Energy Optimised Routing Protocol for MANET

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Abstract: A mobile ad hoc network (MANET) is a wireless ad-hoc network consisting of mobile nodes. These kinds of networks are very flexible, they do not require any existing infrastructure or central administration. The biggest challenge in this kind of networks is to find a path between the source and destination. There are different routing protocol to find shortest path . Ant Colony Optimization Routing Algorithm (ACORA) is new emerging routing algorithm. In this paper a new routing algorithm ACORA for mobile, multi-hop ad-hoc networks discussed to improve the performance of the existing protocol of mobile ad hoc network. The protocol is based on swarm intelligence and especially on the ant colony based metaheuristic.

This paper is a comparison of new emerging routing algorithm i.e. Ant Colony Optimization Routing Algorithm (ACORA) with conventional routing approaches specially Ad-hoc on-demand distance vector routing (AODV) and Dynamic source routing (DSR) using the performance metric such as energy consumption.We analyses these routing protocols by extensive simulations in ns-2.34.

Keywords: *MANET, ACO, Pheromone, AODV, DSR.*

I. INTRODUCTION

MANET is infrastrucuure less nework consist of mobile node without central asministration. It's routing algorithm should not only be capable of finding the shortest path between the source and destination, but it should also be adaptive, in terms of the changing state of the nodes, the changing load conditions of the network and the changing state of the environment.

MANET routing algorithms can be classified into three categories as proactive, reactive or hybrid.

Proactive algorithms try to maintain up-to-date routes between all pairs of nodes in the network at all times. Examples of proactive algorithms are Destination-Sequence Distance-Vector routing (DSDV) and Optimized Link State Routing (OLSR).

Reactive algorithms only maintain routing information that is strictly necessary, they set up routes on demand when a new communication session is started, or when a running communication session falls without route. Examples of reactive routing algorithms include Dynamic Source Routing (DSR) and Adhoc On-demand Distance-Vector routing (AODV). Finally, hybrid algorithms use both proactive and reactive elements, trying to combine the best of both. An example is the Sharp Hybrid Adaptive Routing Protocol (SHARP).

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II. ROUTING

The routing protocols DSR, AODV are often used as reference protocols when a new protocol shall be evaluated. To understand the characteristics of these protocols they are described in the sections below[3][4].

DSR

DSR is an entirely on-demand ad hoc network routing protocol composed of two parts: Route Discovery and Route Maintenance. In DSR, when a node has a packet to send to some destination and does not currently have a route to that destination in its Route Cache, the node initiates Route Discovery to find a route; this node is known as the initiator of the Route Discovery, and the destination of the packet is known as the Discovery's target. The initiator transmits a ROUTE REQUEST packet as a local broadcast, specifying the target and a unique identifier from the initiator. Each node receiving the ROUTE REQUEST, if it has recently seen this request identifier from the initiator, discards the REQUEST. Otherwise, it appends its own node address to a list in the REQUEST and rebroadcasts the REQUEST. When the ROUTE REQUEST reaches its target node, the target sends a ROUTE REPLY back to the initiator of the REQUEST, including a copy of the accumulated list of addresses from the REQUEST. When the REPLY reaches the initiator of the REQUEST, it caches the new route in its Route Cache.

Route Maintenance is the mechanism by which a node sending a packet along a specified route to some destination detects if that route has broken, for example because two nodes in it have moved too far apart. DSR is based on source routing: when sending a packet, the originator lists in the header of the packet the complete Sequence of nodes through which the packet is to be forwarded. Each node along the route forwards the packet to the next hop indicated in the packet's header, and attempts to confirm that the packet was received by that next node; a node may confirm this by means of a link-layer acknowledgment, passive acknowledgment, or network-layer acknowledgment. If, after a limited number of local retransmissions of the packet, a node in the route is unable to make this confirmation, it returns a ROUTE ERROR to the original source of the packet, identifying the link from itself to the next node as broken. The sender then removes this broken link from its Route Cache; for subsequent packets to this destination, the sender may use any other route to that destination in its Cache, or it may attempt a new Route Discovery for that target if necessary.

AODV

AODV is a reactive protocol that determines routes solely on-demand. It is based on the distance vector technology. The hosts only know the next hop to every destination. When a source host wants to send packets to the destination and

cannot get the routes from its routing table, it will broadcast a Route Request (RREQ). The receivers may establish the routes back to the source host through the paths that they get the RREQ. If the receiver has an active route to the destination, it will be unicast a Route Reply (RREP) back to the source. Otherwise, the RREQ will be re-broadcast further. If a reply is sent, all hosts along that path may record the route to the destination through this packet. Because there may exist multiple exclusive paths between two hosts, a mobile host can receive the same RREQ more than once. To prevent the same request from being broadcast repeatedly, every request is uniquely identified by a _Host ID, Broadcast ID_ couple. Every host keeps a record for the RREQs that have been processed. The mobile hosts send out the Route Error (RERR) packets to their neighbours to report broken paths and activate the route re-discovery procedure. To avoid routing loop and identify the freshness of the route, destination sequence number is introduced. The sequence number of a mobile host can only be updated by itself in monotonically increasing mode. A larger sequence number denotes a fresher route. The sequence number is carried in both RREQ and RREP. The sequence number in RREP must be larger than or equal to the one carried in corresponding RREQ to avoid the source host to adopt a stale path. When more than one path represented by different RREPs is available, the one with the largest destination sequence number is used. If several paths have the same sequence number, the shortest one is chosen. AODV's desirable features are its low byte overhead in relatively static networks and loop free routing using the destination sequence numbers.

III. BASIC ANT COLONY OPTIMIZATION (ACO)

ACO algorithm belongs to a class of Swarm Intelligence (SI)[1][2][6][8]. This algorithms is based on behavior of ants, their food searching mechanism inspired all researchers to find shortest route in communication network which was further implemented for ad-hoc networks.

The basic idea of the ant colony optimization is taken from the food searching behavior of real ants. When ants are on they way to search for food, they start from their nest and walk toward the food. When an ant reaches an intersection, it has to decide which branch to take next. While walking, ants deposit *pheromone*, which marks the route taken. The concentration of pheromone on a certain path is an indication of its usage. With time the concentration of pheromone decreases due to diffusion effects. This property is important because it is integrating dynamic into the path searching process.
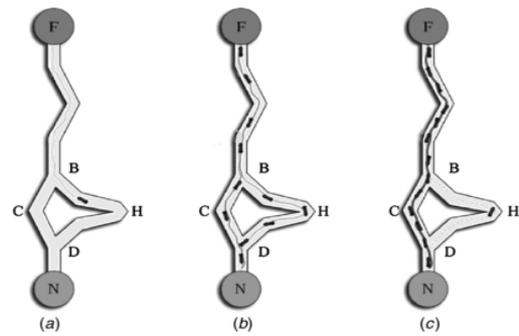

Figure 1

Above figure shows how actually routes from the nest to the food place. At the intersection, the first ants randomly select the next branch. Since the below route is shorter than the upper one, the ants which take this path will reach the food place first. On their way back to the nest, the ants again have to select a path. After a short time the pheromone concentration on the shorter path will be higher than on the longer path, because the ants using the shorter path will increase the pheromone concentration faster. The shortest path will thus be identified and eventually all ants will only use this one. This behavior of the ants can be used to find the shortest path in networks. Especially, the dynamic component of this method allows a high adaptation to changes in mobile ad-hoc network topology, since in these networks the existence of links are not guaranteed and link changes occur very often. Also ACO mainly suits for ad hoc networks due to link quality, local work and support for multipath.

Properties of ARA(Ant Colony Routing Algorithm):
Dynamic topology **-**is responsible for the bad performance of several routing algorithms in mobile multi-hop ad hoc networks. The ant Colony optimization meta-heuristic is based on agent systems and works with individual ants. This allows a high adaptation to the current topology of the network.
Local work **-** In contrast to other routing approaches, ant Colony optimization meta-heuristic is based only on local information i.e., no routing tables or other information blocks have to be transmitted to neighbors or to all nodes of the network.
Link quality **-**is possible to integrate the connection/link quality into the computation of the pheromone concentration, especially into the evaporation process. This will improve the decision process with respect to the link quality. It is here important to notice, that the approach has to be modified so that nodes can also manipulate the pheromone concentration independent of the ants, i.e. data packets, for this a node has to monitor the link quality.
Support for multi-path –Each node has a routing table with entries for all its neighbors, which contains also the pheromone concentration. The decision rule, to select the next node, is based on the pheromone concentration on the current node, which is provided for each possible link. Thus, the approach supports multi-path routing.

Overhead of ARA- The expected overhead of ARA is very small, because there are no routing tables which are interchanged between the nodes. Unlike other routing algorithms, the FANT and BANT packets do not transmit much routing information. Only a unique sequence number is transmitted in the routing packets. Most route maintenance is performed through data packets, thus they do not have to transmit additional routing information. ARA only needs the information in the IP header of the data packets.

*Loop-free-*The nodes register the unique sequence number of route finding packets, FANT and BANT, so they do not generate loops.

Demand-based operation- Routes are established by manipulating the pheromone counter in the nodes. Over time, the amount of pheromone decreases to zero when ants do not visit this node. A route finding process is only run, when a sender demands.

IV. ANT COLONY OPTIMIZATION ROUTING ALGORITHM (ACORA):

This algorithm is built up[4][8][9] in three phases:
• Route Discovery Phase:
In the route discovery phase new routes are created. The creation of new routes requires the use of a *Forward Ant* (FAnt) and a *Backward Ant* (BAnt). A FAnt is an agent which establishes the pheromone track to the source node. In contrast, a BAnt establishes the pheromone track to the destination node. The FAnt is a small packet with a unique sequence number. Nodes are able to distinguish duplicate packets on the basis of the sequence number and the source address of the FAnt. A Forward Ant is broadcasted by the sender and will be relayed by the neighbors of the sender. A node receiving a FAnt for the first time creates a record in its routing table. A record in the routing table is a triple and consists of (destination address, next hop, pheromone value). The node interprets the source address of the Forward Ant as destination address, the address of the previous node as the next hop, and computes the pheromone value depending on the number of hops the FAnt needed to

reach the node. Then the node relays the FAnt to the neighbors. Duplicate FAnt are identified through the unique sequence number and destroyed by the nodes. When the FAnt reaches the destination node, it is processed in a special way. The destination node extracts the information of the FAnt and destroys it. Subsequently, it creates a BAnt and sends to the source node. The BAnt has the same task as the FAnt, i.e. establishing a track to this node. When the sender receives the BAnt from the destination node, the path is established and data packets can be sent.
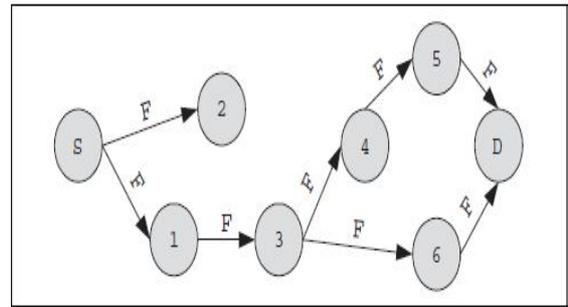

Figure 2. Route discovery phase. A forward ant (F) is send from the sender (S) toward the destination node (D). The forward ant is relayed by other nodes, which initialize their routing table and the pheromone values.
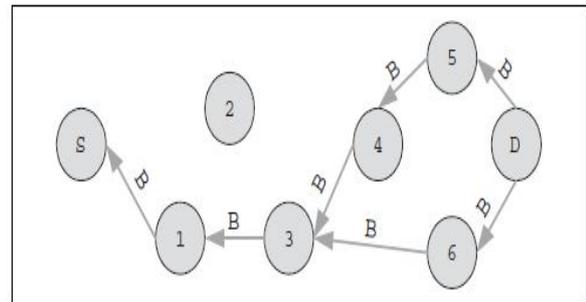

Figure 3. Route discovery phase. The backward ant (B) has the same task as the forward ant. It is send by the destination node toward the source node.

• Route Maintenance:
Once the FANTs and BANTs have established the pheromone tracks for the source and the destination node, ACORA does not need any special packets for route maintenance, subsequent data packets also increase the pheromone value.

• Route Failure Handling:
ARA recognizes a route failure through a missing acknowledgement. If a node gets a ROUTE ERROR message for a certain link, it first deactivates this link by setting the pheromone value to 0. Then the node searches for an alternative link in its routing table. If there is a second link it sends the packet via this path. Otherwise the node informs its neighbors, hoping that they can relay the packet. Either the packet can be transported to the destination node or the backtracking continues to the source node. If the packet does not reach the destination, the source has to initiate a new route discovery phase.

V. SIMULATIONS AND RESULTS

The simulations were performed using Network Simulator 2 (Ns-2.34).[10][11][12][13] The traffic sources are CBR (continuous bit –rate), number of data connections is 10,data packet size is 512 byte and data sending rate is 4 packet/sec. The simulation time is 200 seconds and maximum speed of nodes is 10 m/s. The interface queue is 50- packet drop-tail

priority queue. The network scenario for different number of nodes are generated.

In this simulation number of nodes is varying and considered 10, 20, 30, 40, 50.

Scenario for simulation:

nodes: 10, 20, 30, 40, 50

pause time: 2.00,

speed of node: 10 m/s

Topography x: 670.00, y: 670.00

simulation time: 200s

routing protocol: ACORA, AODV, DSR

traffic: constant bit rate (CBR)

To evaluate performance of ACORA with that of AODV & DSR protocol, we compare them using energy consumption by using above scenario.

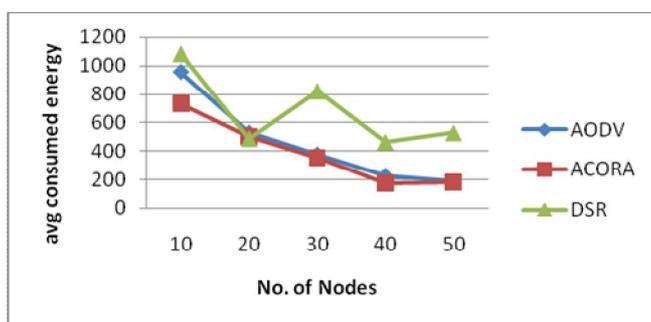Result: graphical representation of the results shown below

Figure 4. comparison between three routing protocol

VI. CONCLUSIONS

In this paper, a new approach for mobile ad hoc network routing is presented. It describes an effective routing mechanism based on the swarm intelligence, particularly the ant-colony optimization heuristic. Utilizing a collection of mobile agents (forward, backward and update ants), Ant colony optimization (ACO) is able to solve the complex problem of routing in MANET.

Through the analysis conducted between ACORA, AODV& DSR, we proved that ACO exhibits better routing performance in energy consumption as compared with conventional routing methods like AODV and DSR.

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