ACO-Delay aware Energy Efficient MANET Protocol using Cross Layer Design for Real Time Applications

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Abstract

Due to the specified designed network on behalf of the on-demand necessities in addition to the various circumstances in which establishing the physical network is impossible, a significant role is played by the mobile ad-hoc network (MANET) in the military applications. The severe issues like extremely strong as well as dynamic military workstations, devices in addition to insignificant sub-networks within the battlefield are handled by the various kinds of the network that is controlled within the infrastructure less communication. In order to transmit the extremely sensible as well as secured military data within the defense networks, a higher demand of efficient routing protocol design that ensures the safety as well as reliability. The designing and the simulation of the power efficient network layer routing protocol within the network on behalf of the military applications is done by this aim in addition to a novel cross layer method for widely increasing the accuracy as well as lifetime of the network. The selection of the optimal path is not supported by the PDO-AODV approach. Therefore, a novel ACO-DAEE (Ant colony optimization with delay aware energy efficient) is proposed in order to select the optimal path and to mitigate the network system's delay time. Maintaining the optimal path within the network in the duration of transmitting the data effectively is the objective of this method. With respect to packet delivery ratio, end to end delay, and throughput, the performance of the ACO-ADEE is effective as shown in the simulation outcomes. The efficiency of this approach is verified by using NS2 through the simulation outcomes.

Keywords: *Mobile ad-hoc network, Power efficient network layer routing protocol, Ant colony optimization with delay aware energy efficient, power and delay optimized AODV.*

I. Introduction

Currently, the gigantic technological rejuvenation of wireless communique [1] was developed into a system of MANETs. Depending upon the unsettled framework, the networking structure of MANETs are perfect. With respect to transmission, throughput as well as reliability [2], the efficiency of this network is excellent due to the extremely dynamic, very mobile as well as self-configurable behavior of the autonomous nodes. Within the battle fields as well as within the disastrous circumstances like network deployment, higher security within the network, end to end transmission, mobile connectivity excluding the failure, anti-jamming mechanism and so on, various significant applications are included within MANETs [3-4]. Excluding the link failure although in the microsecond level, the entire network activities need to be performed. For obtaining the modern data or the commands out of the chief or for discussing earlier to certain situations, a continuous connection must be established between the soldiers in the duration of line battle [5]. In some cases, penetrating the satellite signals for the caves or dense forest or under sea is undesirable as sustaining the connection is a difficult issue. The MANET's security is concentrated by various investigation works. For combating the respective nodes that are misbehaving, the preventing as well as detecting methods are dealt mostly [6]. Accordingly, during the collision of various malicious nodes with initiating a collaborative attack that results in additional devastating compensations for the network, the efficiency of the presented methods turns to be vulnerable.

II. Related work

A routing engine which the entire operations within the mobile workstation are controlled is referred as a power delay optimized AODV protocol in the earlier papers [7]. Within the duration of the static or mobile position of a node, the significant tasks are performed by 3 significant operations and later a packet arrives near a node like channel sensing, the mini database handling module in addition to the intelligent decision-making sub module. For broadcasting the existence of channel node, the transmission of the status messages using the regular time interruption with the help of a node is done in the initial sub module of channel sensing [8-9]. The maintenance of a small database within the succeeding sub module is done for reserving and recalling the routing data about a specific path wherein the transmission of the data is referred later amid the similar sender and the receiver. For the selection of the additional hop station according to the procedure as presented, the calculation of threshold value is done where the routing decision module is utilized for selecting an appropriate station in conclusion [10-11]. With the introduction of a good-natured packet amid 2 layers, a cross layer approach among the data link layer in addition to the system layer is existing. With respect to the delay and power consumption, the friendly packet in which the required data out of the data-access link layer towards the upper network layer is provided for reducing the route discovery overhead [12]. An enhanced channel accessing method adjacent to the MAC layer is made consistent towards the PDO-AODV is developed.

III. Proposed framework

Using the Distance, Energy, as well as Link quality, ACO Based Efficient Routing protocol is presented on behalf of MANET in this paper. Trust Model, Optimal Forwarder Selection Function as well as Enhanced Pheromone Update Model are included in figure 1.

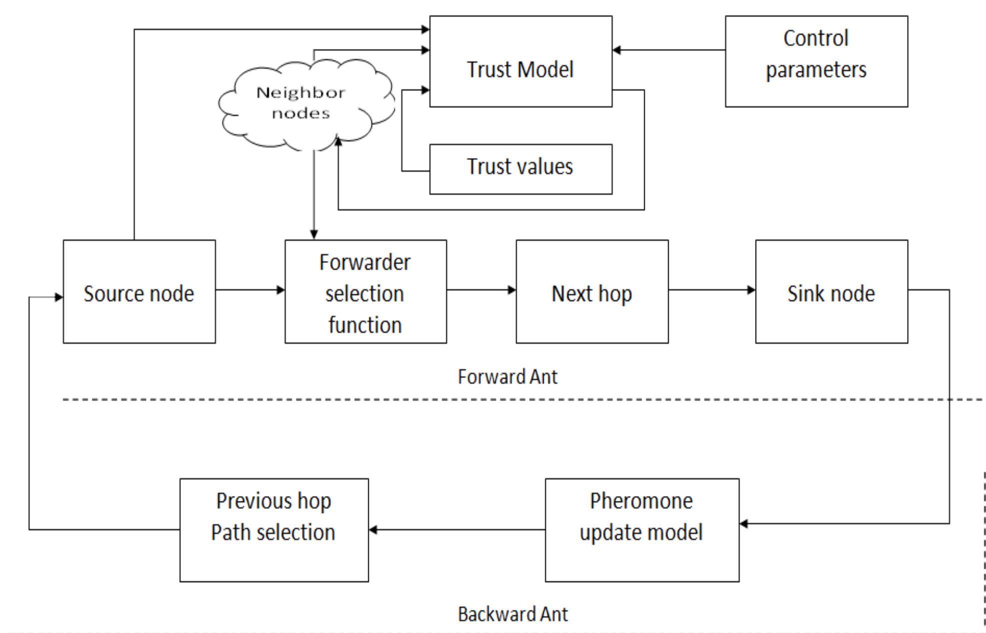

Figure 1: ACO based efficient routing framework.

A. Trust model

With the help of the respective data from the direct interactions with their neighbors, all the nodes are rated by another nodes in Trust Model and Firsthand Information (FHI) is the label given to it in literature. The communication between the neighboring nodes that are assumed as indirect are collected for making the rating as unbiased. Secondhand Information (SHI) is referred as the rating data which is collected out of the neighboring nodes. A number of 'n' slots are obtained by dividing the simulation time in which 2 sub-periods such as Forwarding as well as Monitoring Interval, TFMI followed by Update Interval TUPI are included as presented in Table 1.

Table 1: Simulation period slots.

[1] **Initialization** [2] **Phase**	[3] T_{FMI}	[4] T_{UPI}	[5] T_{FMI}	[6] T_{UPI}	[7] …	[8] T_{FMI}	[9] T_{UPI}	[10] ..	[11] T_{FMI}	[12] T_{UPI}

B. Forwarder selection function

A probability function which is utilized by each node in its path from the source node to the sink node within the network for selecting the optimum adjacent neighbor for sending the packet towards the sink node is referred as Forwarder Selection Function. The Network Lifetime is enhanced by selecting optimal path from the source towards the sink for forwarding the packets by the Forwarder Selection Function. As a result of the repeated retransmission, the limited wastage of the energy is guaranteed by ensuring certain nodes through the path that is not depleted rapidly and selection of links with superior quality with the balancing of the energy amongst the nodes within the network.

A probability function for the selection of optimum sending node within the neighboring nodes of the current node that is depending upon the Pheromone Trail (PT) as well as heuristic function that involves 2 parts such as Node Energy level (EN) and node link quality (LP) functions is referred as Forwarder Selection Function, FSF that is implemented here. The pheromone concentration which is deposited upon the path amid the nodes that considers Energy, distance, and link quality along the path (containing the link between current and neighboring nodes) from source to destination is referred as Pheromone Trail (PT). Specifically, with respect to energy, distance and link quality, the enhanced quality path from the source to destination is represented by high PT. The neighbor node's energy level is represented by the Node Energy (EN) function and the link quality amid the current node and the neighbor node are represented by the Link quality (LP) at issue.

A probability function wherein an optimum path should be selected from the source to sink for the packet forwarding using various aims is referred as Forwarder Selection Function.

- In order to offer a safe reliable path from the source to the destination with the avoidance of the insider attacks.
- With the intention of improving the network lifetime with the balancing the energy within the nodes of the network for ensuring that certain nodes don't deplete rapidly and it results in disconnection and partitioning of the network.
- For guaranteeing the limited wastage of energy because of the regular retransmissions while choosing the links with improved quality.

- Moreover, additional energy is saved by selecting the insignificant paths that involves reduced number of nodes since reduced number of nodes are involved in forwarding the packet.

The finest forwarder node n_j is selected from the neighboring nodes of the current node n_i by the Forwarder Selection Function, FSF (n_i, n_j) and it is represented in the equation below.

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

Where, the set of neighboring nodes of n_i is represented by NBS (n_i), the pheromone concentration deposited upon a path amid the nodes n_i and n_j is represented by PT (n_i,n_j), the energy level of the neighbor node n_i is EN (n_j), the Trust rating of the neighbor node n_j as presented by node n_i is represented using TR (n_i,n_i).

The link quality between nodes n_i and n_j, i.e., link probability is represented by LP (n_i, n_j). A measurement of transmission link that is computed depending upon the previous events that occurred upon the link is referred as Expected Transmission Count, ETX. Then the link probability LP (n_i,n_j) amid nodes n_i & n_j is presented using the below expression:

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

The influence of the pheromone trail of the path, node energy level, link quality between nodes and node trust rating is controlled by the parameters namely α, β, γ, δ.

When α= β =γ = δ =1, the entire 4 parameters PT, EN, LP, TR are provided with similar significance while selecting a forwarder node.

One could make α=β =γ =2, δ =1, whenever one is attentive in providing superior significance to TR, node trust rating. In the same way, α=2, β =1, γ =δ =2 for raising the significance of EN, Node Energy Level, α=2, β =δ=2, γ =1 for making the significance of link quality more essential within the forwarder node selection.

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

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

C. Pheromone Model

Within the duration of the returning journey is incorrect for reflecting which path by means of the optimal in the simulation time was detected by the quantity of the pheromone that must be located upon the path. Increased number of pheromones must be included in the stronger path in which less number or no pheromone must be present in the weaker path. The selection of the stronger path is done every time due to the differences within the pheromone concentration amongst the challenging stronger paths in the selection.

The forward ant parameters were combined together in the duration of the journey from source to destination with the consideration of the design of pheromone update model. Analyzing the parameters given below is combined whenever the destination is reached by the forward ant.

IV. Result and discussion

NS-2.34 simulator is used for conducting the experiments in 2 stages. Verifying the feasibility of this approach is the primary stage and investigating is the depth study for assessing the delay and throughput in depth. 40 mobile nodes are present within the network which is the initial stage, and the communication is started from the source towards the destination. The communication between the hops is occurred by calculating the distance depending upon the individual node's position. The measurement of the respective communication amid the users and the number of the information flows is done. Depending upon the standards of pheromone, the transmission rate of individual node can be known in this method. The power and the delay on behalf of the respective nodes is maintained in this method and the optimum path is found in order to select a routing path. UDP connections are the connections between the mobile nodes and CBR (Constant Bit Rate) traffic within respective communication is forwarded. 512Kb/s of CBR rate is used for the connection. 1500m x 1500m size of scenario field is used. Revised AODV routing protocol is used in this routing protocol in which ACO-DAEE, PDO-AODV approaches are integrated.

Table 2: Simulation parameters for network process.

PARAMETER	**VALUE**
Application traffic	CBR
Transmission rate	5 packets/sec
Radio range	250m
Packet size	1000 bytes
Channel data rate	2Mbps
Maximum speed	20m/s
Simulation time	10secs
Number of nodes	40
Area	1500x1500
Routing protocol	AODV
Routing methods	PDO-AODV, ACO-DAEE

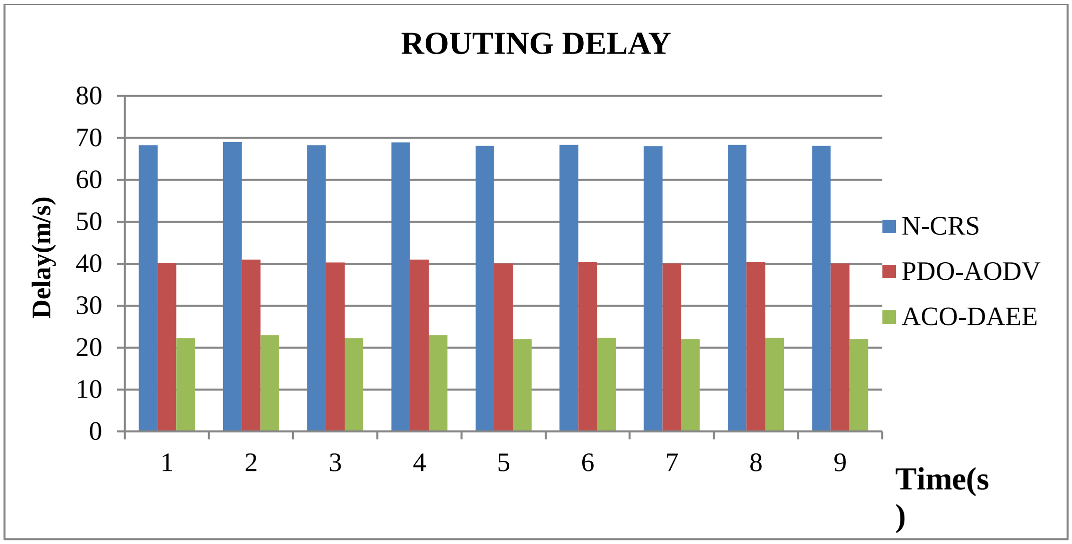

Figure 2: Network delay.

The delay time in network is presented in the above graph and it is depended upon the time to vary for varying the output. The number of the packets that travels and delivers depending upon the procedure is presented in this method. Depending upon the measured delay time, the respective packet is travelled. The delay within the network is reduced by the ACO-DAEE performance than the Power and Delay Optimized-AODV approach as well as Cross Layer Power Control approach.

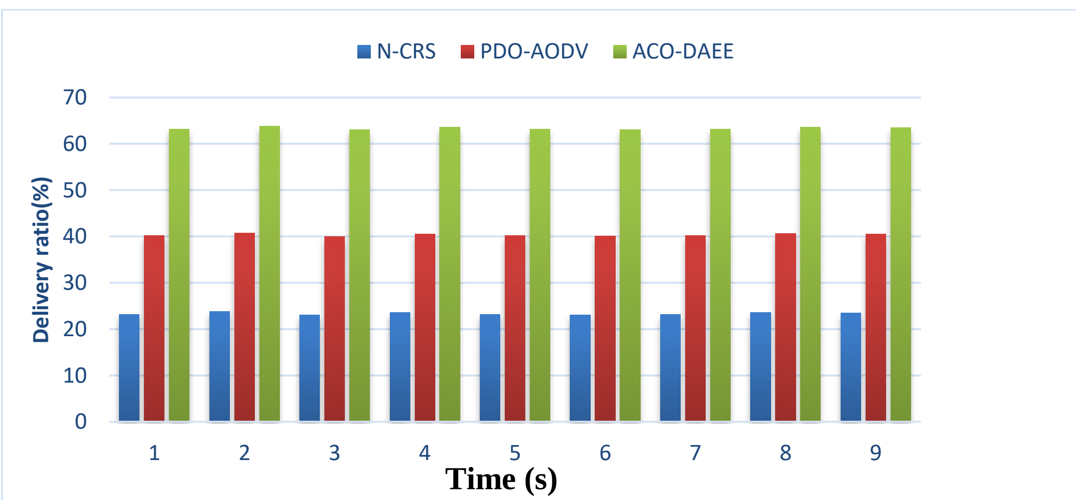

Figure 3: Packet delivery ratio.

The packet delivery ratio is presented in the figure above and it depends upon the on time to vary the output. The number of packets that travels and delivers are considered here. The delivery ratio is improved by the ACO-DAEE performance than the Cross Layer Power Control approach as well as Power and Delay Optimized-AODV approach.

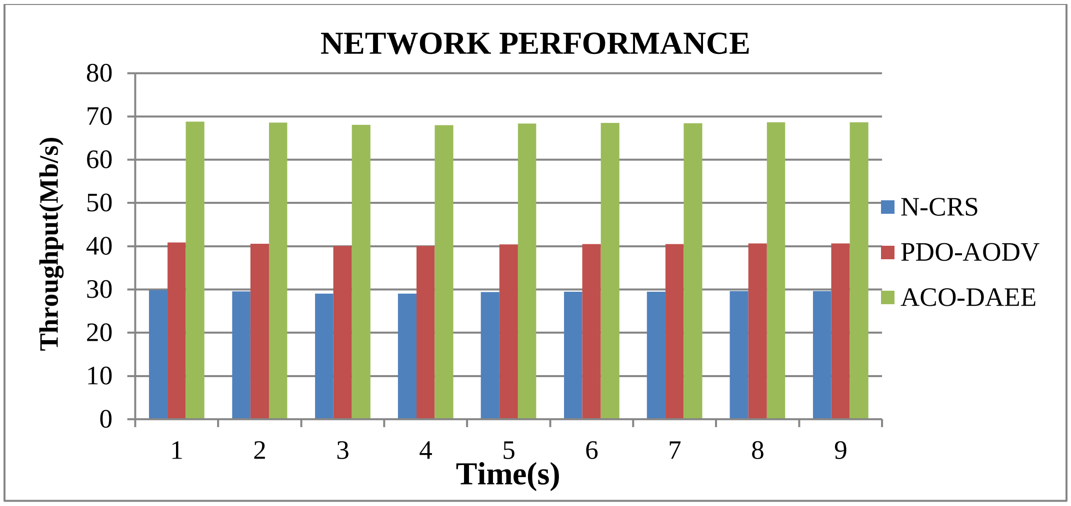

Figure 4: Network performance.

Throughput is presented in the above graph and is based upon the time to vary the output. Compared to the Power and Delay Optimized-AODV using DDOS attack procedure as well as Cross Layer Power Control approach, the throughput is improved by the ACO-DAEE performance.

V. Conclusion

The problems of power efficiency, selection of nodes in addition to the improper load balancing on behalf of MANETs is studied by the authors with the help of communication based cross layer approach in this method. Depending upon the power and delay parameters, the optimizing link cost is concentrated by them for mitigating the serious issues that restores the resources of the precious networks. A friendly handshaking application is implemented additionally by means of a cross layer mechanism amid the data link layer and network layer for accelerating the procedure of the routing layer. The ACO (ant colony optimization) is presented by collecting the information and routing delay using the approach which is delay aware energy efficient. The issue of the resource limitation of the ad-hoc network is solved greatly in this paper and compared to the additional leading MANET protocols depending upon the comparable cross layer method, improved performance is exhibited by the simulation study. NS2 is used for conducting the simulation and ACO-DAEE remains realistic on behalf of the discriminate delay aware nodes as shown in the examining results and the ratio in network performance is improved.

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