An Efficient Integral Power-Elector Method with Enhanced AODV to Avoid Sleep Deprivation in Manet

S. Madhurikkha[1]* and R. Sabitha[2]

[1]Sathyabama University, Chennai - 600119, Tamil Nadu, India; madhurikkha@gmail.com
[2]Jeppiaar Engineering College, Chennai - 600119, Tamil Nadu, India; sabisam73@gmail.com

Abstract

Objectives: To Enhance Ad hoc On-demand Distance Vector routing (AODV) mechanism with Integral power-elector algorithm and power neural technique to manage node from sleep deprivation attack in Mobile Ad hoc Network (MANET). **Methods:** Sleep deprivation Attack in MANETs make frequent request to the nodes and deplete the battery level. Colony formation technique implemented using power – elector algorithm with power consumption value of mobile nodes as a key value. A group of wireless devices such as Colonies with Processing head and transmission head avoid the sleep deprivation attack by forwarding the packets to the intended destination. Results are simulated through *ns-2* tool. **Findings:** An efficient power- elector method with power consumption value as a key is introduced. The enhanced AODV protocol with extra two fields added helps to know about the Size of packets to be transmitted and also identifies the number of packets to be transmitted to destination. The algorithm imports colony formation technique and adds up with colony chaining method with optimal value checks for each colony nodes for successful transmission of packets by avoiding the sleep deprivation Attack. The Power value of nodes compared and the proposed methodology shows an improvement. Results are simulated through *ns* 2.34. **Improvement:** The proposed method has shown improvement on the power values of node. The existing protocol without proposed method decreases the power value while the proposed method improves it and results are shown.

Keywords: AODV, Colony, MANET; Power Consumption; Sleep Deprivation Attack

1. Introduction

Mobile Ad-Hoc Networks (MANET) are self organized, self created and self managed networks without any basic infrastructure. They can be rapidly deployed and reconfigured[1]. A critical issue for MANETs of untethered nodes is that nodes are normally power constrained[2]. Unlike traditional networks; the power exhaustion and the mobility nature of nodes cause frequent topology changes. A node may exhaust its power or move away without giving any notice to its cooperative nodes, causing changes in network topology, and may significantly degrade the performance of the routing protocol. Therefore the path between nodes or group of nodes may change periodically[3]. In mobile ad hoc networks, the route needs to be discovered with

longer route lifetime with fewer changes. When there is no cooperation, activities of even a small number of nodes may significantly decrease the performance of the network[4]. Ad hoc On-demand Distance Vector routing (AODV) is commonly used reactive protocol which establishes a route to a destination only on demand[5]. However AODV is also vulnerable to Sleep Deprivation Attack. Sleep deprivation Attack in MANETs make frequent request to the nodes and deplete the battery level. It is difficult to identify and avoid such attack as it dramatically destroys the power source. A malicious node intentionally sends control packets (RREQ, RREP, and RERR) or data packets to the targeted node to deplete its battery power. The victim node moves to a sleep state and its identity from the network is destroyed due to this attack. In this

*Author for correspondence

paper an Integral power-elector algorithm is used to avoid this attack with Colony formation technique.

A number of works have been done to overcome the security problem on the area of ad hoc network community. Some of the works are listed here[6]. Has presented the Number of Attackers and Attack position to find out the degradation in Packet Delivery Ratio and Delay Jitter by considering many options. The attackers' radio range and flooding rate is not tested. AODV protocol not modified for the security concern. In[7] proposed a power consumption model which describes an efficient way for energy consumption in wireless sensor node. Multi-hop transmission is investigated by the optimal transmission range. Various parameters are introduced for wireless sensor node and relay nodes. Optimal transmission range is identified that can minimize the use of power source consumption. In[8] proposed a method to control the topology network of MANET. Energy can be conserved by controlling the neighbour nodes to which it communicates.

Depending upon the sleep technique, the topology network saves the power by controlling it and distributing work load to neighbour nodes. It uses priority technique to enhance the packet transmission among nodes in the network by diverting the transmission through the efficient path. In[9] proposed a hierarchical framework based on distributed collaborative mechanism for detecting sleep deprivation torture in wireless sensor network efficiently. Proposed model uses anomaly detection technique in two steps to reduce the probability of false intrusion. In[10] proposed three off-line algorithms to extend the battery life of the sensor node. DVFS-enabled periodical task execution algorithm and time scaling periodical task execution algorithm are used to improve the power consumption of sensor node. This proposed method implies that three sensor scheduling algorithms extended battery life three times as long as in scheduling algorithms. In[11] proposed a Clustering algorithm which avoids the attacker by saving the life time of the victim node from sleep deprivation attack. Least Cluster Change Algorithm used with counter value to check with threshold. The improvement in reduction of battery power by the attacker is not shown.

2. Materials and Methods

2.1 Enhanced AODV Routing

In a wireless network when a node tries to communicate, it broadcast the request with AODV packet to the neighboring nodes. Request packet checks the route in route table of the neighboring node. Availability of route in table may return the acknowledgement packet to the needy node else the packet is forwarded to the neighboring nodes. Table 1 describes the header packet forwarded by nodes to identify the destination route. In our method we have added two fields such as SIZE and STYPE in the header packet to identify the number of packets that are transmitted to the destination. The SIZE field is the total size to be transmitted. SIZE TYPE represents the type either in Bytes (00), KB (01), GB (10), and TB (11).

The Table 2 represents the Header Packet Keywords. These fields are used to identify the total power needed for transmission. Thus there is a need for identifying all the power usage and other processing data for comparing the packet and energy usage in the device during information Transfer.

2.2 Colony Arrangement

Wireless network has a collection of wireless devices connected with each other in dynamic manner. As devices

Table 1. Header packet

Type	J	R	G	D	U	SIZE	STYPE	Reserved	HOP COUNT
RREQ ID									
Destination IP Address									
Destination Sequence Number									
Originator IP Address									
Originator Sequence Number									

Table 2. Header packet keywords

Keyword	Description
J	Join flag reserved for multicast.
R	Repair flag reserved for multicast.
G	Gratuitous RREP flag. It indicates whether a gratuitous RREP should be unicast to the node specified in the Destination IP Address field
D	Destination only flag. It indicates only the destination may respond to this RREQ
U	Unknown sequence number; indicates the destination sequence number is unknown
SIZE	Total size to be transmitted
STYPE	Size type
Reserved	Sent as 0; ignored on reception.
Hop Count	The number of hops from the Originator IP Address to the node handling the request.

are mobile in nature, frequent changes occur in the network and the nature of the network changes automatically. A group of wireless devices such as node that are capable of processing and transmitting the packets are known as Colony. Each dotted circle represents the colony. Each node in the colony possesses many parameters to consider while processing and transmitting the packets. Power source is an important phenomenon to consider while transmitting packets. Transmitting packet requires more power consumption compared to processing a request by node. Figure 1(a), small circle represent the node in the MANET and each are labelled with colours. Figure 1(b) represents the legendary description for each coloured node. The Dead region node is the one which depleted its battery (sleep deprivation attack). The low level and critical level nodes are about to get depleted. The medium level node has battery left and can be used for processing the packets. The high level node has enough battery to transmit the packets in the network.

Each node in the colony can connect with the nodes in the neighbouring colony. Each node will be examined with the amount of power (Amount of battery left in that node) and power consumption value (rate of change of power the node consumes). The power consumption value of the node is found out using the slope Equation (1). Let X1, X2 are the two time stamps and Y1, Y2 are the power range for time X1 and X2 respectively Figure 2.

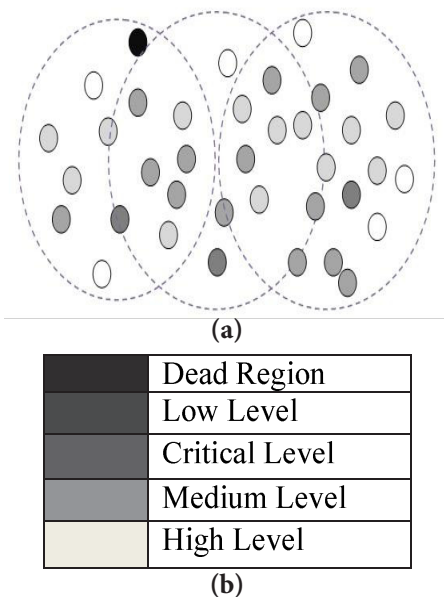Rate of change of power consumed between point P and Q (slope equation),

$$f(x) = (Y2 - Y1)/(X2 - X1) \tag{1}$$

Total rate of change over the time limit in power consumption

$$\int_0^n f(x)\,dx \tag{2}$$

The power consumption value Equation (2) ranges from 0 to 0.5. Each node calculates the power consumption value periodically. Power consumption drops drastically when there is transmission of packets. Each node calculated the Power-Consumption value and is used by the algorithm to elect the node to form colony.

2.3 Colony Chaining Technique

In this technique the nodes power value and power consumption value are taken in to account. The nodes with less power consumption values are chosen to form a colony Figure 3. The integral power elector algorithm is used to avoid the sleep deprivation attack. Each colony has many nodes each with different power consumption values. To add nodes to each colony the optimal value is calculated. The optimal value is the power consumption value by the number of nodes * average total power. Each
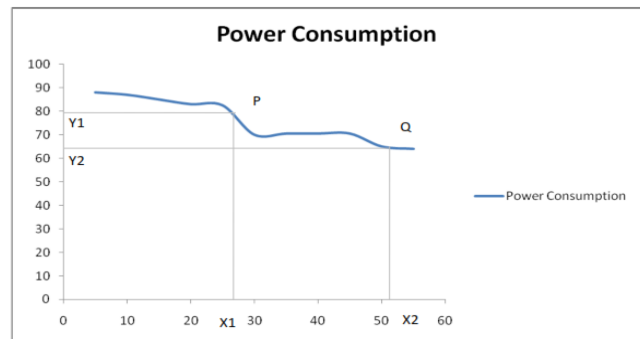

Figure 2. Slope equation.

Figure 1. (a) Nodes in MANET. (b) Legendary description of nodes.
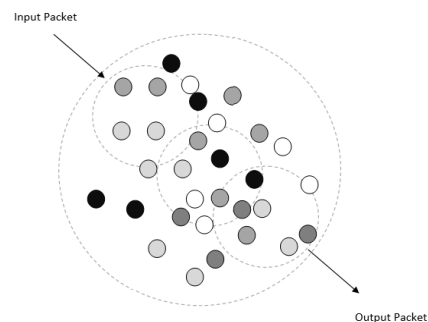

Figure 3. Colony chaining.

colony may have a processing head and the transmission head which are elected. Low Power-Consumption value node in a colony may lead the transmission head role. When there is a severe drop in the power, the other node is elected to replace the active transmission head node. A middle range power node is used for processing section. Transmission in short range may consume low power so that the transmission head receives from a wide range and transmit to the neighbouring processing node. The processing node processes the packet and retransmits to the transmission head. Since the transmission head is near, processing node consumes less power energy.

Colony chaining technique is defined as the connection of each node in a colony that creates a healthy transaction of packets with lower power consumption. This type of chaining will have a good relationship with the nodes that are in active mode. This provides sufficient transfer of information and packets in a low power manner. When a packet enters into the colony, inner groups are formed with low Power-Consumption value. Using Integral Power-Elector algorithm, it identifies the nodes to travel and reach the other inner group. Thus when the nodes are connected to each other, it will travel uniformly and communicate with the required inner nodes and colony. This inner chaining technique may utilize the power consumption effectively.

2.4 Algorithm

Colony ColonyFormation (Nodes nodes)
Begin
Colony newColony;
$f(x) = (Y2 – Y1)/(X2 – X1)$
$PowerConsumptionValue = \int_0^n f(x)\, dx$
newColony.OverallPowerConsumption=PowerConsumptionValue;
OptimalValue= PowerConsumptionValue / no.of.nodes * average TotalPower
For each Node in nodes
Begin
If (Node.PowerConsumptionValue < 0.5)
Begin
newColony.AddNewNode (Node);
If (Node.PowerConsumptionValue * Node.TotalPower > optimalValue)
Begin
    Node.IsTransmissionSection = true;
    Node.IsProcessingSection = false;
End

Else
Begin
    Node.IsTransmissionSection = false;
    Node.IsProcessingSection = true;
End
End
End
Return newColony;
End

The algorithm explains the steps for avoiding the sleep deprivation attack. The colony formation is done with the nodes. The power consumption value is calculated for each node and the optimal value is computed for each colony. The nodes are now checked to include in the colony. If the computed value for each node is greater than the optimal value, then that particular node is selected as a transmission head for that colony. The nodes whose value is lesser than the optimal value are included as a processing node in the colony. Let us consider an example, a node with power consumption value 0.2 and total power 80. To add this node in a colony the optimal value for that particular colony need to be computed. The optimal value for that colony is 35. The power consumption value of the node (0.2) is lesser than the value 0.5 (as described in algorithm). Now the condition for adding the node to the colony is checked i.e., 0.2 (power consumption value of node) * 80 (power value of the node) > 35 (optimal value for that colony). The value is 40 > 35, so the value of the particular node is higher than the optimal value of the colony. This node is now added as the transmission head for that colony. The worst case is when the power consumption value of any node is greater than 0.5 then it is considered to be an unfit node for the colony formation and it is neglected to participate in packet transmission.

Figure 4 illustrates the group of wireless networks that are organized as colonies. Each colony has Power-Consumption value that is calculated and each colony consist of inner groups. Figures 1.b express the legends used in Figure 4. Let A,B,C,D,E,F,G,H,I,J,K,L,M are colonies that contains many inner colonies. Each colony is categorized with region that are shown. The critical factor for the region ranges from Dead region to High Level region. Dead region are region in which the Power-Consumption value is very high thus defines that the hosts in that region have low power values. High level region has low Power-Consumption value that consumes less power so those are highly recommended for packet transmission.

Total rate of change over the time limit in power consumption is taken from Equation (1).

A colony consist of many nodes may have inner groups. This average of the Power-Consumption value in Equation (3) is calculated as,

$$\frac{\sum \int_0^n f(x)\,dx}{N} \qquad (3)$$

Let all nodes may represent a colony with inner chained techniques. Consider node 'A' initiates the packet transfer to node L of size 512 kb size. Node A initiates the transfer by constructing the AODV header packet. Our proposed header has SIZE section filled by 512 and SIZE TYPE as 1. It request for transmission route by beaconing the request signal to the neighbour nodes. Initially, a node in the network computes their Power-Consumption value. AODV header packet pings node C, D and E. The size to be transmitted is the key parameter to compute the transmission time and path to transmit. Node C, D and E transmit the packets to the neighbouring nodes.

- C -> B, H.
- D -> I.
- E -> F, J.

Since the sequence number is already registered in the node D, D nodes ignore the request from the node C. Packet is processed till it reaches the destination node. The responses possess the Power-Consumption value of the entire associated node in the route path. The minimal value path is chosen for the packet transfer.

3. Result and Discussion

The proposed method is simulated using NS 2.34 simulator and Table 3 shows the parameters digest used in the simulator. AODV protocol header has been modified and proposed header section is implemented in the simulation. Size of the transmission packet are calculated and raised in the AODV header. Initial energy nodes are variable for each node and are assigned randomly. Traffic
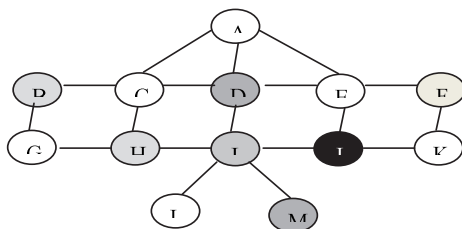
stimulation is set to medium range for better proposed simulation. A group of 125 nodes are considered as colony. Each node in a colony possesses various differential initial powers. Each node is connected to one other in uniform manner that keeps it connected with the group in the colony. Power-Consumption value is calculated for each node. Based on the value of Power-Consumption, the effect of attacks is calculated through authorized techniques. Each colony has a sleep deprivation attacker node in which frequent request is raised consistently over the network. Each request from the attacker node is routed in a way through the node which lies in high region.

Eight colonies with 1000 nodes are stimulated in network simulator. Nodes are randomly picked for packet transmission over the network.

These nodes serve as source node and transmit packets randomly in timed manner. Total size of the packets that are transmitted ranges from 512MB to 10GB. Figure 6 Shows the number of bytes that are transmitted. Figure 6(a) and Figure 6(b) shows the comparison result of the power that has been consumed during sleep deprivation attack. The Existing model under goes attack and power of the node will be decreased to critical level. In

Table 3. Simulation

| Parameter list	Values
Simulator Time	950s
Number of Nodes	125 each colony
Routing Protocol	AODV
Traffic Type	CBR
Channel	Wireless Channel
Energy Model	Energy Model
Transmission Power	Power in terms of watts (0.32)
Receiving Power	Power in terms of watts (0.1)
Minimum Initial Energy	5.23 joules
Antenna Type	OmniAntenna
Interface Queue Type	DropTail

Figure 4. MANET with nodes.
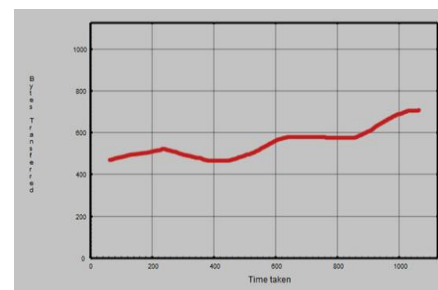
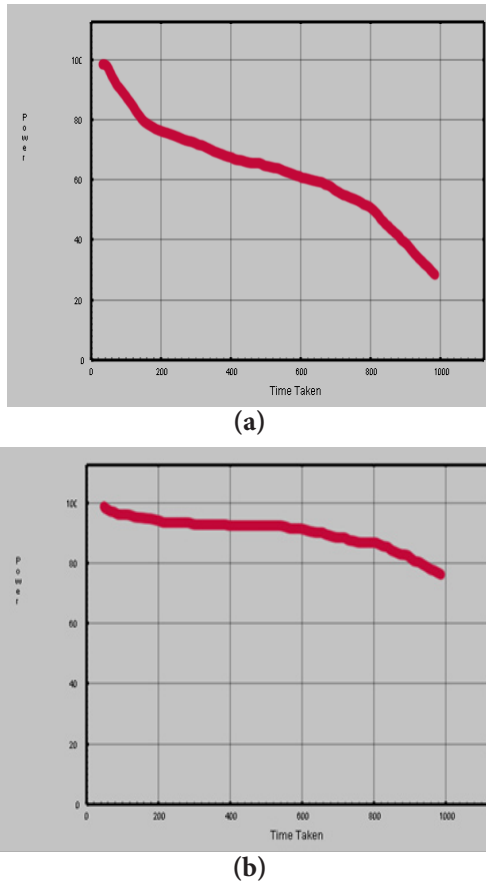**Figure 5.** Byte transmission vs time taken.

(a)

(b)

Figure 6. **(a)** Power vs time in existing model. **(b)** Power vs time in proposed model.

our proposed model, we transfer the handling request by using proposed algorithm. Thus, the power consumption was effectively used by the clusters.

4. Conclusion and Future work

Our proposed algorithm effectively routes the packets by reducing the power consumption targeted on a particular node. AODV with size related parameter helps in identifying the long term route assignment for the packet transmission. Colony formation technique helps in identifying the efficient nodes in the network for transmitting the packets. Proposed colony chaining technique helps in transmitting the packets through colonies. Power consumption value determines the power consumed by the node that determines the node efficiency. Sleep deprivation attack may have less effort over the node since proposed algorithm swaps the node to avoid sleep state over the node. Simulated results are favourable and nodes

are effectively arranged as a colony that consumes less power to avoid sleep deprivation attack. Our future work enhances the proposed model with quality of service for packet transmission with priority enabled approach.

5. References

1. Krishnan MBM, Balachander T, Rajasekar P. Agent based trust estimation for mobile ad hoc network. Indian Journal of Science and Technology. 2015 May; 8(S9):223–7.
2. Kim D, Garcia-Luna-Aceves JJ, Obraczka K, Cano JC. Power-aware routing based on the energy drain rate for mobile ad hoc networks. Proceedings of IEEE; 2002 Oct. p. 565–9.
3. Priyadsrini S, Navamani TM, Mahadevan V. An efficient route discovery in MANET'S with improved route lifetime. International Journal of Information and Electronics Engineering. 2012 Jull 2(4):1–4.
4. Denko MK. Detection and prevention of DOS attack in MANET using reputation based incentive scheme. Proceedings of Systemics, cybernetic and informatics. 2010; 3(4):1–9.
5. Madhurikkha S, Sabitha R. An efficient credence based scheme to fight against packet dropping attack in mobile ad hoc network. Proceedings of International Journal of Applied Engineering Research. 2015; 10(8):6224–8.
6. Abdelhaq M, Alsaqour R. The impact of resource consumption attack on mobile ad hoc network routing. International Journal of Network Security. 2014 Sep; 16(5):376–81.
7. Zhu J. On the power efficiency and optimal transmission range of wireless sensor nodes. IEEE International Conference on Electro/Information Technology, EIT; 2009 Jun. p. 277–81.
8. Rout S, Turuk AK, Sahoo B. Energy aware routing protocol in MANET using power efficient topology control method. Proceedings of International Journal of Computer Applications. 2012Apr; 43(5):33–42.
9. Bhattasali T, Chaki R, Sanyal S. Sleep deprivation attack detection in wireless sensor network. Proceedings of International Journal of Computer Applications. 2012 Feb; 40(15):1–7.
10. Zhao Q, Nakamoto Y. Energy-efficient sensor and task scheduling for extending battery life in a sensor node. Proceedings of IEEE International Conference on Cyber-Physical Systems, Networks and Applications; 2013 Aug. p. 96–100.
11. Sarkar M, Roy DB. Prevention of sleep deprivation attacks using clustering. 2011 3rd International Conference on Electronics Computer Technology (ICECT); 2011 Apr. p. 391–4.