ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

A Power Efficient Network Layer Routing Protocol Using Cross Layer Design with Ant Colony Optimization

Priyabrata Nayak[1], Malla Reddy Meka[2], Akshay Prasad Satapathy[1]
[1]Assistant Professor,[2]Associate Professor,[1,2]Dept. of CSE

[1,2]Gandhi Institute for Technology, Bhubaneshwar, India

Abstract

In military applications mobile ad-hoc network plays very important role because it is specifically designed network for on demand requirement and in situations where set up of physical network is not possible. This special type of network which takes control in infrastructure less communication handles serious challenges tactfully such as highly robust and dynamic military workstations, devices and smaller sub-networks in the battlefield. Therefore, there is a high demand of designing efficient routing protocols ensuring security and reliability for successful transmission of highly sensitive and confidential military information in defence networks. With this objective, a power efficient network layer routing protocol in the network for military application is designed and simulated using a new cross layer approach of design to increase reliability and network lifetime up. But here PDO-AODV approach does not support to optimal path selection. So, we propose a new ACO-DAEE (Ant colony optimization with delay aware energy efficient) for optimal path selection and mitigating the delay time in network system. The main goal is to maintain the optimal routes in network, during data transmission in an efficient manner. Our simulation results indicate that ACO-ADEE performs extremely well in terms of packet delivery ratio, end to end delay, and throughput. Simulation results through NS2 software to verify the effectiveness of our method.

Keywords: Mobile Ad-Hoc Network, Cross layer design, ant colony optimization

1. Introduction

The gigantic technological rejuvenation of wireless communiqué [1] has been emerged in the system of mobile ad hoc networks (MANETs) in current decade. MANETs are excellent networking structure that is based with no settled framework. Because of the highly dynamic, extremely mobile and self-configurable nature of its autonomous nodes, performance of this network is outstanding in terms of transmission, throughput and reliability.Mobile ad hoc networks [1] have very important application and operations in battle fields and in disaster situations such as deployment of networks, high security measures in the network, any end to end transmission, mobile connectivity without failure, anti jamming mechanism, etc. All network activity must be done spontaneously without any link failure even in microsecond level. The soldiers during online battle should be able to remain continuously connected with each other to get any latest information, or command from their chief or to discuss before any action. Sometimes penetration of the satellite signals is not desirable to caves or dense forest or under sea places where it is again challenging to sustain connectivity.Many research works have focused on the security of MANETs. Most of them deal with prevention and detection approaches to combat individual misbehaving nodes. In this regard, the effectiveness of these approaches becomes weak when multiple malicious nodes collude together to initiate a collaborative attack, which may result to more devastating damages to the network.

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

2. Related Work

In previous works [2], power delay optimized AODV protocol is a routing engine that is the controller of all functions in the mobile workstation. Sequentially it performs three important tasks during static or mobile position of a node and after a packet arrives to a node such as the channel sensing, the mini database handling module and the intelligent decision taking sub module. In the first sub module of channel sensing, status messages are transmitted periodically with formal interruption of time by the node to broadcast presence of that node in the channel. In the next sub module, a small database is maintained to reserve and recall routing information's regarding a path, which can be referred next time data transmission takes place between same sender and receiver. A threshold value is calculated procedure to select the next hop station as per the algorithm as given below, which will be used in the routing decision module to finally select a suitable station. We existed a cross layer mechanism between the data link layer and the system layer by introducing a friendly packet between the two layers. To reduce the overhead of route finding in terms of delay and power consumption we suggest that this friendly packet provides necessary information from the data-access link layer to its upper network layer. Developed an improved channel access technique at the MAC layer make it compatible to work with PDO-AODV.

3. Proposed Framework

In this section, we present our model, **ACOB**ased **E**fficient **R**outing protocol for MANET with **D**istance, **E**nergy, and **L**ink quality.The model is shown in figure 1 which consists of three main components -Trust Model, Optimal Forwarder Selection Function and Improved Pheromone Update Model.

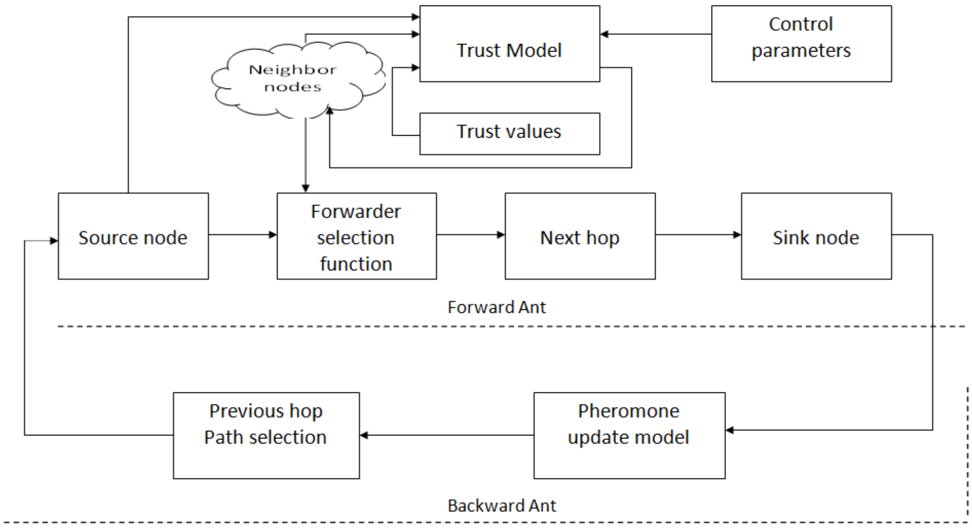

Figure 1. ACO based efficient routing framework

3.1. Trust model

In Trust Model, nodes rate each other by using the information of their own direct interactions with their neighbors. This is termed in the literature as First-Hand Information (FHI). To make the rating unbiased, the nodes also collect their neighbors' interactions with that node being rated considered as indirect interaction. This rating information collected from the neighbors is also known as Secondhand Information (SHI). The simulation period is now divided into 'n' slots where each slot consists of two sub-periods -Forwarding and Monitoring Interval, TFMI followed by Update Interval TUPI.

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

3.2. Forwarder selection function

Forwarder Selection Function is a probability function that is used at every node along the path from source to sink node in the network to select the best next neighbor to forward the packet to the sink node. The Forwarder Selection Function must always choose an optimal path from source to the sink to forward the packets with the sole objective to improve the Network Lifetime by balancing the energy among the nodes in the network to ensure that some nodes along the path do not get depleted fast and at the same time selecting good quality links along the path to guarantee that node energy is not wasted due to too frequent retransmissions.

With these objectives in mind, we have used the Forwarder Selection Function, FSF, a probability function to select the best forwarder node among the neighboring nodes of the current node, which is based on Pheromone Trail (PT) and heuristic function involving two parts representing Node Energy level (EN) and node link quality (LP) functions. Pheromone Trail (PT) represents the concentration of pheromone deposited on the path between the nodes considering Energy, distance and link quality along the path (containing the link between current and neighboring nodes) from source to destination. In other words, higher PT represents the better good quality path from source node to the destination in terms of energy, distance and link quality. Node Energy (EN) function represents energy level of the neighbor node and Link quality (LP) function represents the quality of the link between the current node and the neighbor node under consideration.

The Forwarder Selection Function is a probability function which must always choose an optimal path from source to the sink to forward the packets with multiple objectives:

- To provide a secure trustworthy path from source to sink by avoiding insider attacks,
- To improve the Network Lifetime by balancing the energy among the nodes in the network to ensure that some nodes along the path do not get depleted fast (resulting in Network disconnections or partitioning)
- At the same time selecting good quality links along the path to guarantee that node energy is not wasted due to too frequent retransmissions.
- Further, selection of shorter paths involving less number of nodes resulting in further saving of energy due to less number of nodes participating in packet forwarding.

Forwarder Selection Function, FSF (n_i,n_j) to select the best forwarder node n_j among the neighboring nodes of the current node n_i can be defined as

FSF (n_i, n_j) =

$$\begin{Bmatrix} \dfrac{[PT(n_i,n_j)]^{\alpha}[EN(n_j)]^{\beta}[LP(n_i,n_j)]^{\gamma}[TR(n_i,n_j)]^{\delta}}{\sum n_j \in NBS(n_i)[PT(n_i,n_j)]^{\alpha}[EN(n_j)]^{\beta}[LP(n_i,n_j)]^{\gamma}[TR(n_i,n_j)]^{\delta}} & if\ n_j \in NBS(n_i) \\ 0 & otherwise \end{Bmatrix} \quad (1)$$

Where NBS (n_i) represents the set of neighboring nodes ofn_i, PT (n_i,n_j) represents the concentration of pheromone deposited onthe path between the nodes n_i andn_j, EN (n_j) represents the energy level of the neighbor noden_i. TR (n_i,n_i) represents the Trust rating of the neighbor node n_j as given by noden_i.

LP (n_i,n_j) represents the quality of the link between nodes n_i andn_j, i.e., link probability. The Expected Transmission Count, ETX is a measurement of the transmission link which is calculated based on the past events occurred on that link.

Then the link probability LP (n_i,n_j) between nodes n_i and n_j is given by the expression:

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

$$\text{LP}\ (n_i,n_j) = \frac{1}{\text{ETX}\ (n_i,n_j)} \quad (2)$$

α, β, γ, δ are the parameters to control the significance or importance of pheromone trail of the path, node energy level, link quality between nodes and node trust rating.

When α= β =γ = δ =1, all four parameters PT, EN, LP, TR are given equal importance in the selection of the forwarder node. If one is interested in giving higher importance to TR, node trust rating, then one could make α=β =γ =2,δ =1, similarly α=2, β =1,γ =δ =2 to raise importance of EN, Node Energy Level, α=2, β =δ=2,γ =1 to make importance of link quality more significant in the selection of forwarder node.

Let EI (n_j) be the initial energy of node n_j and ER (n_j) be the Remaining (Actual) Energy of noden_j, then the Node Energy level, EN (n_j) is defined as

$$EN(n_j) = \frac{ER(n_j)}{EI(n_j} \ Where\ ER(n_j) > E_{th} \quad (3)$$

3.3. Pheromone Model

It has been observed that the amount of pheromone computed to be placed on the path during return journey is not proper to reflect that path as the optimal during the simulation period. Strongest path should have largest amount of pheromone whereas weakest path should have least amount of pheromone or almost zero. Among the competing stronger paths for selection, the variations in pheromone concentration should be such that always strongest path is selected. Keeping these in mind, pheromone update model has been designed considering the parameters the forward ant has collected during its travel from source to the destination. Once the forward ant reaches the destination, the following parameters collected by the forward ant are analyzed.

4. Result and Discussion

Our experiments are conducted using the NS-2.34 simulator. We conduct the experiments in two steps. The initial step is to check the viability of our plan, and then deeper study is investigation is done to assess the delay and throughput in more detail. In the first step, there are 40 mobile nodes in the network, and communication starts from source to destination. Here hop to hop communication occurs and we can calculate the distance based on position of an individual node. The individual communication between user to user, numbers of data flows measured. Here we can know the transmission rate of every node based on pheromone values. In our work, we can maintain power and delay for individual nodes and finding the optimal path for selection of a routing.The connections among mobile nodes are UDP connections, and we send CBR (Constant Bit Rate) traffic in each communication channel. The CBR rate of the connections is 512Kb/s. The size of the scenario field is 1500m x 1500m. The routing protocol we use is a revised AODV routing protocol that integrates our ACO-DAEE, PDO-AODV methods.

Table II. Simulation parameters

PARAMETER	VALUE
Application traffic	CBR
Transmission rate	5 packets/sec
Radio range	250m
Packet size	1000 bytes
Channel data rate	2Mbps

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

Maximum speed	20m/s
Simulation time	10secs
Number of nodes	40
Area	1500x1500
Routing protocol	AODV
Routing methods	PDO-AODV, ACO-DAEE

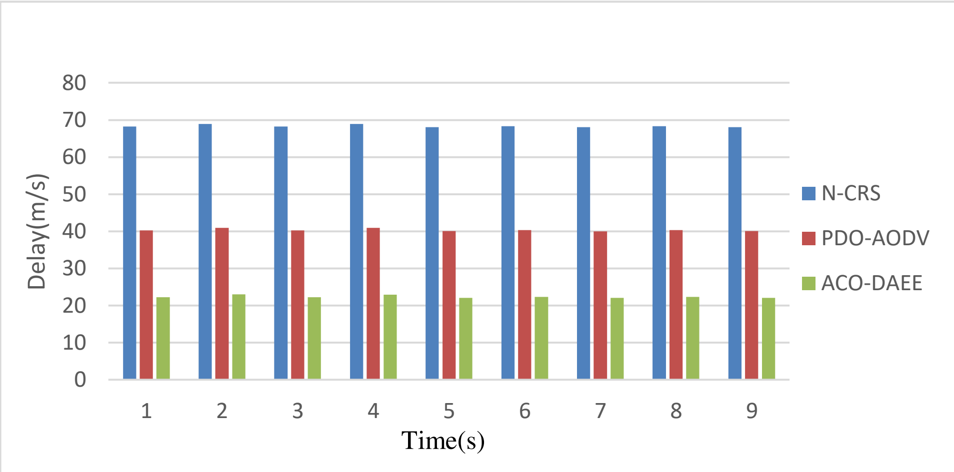

Figure 2.Network Routing delay

The above graph representsthe delay time in network, and it depends on time to vary the output. It depends on number of packets travelling and delivered as per process. Here each packet travelling time based on that delay time measured. The performance of the ACO-DAEE decrease the delay time in network compare to PDO-AODV method and Cross Layer Power Control method.

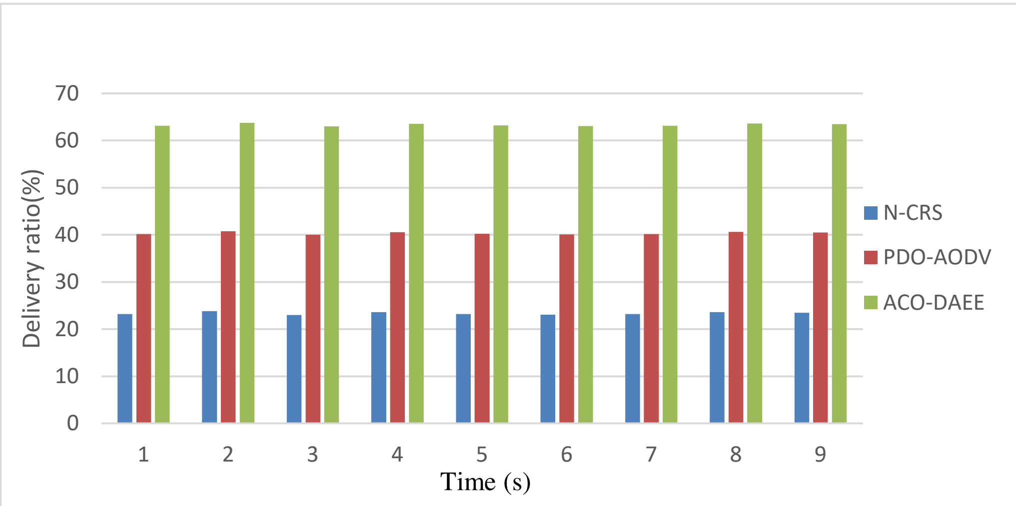

Figure 3.Packet delivery ratio

Figure 3 represents packet delivery ratio performance, whichdepends on time to vary the output also depends on number of packets travelling and delivered as per process. The performance of the ACO-DAEE improves the delivery ratio compare to PDO-AODV method and Cross Layer Power Control method.

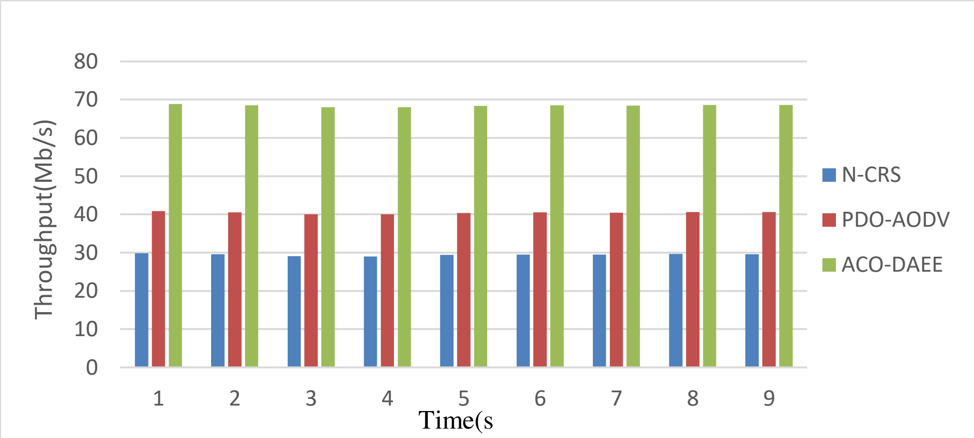

Figure4. Network performance

Performance of throughput is demonstrated in Figure 4, where it depends on time to vary the output. The performance of the ACO-DAEE improves the throughput compare to PDO-AODV with DDOS attack algorithm and Cross Layer Power Control method.

5. Conclusion

This article inspected the issue of power efficiency, node selection and unfair load balancing for mobile ad-hoc networks using an interaction based cross layer mechanism. They focused on optimizing link cost based on power and delay metric to mitigate this severe issue restoring precious network resources. In addition to this we have used a friendship-based handshaking utility as a cross layer approach between data link layer and network layer to accelerate the routing layer process. Here collection of data and delay on routing more so we proposed ACO (ant colony optimization) with delay aware energy efficient method. This protocol solves the resource constraint problem of ad-hoc network and the simulation study shows that it shows better performance than other leading MANET protocols based on similar cross layer approach. We also conducted simulation by using NS2 and exploratory outcomes demonstrate that our ACO-DAEE is practical for the discriminate delay aware nodes and improve the performance ratio in network.

References

[1] Mamata Rath, Binod Kumar Pattanayak and Bidudhendu Pati, - Energy efficient MANET Protocol using Cross Layer Design for Military Applications -, vol.66, no.2, March 2016, pp.146-150.

[2] Mamata Rath, Binod Kumar, Pattanayak and Bibudhendu Pati, - Energy efficient MANET Protocol Using Cross Layer Design for Military Applications -, Vol.66.2, March 2016, pp.146-150, DOI:10.14429/dsj.66.9705.

[3] Agbaria, A.; Gershinsky, G.; Naaman N. & Shagin, K. Extrapolation-based and QoS-aware real-time communication in wireless mobile ad hoc networks. *In* the 8th IFIP Annual Mediterranean Adhoc Networking Workshop, Med-Hoc-Net 2009. pp.21-26. doi: 10.1109/MEDHOCNET.2009.5205201

[4] Siva, K. & P. Duraiswamy, K. A QoS routing protocol for mobile ad hoc networks based on the load distribution. *In* the IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), 2010, pp.1-6. doi: 10.1109/ICCIC.2010.5705724

[5] Srivastava, S.; Daniel, A.K.; Singh, R. & Saini, J.P. Energyefficient position based routing protocol for mobile ad hoc Networks. *In* the IEEE International Conference on Radar Communication and Computing (ICRCC), 2012, pp.18- 23. doi: 10.1109/ICRCC.2012.6450540.

[6] Ahmed, M.; Elmoniem, Abd; Ibrahim, Hosny M.; Mohamed, Marghny H. & Hedar, Abdel Rahman. Ant colony and load balancing optimizations for AODV routing protocol. *Int. J. Sensor Networks Data Commun.*, 2012, 1. doi: doi:10.4303/ijsndc/X110203