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ACO-GA based routing algorithm for MANET

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Abstract—MANET is made up of a collection of mobile wireless nodes, each node act as router as there is no central coordinator present in this network to ensure in network routing.In MANETmultiple paths are available for data transmission, but itis required to choosemost efficient path between multiple pathsby providing better Quality of Service(QoS).Routing in MANET network is a challenging task, because the topology of the network is frequently changes. This issue is addressed in this paper.Here we introduce new routing mechanism by using ACO and GA approach to satisfy quality matrix.By using ant algorithm to explore the network using intelligent ANT packets based on pheromone concentration. Multiple paths are generated by ant algorithm and best path is chosen for data transmission, if link failure is occurs while data transmission then genetic algorithm is used for handling link failure by selecting another backup path based on fitness value.

Keywords—ACO,GA,pheromone, fitness

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I. INTRODUCTION

MANET is made up of collection of mobile wireless nodes. Each node act as router as there is no central coordinator present in this network to assist in network routing. Now a days MANETs are used in many applications like, personal area networkmilitary battlefields,crisis management services classrooms, etc.In wireless networks, it is necessary to create paths from one host to another to exchange information. Routing is the process of finding an efficient path to transfer data from source to destination while maintaining Quality.

Routing is a process of finding the paths between nodes. There are mainly two types of routing mechanisms static routing and dynamic routing. In static routing, the routes between the nodes are precomputed and stored in routing table. If a topology of network changes, then the path between nodes may also change, and hence in dynamic routing is used. In dynamic routing routes are not stored previously, routes are generated when required.All packets between any two nodes are sent in the same path. The new routes are generated based on the factors like link utilization, traffic etc formaximum performance. Some traditional routing protocols are RIP (Routing Information Protocol), OSPF(open shortest path first),BGP(border gatway protocol).this protocols are not supported for MANET.

MANETs uses protocols which are classified into three categories are: 1) table driven or proactive protocol (DSDV) which maintains all information of nodes for fixed interval of time. 2) On demand or reactive routing protocols (ad hoc on demand vector routing protocol) which establish routes as per requirement. 3) Hybrid protocols (ZRP) are the combination of reactive andproactive routing protocol. Following figure shows protocol list used by mobile ad-hoc network.

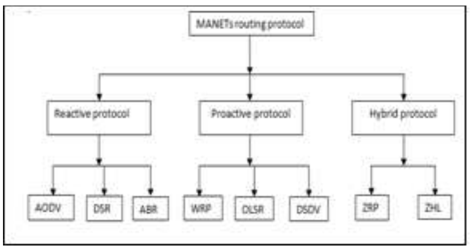

Figure 1:different types of protocol for manet

These all protocols are designed using different algorithms such as Bellman ford, Djkestra, shortest path algorithm etc. All of these protocols are works better for specific applications, but are not suitable for all environments. A Comparisonof reactiveand proactiveprotocolis givenin table1.

Table 1: comparison of protocols

Proactiveprotocol	Reactiveprotocol
Maintain consistent, up-to-dateroutinginformation betweenevery pair of nodes	Establisha routetoadestination whenthereisademandfor it
Routeupdatesatfixedintervals	Therearen o periodic updates
Arouteto eachother nodein ad-hocnetworkisatalltimes available	Routeto allnodesnotavailableallthetime

Many protocols are designed as per applications requirment. It is essential to design an efficient, scalable and adaptiveprotocol which can make decisions in serious situations. The main purposes of designing new protocol ACO-GA is to find a path from source to destination by satisfying user's requirement by improving QoS and repairing the path quickly in case of link failure without corrupting the level of QoS. In this protocol we combine two optimization methods Ant colony optimization and Genetic algorithm.

II. PROPOSED ALGORITHM

The static routing protocols are not suitableBecause of the dynamic nature of the MANETs. Hence there is a need to create new a dynamic routing protocol. The dynamic routing protocol should be able to provide certain level of Quality of Service (QoS) as required by the application.MANET has dynamic topology and supports both single hop and multiple hops configuration. Many algorithms have proposed for dynamic network as discuss above. On the other hand many of Protocols are specified forapplication so there is a need to design an adaptive protocol. The proposed algorithm ACO-GA enabled ant colony and Genetic based multipath routing.the idea is to uses ant colony optimization to find the possible paths from any source node to destination node for the given network topology. Once the set of possible routes arefound based on the pheromone concentration by the artificial ants, the resulting set of routes forms the initial population given for the genetic algorithm phase.Then based on the fitness function and genetic operations, the set of

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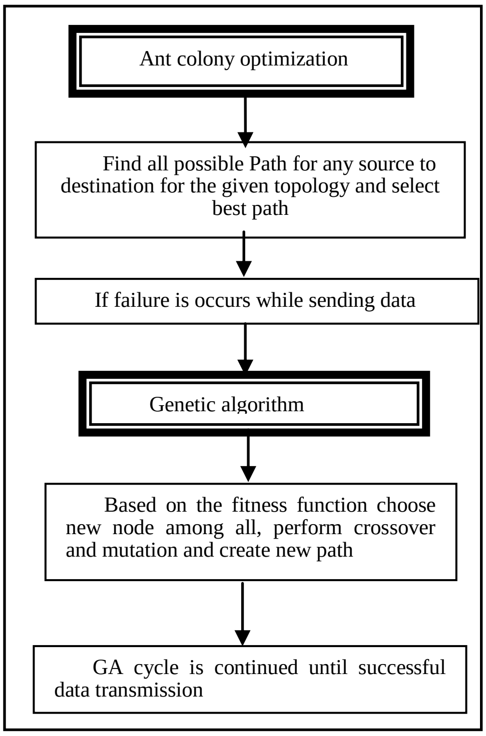
optimal pathsare identified from the initial population for the network for any source-destination pair. The GA cycle is continued until there are failure in network. Bellow flow diagram describe whole concept of ACO-GA in short.



III. ANT COLONY OPTIMIZATION

Ant colony optimization is a meta-heuristic technique that uses behaviour of artificial ants to find solutions to combinatorialoptimization problems. ACO is based on the behaviour ofreal ants and enhanced abilities such as memoryof past actions and knowledge about the distance to otherlocations. In nature, an individual ant is unable tocommunicate or effectively hunt for food, but as a group,ants possess the ability to solve complex problems andsuccessfully find and collect food for their colony. Antscommunicate using a chemical substance called as pheromone.As an ant travels, it deposits a constant amount ofpheromone that other ants can follow. Each ant moves in arandom fashion, but when an ant meets apheromone trail, it must decide whether to track it. If itfollows the trail, the ant’s own pheromone reinforces theexisting trail, and the increase in pheromone increases theprobability of the next ant to selecting the path. Therefore, themore ants that travel on a path, the more attractive the pathbecomes for subsequent ants. Additionally, an ant using ashort route to a food source will return to the nest sooner andtherefore, mark its path twice, before other ants return. Thisdirectly influences the selection probability for the next antleaving the nest.

Figure 2: ACO behaviour

This diagram shows the total amount of the pheromone level. The large value of pheromone path isconsidered as a shortest path.

In our work, the ACO is used for finding the optimal path using the distance value and bandwidth value assign to the each node. The host of the ant is considering as the source node and their food is representing as the destination. The current node is act as an ant in routing process for finding the next shortest nodes in the manet network.

In general the ACO along with routing table and data packets, uses two ant packets such as forward and backward ant. The forward ant is used while searching the food and the backward ant is used when the ant get back to source. Following is pseudo code for ACO.

```
if (forward ant)
{
Get the next node
        if (the link is available and no loopcaused) then
        {
•       Calculate pheromone value
•       Update forward ant with network status(stack)
•       Broadcast forward ant packet to all neighbor
        }
        else if (no such link exist)
        {
             • Create backward ant and load contents of forward ant
        tobackward ant (queue).
             • send Backward ant towards source along the
        highest value ofpheromone path
        }
}
```

In ant colony optimization eachnode in the network periodically launches forward ant towards destination. Forward ants broadcasted in network for finding destination. It explores the network to reach to the destination. While exploring network Forward ant collects the information of network like time stamp, node identification number, at which the specific node was visited etc. This information is stored in the stack of forward ant. When forward ant visiting a next node it deposits some pheromone on the link to indicate that the path taken. Forward ant on successfully reaching destination, gets converted to backward ant. The parameters of forward ant is copied to the queue of backward ant. Backward ant backtrack the same path as forward ant followed. It updates the routing table at each node, based on the information collected by forward ant . Backward having higher priority than forward ant. Backward ants are killed once they reach to the source.

❖ *Strengths of ant colony optimization algorithm*

- ✓ Providing traffic-adaptive and multipath routing.
- ✓ Relying on both passive and active information monitoring and gathering.
- ✓ Making use of stochastic components.
- ✓ Not allowing local estimates to have global impact.
- ✓ Setting up paths in a less selfish way than in pure shortest path schemes favoring load balancing.
- ✓ Showing limited sensitivity to parameter settings
- ✓ Robust to agent failures, provide multipath routing
- ✓ Take care of data load spreading

IV. GENETIC ALGORITHMS

Genetic Algorithm (GA) is a optimization technique that describes the biological evolution as the problem solving technique. GA works on the search space which called aspopulation. Each element in the population is called as chromosome. GA first starts with randomly selecting set of feasible solution from population. Each chromosome is a solution by itself. Each chromosome is estimated for fitness and this fitness describe the quality of solution. GA uses adaptive heuristic searching technique through which finds the set of best outcome from the existing population. New offsprings means childs are generated from the selected chromosomes using operators like selection, crossover and mutation. A Most fit chromosomes are moved for next generation. The weaker chromosomes get less chance for moving to next the generation. A population with average fitness are increases at each iteration, so by repeating the process of GA for many iterations, better results are revealed.

GA has been widely studied and inspected on manyfields of engineering. GA offersanother methods forresolving problems which can't possible to solve using traditional methods. GA can be applied for nonlinear programming like minimum spanning tree, traveling salesman problem, scheduling problem and etc.

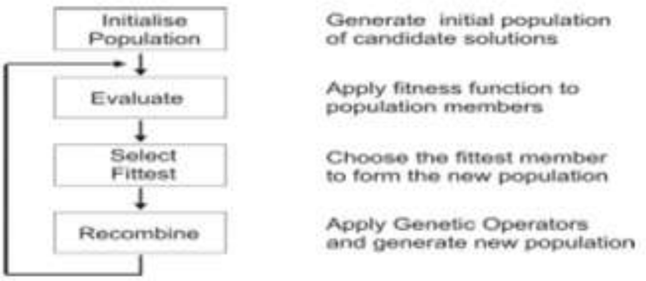


Figure 3: genetic flowchart

The optima path which is found by ACO algorithm, is given as a input to the GA. The initialise population contain the path input which is going to evaluate a fitness for each path. GA consists of three process

Pseudo code for GA:

Choose initial population(Random)

Repeat (until terminated)

✓Evaluate each individual Fitness

✓Prune population(Typically all; If not then the worst)

✓Select pairs to mate from best-ranked individuals

✓Replenish population(Selected pairs)

▪Apply Crossover operator

▪Apply mutation operator

Check for termination criteria

✓Loop if not terminating(Repeat from step 2)

❖ *Strengths of Genetic algorithm*

- They are parallel in nature.
- They explore solution space in Multiple directions at once.
- well suitable for solving problems where the solution space is massive and time taken to search comprehensively is very high.
- They perform well in problems with complex fitness. If the function is complex, discontinuous, noisy and changes over time or has many local optima, then GA gives better results
- Genetic algorithm has ability to solve problems with no prior knowledge

The performance of GA is based on efficientrepresentation, evaluation of fitness function and otherparameters like size of population, rate of crossover andmutation and the strength of selection.

V. PROBLEM DEFINITION

Here we combined two optimization methods ACO and GA for better performance and quality of service. The network is represented as connected graph G = (V,E), with N nodes. The goal is to find the path with minimum total cost between source node V_s and destination V_d, where V_s and V belong to V. This paper presents the efficient on-demand routing algorithm using ant colony optimization and genetic algorithm. It is implemented as two modules are ant algorithm used forNetwork generation or initialization of routing tables and optimal path are generated by using ant algorithm. Finally data is sent along the generated path.

A. Initialization of routing table

Every node of network has a routing table. The table creates betweenneighbor nodes and nodes (destinations) of network. This table gives probability to reach particular destination through particular neighbor. The probability depends on pheromone value of that link of particular destination. The table also called pheromone table. The probability is calculated according to this pheromone value for that link and optimization constraints.

B. Route request

when any node requires to send data to any destination, it first looks inthe routing table. If there is any route available for that destination then source node send data through that route. Availability of route check as, if any neighbor node available for that destination, and pheromone value is more than threshold pheromone value than route of that destination is available. If route is not available than route request process get start.

Forward ants are broadcast to search the destination. Forward ants move in the networknode-to-node and collect information about the nodes they have visited.When forward ant reaches to destination it is converted into backward ant. The local pheromone calculation can be done by using equation 1.

$$\textbf{local pheromone}\,(\textbf{ij}) = (\mathbf{1} + \boldsymbol{distance}(\boldsymbol{ij})^{-\mathbf{1}} \ldots\ldots\ldots\ldots \text{ eqn } (1)$$

Let assume source node *A* wants to send data to a destination *D* without any data loss and delay. First node A broadcasts the Hello message to all the nodes by sending ANTHELLOPACKET. By means of receivingHELLO message neighbouring nodes are discovered.Then source node A sends a Routing request in form of Forward Ant packet to destination *D* through all its neighbours and simultaneously depositssome pheromone and reinforce it. While roaming to the destination the Forward Ant upgrades routing table which includes the information about source address, destination addressand pheromone value. When the Forward Ant reaches the destination, it will be converted intoBackward Ant and sends towards the original source in the form of acknowledgement. The Backward Antwill take the same path of the corresponding Forward Ant but in reverse direction. finally the path selected whose pheromone value is high. As multiple paths are available, in case of link failures the genetic approach is used and new path is chosen for uninterrupted transmission.

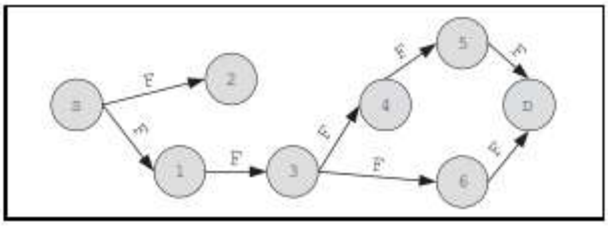


Figure 4: route discovery phase of forward ant

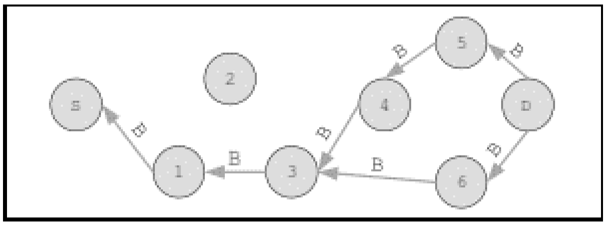


Figure 5: route discovery phase of backward ant

When BANT reaches the source, it Calculate Global pheromone for all set of path ij

$\boldsymbol{Global\ pheromone\ (ij) = (Total\ pheromone\ (ij) + hop)^{-1}} \ldots\ldots\ldots\ldots$ eqn (2)

Calculate Probability for path selection based on global pheromone value of all the path

$$P_{ij} = \frac{[\tau_{ij}]\ .[n_{ij}]}{\sum j \in N_i \quad [\tau_{ij}]\ .[n\ _{ij}]}$$

- ❖ Processing at each node

On arrival of ant at intermediate node, It is required to find the type of ant whether it is forward or backword .If forward ant, it discovers path to destination and if backward ant go back over path to source by updating routing tables at intermediate nodes.

Pseudo code for ANT algorithm

```
if (forward ant)
{
 Get the next node
   if (the link is available and no loop caused) then
   {
 •   Send forward ant to the next node
 •   Calculate pheromone value
 •   Update forward ant with network status (stack)
}
   else if  (no such link exist)
   {
 •   Create backward ant and load information offorward ant to
     backward ant (queue).
 •   send Backward ant towards source along thesame path as
     forward ant
   }
}
if backward ant
{
   if current node is source node
   {
 •   Store path and kill backward ant
 •   Update routing table
   }
 else
{
 •   Forward backward ant on to link available on queue
 •   Update routing table
}
}
if next node is not available

       Kill backward ant
}
```

C. Data transmission

Once number of path created by ACO, a best path i.e a path which having highest pheromone value will be selected as primary path for the data transmission. then data transmission is carried out with primary path.

D. Route mintainance

The second phase of the routing algorithm is route maintenance phase. This phase is responsible for the improvement of the quality of routes during the communication. ACO does not need any special packets for route maintenance. Once the FANT and BANT are established the pheromone tracks for thesource and destination nodes, subsequent data packets areused to maintain the path.

E. Failuer handlinling

ACO recognizes a route failure through a missing acknowledgement. If a certain node gets a ROUTE_ERROR message for a certain link, it will first deactivates this link by setting the pheromone value of that link to 0. Then the node search for ananother alternative link in its own routing table. If there exists a alternative link node sends the packet via this path but can not check forthe quality of the path.if second link doesnot exist the node informs its neighboursthat they can handover the packet. Either the packet can be transmitted to the destination node or the backtrack continues to the source node. If the packet gets fails to reach the destination, the source node again initiate a new route discovery phase.This will be time consuming process to again process route discovery phase. We use genetic algorithm for failure handling which removes the process of route discovery phase after route failure occurs.

F. Genetic algorithm

The design of the GA has phases like genetic representation, population initialization, fitness function,selection scheme, crossover and mutation. A routing path comprises of sequence of nodes in network. The genetic algorithm is applied to paths which is obtained from the route discovery that is by using ACO phase.

In this section we determine a backup path from source node todestination in case of primary path failure. By using GA we obtain an alternate path to be used in link failure. The alternate path will be next best path when compared tothe optimal path. When a primary path get fails wecan recover the connection by using the backup paths. The process of backup path routing contains three main functions: connectivitymanagement, path discovery phase and path maintenance phase.

➢ *Initial population*

In GA each chromosome represents a multiple paths which obtained in route discovery.

➢ *Fitness function*

For an obtained solution we should be able to evaluate its quality accurately which can be done with the help of fitness function. Our goal of using this GA is to handle link failuer, minimize delay between source and destination.The fitness of each chromosome considerd as pheromone value of that node

➢ *Selection scheme, crossover and mutation*

Selection role improving the quality of population of chromosomes. The selection of chromosome is done on the result of fitness function.This section describe different methods for selecting parents for next generation. Following are some of the selection methods.

a) **Elitist selection**- In this method most fit chromosomes are sure to be selected for next generation.

b) **Rank selection**- In rank selection each individual is selected based on its rank.

c) **Roulette wheel selection** – In roulette wheel selection, the individual is selected based on the relative fitness with its competitors.

Crossover is done to find the better solution from current one. every time we choose two chromosomes PATH1 and PATH2 for crossover. PATH1 and PATH2 should have at least one common node mentioned as v. Now we have two paths i.e path1(s→r) and path2(s→r). Now we have v in both paths can be mentioned as subpath1(s→v) and subpath(v→r), subpath2(s→v) and subpath(v→r). Now we exchange the sub path (v→r) and (v→r). The population will go through mutation after the crossover had been performed. Both crossover and mutation may produce infeasible solution so we check it is acyclic. The crossover can be explained with the following example.

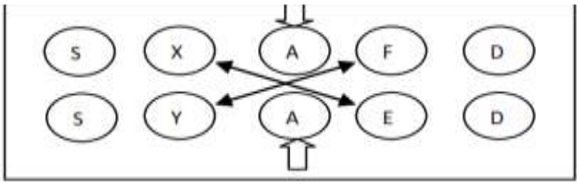


Figure 6: crossover

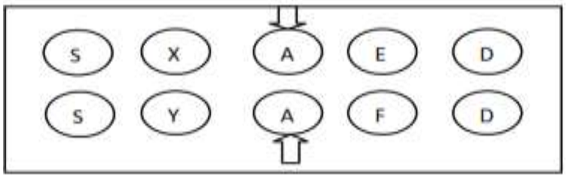


Figure 7: result of crossover

In the above example A is the common node in both chromosomes. So by performing GA we obtain new two more chromosomes in order to obtain optimal value.

➢ *Path discovery phase*

The backup paths are intersect with the primary paths to establish a newpath. The primary path and backup path are recognised during the route discovery phase itself when we discover optimal path by using aco. The backup paths are geographically closer to the primary paths.

➢ *Path maintenance*

The data packets are transported via the primary path till the primary path is gets failed. When a node notices a link failure, it uses the backup path instead of primary path. This is done with the help of Route_error message where, when a node detects the link or node failure it will send a Route_error message to the sourcenode that that initiates the routing process. So after getting Route_error message the source node selects the backup path from where the link has broken insteadof finding a new route by route discovery process. This is describe in the Fig.8.

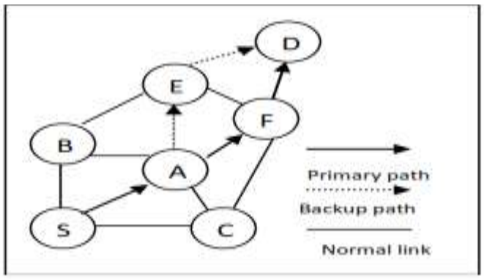


Figure 8: backup path selection

In above digram S is source node and D is the destination node and other nodes acts as intermediate nodes. data is been sent initially in the primary path i.e S—A—F –D .When the node "F" detects the link or node failure it sends a Route_ error message to the source node. Now the source node knows that where the failure has occurred and it selects the backup path that is from node "A" it selects "E" as a backup path and continues to send the data packet. now there is no required for reroute discovery mechanism in case of link failure which avoids timeand power consumption.

Flowchart for ACO-GA

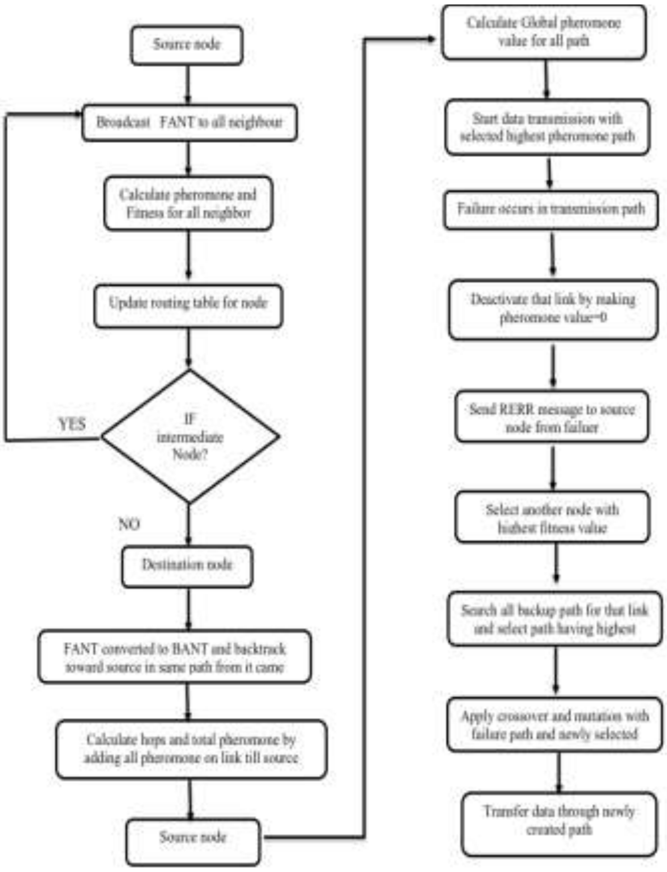


Figure 9: ACO-GA Flowchart

VI. PERFORMANCE EVALUATION

The performance of ACO-GA protocol is verified by comparing it with ACO. Network simulator (NS2) is used simulate network. For given simulation the different simulation parameters are tabulated in Table 2. Performance metrics are examined by varying the number mobility and number of node. the topology is examined for 20,50 and 80 node and it shows that ACO-GA works best in 80 nodes.Results are generated in the form of graph.

The results given below are examined by Miss Nikita Barve which shows ACO-GA protocol performs better than ACO protocol.

Table 2: performance table

Parameter	Values
Propagation	TwoRayGround
Simulation time	200s
Simulation area	1000x1000
Antenna	Omini directional
MAC layers protocol	IEEE 802.11
Routing protocol	ACO-GA
Traffic pattern	CBR
No. of nodes	20,50,80 nodes
Max speed	5m/s,10m/s,….25m/s

Performance metrics are evaluated to check QoS of a presented protocol are as follows.

1)Packet delivery ratio- It is ratio of number of packets sent by sources and the number of received packets at the destination.

2)Throughput- It is the average rate of successful message delivery over a communication channel. It is measured in bits per second

3)End to end delay- It is a time required for packets to reach to destination node from source node.

Now here, results for ACO-GA protocol are given. These results are obtained for packet delivery ratio, packet loss, controlled overhead, throughput and average end to end delay parameters for different speed time.

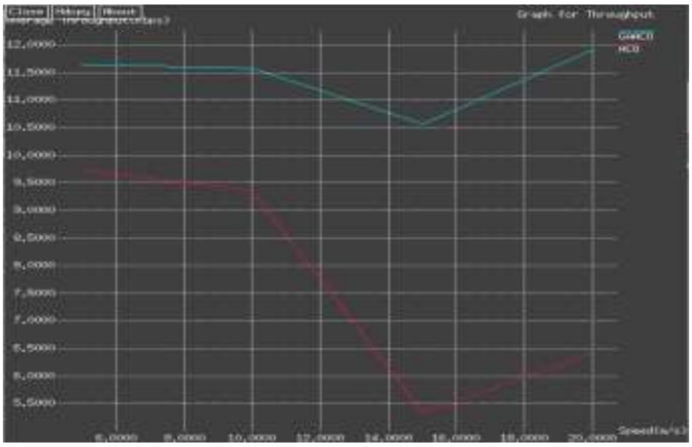


Figure 10: throughput

Fig 10 shows throughput of ACO-GA. Which is higher than ACO

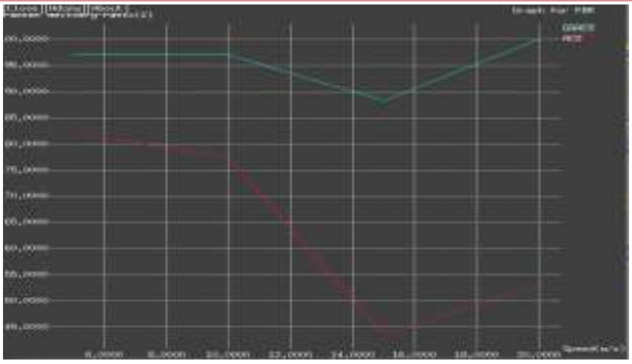


Figure 11: Packet delivery ratio

Fig 11. It shows the effect of mobility of nodes on packet delivery ratio. ACO-GA is compare with ACO. As MANET is set of mobile nodes, these nodes move randomly.in ACO Increase in speed of nodes leads to decrease in packet delivery ratio. As the mobility of the nodes increases, the probability of link failure increases and hence the number of packet drops. But in ACO-GA packet delivery ratio is increases as speed increases. ACO-GA has much higher packet delivery ratio than that of ACO.

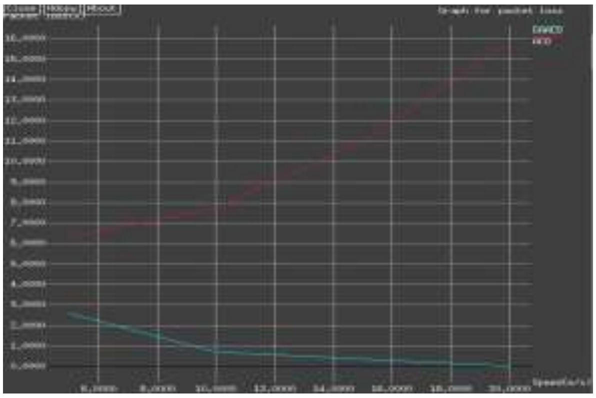


Figure 12: Packet loss

Fig 12 shows the effect of packet loss .in ACO as speed of nodes increases packet loss is also increases. In ACO-GA as speed increases packet loss decreases.packet loss ratio is much less in ACO-GA as compare to ACO.

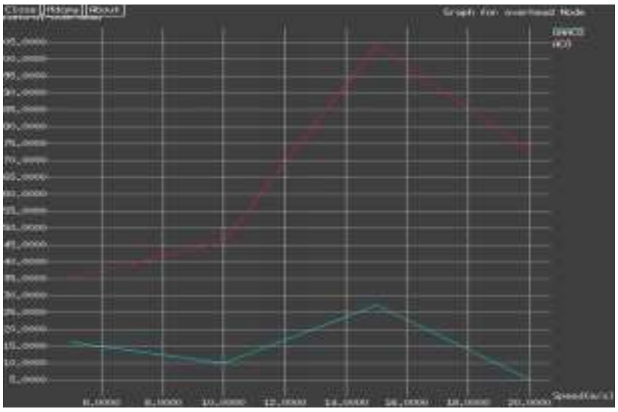


Figure 13: Overhead

Overhead is increases in ACO because of route discovery phase .in ACO-GA overhead is decreses as mobility of the nodes increase

Figure 14: average delay

Fig 14 shows average delay. As compare to other Qos parameters end to end delay is much high in ACO-GA protocol, which will be improve in future work

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Conclusion

In this work ant algorithm and genetic algorithm are used for routing in Manet networks. Ant algorithm is found to reduce the size of routing table and ti found optimal path through forward ant and backward ant by using pheromone value. But it cannot works well in failure handling, thus Genetic algorithm. Genetic algorithm reduces route discovery phase by using backup path and also maintain quality of the path. Hence, the combination of these two algorithms,which makes the packets to explore the network independently, helps in finding path between pair of
nodes effectively.

References

[1] Rajanigandha Metri, Prof. Sujata Agrawal, "Ant Colony Optimization Algorithm Based An Intelligent Protocol To Improve QoS of MANETs" 2014 International Conference on Circuits, Systems, Communication and Information Technology Applications, (CSCITA)978-1-4799-2494-3/14/$31.00 ©2014 IEEE.

[2] S.Aravindhand Mr.G.Michael, "HYBRID OF ANT COLONY OPTIMIZATION AND GENETIC ALGORITHM FOR SHORTEST PATH IN WIRELESS MESH NETWORKs", Journal of Global Research in Computer Science, Volume 3, No. 1, January 2012, ISSN-2229-371X

[3] Jaspal Jindal ,Vishal Gupta, "Fuzzy Improved Genetic Approach for Route Optimization inMANET", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 6, June 2013, ISSN: 2277 128X.

[4] Xue-Mei Sun, Xiao-Yu Lv," Novel dynamic ant genetic algorithmfor QoS routing in wireless mesh networks", 978-1-4244-3693-4/09/$25.00 ©2009 IEEE.

[5] Mesut Gunes¸, Udo Sorges, Imed Bouazizi,"ARA – The Ant-Colony Based Routing Algorithm for MANETs",International Workshop on Ad Hoc Networking (IWAHN 2002), Vancouver,British Columbia, Canada, August 18-21, 2002.

[6] D.Suresh kumar , K.Manikandan , M.A.Saleem Durai,"Secure On-Demand Routing Protocol for MANET using Genetic Algorithm",International Journal of Computer Applications (0975 – 8887) Volume 19– No.8, April 2011.

[7] Cauvery N Kand Dr K V Viswanatha, "Routing in Dynamic Network using Ants and Genetic Algorithm", IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.3, March 2009.

[8] S.Nagalakshmi , Dr.Rakesh Poonia , "Ant Inspired Adaptive Routing: MANET Routing Protocols- A Survey", International Journal of Innovative Research in Science, Engineering and Technology,2319-875

[9] Said Elaiwat , Ammar Alazab, Sitalakshmi Venkatraman, MamounAlazab, "GOM: New Genetic Optimizing Model for Broadcasting Treein MANET", 2nd International Conference on Computer Technology andDevelopment (ICCTD 2010),ISSN-978-1-4244-8845-2