AODV follows shortest path for data communication through its hop count mechanism.
iii) Through RREP, the EP-AODV also receives the distance between the source node and destination node to identify the distance.
iv) (a) When the distance seems high and hop count is less, then the proposed protocol doses not choose the path as shortest.
(b) When the distance seems low and hop count is high, the proposed protocol does not choose the shortest path as a communication path.
v) When the distance and hop count seems moderate then the EP-AODV chooses the path as communication.
vi) Finally, the residual energy level of the sensor node also plays a vital role in choosing the proficient path for WSN communications.
vii) Next, after deciding the communication path,
viii) EP-AODV amplifies the battery level of the sensor node avail in communication path.

The proposed algorithm for EP-AODV is as follows,

```
1   For each neighbor node, node A forwards RREQ
2   Node A receives RREP with hop count, distance and
    residual energy from its neighbors.
3       Checks each neighbor's RREP for less hop count
        to sink, less distance between node and sink node
        and finally the destination node maintains high
        residual energy than the other nodes.
4   If node A attains the best RREP ( For Instance node
    B) Then
5       Power amplification changed to HIGH for node
        A.
6       Data transmission starts
7       If node B is sink
8           Successfully received
9           Communication ends
10          Power amplification changed to LOW for
            node A.
11      Else
12          GOTO step 1.
13  End Process.
```

EP-AODV protocol proposed the upcoming equations Eq.1, Eq.2, Eq. 3 and Eq.4 for hop count, distance between node and sink node, residual energy and power amplification respectively.

$$H_n = \sum_{i=1}^{n-1} 2^{2i-1} \qquad (1)$$

where, $H_n$ denotes Hop Count, $n$ denotes number of nodes and $i$ denotes iterations.

$$Distance = \frac{Dis_{Sink}}{Dis_{far}} \qquad (2)$$

where, $Dis$ denotes distance, $sink$ denotes sink node and $far$ denotes farthest node.

$$Res_{Egy} = \left[\frac{EGY_{curr}}{EGY_{max}}\right] \qquad (3)$$

where, $Res_{Egy}$ denotes residual energy, $EGY_{curr}$ denotes current energy and $EGY_{max}$ denotes maximum energy.

$$Pwr_{amp} = \left\{ \begin{array}{ll} Hi_{pwr}\left(\frac{EGY_{curr}}{EGY_{max}}\right) & n = transmitting \\ Low_{pwr}\left(\frac{EGY_{curr}}{EGY_{max}}\right) & n = normal\ node \end{array} \right\} \qquad (4)$$

where, $Pwr_{amp}$ denotes power amplification, $Hi_{pwr}$ denotes high power, $Low_{pwr}$ denotes low power amplification.

## V. EXPERIMENTAL RESULTS

This section compares the proposed EP-AODV protocol with existing works using NS 3.25. The parameters for the proposed work detailed in table I.

Table I: Parameters for the proposed EP-AODV Protocol

| PARAMETERS | VALUE |
|---|---|
| NETWORK SPACE | 1000 X 1000 |
| NUMBER OF NODES | 200 |
| INITIAL ENERGY | 1 JOULE |
| PACKET LENGTH | 360 BITS |

The performance of the proposed EP-AODV is compared using the metrics number of alive nodes, residual energy and packet delivery ratio.

Number of alive nodes metrics is used to analyse the proficiency of the network lifetime improved by the proposed protocol. Analysing the residual energy to understand the effectiveness of power amplification in proposed protocol and finally, the packet delivery ratio is to analyse the safe and fast communication between the source node and sink node.

Figure 2 shows the number of alive nodes between the EP-AODV and other previous protocols.

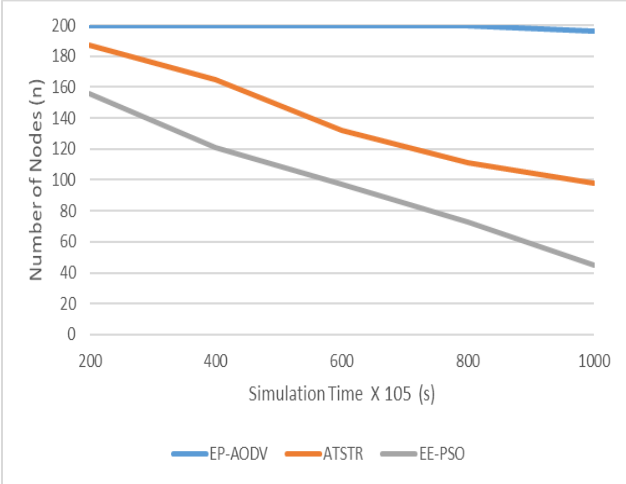


**Fig. 2.**Example of a Number of alive nodes

The proposed EP-AODV protocol achieves higher number of alive nodes than the other two existing protocols.

Figure 3 presents residual energy between EP-AODV and previous protocols.

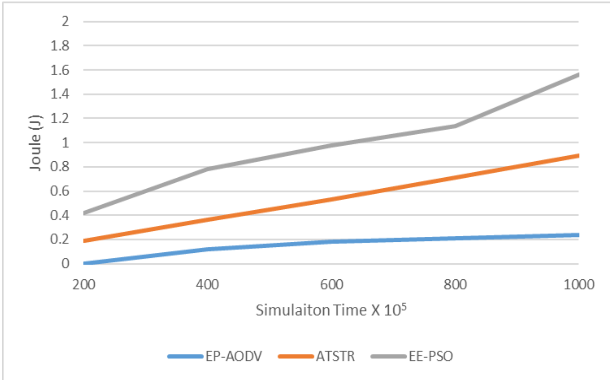


**Fig. 3.**Residual Energy

EP-AODV proposed protocol maintains a residual energy of 1.78 after completion of simulation running time compared to ATSTR and EE-PSO protocols.

Figure 4 shows packet delivery ratio between the EP-AODV and other previous protocols.

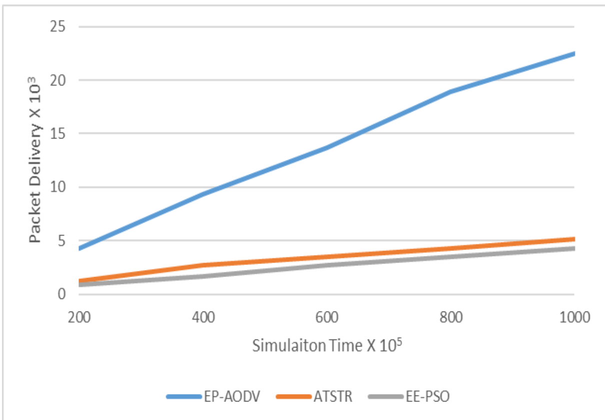


**Fig. 4.Packet Delivery Ratio**

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In Figure 4 EP-AODV maintains a higher packet delivery ratio of 22,587 messages than the existing protocols ATSTR and EE-PSO which receives 5,140 and 4,310 messages after the simulation time respectively.

The above figures Fig.2, Fig.3 and Fig.4 shows the proficiency of the EP-AODV compared with the other two existing protocols.

## VI. CONCLUSION

The need for WSN is increasing every day due to its efficient configuration and easy installation. Therefore, the need for new protocols are need to maintain the necessity and efficiency of the network. In addition, security and energy proficiency is also a special need for WSN. This paper focused in improving the energy efficiency through EP-AODV protocol that chose the sensor node, which is of less distance to sink & higher residual energy and hop count basis. This proposed protocol achieves a better proficiency than the existing protocols which is proves through the performance analysis section. The parameters for proposed protocol may include variants based on the network architecture in future.

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## AUTHORS PROFILE

**Vignesh Ramamoorthy H** received his M.Sc (Software Engineering) from Anna University, Chennai in 2010, MCA from Bharathiar University in 2012, Post Graduate Diploma in Mobile Computing from Annamalai University in 2012. He also completed his M.Phil Computer Science from Bharathiar University during 2014. He is currently working as an Assistant Professor at Sri Krishna Arts and Science College, Coimbatore, TN, India and also pursuing his part time Ph.D at Bharathiar University, Coimbatore. He has presented more than 37 papers in National and International Conferences and has 28 publications in various reputed journals. He has attended 20 workshop/FDPs/trainings all together. His areas of interests are Wireless Sensor Networks, Mobile Computing, Artificial Intelligence and Virtual Reality.

**Dr. R. Gunavathi** has completed her Ph.D. in Computer Science at Mother Teresa Women's University, Kodaikanal, and her research is on "Efficient Cluster head selection algorithms to improve the Quality of service in Mobile Ad hoc networks". She has 20 years of teaching experience and currently working as Associate Professor and Head, Department of MCA at Sree Saraswathi Thyagaraja College, Pollachi, India. She has 15 years of research experience. Her current research interest is in Mobile Ad Hoc Networks, Vehicular Ad hoc Networks and Big Data Analytics. She has published around 30 research articles in the refereed International journals with good impact factor and also presented 25 research papers in the National and International level conferences. She has organized many National level Seminars, Workshops and Conferences.