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Energy Efficient DSR Protocol Using ACO

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Abstract- DSR protocol is used to find the available routes to send the packets. But it does not always give the best path. Due to this limitation, a new version of DSR protocol is needed. To do so, ACO is combined with DSR protocol. The main objective is to find the optimize path to send the packets. It also increase the lifetime of network. This is achieved by balancing the residual energy of all nodes in network. No of Dead nodes will be calculated in DSR as well as in DSR-ACO. Simulation results are obtained in terms of metric- network lifetime. It is observed that the DSR-ACO gives better result than DSR.

Keywords- DSR, DSR-ACO, Mobile ad-hoc networks, Ant colony optimization, Quality of service, Energy efficient routing

I. INTRODUCTION

Wireless mobile Ad hoc network mobile nodes communicate each other without any infrastructure. MANET is a self-configuring network which is organized several movable user equipment. In recent years MANET has a great impact on wireless networks, there are no basic network work devices, such as routers or access points to transfer data among nodes. Instead each node acts as a router to establish a route and transfer data by means of multiple hops.

The performance of an ad hoc wireless network is dependent on which routing algorithm (protocol) it employed. However since the mobile nodes in an ad hoc network need to relay their packets through the other mobile nodes toward the intended destinations, a decrease in the number of participating mobile nodes may lead to the network disconnected, thereby hurting the performance of the network.

The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. Network nodes cooperate to forward packets for each other to allow communication over multiple "hops" between nodes not directly within wireless transmission range of one another. As nodes in the network move about or join or leave the network, and as wireless transmission conditions such as sources of interference change, all routing is automatically determined and maintained by the DSR routing protocol. Since the number or sequence of intermediate hops needed to reach any destination may change at any time, the resulting network topology may be quite rich and rapidly changing. In designing DSR, we sought to create a routing protocol that had very low overhead yet been able to react very quickly to changes in the network. The DSR protocol provides highly reactive service in order to help ensure successful delivery of data packets in spite of node movement or other changes in network conditions. The DSR protocol is based on source routing.

The DSR protocol is composed of two mechanisms: route discovery and route maintenance.

(i) Route discovery is the mechanism by which a source node discovers a route to a destination. When a source node has some packets to send to a destination, it will search its route cache to find a route to that destination. If it cannot find a route, it initiates a route discovery by sending a route request packet as a local broadcast packet. Each route request contains the source and the destination addresses, as well as unique route identification (ID). When a neighbouring node receives that route request message, it checks the unique route request ID to determine whether it has already processed that request. If the node determines that it has already processed that request, it simply drops that request message. Otherwise, it checks whether it is the intended destination. If the node is not the destination, it adds its own ID in the request packet and forwards that request packet to its neighbours. If a node is the destination, it sends a route reply to the source after copying the accumulated route from the route request packet into a route reply packet.

(ii) Route maintenance is the mechanism by which a node is able to detect any changes in the network topology. In the DSR protocol, each node is responsible for confirming that the packet flows over the link from itself to the next hop by using an acknowledgment. Such acknowledgment can be provided by the MAC layer protocol (i.e. IEEE 802.11). If the node does not receive an acknowledgment, it treats the link as 'broken'. It will send a route error message to the source and all other nodes which have used that link. After receiving the route error packet, a source node marks that route as 'invalid' in the route cache, and then it tries to find another alternative route in the cache. If it finds another route in its route cache, it will use that route; if not, it then initiates a new route discovery process.

The source of each packet determines an ordered list of nodes through which packet will travel to reach the destination.

The ACO meta-heuristic is based on generic problem representation and the definition of the ant's behavior. ACO adopts the foraging behavior of real ants. When multiple paths are available from nest to food, ants do random walk initially. During their trip to food as well as their return trip to nest, they lay a chemical substance called pheromone, which serves as a route mark that the ants have taken. Subsequently, the newer ants will take a path which has higher pheromone concentration and also will reinforce the path they have taken. As a result of this autocatalytic effect, the solution emerges rapidly. The main goal of making changes to the DSR protocols referred as DSRACO is to extend the performance component of DSR. It will introduce the Network lifetime.

II. LITERATURE SURVEY

[1] Giampaolo Bella, Gianpiero Costantino, Jon Crowcroft, Salvatore Riccobene introduces a power-aware route maintenance protocol for Mobile Ad Hoc Networks (MANETs) . Termed Dynamic Path Switching (DPS), the new protocol puts an overloaded node to sleep before a route link breaks because that node runs out of energy, and brings other suitable nodes into play instead. The new protocol has been extensively simulated with the established network simulator NS2. The findings indicate a much improved power awareness of the updated routing protocol with respect to the unadorned one. Power saving is particularly effective during long-lived sessions.

Conditions for going to sleep

A forwarding node shall go to a sleep state either if: 1) it has forwarded packets for a long time, or 2) its battery is finishing.

Node N shall go to a sleep state either if

$$\left(1-\frac{e_c(N)}{e_s(N)}\right) * 100 > \delta \quad \text{OR} \quad \frac{e_c(N)}{e(N)} * 100 < \gamma.$$

e(N) be N's total battery power (when fully charged);

$e_s(N)$ be N's battery level at the beginning of the forwarding session;

$e_c(N)$ be N's current battery level;

δ be the maximum percentage of $e_s(N)$ that can be spent in forwarding;

γ be the minimum percentage of e(N) that must be preserved.

In this paper they have set some values for δ and γ.

[2] S. Soundararajan, R. S. Bhuvaneswaran said that in mobile ad hoc networks, the on demand multi-path routing protocols addresses certain issues such as more message overheads, link failures and node's high mobility. More message overheads are caused due to increased flooding. Packets are dropped by intermediate nodes due to frequent link failures. Moreover the overall throughput and the packet delivery ratio is reduced in high mobility scenarios. In order to overcome the issues an efficient multi-path routing protocol ABMRLBCC (Ant Based Multi-path Routing for Load Balancing and Congestion Control) based on Ant Colony Optimization is proposed. The best path for each ant is selected based upon the number of hops and travel time.

Ant Based Multi-path Routing for Load Balancing and Congestion Control (ABMRLBCC)

Algorithm

1. The node n4 receives two BANTs. BANT (B) having ORP=1 and BANT(C) having ORP=0.
2. Initially, Node n4 don't have any other route entry to source S
3. If BANT(B) arrives first, Node n4 establishes forward path S-n4-n5-n6-D.

BANT(C) is discarded.

End if

4. Now, add CNN to BANT and calculate the number of common nodes.
5. CNN of BANT(C) is incremented by 1.
6. Choose BANT with smaller CNN
7. BANT (B) has ORP=1 and CNN=0, so the reverse path is omitted.
8. BANT(C) has ORP=0 and CNN=1.
9. Node *n*4 updates route entry on receiving BANT(C).
10. Forward path *S*-*n*10-*n*11-*n*12-*n*13-*D* and *S*-*n*1-*n*2-*n*3-*D* is also chosen.

[3] Morteza Maleki, Karthik Dantu, and Massoud Pedram said that Ad hoc wireless networks are power constrained since nodes operate with limited battery energy. To maximize the lifetime of these networks (defined by the condition that a fixed percentage of the nodes in the network "die out" due to lack of energy), network-related transactions through each mobile node must be controlled such that the power dissipation rates of all nodes are nearly the same. Assuming that all nodes start with a finite amount of battery capacity and that the energy dissipation per bit of data and control packet transmission or reception is known, this paper presents a new source-initiated (on-demand) routing protocol for mobile ad hoc networks that increases the network lifetime. Simulation results show that the proposed power-aware source routing protocol has a higher performance than other source initiated routing protocols in terms of the network lifetime.

Power aware source routing PSR presented in this paper solves the problem of finding a route $\prod$ at route discovery time t such that the following cost function is minimized:

$$C(\pi, t) = \sum_{i \in \pi} C_i(t)$$

$$\text{where} \quad C_i(t) = \rho_i \cdot \left(\frac{F_i}{R_i(t)} \right)^{\alpha}$$

ρ_i= Transmit power of node i.
F_i=Full charge battery capacity of node i.
R_i=Remaining battery capacity of node at time
α=A positive weighting factor
Unlike DSR not only the mobility of nodes makes the path invalid but also the energy depletion will result invalidation of path.
Now route maintenance is necessary as the route get invalid because of mobility of nodes and energy depletion. In case of mobility the RREQ packet is resent. In later case, each node monitors the decrease in energy level that result in increase in cost.
i.e. when **Ci (t) -Ci (t_0)>d**
t= current time, $t_{0=}$ route discovery time, d= threshold value.
In case the cost goes beyond threshold value the RERR message is sent to intermediate nodes.

[4] S. Chettibi and M. Benmohamed said that Energy consumption is the most challenging issue in routing protocol design. In this paper, they present multipath and energy-aware on demand source routing (MEA-DSR) protocol, which exploits route diversity and information about batteries-energy levels for balancing energy consumption between mobile nodes.
MEA-DSR algorithm proposed in this paper, limits the number of routes that a destination node provides to a source node to two. The choice of the primary route in thus algorithm is conditioned by two factors: 1) the residual energy of nodes belonging to the route; 2) the total transmission power required to transmit data on this route. Little modification is done in RREQ packet where a field called « *min_bat_lev*» has been added. It takes as value the minimum of residual energies of nodes traversed by the RREQ packet. In route discovery phase the source broadcast the RREQ packet, and acc to this algorithm only destination can respond to source node. In order to avoid overlapped route problem, intermediate nodes do not drop every duplicate RREQs and forward duplicate packets coming on a different link than the link from which the first RREQ is received, whose hop count is not larger than that of the first received RREQ. An intermediate node when receives the RREQ packet it adds its residual energy to «*min_bat_lev*» and append its identifier. After reception of first route the destination waits for time «*wait_time*». When period expires destination finds the primary route using:

$$\frac{min\_bat\_lev_i}{route\_length_i} = \max_{j=1,n}\left(\frac{min\_bat\_lev_j}{route\_length_j} \right)$$

According to this equation after finding primary route destination sends the RREP message to source. Route maintenance is done as if any node find the link breakage it send s the RERR message to next node to delete the corresponding path from cache. If the source node has no valid route in its cache, then it reinitiates a new route discovery phase.
[5] Gurpreet Singh, Neeraj Kumar, Anil Kumar Verma said that Mobile ad-hoc networks (MANETs) consist of special kind of wireless mobile nodes which form a temporary network without using any infrastructure or centralized administration. MANETs can be used in wide range of future applications as they have the capability to establish networks at anytime, anywhere without aid of any established infrastructure. It is a challenging task to find most efficient routing due to the changing topology and the dynamic behavior of the nodes in MANET. It has been found that ant colony optimization (ACO) algorithms can give better results as they are having characterization of Swarm Intelligence (SI) which is highly suitable for finding the adaptive routing for such type of volatile network. ACO algorithms are inspired by a foraging behavior of group of ants which are able to find optimal path based upon some defined metric which is evaluated during the motion of ants.

III. PROBLEM FORMULATION

Ad hoc networks are the autonomous systems consist of mobile nodes that communicate with each other using wireless communication. In ad hoc networks mobile devices are battery operated and the battery technology has not been improving rapidly. Therefore power consumption is likely to remain an issue in mobile wireless network routing.
The overall lifetime of the entire ad hoc network can be increased by improving the power consumption balance among nodes and the connection of the network. In most existing protocols, a mobile node may consume all its energy to participate in the operation without considering the remaining energy. In the proposed energy efficient DSR protocol each node will only use part of energy to transmit the data packets. This is done through a route discovery procedure. The new protocol uses a cost function to decide route selection instead of using the traditional shortest hop algorithm. The reason that DSR is used as our base model is mainly due to the fact that it is a typical on demand protocol with less bandwidth and energy use. Main objective of this dissertation is:

1. To propose a new route discovery algorithm that considers the remaining energy for each node and uses a cost function to choose the best power saving route.
2. To propose a new algorithm that provides a probabilistic multi-path routing algorithm and incorporates path pheromones scents which constantly update the goodness of choosing a particular path based on ant colony optimization.

We analyze Minimum Battery Cost Routing **(**MBCR) to develop Energy Efficient Power Aware Dynamic Source Routing based on DSR. If the specific host is always on the minimum total transmission power route, the battery power of this host will be deplete quickly. To overcome this node's residual power we can use cost metric in route selection. To do this, they need some optimization mechanism, so we use ant colony optimization technique i.e. (ACO).

IV**. Proposed Work**

This dissertation performs following task to implement DSR protocol with ACO (DSR-ACO):

- Enhancement of DSR protocol with ACO technique
- DSR with ACO is implemented and simulated DSR and DSR-ACO
- Compared the results of DSR protocols with and without ACO technique using NS2.

In each transmission, the node uses only parts of the power to participate in the operation and leaves the remaining parts to participate in the future operations. By this method, the nodes avoid using too much energy at one time and this can guarantee that the node with more power will be used to transmit the large size packets and the node with the less power will be used to transmit the small size packets.

As the remaining energy level of a node decreases, the link cost of the node increases. This forces new routing decisions in the network by invalidating its own cache entries to various destinations. However, if a path was recently added to the cache table, the node will not force a new decision (route finding step) unless the node's remaining energy is depleted by a certain normalized amount due to messages passing through that path.

The primary objective of DSR-ACO is to select the path for the specified source to destination in such a way that intermediate nodes have higher power. So idea is instead of following minimum hop count method during the route discovery phase, select those path using nodes energy level.

DSR-ACO Algorithm

1) Source Node initializes the data transmission request.
2) First it checks the route cache for the particular destination; if destination found it uses that path to send data else route discovery process is initiated.
3) At the time of route discovery, a route request (RREQ) packet broad casted by the source. The header of the RREQ packet includes <source_id, destination_id>,
4) Parameters on each node defined are Node Id, Battery Status B_S

Battery status is further divided into 3 categories:

If (Battery Status < 5%)
Then Set *B_S* = 1
If (5% <=Battery Status <95%)
Then Set *B_S* = 2
If (Battery Status >95%)
Then Set *B_S* = 3
Value of Battery status B_S is updated at each node according to it

5) Parameters to Concern during Route Search
T_B_S (Total Battery Status),W*Ns (number of weak nodes)* and *Node_ID*s.
Now according to Battery status B_S Total battery status T_B_S is calculated

If (B_Si == 3)
Then T_B_S = T_B_S + 3
Else-if (B_Si == 2)
Then T_B_S = T_B_S + 1
Else-if (B_Si == 1)
WN= WN + 1

Here WN represents a weak node which has the energy less than 20%.

6) After threshold time T destination node check out the paths and find the path with small number of week nodes.

7) Now the path taken out is the path with nodes having more energy but still there needs to make little changes as if Length of path chosen using DSR-PSR is greater than DSR then older path will be taken into action to save time for sending packets.

If (hopcount (path (DSR-PSR))>hopcount (path (DSR)))
Then
Use path (DSR)

V. **SIMULATION AND RESULT**

This section presents the simulation environment, metrics and the results of the proposed DSR-PSR routing protocol.

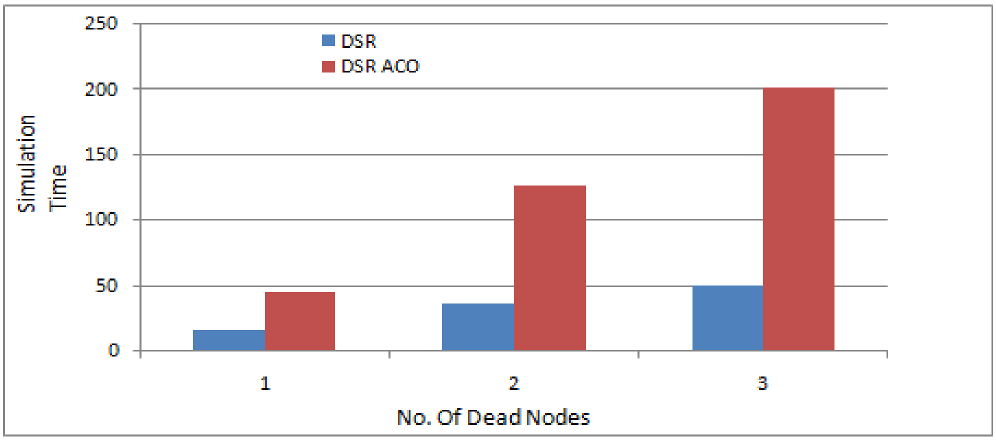
A. Simulation Environment The simulation results presented in this paper has been obtained using the *ns-2* simulator (version *ns-2.25*) on Ubuntu Linux version 11.04. The below table summarize the different configuration values that were used in all performed simulations of general Adhoc network. Simulations are run over a 1200m * 1200m square flat topology. The number of wireless mobile nodes is fixed to 50. Traffic sources are chosen as TCP-IP.

The simulation parameters which are used in my thesis work are shown below.

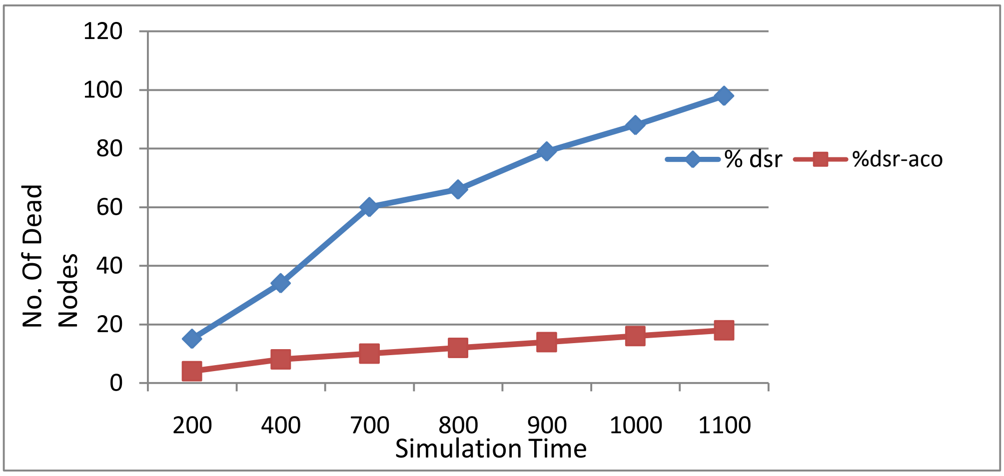
Parameter	**Value**
Simulation Time	1100 sec
No. of Nodes	50
Numbers of Channel	4
Queue Type	Drop Tail
Maximum X-coordinate value	1200 M
Maximum Y-Coordinate value	1200 M
Initial node power	2 J
Traffic Type	CBR(Constant Bit Rate)
MAC Protocol	802.11
Mobility Model	TwoRay Ground
Routing Protocol	DSR

B. Simulation Metrics :

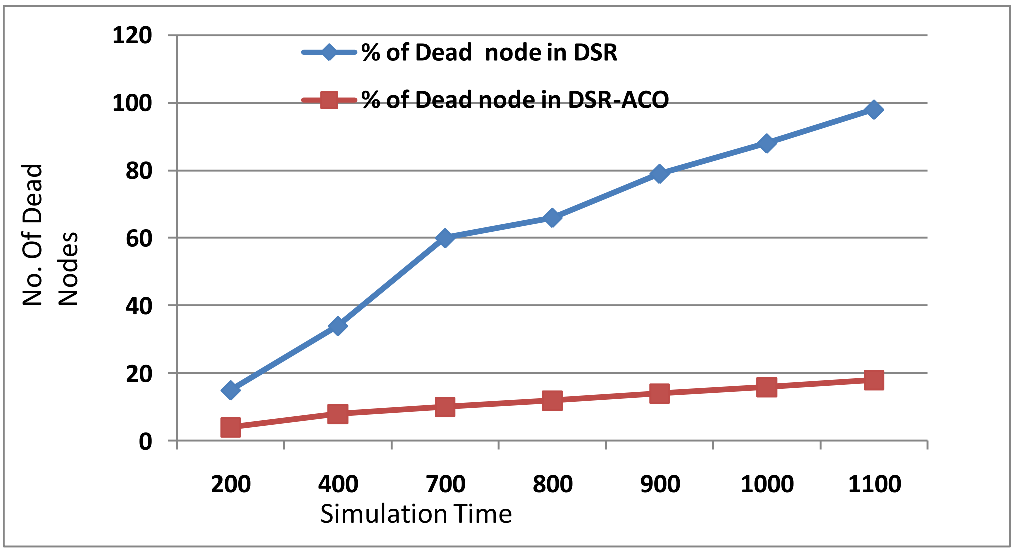
- **First dead node:** Below figure shows that on comparing DSR with new proposed DSR-ACO, simulation results shows that the simulation time of first dead node in DSR-ACO is larger than DSR.



- **All Dead Node:** Below figure shows that on comparing DSR with new proposed DSR-ACO, simulation results shows that the all dead node of DSR-ACO is less than DSR in a given simulation time.



- **Percentage of All Dead Node:**Comparing DSR with new proposed DSR-ACO simulation results shows that the percentages of all dead node of DSR-ACO is less than DSR in a given simulation time.



VI. CONCLUSION

A new DSR protocol is introduced i.e. DSR-ACO which helps in finding the available path to send the packet considering remaining energy of all nodes in network. The path may be longer than DSR but it will surely optimize the path to send the packets. It is observed that the DSR-ACO works better than DSR. It makes the network more energy efficient and also increases the lifetime of network. The throughput of DSR-ACO is also good.

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