

# Implementation of Span-AODV Approach for Best-Energy Path and Enhancement of Lifetime in Caterpillar Network

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## Abstract

Wireless Sensor Networks (WSNs) have been mostly considered with improvements in ubiquitous computing environment. The supply of a sensor node is limited, so it is essential to use energy-efficient routing protocol in WSNs. Energy consumption can be maintained to certain threshold level, so that no individual nodes can go dry beyond that certain level. Here we suggest each node to behave active and idle states, so that average energy level of whole network can be maintained. In SPAN-AODV protocol, we will compute the procedure to identify the nodes, which losing its energy earlier than other. We isolate those nodes below threshold energy from communication. Packet transmission has done only through energy nodes, even non-energy nodes present at accessible distance to communicate. In this paper we compare SPAN-AODV, EDDEEC (Enhanced Developed Distributed Energy-Efficient Clustering) and CATER-AODV (SPAN-AODV implemented in caterpillar network) through performance analysis and the result shows that CATER-AODV is 21% more efficient than EDDEEC and 17% more efficient than SPAN-AODV in terms of residual energy, network lifetime and traffic size.

**Keywords:** CATER-AODV, EDDEEC Routing Protocols, Network Lifetime, Residual Energy, SPAN-AODV Routing Protocols, Threshold level, Traffic Size, Wireless Sensor Network

## 1. Introduction

Wireless Sensor Networks have been largely analyzed in ubiquitous computing environment because of its extensive application. The application area of WSNs includes ecological management, medical services, and military monitoring. WSNs are poised of various sensor nodes furnished with short-range wireless communication, memory and processors. Wireless sensor networks have amply of benefits. The deployment of WSNs is at ease and sooner than the wired sensor networks or any other wireless networks, as they do not need any permanent infrastructure. In the meantime sensor nodes are closely deployed in most of the cases; they are able to tolerate the network failures. The conjoined sensor nodes transmit the sensed data to the central base station, termed

as sink node. A routing protocol is a mode of defining a path for sensed data transmission between a source points to an endpoint (i.e., sink node). The proficiency of WSNs is very dependent on routing protocols that has

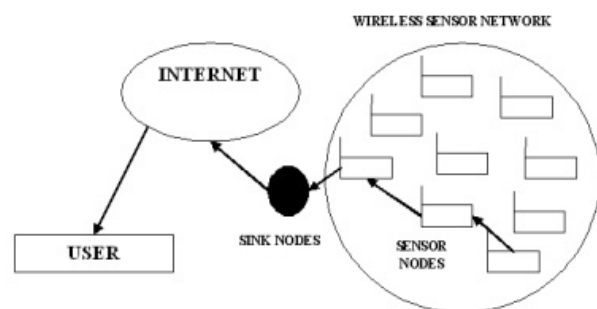


Figure 1. Wireless sensor network architecture.

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direct impact on network lifetime. The main goal of routing protocols is to improve both lifetime and reliability of WSNs by seeing the ability of a sensor node with resource limitations, such as slow processor, low communication bandwidth and inadequate power. Therefore, the dispute of routing protocols is to lessen the communication overhead for data transmission by defining a best energy path in WSN.

## 2. Taxonomy of Clustering Features in WSNs

### 2.1 Network Model

Various architectures and design goals have been considered for many applications of WSNs. The succeeding procedures some of the relevant architectural parameters and highlights their implications on network clustering.

### 2.2 Network Dynamics

WSNs consist of three main components: 1.Sensor nodes, 2.Base station and 3.Monitored events. Most of the network architectures say that sensor nodes are stationary<sup>9</sup>. Every so often it is assumed necessary to support the mobility of base-station or CHs. Node mobility is very challenging features in clustering as the node membership will dynamically change. The monitored events of a sensor can be either intermittent or continual that is depending on the application. Here intermittent events allow the network to work in reactive mode whereas continual event makes the cluster stable.

### 2.3 Node Deployment

Nodes are deployed accordingly to fulfill the needs and objectives of any applications. Node deployments are classified as deterministic and self-organizing. In deterministic case the sensor nodes are deployed manually and so the routing is done along the pre-determined path. In self-organizing schemes, the sensor nodes are dispersed randomly forming an infrastructure in an ad hoc manner<sup>9</sup>.

### 2.4 Cluster Head (CH) Selection

In clustering technology more number of nodes can be formed into the small groups which is termed as clusters. From this cluster it selects one leader called Cluster head (CH). In CH selection the CHs are selected among the

sensor nodes. Various tasks are examined for this selection. The cluster head are left out from sensing responsibilities, by excluding this duty the CH node can probably consume energy and will elude depleting energy quite quickly.

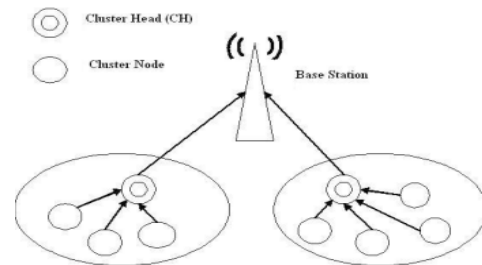


Figure 2. Clustering Techniques.

## 2.5 Improving Reliability of Data Transmission

When compared to homogeneous network the end-to-end delivery rate is higher than heterogeneous network. As the delivery rate is high the reliability of data transmission is improved. When hops increase the delivery rate reduces. So, only fewer hops are processed.

### 2.6 Performance Measures

#### 2.6.1 Network Lifetime

The overall time interval of alive node was the lifetime of the network.

#### 2.6.2 Number of Cluster Heads Per Round

In CH selection the CHs are selected among the sensor nodes. Various tasks are examined for this selection. The cluster head are left out from sensing responsibilities, by excluding this duty the CH node can probably consume energy and will elude depleting energy quite quickly.

#### 2.6.3 Number of Alive Nodes Per Round

We will compute the procedure to identify the nodes, which losing its energy earlier than other. We isolate those nodes below threshold energy from communication. Packet transmission has done only through energy nodes, even non energy nodes present at accessible distance to communicate.

### 2.6.4 Throughput

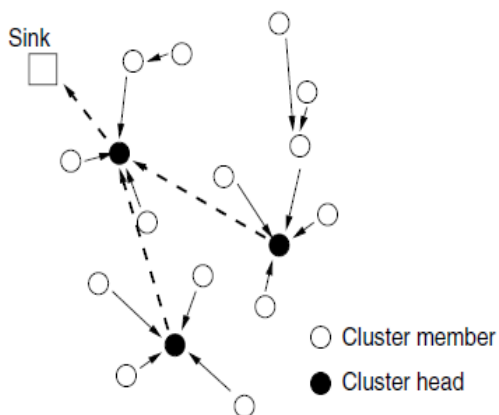
The success rate of data sent from cluster head to base station and also successful data rate along cluster head to sensor nodes are termed as throughput.

### 2.6.5 Inter-Cluster Network

In clustering network each node is interconnected among themselves with cluster head by means inter-cluster network.

## 3. Problem Statements in Existing Methodology

Existing method uses EDDEEC for energy efficiency in WSN. In that approach, it uses packet Delivery ratio, distance and no of child nodes as a parameter to elect cluster head among cluster members. Due to this, there is always a traffic flow exists for contention or selections of cluster head, which require some energy. To determine the best packet delivery ratio, i.e., success rate. The existing approach floods packets throughout the network, these packets could use dummy packets to find PDR.



**Figure 3.** Existing Methodology.

Although, the process of cluster head selection is complex, the process itself consumes energy. Suppose cluster head has been chosen for N set of nodes, then all these N nodes may try to send its packet through selected head causes earlier dry of elected head. So, new cluster head has to be chosen and also the earlier node would die earlier and could not communicate its own data to the network.

## 4. Related Work

To determine energy efficient protocol many researches and survey are made in wireless sensor network. From the results and performance analysis of various researches it has been determined that among the existing protocols, the cluster based routing is predominantly more suitable for uninterrupted data transmission in wireless sensor networks and also in energy conservation. In this section, we exhibit an overview of various works that examine the energy efficient routing protocols and also various methodologies for energy consumption for wireless sensor network along with its limits.

Reena Singh et al. propose an EEAODV routing protocol which is a development in the existing AODV routing protocol. EEAODV has enhanced the Route Request (REQ) and Request Reply (RREP) process to handle energy consumption in mobile devices. EE-AODV considers some minimum energy which should be obtainable in the node to be used as an intermediary node. When the energy of a node reaches to or below that level, the node should not be considered as an intermediary node, until and unless no substitute path is available. So, if the best path is available through the intermediate node having less power and source node has one more route as a substitute path to send data. Energy wastage occurs at idle mode of nodes.

Akhilesh Tripathi et al. introduce MECB-AODV (Modified Energy Constraint Protocol Based on AODV) which is derivative from AODV protocol. In MECB-AODV protocol, at the intermediate nodes the residual energy is considered to sustain the connectivity of the network as long as possible. Being a Proactive protocol it consumes high bandwidth.

Farooq et al. proposed a multi hop routing with Low Energy Adaptive Clustering Hierarchy (MR-LEACH). The MR-LEACH protocol chose the Cluster headers and the aggregated data are transmitted to a sink node by using multi hop routing. Therefore, it attains substantial enhancement on energy consumption, compared with the LEACH protocol. The problem of MR-LEACH is that the selection of a cluster header in a layer exclusively depends on the residual energy of a sensor node, rather than considering the distances among cluster headers.

Elbhiri et al. put forward a developed distributed energy efficient clustering scheme for heterogeneous WSNs. This procedure is based on changing dynamically and with more efficiency the cluster head election

probability. DDEEC is based on DEEC scheme, where all nodes use the initial and residual energy level to define the cluster heads. To evade that each node needs to have the global knowledge of the networks, DDEEC like DEEC estimate the ideal value of network lifetime, which is used to compute the reference energy that each node should expend during each round.

N. Javaid et al. introduced a technique named as EDDEEC (Enhanced Developed Distributed Energy Efficient Clustering) scheme for heterogeneous WSNs. In that technique nodes are changed dynamically and Cluster Head selection probability is more efficiently done, based on the initial and residual energy level of the nodes the EDDEEC protocol implements Cluster Head selection probabilities.

## 5 Proposed Methodology

### 5.1 SPAN-AODV

Our proposed method uses energy efficient SPAN-AODV approach for energy efficiency. Since this protocol finds shortest path by on demand routing protocol and this is added with residual energy and hence, lifetime of nodes is increased. This approach takes the advantage of both shortest path and best energy efficient path. Unlike EDDEEC there is no contention for cluster head selection, it does not add additional traffic to network. For  $N$  set of nodes, here it is not necessary that single node should act as cluster head and all packets of neighbors must pass through it. In proposed method, we will compute the procedure to identify the nodes, which losing its energy earlier than other. We isolate those nodes below threshold energy from communication. Packet transmission has done only through energy nodes, even non energy nodes present at accessible distance to communicate.

### 5.2 Caterpillar Network

#### 5.2.1 Pair or Set Formation

Caterpillar Network applies the cut-set bound Theorem as long as we take the set  $U$  to be a subset of the allowable traitors. If we apply Theorem in above deployed network  $A = \{S, 1, 2, 3, 4\}$  and  $U = \{1, 2\}$ . What properties must it have? The following analysis is not rigorous, but In the cater network we use Span-AODV. In general all nodes in AODV aware of source, destination, previous hop and next hop addresses. Here In merging span-AODV to cater

network every node aware of inlet and outlet pairs. These pairs will be formed by all contributing nodes in between source and destination. Each node accompanies a node which connects them to destination; of course every node knows who helps it to connect with destination. Here the four sets (1, 5), (2, 6), (3, 7) and (4, 8), have been formed.

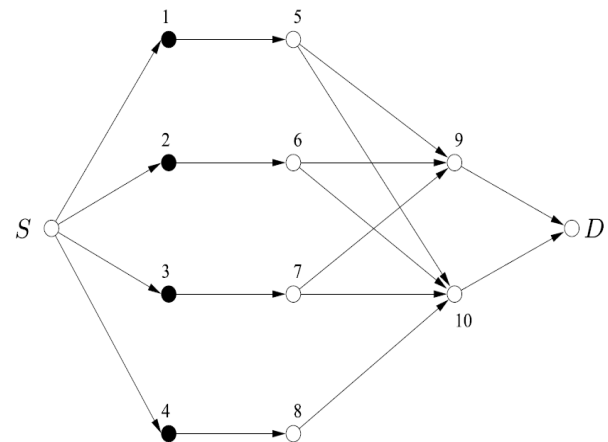


Figure 4. Caterpillar Network.

## 6. Performance Analysis and Simulation Result

In our research we compare the performance of our proposed SPAN-AODV and CATER-AODV routing protocol with EDDEEC. The main parameters we consider here are amount of residual energy, network delay and also traffic size. By the result of simulation we prove that our proposed protocol out performs the existing protocols. The analysis and simulation result given below explains that SPAN-AODV and CATER-AODV out performs EDDEEC in terms of various parameters but here only few parameters are considered.

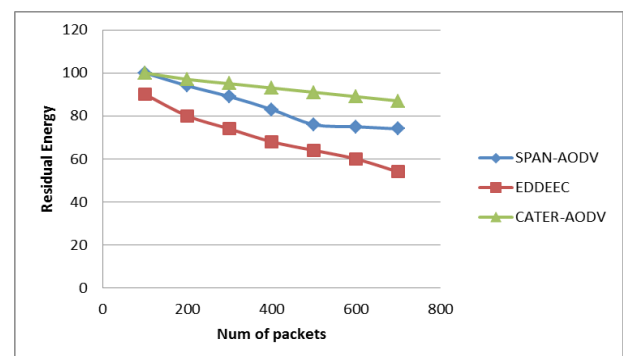


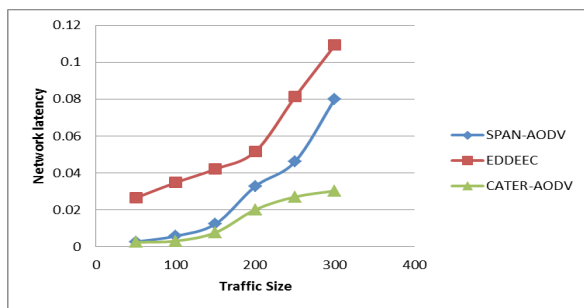
Figure 5. Residual energy of SPAN-AODV, EDDEEC and CATER-AODV.

While considering residual energy, the energy at proposed protocol is high while compared to EDDEEC. The energy reduction is gradually low thus residual energy is high at SPAN-AODV and bit more high in CATER-AODV. Until this energy is maintained the lifetime of network is sustained. Hence overall network life time is increased in our proposed method than existing methodologies.

**Table 1.** Residual energy values of SPAN-AODV, EDDEEC and CATER-AODV

NO. OF PACKETS	EDDEEC	SPAN-AODV	CATER-AODV
100	90	100	100
200	80	94	97
300	74	89	95
400	68	83	93
500	64	76	91
600	60	75	89
700	54	74	87

When considering the traffic size and network delay our proposed SPAN-AODV has low delay and traffic than existing methodology. As the delay time is low the transmission of data along the network is high. Some amount



**Figure 6.** End-to-End delay of SPAN-AODV and EDDEEC.

**Table 2.** End-to-End delay of SPAN-AODV, EDDEEC and CATER-AODV

TRAFFIC	EDDEEC	SPAN-AODV	CATER-AODV
50	0.02651	0.0027	0.002421
100	0.0348	0.0058	0.003124
150	0.0421	0.0124	0.007724
200	0.0516	0.03278	0.02013
250	0.0812	0.0462	0.02705
300	0.1092	0.0801	0.03032

of energy is wasted due to this delay in transmission and this can be avoided by reducing traffic size. The distance also influences delay and energy consumption which can be tackled by means of choosing best energy path. Thus in terms of traffic size and delay are highly low in CATER-AODV and SPAN-AODV than EDDEEC.

## 7. Conclusion

The paper hereby concludes the methodology for enhancing network lifetime in wireless sensor network by implementing SPAN-AODV routing protocol in caterpillar network. SPAN-AODV creates backbone network to forward message and maintains hop positions. From our performance analysis, we show that SPAN-AODV routing protocol outperforms the existing protocols, in terms of energy efficiency, network life time, traffic size and network delay.

Through performance analysis and the result shows that CATER-AODV is 21% more efficient than EDDEEC and 17% more efficient than SPAN-AODV in terms of residual energy, network lifetime and traffic size., and also in terms of the reliability of a sensor network.

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