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Improvement of the SARA strategies for MANET model

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***Abstract*—Wireless ad-hoc networks are autonomous systems composed of mobile hosts that are free to move around arbitrarily. Routing is difficult in MANET's since mobility may cause radio links to break frequently. When any link of a path breaks, this path needs to be either repaired by finding another link if any or replaced with a new path. To reduce rerouting operation, selecting an optimal path in such networks should consider both path reliability and energy efficiency. End-to-end reliability is used to reflect the probability of sending data successfully from the source to destination node. In existing system ACO frame work named Simple Ant Routing Algorithm(SARA) used to reduce the overhead, by using a new route discovery technique, based on the concept of Control Neighbor Broadcast (CNB). The CNB allows SARA to control the control packets flooding level in the network. This flooding mechanism as the disadvantage of increase the time required to discover a route. It lacks an efficient support of MANETs, as they require the use of a significant amount of control information during the route discovery process. The network capability to maintain the routes decreases. In high mobility scenarios it decrease SARA's performance and increase the overhead.**

The Dynamic Source Routing (DSR) plays a prominent role in source routing, where reliability and energy efficiency plays an important role in the performance of routing in MANET". A bio inspired algorithm dynamic source routing has been designed to enhance dynamic source routing based on the integration of ant colony and bee colony optimization techniques. The route discovery process is done by applying ACO and BCO by calculating threshold value based on energy consumed by each intermediate node and pheromone value. The path with minimum threshold and maximum pheromone is chosen as the best path and the path is considered for sending data packets the results show that the energy consumed by BeeDSR is less, PDR is high and delay is reduced.

Keywords: **ad-hoc networks, Dynamic Source Routing, Control Neighbor Broadcast, and ACO frame work, BeeDSR**

I. INTRODUCTION:

A mobile ad hoc network (MANET) grouped by a collection of wireless mobile nodes that are adequate to communicating with each other. There is no use of a static network infrastructure such as base station or any centralized administration in MANET. Due to the limited transmission range of wireless network interfaces, multiple hops (intermediate hosts) may be needed for one host to transfer data to another across the network. In MANET, each mobile host may operate not only as a terminal but also as a router, forwarding packets from other mobile hosts. The mobile hosts are free to move around, thus changing the network topology dynamically. Thus routing protocols for MANET should be adaptive and able to maintain routes in spite of changing the network connectivity. Such networks are very useful in military and other tactical applications such as emergency rescue or exploration missions, where static cellular phone infrastructure is unavailable or unreliable. Commercial applications are also likely where there is a need for ubiquitous communication services without the present or use of a fixed network infrastructure

Dynamic Source Routing (DSR): DSR uses a source routing approach. Operation on DSR can

Be divided in two functions: Route discovery and Route Maintenance. Route discovery operation is used when routes to unknown hosts are required. Route maintenance operation is used to monitor correctness of established routes and to initiate route discovery if any route fails [7].

BeeDSR: An Enhanced Dynamic Source Routing Algorithm for MANETs Based on Ant and Bee Colony Optimization

Bee colony optimization (BCO): The Bee Colony Optimization (BCO) algorithm is inspired

by the behavior of a honey bee colony in nectar collection. Honey bees evaluate the quality of each discovered food site and performs waggle dance on the dance floor if the quality is above a certain threshold. The dance is performed for colony communication and contains three pieces of information regarding a flower patch: the direction in which it will be found, its distance from the hive and its quality rating. Finding an energy efficient route in networks is done by making use of two agents in BCO for their communication. Scouts do the on-demand discovery for the new routes to the destinations. Forgers transport data packets and simultaneously evaluate the quality of the discovered routes [9].

There are many works related to ant and bee colony optimization. This work develops and describes an algorithm BeeDSR which integrates ant and bee colony optimization and applies to DSR which brings an enhanced DSR with energy efficiency and reliability.

Now days, the use of low cost wireless networking solutions has enabled a wide variety of applications and services available in laptops, cellular phones or embedded systems, providing ubiquitous access to information. Mobile Ad-hoc Networks (MANET) play a major role in this area, as any host may act as a router and may communicate with other hosts without requiring a fixed infrastructure, thus extending existing radio coverage areas. In spite of this growing interest in MANETs, a generalized dissemination of the technology is still constrained by the practical restriction imposed by the limited bandwidth of the medium and the highly variable quality of the transmission path. In addition, their mobile, multihop nature also poses other problems as the nodes can move freely and the network topology may change very often. To support this new communication paradigm, robust, reliable and efficient algorithms are needed to allow the network to offer a good, or at least an acceptable, level of service. Routing in such kind of networks is a major research issue and many proposals have appeared within its scope. Some of them resulted from the daptation of classical routing protocols, mostly designed to route information in wired networks that do not suffer from typical wireless network problems, such as resource constraint or frequent and unpredictable topological changes. However, as the challenges in MANET are thereof much bigger, new

Wireless ad-hoc networks are autonomous systems composed of mobile hosts that are free to move around arbitrarily. These mobile hosts are referred to as nodes; each node serves as a router to forward packets originated from other hosts [1]. Routing is difficult in MANET since mobility may cause radio links to break frequently. When any link of a path breaks, this path needs to be either repaired by finding another link if any or replaced with a new path. This re routing operation costs the source resources and battery power while re-routing delay may affect quality of service (QOS). To reduce rerouting operation, selecting an optimal path in such networks should consider both path reliability and energy efficiency. End-to-end reliability is used to reflect the probability of sending data successfully from the source node to destination node. Many researches have concentrated to improve QOS in multipath routing algorithms [2], [3], [4]. But only few of them [5], [6] have focused on reliability and energy consumed metrics.

II RELATED WORK

Improved version of the ACO framework, that aims at reducing the overhead by using a new route discovery technique (CNB) the results show that small values of F are adequate for heavy loaded networks because of more routes enables load balancing and reduces overhead and collisions. The Simple Ant Routing Algorithm (SARA) offers a low overhead solution, by optimizing the routing process. Three complementary strategies were used in our approach: during the route discovery we have used a new broadcast mechanism, called the Controlled Neighbor Broadcast (CNB), in which each node broadcasts a control message (FANT) to its neighbors, but only one of them broadcast this message again. During the route maintenance phase, we further reduce the overhead, by only using data packets to refresh the paths of active sessions. Finally, the route repair phase is also enhanced, by using a deep search procedure as a way of restricting the number of nodes used to recover a route. Thus, instead of discovering a new path from the source to the destination, we start by trying the discovery of a new path between the two end-nodes of the broken link. A broadest search is only executed when the deeper one fails to succeed. The Route Discover and Route Repair procedures introduced in SARA can be considerate as general proposed and used in other routing protocols.

SARA architecture - route discovery
In the traditional ACO

- The source node starts a route discovery process by sending Forward ANT (FANT) packet
- The destination node will send another packet back, the Backward ANT (BANT)

CNB (controlled neighbor broadcast)
Each node broadcasts the FANT to all of its neighbors, but only one of them broadcasts the FANT again, the policy used is to select different nodes each time a FANT is generated using a probabilistic approach.
SARA architecture - route discovery:
The probability, p(u,j,d) , to chose a given nodej,as the next hop to forward the FAN towards destination d is given by following equation:

$$\forall j_i \in Adj[u], \exists p_{(u,j_i,d)} :$$
$$p_{(u,j_i,d)} = \frac{C_{(u,j_i,d)}}{\sum_{k=0}^{k=M} C_{(u,j_k,d)}} \wedge C_{(u,j_i,d)} = \frac{1}{1+n},$$

n is number of times the link was selected M is the number of adjacencies of node u, c (u,j,d) cost of each link.

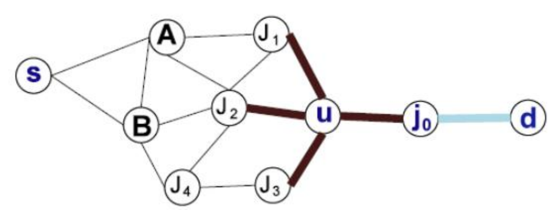

Fig 1: Network Diagram

III PROPOSED PROTOCOL

Dynamic Source Routing protocol (DSR) [8], designed for multi-hop wireless ad hoc networks. This protocol consists of two operations “Route Discovery “and “Route Maintenance “that makes it self-configuring and self-organizing. DSR routing protocol manage the network without any centralized administrator or infrastructure. In route discovery this protocol discovers for the routes from source node to destination. In DSR, data packets stored the routing information of all intermediate nodes in its header to reach at a particular destination. Routing information for every source node can be change at any time in the network and DSR updates it after each change occur [8]. Intermediate routers don´t need to have routing information to route the passing traffic, but they save routing information for their future use.

Basic purpose to develop DSR was to reduce the overhead on the network and designing self organizing and self configuring protocol to support MANET.

Overview two parts:

i. Route discovery
ii. Route maintenance

Route discovery improvements caching overheard info using cached routes to reply to requests

Other optimizations preventing reply storms limiting requests packet salvaging route shortening

Limiting request propagation caching negative information

Route discovery:

In DSR route discovery, when a node want to send a packet to another node normally it stored routing information in the header of the packet. The routing information in DSR is in the form of "Sequence of nodes". This routing information had been learned by every node. If no routing information is available, source node use the "route discovery" mechanism to find the appropriate route to reach destination. The whole process to find the route is called route discovery the route discovery mechanism can be better defined with the figure 3 as an example

In figure x, node "A" starts discovery process to find the route to node "E". So node "A" called initiator and node "E" is called target. When route discovery starts, initiator sends "discovery request" to nodes that are within its wireless range. The discovery request contains initiators, target´s and route information. In the start, route record is set to empty by the initiator. When any node receives the discovery request, it checks the target information. If receiver is not target itself it add it ‟ s information to the route record and forward the discovery request to all nodes in the wireless range. But when the target node receives the discovery requests it send the request reply with final route information containing the complete intermediate path. The target node can send the request reply using its route cache or by reversing the order or discovery request. Thus in this way DSR discover the route from source to destination

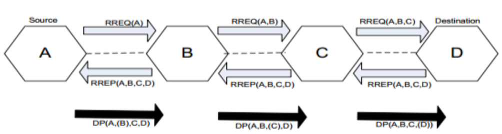

Fig 3: DSR Route Discovery

Source A broadcasts route request (RReq) for route to E

RReq contains

- unique id (2)
- list of nodes traveled
- If node is not target (B, C, or D), it rebroadcasts RReq adding it's id to message
- If node already received RReq with the same id from the same source, or if the node is already in the list – no rebroadcast
- if node is target (E) – sends back route reply (RRep) with RReqs list
- when source A receives RRep from E – it caches route to E (and intermediate nodes)
- target E may also cache route to A (and intermediate nodes), intermediate nodes may cache routes to all nodes exception – unidirectional links
- application packets wait for route discovery, may be dropped if too long, route discovery may be repeated

Route Maintenance:

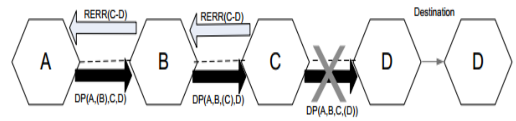

Fig 4. Route maintenance mechanism in DSR l.

- Each node transmitting the packet is responsible for confirming that the packet has been received by next hop.

- Acknowledgement (i).By lower layer protocol MAC, (ii).By DSR-specific software ack

Each node transmitting an application packet is responsible it gets to the next hop (A to B, B to C etc.), retransmit if necessary .Through explicit acks through passive ack – node overhears next hop sending it further (A receives the packet sent by B to C) if transmission fails – link considered broken and route error (RErr) is returned to sender (A), A has to either drop a packet or do a new route discovery, the old route is deleted from the route cache

Additional Route Discovery features

Caching overheard routing information

i.In presence of uni-directional link

ii. In presence of bi-directional link

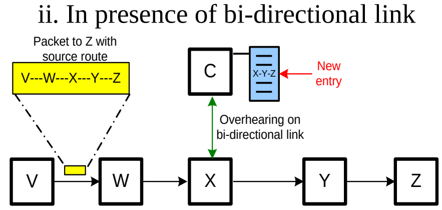

Fig 5. Caching overheard routing information

Packet routing info may be cached by any node thus when C overhears a packet X transmits from V to Z it learns the routes to every node in V-Z chain problem – unidirectional links only "forward" links are useful when C transmits a packet from A to E – it can use the route from C to E but not from C to A when C overhears a packet X transmits

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from V to Z, it can only use the X to Z (if C-X link is bidirectional)

Using cached routes to reply to RReqs:

Replying to Route Request using cached routes the intermediate node must verify that the resulting route being returned contains no duplicate nodes listed in the route record a node F may send RRep to an RReq if it is not a target yet it has it in its route cache problem – what if a node repeats (C) do not edit route to eliminate C – so that the F also learns if the route is broken and would not pollute it in the next route discovery

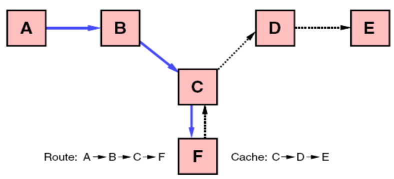

Fig 6. Cached routes to reply to RReqs

Preventing Route Reply storms:

Many Route Reply message could be send to A from the A's neighbors to avoid a possible local congestion, each nodes must wait a variable period before sending the reply. Delay period d = H(h - 1 + r) Each node network interfaces works into "promiscuous" receive mode. RRep storm - a lot of neighbors know the route to target and attempt to send RRep in response to RReq, RRep storm wastes bandwidth and overloads the network to avoid RRep storm each node waits random amount of time before rending its RRep in case it hears another neighbor's reply

- delay time: d = H ×(h -1+ r)

Where d – delay time
H – Constant delay greater than roundtrip
h – Hop count to target
r – random number between 0 and 1

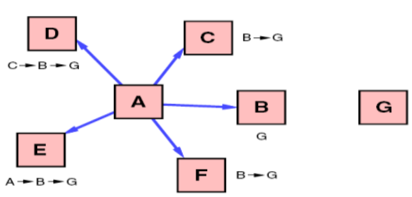

Fig 7. Preventing Route Reply storms

Route request Hop limits
"Nonpropagating" Route Request,"Propagating" Route Request,"Expanding ring"

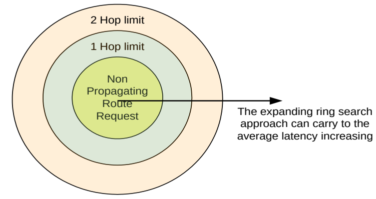

Fig 8. Route request Hop limits

The DSR plays a prominent role in source routing, where reliability and energy efficiency plays an important role in the performance of routing in MANETs. This paper is aimed at improving the energy efficiency and reliability of routing protocols. Hence there is a need for integrating the best of ACO and BCO. The process of the new algorithm named BeeDSR is as follows: Let the source node S has data to send to destination D. S initiates the route request ant to destination D through all its neighbors, which are maintained in route cache of the source Each node receiving the RREQ ant checks the mac_id with the destination address If it matches, it proceeds with route reply process, else it checks its route cache for route availability. If route is available, then it calculates delay and then route reply is send to the source, else it broadcasts its RREQ ant. When the route request ant reaches the destination, it handovers the pheromone deposit value, path information and threshold value to the bee, which will pass in the same path in opposite direction. In intermediate node, the bee checks its energy level based on the threshold value.

Algorithm

//In – intermediate nodes, De – Destination ,R- random number
// Eij - energy consumed by i and j in their communication
// N - number of nodes in the path, k – number of paths
// tk - threshold value of kth node, L – limiting factor
// path – path from source to destination
// psij – amount of pheromone in ith path from edge j to next node
// ATi – arrival time of forward ant to destination for path i
// BTi - birth time of ant for path i
Min:=0 // min– minimum delay path number
// pheromone deposit is calculated based on the distance.
pMax:=0 // index of the path number which contains maximum pheromonedeposit
dm-> ∞_ // d – delay of each path, initially minimum delay is set as ∞
pspmax-> -∞ // sum of pheromone deposit for each path p
// initially maximum pheromone deposit is set as∞
Path:={ }, t:= 0, n:=0, k:=1
If (In contains path information to De)
dd = ∑In + RL
else
for each path (i)
for every neighbor j of i
If (j < > De)

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```
tj:= tj + Eij
Nj:= Nj + 1
pathi:= pathi U {j}
endif
endfor(j)
di: = ATi - BTi
endfor(i)
for every path j from De to S
psj: = 0
for every k in j // k is the node of j
psj: = psj + psjk
endfor(k)
if (psj > pspmax)
set p: = j
endif
if (dj < dmin)
set min: = j
endif
endfor(j)
bpath:= call EEP(t,path)
if (p== bpath)
if (p == m)
set p is the best path
endif
else
set bpath is the best path
end if
```

Simulation Environment

The simulation is implemented in NS2. The parameters used for simulation is given in Table.
Table: Simulation Parameters

Parameter	Value
Simulator	Ns 2.33
Movement model	Random waypoint
Packet size	512 bytes
Area	1000 m*1000m
Number of nodes	100
Simulation time	100 s
Traffic Source	CBR

IV RESULT AND DISCUSSIONS:

The following performance metrics are considered for evaluation of SARA and BEEDSR overhead by varying the network loads. Fig. 9 shows the comparison of overheads. On X-axis we taken network loads and Y-axis we took overheads. The graph shows overhead was less in beedsr than in sara.

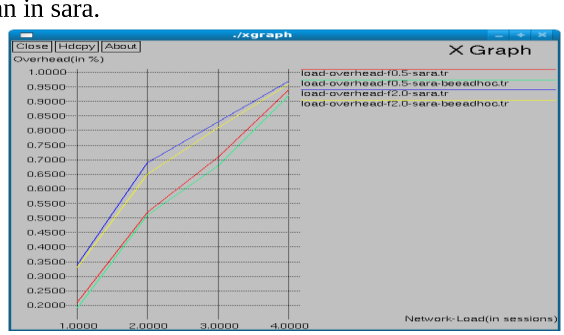

Fig 9: comparison of Network load and their overhead

Fig.10 shows the how the velocity overhead was varying in SARA and BEEADHOC. On X-axis we taken Node Velocity and Y-axis we taken Overhead. Finally this graph shows how the velocity overhead was decreasing in BEEDSR.

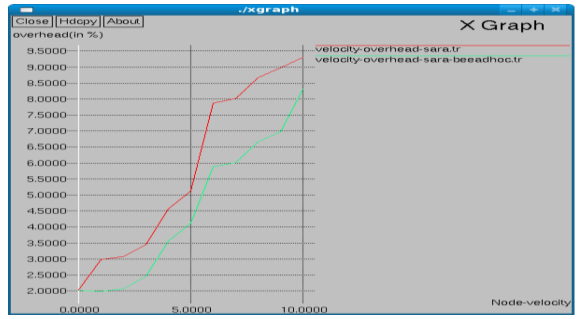

Fig 10. Comparison of overhead with velocity

V. CONCLUSIONS:

Excellent performance of routing in MANET's.Very low routing overhead able to deliver almost all originated data packets, even with rapid motion of all nodes. The Dynamic Source Routing (DSR) plays a prominent role in source routing, where reliability and energy efficiency plays an important role in the performance of routing in MANET". A bio inspired algorithm dynamic source routing (BeeDSR) has been designed to enhance dynamic source routing based on the integration of ant colony and bee colony optimization techniques. The route discovery process is done by applying ACO and BCO by calculating threshold value based on energy consumed by each intermediate node and pheromone value. The path with minimum threshold and maximum pheromone is chosen as the best path and the path is considered for sending data packets. The results show that the energy consumed by BeeDSR is less and delay is reduced.

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