Chapter 1: Introduction

1.1 Introduction to MANETS

A mobile ad-hoc network (MANET) is a collection of independent nodes which communicate with each other by broadcasting wavelengths. The model is in MANET mobile that node can be moved from one location to another.The nodes which are in the radio range of each other can directly communicate to each other and the nodes which are far away can communicate by some routing algorithms. Apiece node has wireless crossing point to exchange a few words to other nods. The network is an infrared structure is not that there is no fix for any communication infrastructure.Figure 1.1 shows a sample network of only three nodes.

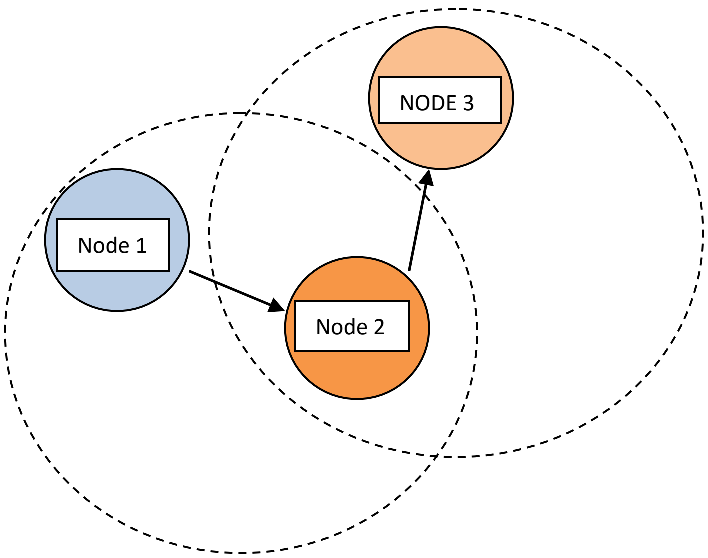

Figure 1.1: A sample mobile ad-hoc network of three nodes.

In the figure 1.1 node-1 and node-2 can directly communicate with each other whereas node-1 and node-3 won’t directly communicate with each other. Node-1 and node-3 can communicate with each other via node-2. This type of announcement wants some routing algorithm to make the communication possible between nodes which are far away with respect to others.

1.1.1 Characteristics of MANETS:-

Ad-hoc arrangement has definite features compared to the rehabilitation of infrastructure. The important characteristics of MANETs are as follows:

1. Dynamic Topology- Nodes of the MANETS can freely move from one position to another with dissimilarhurry.The network topology can vary randomly. In MANET node can route packets regardless of this dynamic environment.Nodes are fit to make any statement possible even after changing their position.

2. Distributed Operation- The control of the network is distributed among all the nodes of the network and there is not any central node which is responsible for all the communication. Each node is equally responsible for making the statementprobable.Nodes themselves can resolve their own.

3, Multi Hop Routing- This means one node can transfer data to other node via several in-between nods. In-between nods can forward the data coming and going from the source node to the destination node. So the multi hop communication is also possible in MANETs.

4. Autonomous Terminal- Each node of the mobile ad hoc network can work as a router or a host. So each node can sent or receive data as well as can forward the data coming from one node and going to some other node.

5. Light Weight Terminals- In most of the cases the nodes in the MANET are small computing devices such as laptops, mobiles etc. These devices are having low CPU capabilities, low power and small memory.

6. Shared Physical Medium- The communication channel has been shared among all the nodes of the MANET.

Advantages of MANETS-Following are the advantages of mobile ad hoc networks.

1. MANETS are forming networks.
2. MANETS are less expensive as compared to fix networks.
3. MANETS provide communication regardless of the geographical region.
4. MANETS are free from central administration.

5. MANETS are scalable networks. More and more nodes can be added in mobile ad hoc networks at any time.
6. MANETS are flexible networks as compared to infrastructure based networks.
7. MANETS are robust because there is not any centralized control.
8. MANETS can be set up at any time and at any place.

1.1.2 Challenges in MANETS:-

1. Dynamic Topology- In MANET network topology is not fixed. A node may be directly reachable from one node at a time while after some time node may not be directly reachable. So every node has to refresh the information regarding their nationals.

2. Limited Bandwidth- Wireless links are having less capability of sending information as compared to wired links. So less bandwidth is provided to MANTES for communication as compared to substructure based networks.

3. Routing Overhead- Every time before sending the date nodes have to find the route of the data packets. As position of the nodes may change with time so routing is not easy in MANETS as compared to fix substructure based networks.

4. Hidden Terminal Problem- It refers to the collision of the data packets at receivers end.The problem is known as the hidden terminal problem.

5. Packet loss due to transmission errors- As wireless links are used for communication in the MANETS so there may be some transmission errors in sending the data between the nodes.

6. Mobility-Induced Route changes- Because of the mobility of the nodes the route for a communication may change at any time. It is a serious challenge in establishing MANETS.

7. Battery Constraints- Normally all the devices in the MANTES are battery ran.These less battery life, after a period of time required to recharge. Power consumption of these battery operated devices is also a challenge in MANETS.

8. Security Threat- Because the wireless communication some new security challenges has been introduced in mobile ad hoc networks which were not present in fix infrastructure based networks.

1.1.3 Application Areas of MANETS:-

Following are the main application areas of MANETS:

1. Military Battlefield- Because MANETS do not need any infrastructure and can be established easily in any geographical region so these networks are very useful in military battlefield to make the communication possible between soldiers, headquarters and military vehicles.
2. Collaborative Work- MANETS are needed by some business enterprises to make the collaborative computing.
3. Local Level- Ad-Hoc networks can make the link between devices at any instance of the time. So these networks are useful to make the communication possible locally i.e. in a conference or a classroom etc.
4. Personal Area network and Bluetooth- A personal area network has short range and limited number of terminals connected to each other. Bluetooth technology can be useful in making connection between devices and these systems also follow the protocols of MANETS.
5. Rescue and Disaster Management- MANETS can be easily creating the communication possible in case of rescue operations in case of a disaster such as flood, fire or earthquake where our normal infrastructure networks fails.

1.2 Routing Protocols in MANETS:-

Routing is a main challenge in MANETS because of the dynamic topology and motivation. The most preferred device is battery powerso power consumption in routing protocols is also a serious issue.In wireless ad hoc network routing protocols can be divided into two main type, as follow:

Types of routing protocols in MANETS:

1. Table driver / Proactive routing protocols
2. Reactive / Source initiated on-demand routing protocols
3. Hybrid Protocols

In the literature there are many protocols which have been proposed in these two categories. The most important protocol in these categoriesis shown in figure 1.2.

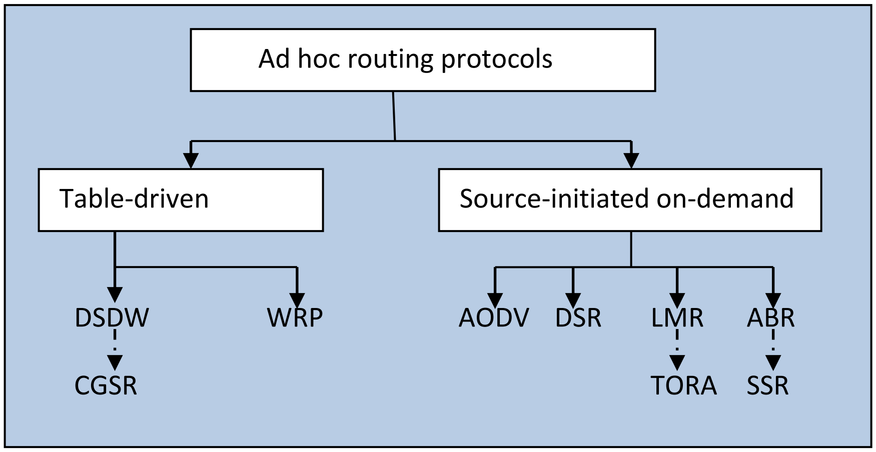

Figure 1.2: Types of ad-hoc routing protocols

1.2.1 Table Driven Routing Protocols-

In Table driven routing protocols every node maintain a table which keeps track of information about the other entire node in the mobile ad hoc network. Each node maintains one or more tables for these facts.To keep the no. of slabs depends on a protocol to the other. Because the dynamic topology and mobility of the network each node has to refresh the table storing information about other nodes with time.

Following are the different types of table driven protocols:

Types of table driven protocols:

1. DSDV Destination Sequenced Distance Vector Routing Algorithm

2. CGSR Cluster Gateway Switch Routing

1.2.1.1 DSDV Destination Sequenced Distance Vector Routing Algorithm

DSDV Destination Sequenced Distance Vector Routing Algorithm is mainly based on distributed Bellman Ford DBF algorithm. It makes some improvements in DBF algorithm. In DBF algorithm the formation of looping routes and counting to infinity problem were the two major problems. DSDV algorithm removes the looping problem and guarantees in loop free communication between nodes. In DSDV algorithm each node maintains a routing table which consists of the information about all the other nodes in the network. DSDV algorithm maintains the following information in the routing table:

1. The address of the destinations
2. The number of hops needed to reach the data to that destination (Hop count)
3. The sequence number stamped by the destination node.

In DSDV protocol when a node A comes into the network it sends a “I am alive” message in the network. It also marks the new sequence number on that notification. As soon as other nod gets the notification, they check in their respective node-A routing table entries.If they not have any entry with the name-A then they make the new entry for the new node A and also write the hop count needed to communicate with the node A. If the nodes already having the entry for node-A in their routing table then they compare the sequence number with the entry. However sequence no. differs, then they informs the node A entry in the routing table. Fresh information node receives plans to be forwarded to other nodes in the network so that the other nodes can also make the changes in their steering table.Other nodes can route the packet with this new topology. As A moves then A also have to change routing table according to new nationals. A also changes it routing table as A receives new beacon messages from its current nationals and does not receive beacon messages from itpreviousfellow.

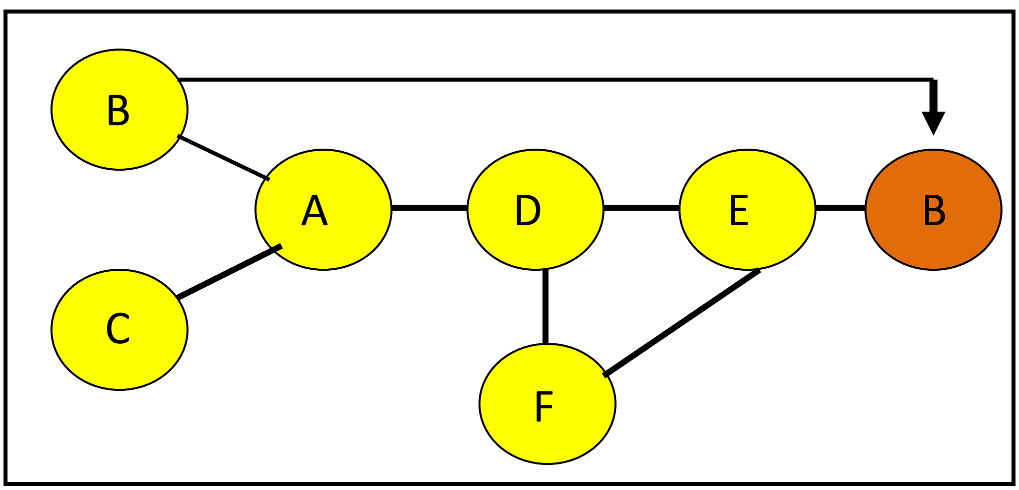

Table 1.1 A’s Routing Table before Change

Destination	Neighbor hop	Distance	Sequence Number
A	A	0	S205_A
B	B	1	S334_B
C	C	1	S198_C
D	D	1	S567_D
E	D	2	S767_E
F	D	2	S45_F

Table 1.2 A's Routing Table after Change

Destination	Neighbor Hop	Distance	Sequence Number
A	A	0	S304_A
B	D	3	S424_B
C	C	1	S297_C
D	D	1	S687_D
E	D	2	S868_E
F	D	2	S164_F

In case of absence of transmission notification within a definite time interval, the link should be broken. Now the next hop for that neighbor is immediately assigned to a infinite matrix. Infinite matrix is any number greater than the maximum permitted figures. If the neighbor node has been selected broken link node as intermediate node for any communication then they also set the route to destination as infinity. Some sequence numbers generated by then hosts are even numbers and the sequence numbers generated to indicate infinite metric are odd numbers. So with the even & odd sequence no the problem of infinite loop got resolved. The concepts of sequence number ensure the loop free routing.

1.2.1.2 Cluster Head Gateway Switch Routing CGSR

The Cluster Head Gateway Switch Routing CGSR protocol differs from the other protocol in the way that it uses the clusters concept. CGSR is a multiple hop routing scheme that many heuristic directingsystems.Events cluster head is controlled in multiple nodes of the cluster.It controls the code parting, channel contact, directing and bandwidth sharing. A circulated algorithm is used to select a node as the head of all the nodes in band. The coredrawbacks of this system is that when frequent cluster changes taken places then the routing is not easy and the performance of the CGSR routing protocol decreases.

Another optimization of CGSR is LCC Least cluster modify structure. When LCC group head only modifytwo cluster heads comes very close to each other or a node goes out of scope of all cluster heads. Gateway nodes are the nodes that are within communication range of two or more cluster heads.

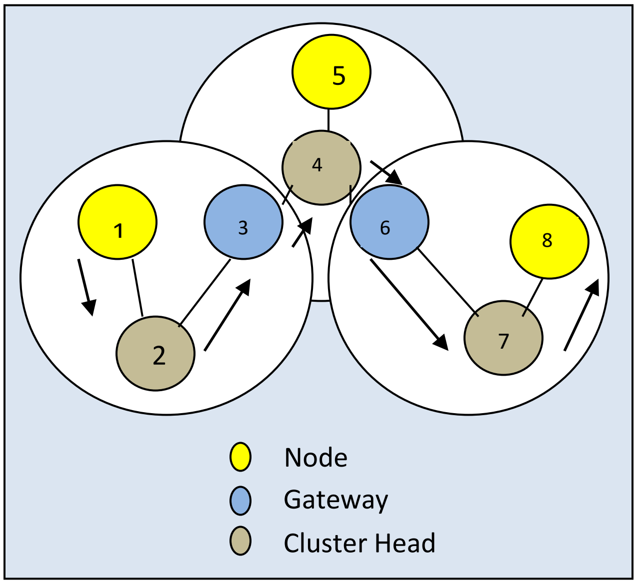

Figure 1.4:-CGSR: routing from node 1 to node 8.

A packet send by one node is first reaches to the node selected as the cluster head of the sender node. Then the packet is routed from the cluster head of this node to the cluster head of the second cluster through the gateway node. The packet is keep on going until it does not reaches to the cluster head of the receivers node and finally to the destination node from the cluster head of the destination node. The figure shows the functioning of the CGSR algorithm.

For example let suppose node-1 is the sender node and node-8 is the receiver node as presented in figure. The packet in progress its passage from node 1 and reaches to node 2 which is the cluster head of the nodes 1, 2 and 3. Then it reaches to the common gateway node which is the node-3 and then from noide-3 to node-4 as node-4 is the cluster head of the 2ndgroup. Then it reaches from node 4 to node 6 as node-6 is the gateway node of 3rd cluster. From node-6 it reaches to node-7 which is the cluster head of the 3rdbunch. From node 7, it finally reaches node 8 which is the target node.

1.2.2 Source Initiated On Demand Routing

In on demand routing protocol also called reactive protocol the routing information is found when one needs to send information to other node. When a node needs a route from it to any destination then that node initiate a route discovery process within the network. The process is completed when needed route is found after examining all the possible routes. Once route is founded the route is maintained by a route maintenance procedure until the destination is not reachable from any of the route or need for route has been lost. There are many protocols which are based on source initiated on demand routing.

Types of source initiated on demand routing protocols:

1. AODV Ad hoc on demand distance vector routing
2. DSR Dynamic Source Routing Protocol
3. ZONE Routing Protocol ZRP

1.1.2.1 AODV Ad hoc on demand distance vector routing (AODV)

AODV Ad hoc on demand distance vector routing (AODV) is based on the DSDV.AOD is based DSDV, as it will reduces the broadcast mug needed to maintain the routing information between the nodes for which it is not requiredup till now.Before AOD not continue looking for routing between nodes, unless it is not needed

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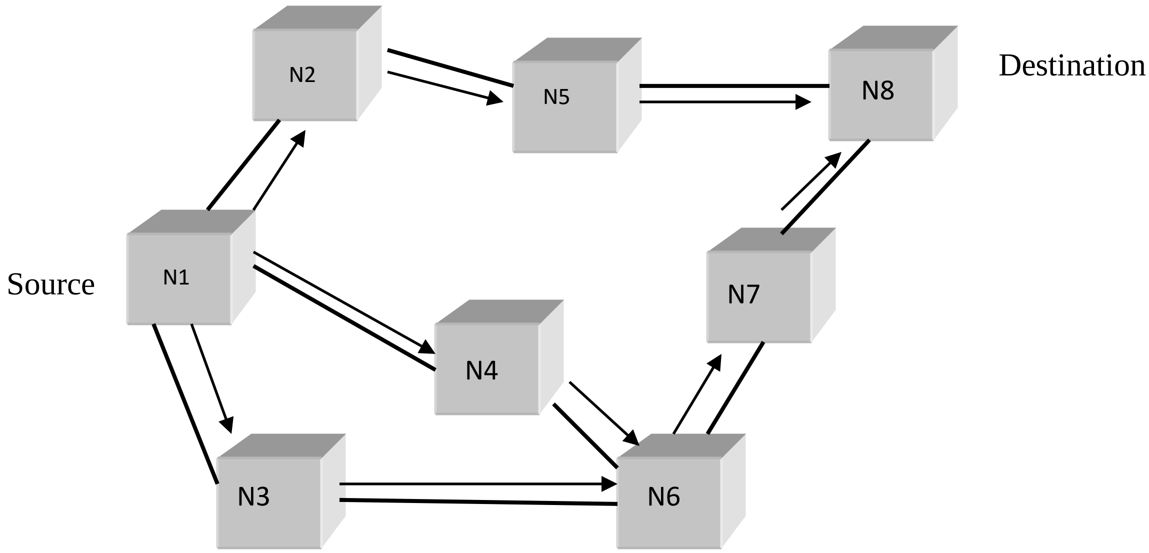
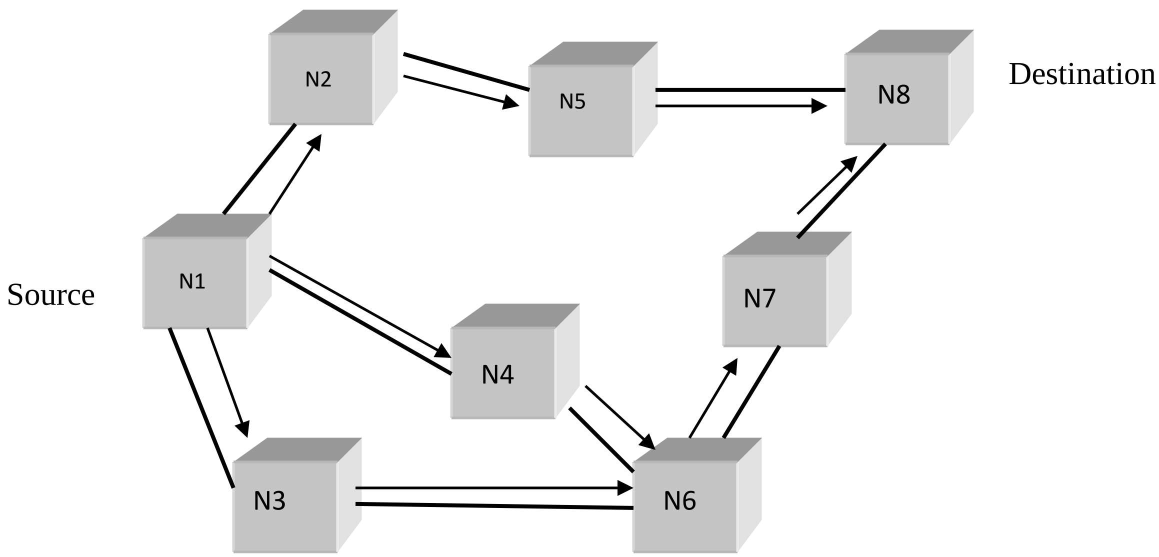


(a) Propagation of the RREQ



(b) Path of the RREP to the source

Figure 1.5:AODV routing protocol

In AODV protocol when a node need to find the path to other node then it initiates a route discovery process. For route discovery process it refers a RREQ route request packet top all its nationals' nodes. The RERQ messages are also forwarded by all its nationals to their nationals until it does not reaches to the destination or to an intermediate node which knows the route to the end. AODV practicesendpoint system to ensure all routes is loop free and contains the most recent route information. Figure 1.5 (a) and (b) demonstrate the process of path outcome. If transitional nods recognizedsome copies of the RREQ packet then these nodes discarded the copy after receiving the one RREQ message. When receiving the

RREQ message the intermediate nodes can find the reverse path by using the RREQ message and their routing table.

Once the RREQ message reaches to the destination node then destination node found that the source node initiates the route discovery theory.The endpoints nodes then lead the path response pack RREP to the sore nod. RREP packet trails the opposite path of the RREQ packet as shown in figure 1.5(b). Once the RREP packet reaches to the source node then source node found the route to send the data to the destination. Now the source node can send the data to the destination node via the found route. An additional overhead of AODV protocol is that the nodes have to send “Hello” message to find the nationals nodes which are one hop away from it.

1.2.3 Dynamic Source Routing Protocol DSR

The dynamic source routing protocol is an on demand routing protocol which based on the concept of source routing. In this protocol mobile host are required to maintain a route cache that constrains the source routes about which the mobile host is aware. The host is keeping on updating the route cache when new routes are learned.

When a node needs to find the route to a destination node then it first checks it route cache. If the route cache of the sender node contain route to the given destination then it uses that route. If not any route found in the router cache to the specified destination then the source node initiates a route with the help of process of discovery. In the route process of discovery the sender node sends a route discovery packet to all its neighbor nodes until route request packet reaches to the destination node or to node which knows the path to the end nod. The transitional node chokedwhither the destination node address on the route request packet is the address of its own or there is route from the intermediate node to the destination node then it sends the route reply message back to the source node by using the reverse path. In other case the intermediate node will forwarded the route request packet to its nationals. Before forwarding the route request packet the intermediate node also added its own address on the packet so that reverse path able toinitiate. Figure 1.6 show the routeof DSR process.

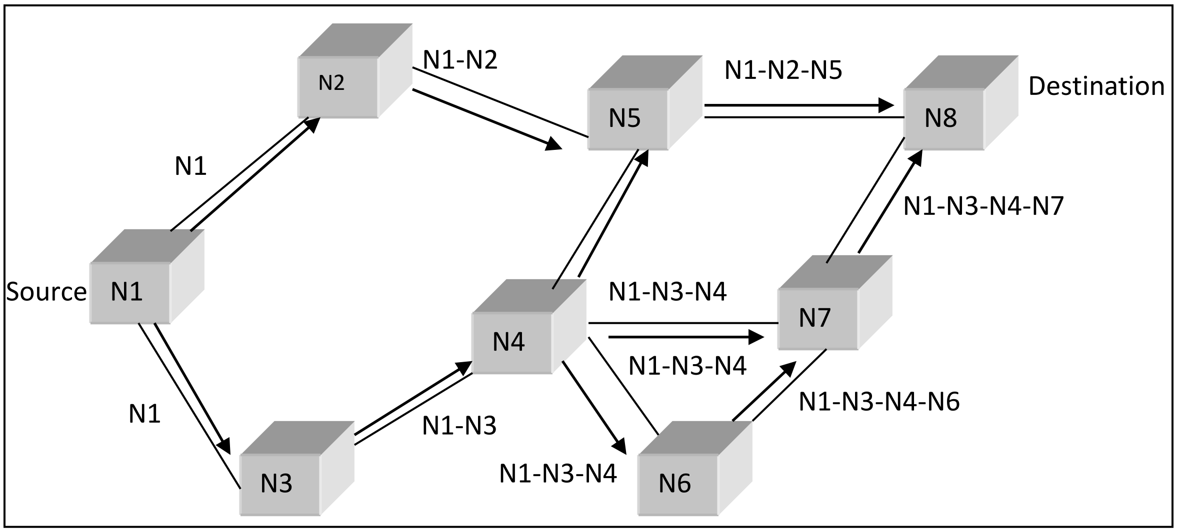


Figure 1.6 (a) : DSR routing protocol

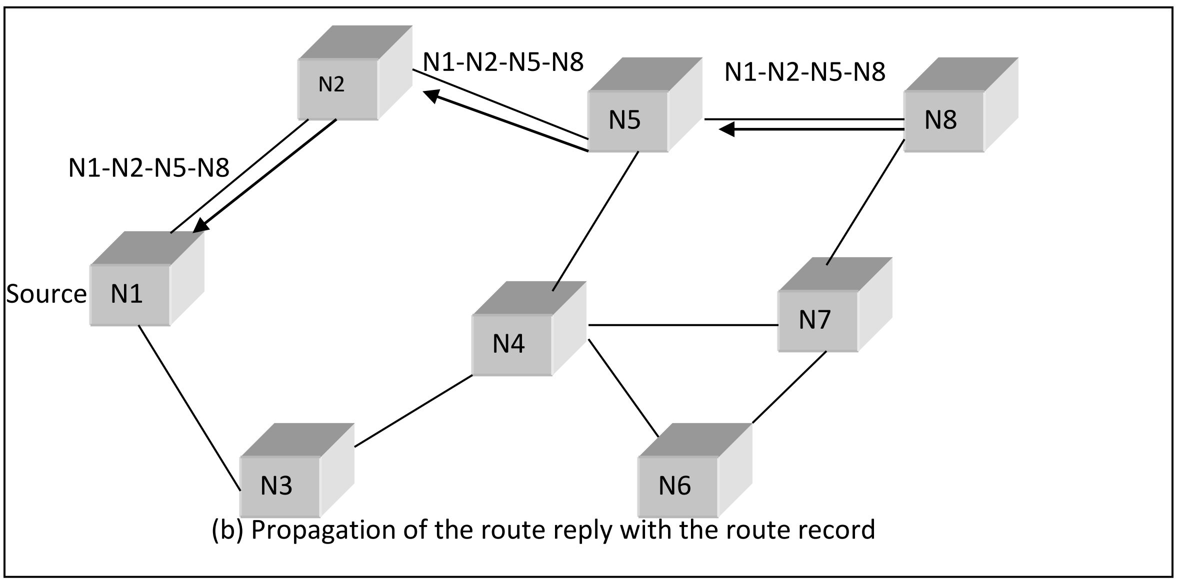


Figure 1.6 (b): DSR routing protocol.

When the source discover the route then it add the route in its route cache for future use. The route maintenance is done by route error packets and acknowledgements. Route error packets are sent from a node when the link between the two nodes encounters a transmission problem.

1.2.4 Hybrid Protocols

These protocols combine the proactive and reactive routing protocols and try to find the optimal solution using the advantages of both the protocols. ZRP is a very popular protocol in this category.

1.2.4.1 ZONE Routing Protocol ZRP

Proactive routing protocols use large bandwidth in maintaining the routing information whereas reactive protocols suffer from long route request delay. Reactive protocols can also flood the network with packets in route discovery process. ZRP tries to confine the both protocols to find a suitable explanation.The ZONE protocol divides the networks in to many zones with radii 1 & 2 & 3…...In many cases, the data packets will be forwarded to a wireless ad hoc network in the neighborhood. It 1^{st} then tries to discover its destination from the nodes which are 1 hop away from its sender. Then it will discover the route to its destination nodes which are 2 hopsaway. Thus it split the web in different zones as 1 hop, 2 hop, 3 hop and more, away from the cause. Figure shows a network with zone routing protocol.

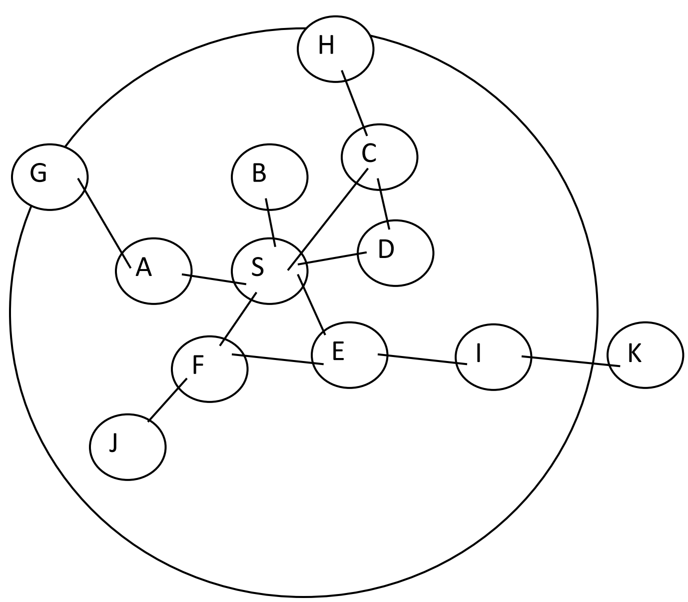


Figure 1.7: Zone routing protocol with radius = 2

Table 1.3 Comparison of various routing protocols

Serial No.	Parameters	On Demand protocols	Table driven protocols
1	Routing information	Available on demand	Always available
2	Routing Philosophy	Flat	Mostly flat except CGSR
3	Periodic Route Update need	Not required	Required
4	Mobile Handling	Use local route discovery	Inform other nodes to achieve a consistent routing.
5	Signaling Traffic	Grows the increasing size	Greater than on demand routing.

Chapter 2: Literature Survey

Literature Review:

[**9**] **N.Kumar and C.Suresh Gnana Dhass** present a survey on mobile ad-hoc networks. In existing literature routing in mobile ad-hoc networks can be categories into three major categories such as proactive, Reactiveand Hybrid protocols. Further author following major application areas of mobile ad-hoc networks:

Application areas of MANETS

1. In search and rescue operations.
2. Making some decisions in battlefield.
3. Data acquisition system in some operations such as hostile terrain etc.

Further author found some challenges for mobile ad-hoc networks which are:

1. Multi-hop transfer of data
2. Dynamic network
3. Limited resources such as processing speed, battery life, available bandwidth etc.

Authors direct that routing is a major problem in mobile ad-hoc networks. Author used also some key issues in optimization of routed protocols.

1. To maximize the throughput of the network.
2. To minimize the delay between packets.
3. To maximize the lifetime of the network.

Author toocounsel an energy prototype for the MANET and suggest that the nodes in any of the following four energy states:

1. Transfer state: The node is transferring some data
2. Receive state: Node is receiving some data
3. Idle state: Node is sitting idle.
4. Sleep state: Node goes in sleeping state. It does not participate in any communication and also not listening to different messages.

In all the states the energy consumption of the nodes of the MANETs is different.

The author proposes that there are four possibilities of saving the power of the nodes.

1. Minimum energy consumption per packet.
2. Maximize the network connectivity
3. Minimum variance in the power levels of the nodes.
4. Minimize the maximum cost of the node.

Further author explains different protocols for proactive, reactive and hybrid categories. Numerous key issues, advantages and disadvantages for different protocols have also been advised.The authors concluded that any agreement is not the most suitable in all cases. Some protocol may be better where the mobility of the nodes is high whereas other protocol may be better where mobility is low. Also some protocol may be better where node density is high whereas other protocol may be better where node density is low.

BijayGuragain [10]presents a power efficient routing protocol for mobile Ad hoc Networks. The author consider following three points while optimizing the routing process in Mobile ad-hoc networks.

1. Residual Battery Capacity of the nodes
2. Transmission Power of the node
3. Hop count to route the data packets.

The author proposed a new algorithm named PER to transfer packet in MANET. The ago introduce the following issues while transferring the packets in the network:

1. Packet delivery ratio.
2. End to End delay.
3. Energy consumption in sending data.
4. Lifetime of the network.

According to the algorithm if the residual battery capacity RBC is above the threshold value then the node is qualified and able to broadcast the RREQ packet otherwise reject it. Following diagram expoundthe effect of threshold value while selecting nodes to forward the RERQ packet.

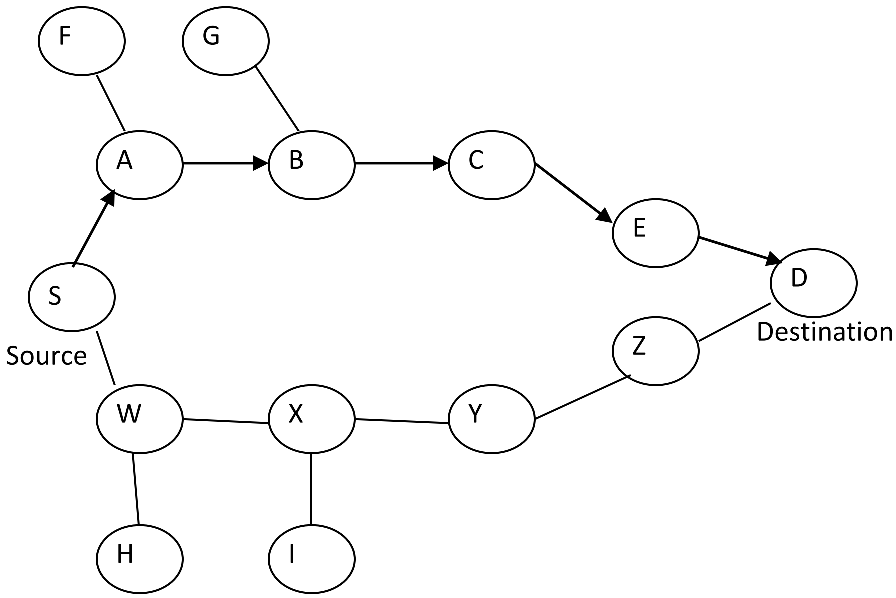


Figure 2.1: Route Request with Adaptive Threshold.

The cost of any route can be calculated as

$RC_i = 1/RBC_i$, Where RCi – Route cost of ith route and RBCi is residual battery capacity of ith node.Efficient route is the route with minimum route cost and efficient route cost can be calculated as

ERC = Minimum route cost of all the routes.

The author implemented the algorithm on a simulator. The following parameters have been taken for simulation:

Table2.1: Simulation parameters.

Parameters	Values
Number of nodes	100
Transmission range	250m
Topology size	100m x 100m
Number of destination	1
Traffic Size	Constant Bit Rate(CBR)
Packet size	512 bytes
Packet rate	5 packet per second
MAC layer	802.11
Bandwidth	2 Mbps
Nodal placement	Uniform
Initial energy for all nodes	0.5J
Transmit power	0.660W
Receive Power	0.395

Nodes Mobility	0-30m/s
Mobility	Random waypoint model

The author concluded the mobility and energy consumption of AODV and proposed PER rules. The resulting table explains the varianceamid AODV and PER system.

Table2.2: Energy vs. mobility in AODV and PER algorithms

Mobility(m/s)	AODV	PER
0	0.0000	0.0000
5	0.2252	0.0373
10	0.2391	0.1847
15	0.2658	0.2064
20	0.2743	0.2016
25	0.2917	0.2709
30	0.2854	0.2638

The table below shows that the energy intake of PER algorithm is lower than the AODV algorithm.

Author also compare the lifetime of the network in case of AODV and PER. The table shows the difference:

Table2.3: No of nodes-time in AODV and PER

TIME	AODV	PER
0	100	100
100	100	100
200	100	100
300	96	100
400	90	94
500	83	90
600	61	80

The author explain that the proposed PER system is better than the existing AODV protocol in terms of mobility and lifetime of the network.

[1] Anjum Asma proposed an energy efficient routing algorithm for maximizing lifetime of MANETs. The authors optimize the algorithm after analyzing two metrics: (1) Total transmission energy of a route (2) Maximum number of hops.

Author consider following design considerations in the algorithm:

1. Initial battery energy (IBE) is 50 Jules for every node.
2. Node can calculate the residual battery energy RBE.
3. Nodes can keep track of previously used paths.
4. Algorithm consider all possible paths in the beginning.
5. The energy consumed in receiving is not considered.
6. The network lifetime can be considered as the time when no path is available to transfer data.

The algorithm work in following steps:

The virtual program for this proposed algorithm is as follows:

STEP1:Generate all the likely routes.
STEP2: find the TE_{nod} node of each route.
STEP3:check the below condition for each route till no route is available to transmit the packet.

If ($RBE<=TE_{nod}$)
Make the node into sleep mode.
Else
Select a whole path which hasdynamic nodes.
End
STEP4:
Compute the whole broadcastangry for every labeledpath.
STEP5:Select the energy efficient route on the basis of minim total transmission energy of the route.
STEP6:calculate the RBE for every node of the particular route.
STEP7:GO TO STEP3.
STEP8:end.

The authors deliberate the whole algorithm and draw the following results:

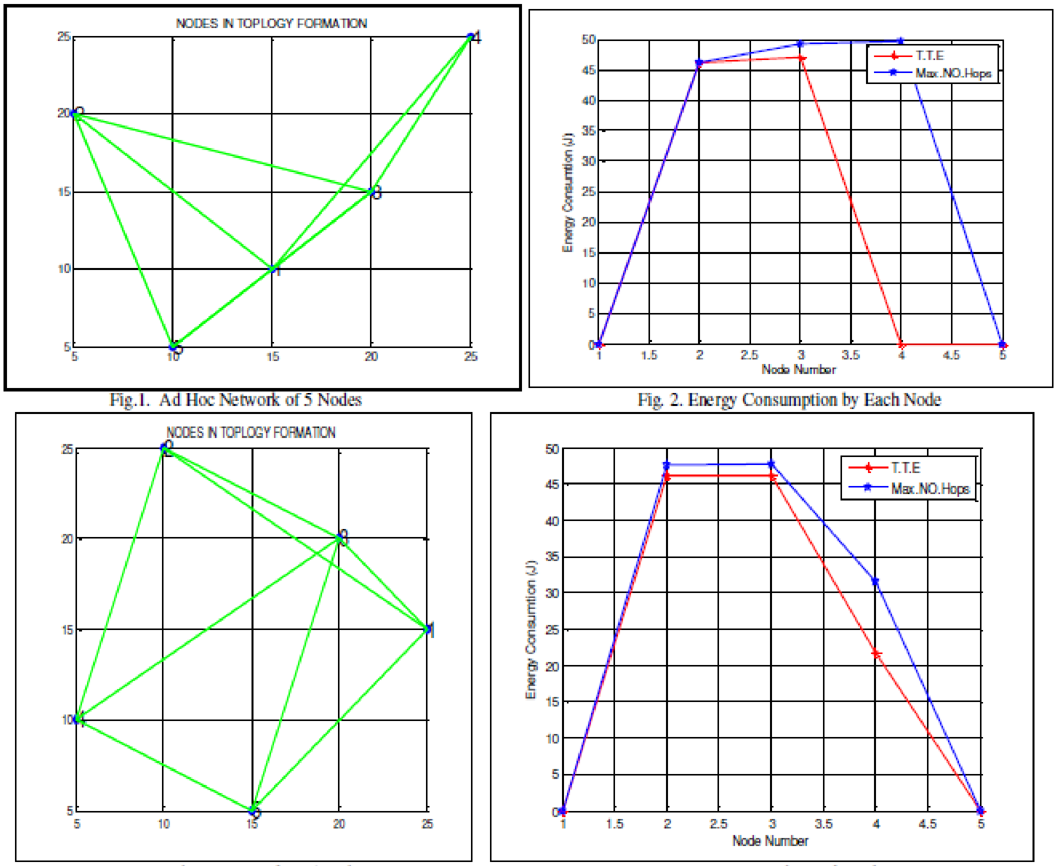


Fig.1. Ad Hoc Network of 5 Nodes

Fig. 2. Energy Consumption by Each Node

Fig. 3. Ad Hoc Network of 5 Nodes

Fig 4. Energy Consumption by Each Node

Figure2.2: The simulation results of algorithm.

It can be concluded from the results that the algorithm proposed by [1] works better for the total transmission energy metric as compared to maximum number of thatlegs matrix. Additional the graft has been counterfeited for a small network of 5 nodes and need to be simulated for a binger network.

Sangita Kurundkar and Aporva Maidamwaar [2]proposed an improved AODV routing protocol for mobile ad-hoc networks'. They proposed a stable factor which observes and stabilize energy among the nodes and delay reduction mechanism which reduces the average end-to-end delay of the network. In this proposed and improved AODV (I-AODV) protocol the stabilizing factor can be found as follows:

Stability factor (SF) = Remaining energy of a node/ Initial full energy of a node.

If the SF factor of a node is higher than a threshold then only the node will process a RREQ message otherwise discard it.

The flowchart of the work has been given in the figure.

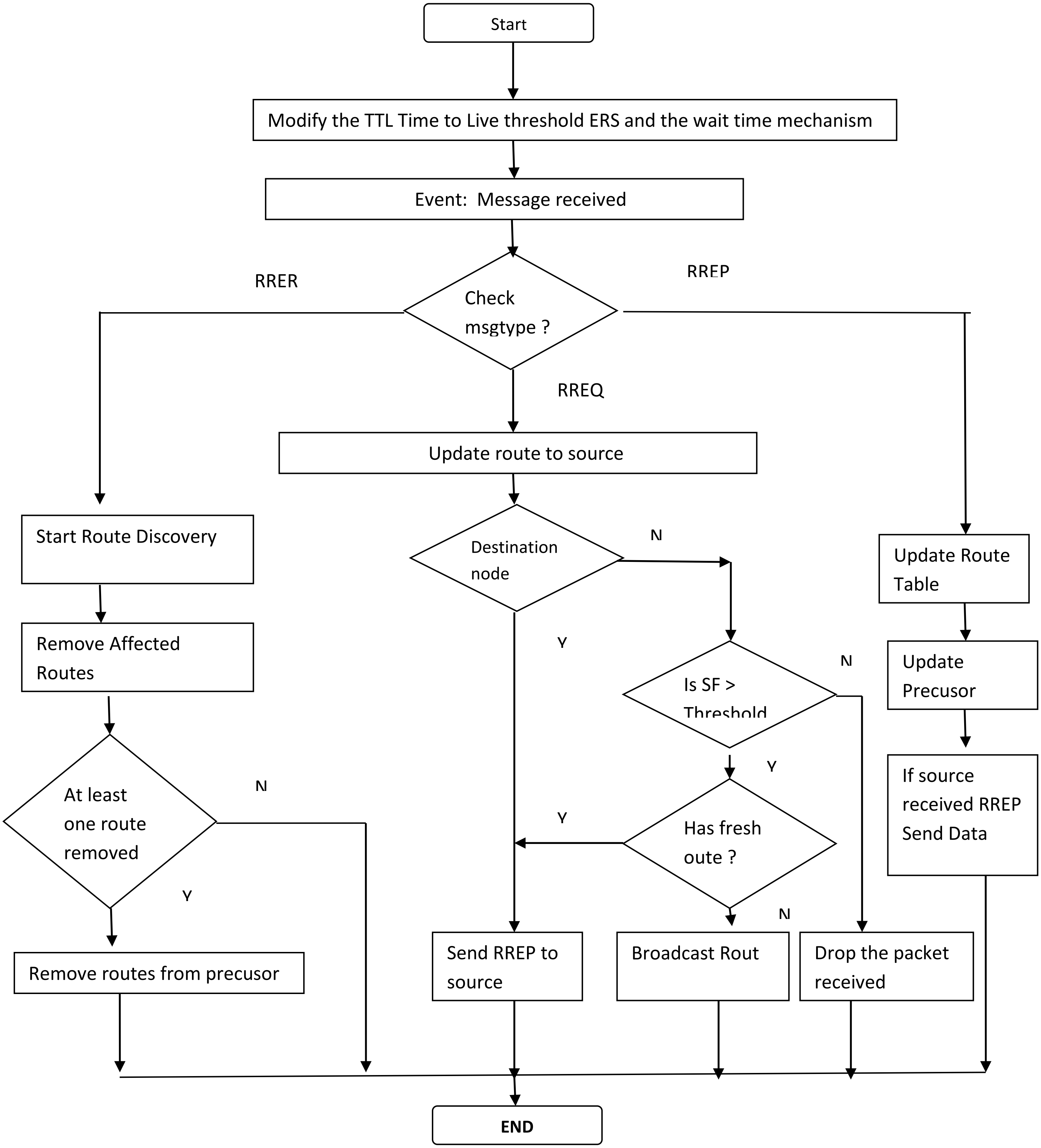


Figure2.3: Flowchart of improved - AODV protocol

The proposed I-AODV systems also optimize the ERS mechanism for faster route discovery by using TTL Time to live constraint. Initially TTL will be set to no.1. If the nodes with hop count 1 are not able to find the destination node then the TTL is increased to 2 to find path till destination with hop count 2. If nodes in layer-2 are still not able to find the destination node then TTL is further increased to 3 and the RREQ message is flooded in the network.

The proposed I-AODV protocol has been simulated in NS-2 simulator and results shows that the algorithm is able to reduce the energy and end-to-end delay by near 7-24 in percentage. Added the I-AODV system is appropriate for applications in which packet of different sizes are to be sent.

[3] Sonia Ahuja and Sukhpreet Kaurproposed an energy efficient approach for routing in mobile ad-hoc networks using genetic algorithm and ACO Ant colony optimization. The author tries to apply GA and ACO for multicast routing in mobile ad-hoc networks. Author proposed a hybrid algorithm of genetic and ant colony optimization techniques. The steps of the proposed algorithm are as follows:

Step 1: Define numbers of nodes in the network.

Step 2: Put on optimization process in hybrid algorithm.

Step 3: Apply GA & ACO as follows.

3.1 Define chromosomes and ants which are equal to numbers of nodes in the networks'.

3.2 Apply nodes fitness using GA or check distance and energy factor.

3.3 Share pheromones or shortcut distance and take maximum ants or leader ants.

3.4 Check fitness and select node.

3.5 Find crossover results or accordingly to appropriate range.Learnmakeoveroutcome.

3.6 Combine both pheromone and P best value.

3.7 Find G best value according to above condition.

Step 4: End.

The proposed algorithm works for the following three parameters:

1. Delay: Transmission delay.
2. Throughput: The rate of successful message delivery.
3. Cost:Cost to transfer the data with best path.

The above proposed algorithm has been simulated in NS-2 and results have been analyzed. The results shows that lifetime of the network are improved by optimizing the path by using Genetic Algorithm GA and Ant Colony Optimization ACO.

[4] P.Prasanna proposed an energy efficient multicast routing based on genetic algorithm for mobile ad-hoc networks. The proposed algorithm works on two factors:

(1) End to End delay

(2) Minimum energy cost of the multicast tree.

In literature LDT Least Delay Multicast Tree algorithm is the best algorithm and it has low cost as compare to the AODV algorithm. But the serious drawback of LTD is that its running time is more. The intended here processhas following processes:

1. Extended ST encoding
2. Generation of Initial population
3. Evaluation of fitness
4. Selection of parents
5. Crossover operation
6. Mutation Operation

After applying the above process the algorithm find the best path to transfer data. The following parameters have been analyzed on the results of the implementations:

PDR Packagetransfer ratio.

End to end delay and energy spent.

The results have been compared with LDT and AODV protocols. Graphs are generated on the outcomes. :

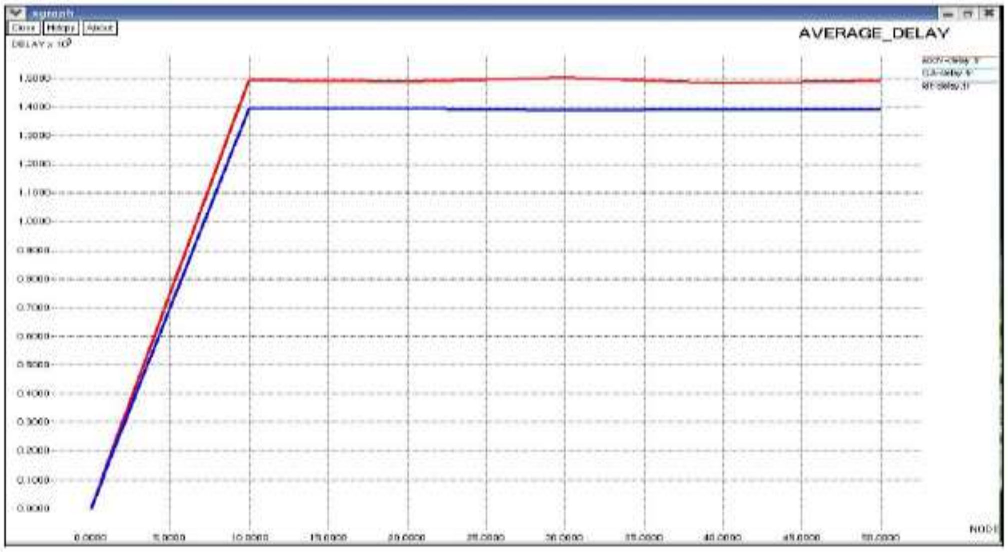


Figure2.4: Comparison of delay between AODV, LDT and proposed genetic algorithm.

It’s been cleared form the graph that projected GA algorithm ensures minimum end to end delay.

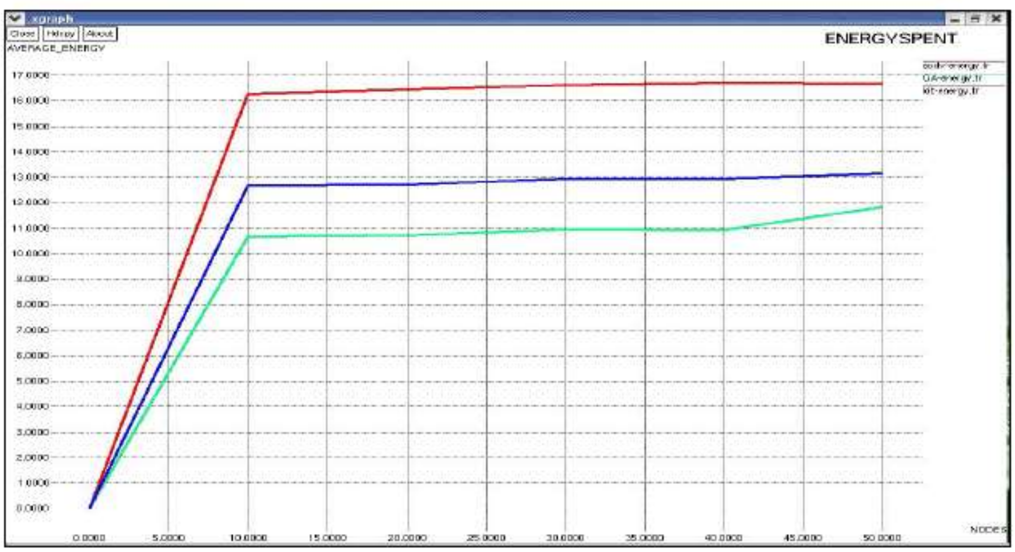


Figure2.5: Comparison of energy spent in the course of AODV, LDT and proposed Genetic Algorithm.

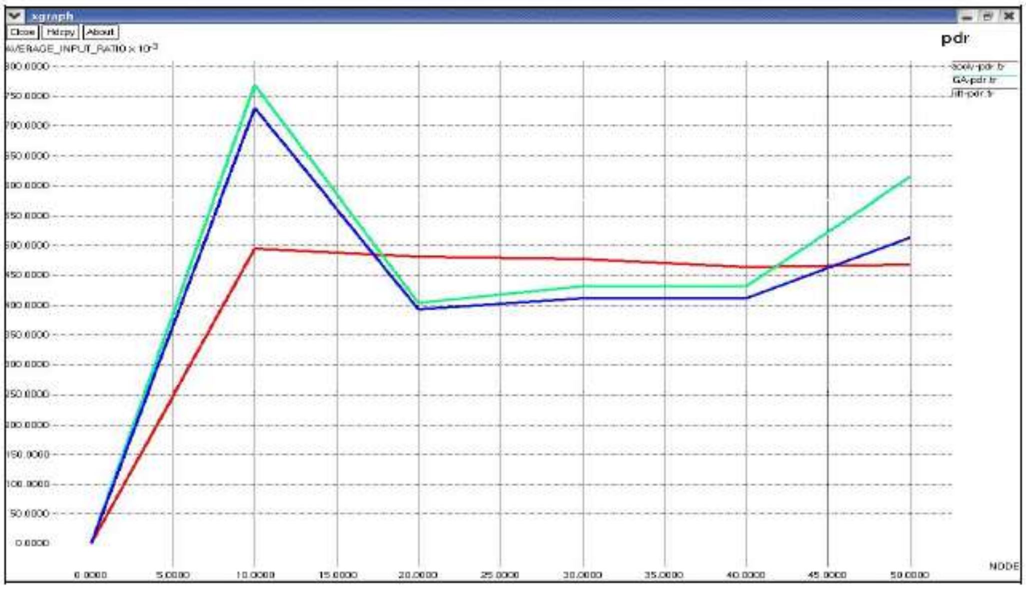


Figure2.6: Comparison of PDR between AODV, LDT and proposed Genetic Algorithm.

It is clear from the figures that LDT has low energy spent as compare to AODV and in proposed GA based algorithm energy spent is less than the LDT process.GA also suggested routing algorithm has higher compared PDR, LDT and AODV protocol.

[5] Priti Gaurrecommends an implementation of multicast routing using geneticprocess.The authors suggest a new route burst throughstrategy;contract to deal with the dynamic nature of mobile ad-hoc set-up. QoS parameters in a quantity ofthe work MANET routing. Authorprovides a view on the features of the multicast network which are as follows:

1. The host can be a member of any multicast group.
2. The membership of a host with a multicast group may also change.
3. A node may send the data to the members of the same or some other multicast group.
4. UDP user datagram protocol is used for data communication.
5. Each multicast group is defined by a class.

The multicast application may be any of the following classes:

1. Single point to multipoint
2. Multi point to multi point

3. Multi point to single point.

Author proposed following algorithm for the routing process in multicast ad-hoc networks:

1. Generate initial population.
2. Calculate distance for each member of the population.
3. Check whether to terminate the process or not if yes then go to step 8 otherwise go to step 4.
4. Perform the genetic operators: selection, cross over and mutation.
5. Generate next generation.
6. Remove invalid set of nodes.
7. Goto step 3.
8. Stop.

The author uses following parameters for the simulation:

Parameters	**Description**
No of nodes	20,40
Mobility model	Randomewalk2dmobmodel
Simulation time	50 sec
Simulation size	500X500
Routing protocol	ADOV and genetic
Lossmodel	Fixed loss mode
Data rate	500kb/s

Table2.4: Simulations parameters for genetic algorithm.

[6] Gihan Nagib and Wahied G. Ali proposed network routing protocols using genetic algorithms. Author tries to disclose the best path using geneticcoordination.This work has been with the famous Dijkastra system was compared to find the minimum path between two nodes.

The ersatz code of the wished-for algorithm is as follows:

BEGIN

Initializes *start and end point*

Generates*the original inhabitants using via*

Node in every gene

Whilenot *(conjunction state)****DO***

Evacuate*the suitability for every gene in recent populace*

Rink*the populaceby the suitablestandards*

Eliminate'*the minor peak suitable gene*

Duplicate'*the uppermost suitable gene*

Apply'*randomcrows over amongcurrants parent using the detailed opportunity*

Apply'*the conversion system within given possibility*

Generates'*the unique occupants*

END

Outcome is the best singular found

END

The figure showing the network topology for simulation is shown in figure.

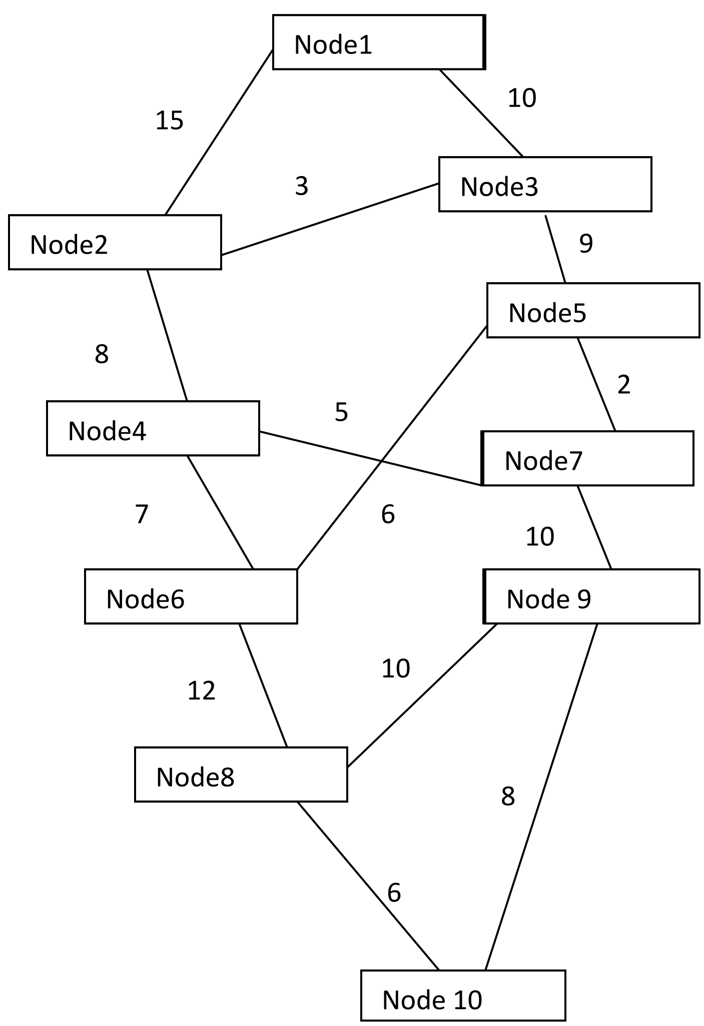


Figure2.7: Network topology to perform simulation using GA

The cross over operation is as follows

Parent-1: 1-3-5-7-9-10

Parent 2: 1-2-4-7-9-8-10

The new-angleproducedas follows:

Child-1: 1-3-5-7-9-9-10

Child-2: 1-2-4-7-9-10

Using the above cross over method the more and more iterations can be performed to find the finest path. It has been concluded that for slighter network Dijkastra algorithm works same as the GA but in larger networks GA based routing scheme can found optimal or near optimal results in less time.

[7] Anjum A. Mohammad and Guhan Nahib proposed optimal routing in ad-hoc networks using genetic algorithm. The developed new algorithm is compared with existing Dynamic Source Routing DSR.

The proposed algorithm is as follows:

Step1: The constraint limits is set for the sp routes.
Step2: Arbitrary values are generated between limits.
Step3: The value of generate routes are put into the objective function.
Step4: The fitness evolution is done for the various routes.
Fmax (n, 1)= max (FX (n, 1))
Fmin(n, 1)= min (FX (n, 1))
For i=1: z
Ft(i,1)={fmax(i,1)–Fmin (n, 1)} – FX (n,1);
End
Ft. =mean(ft);
i=1: z
End

step5: The best fit is calculated based on the above eq.
step6: Selection based on the route wheel concept is done. The value proving is the best fit being given a higher percentage on the wheel area.
Step7: Crossover is performed on strings using mid-point.
Step8: Mutilation is done if serial iteration values are the same.
Step9: The new routes that satisfy the object of minimization and related parameters are planned.
Where, FX is the opinion and ft is unvaryingFX.

Evaluation of aptness: The fitness of a route is the cost to transfer data via that route.

Richness of Best fit: Path having the lowest route cost is the most fit chromosome in the population.

The network topology on which implementation has been made is shown in figure:

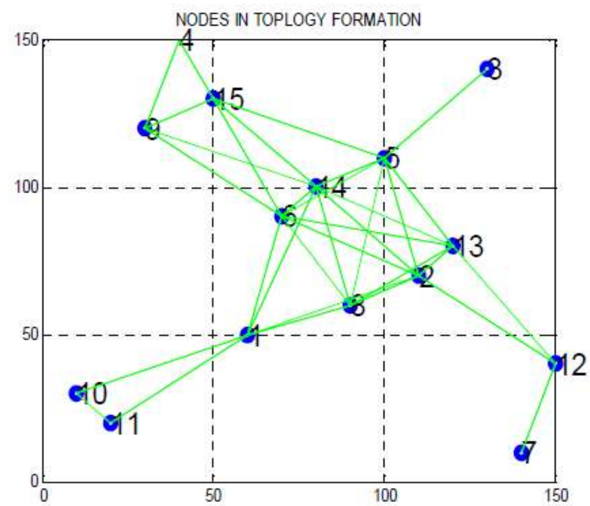


Figure2.8: Network topology for the implementation

Around 15 nod in the model network.

The proposed algorithm has been implemented using MATLAB and results' have been evaluates. A graph has been drawn between DSR and predictable algorithm that represent stays between end-to-end delivery and transmission range.

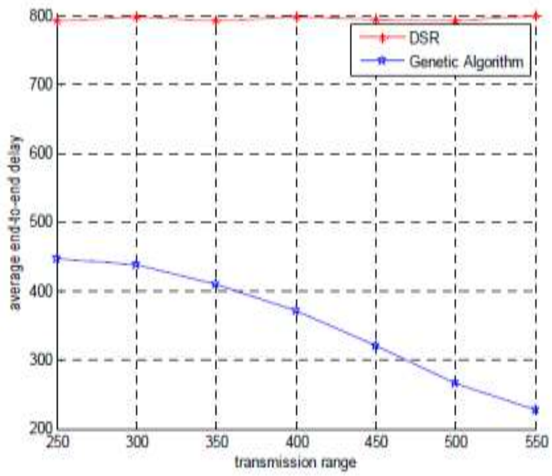


Figure2.9: Average end to end delivery delay vs. transmission range

The graph shows that the proposed genetic algorithm the delay is less as compared to DSR algorithm.

[8] Annapurna P Patilproposed an energy efficient routing protocol for MANETS based on AODV. Author reviews the cost metrics as follows:

Table 2.5: Energy related cost metrics

Metrics classification	Objectives	Drawbacks
Total transmission power	minimize energy consumption	May cause node deletion
Remanding energy capacity	Evenly distributed energy depletion	Does not certifyleast energy cost path
Estimate nodes life-time	Likewise tiredness	Do not ensure least energy path
Combination	Tradeoff between power consumption and fairness	Hard to find perfect tradeoff

The author tries to combine two existing protocols and then compare the results of the combined protocol with existing protocol. Author used following metrics to improve:

1. Packet delivery ratio
2. Throughput
3. Network lifetime
4. Average energy consumed

Two energy metrics author tries to combine are Transmission power and continuing energy capacity. After sending the RREQ packet and receiving the RREP packets the node alternate between the maximum remaining energy capacity and minimum transmission power.

2.3 Problem Statement

Routing is a major challenge in mobile ad-hoc structure.It has been piercing out in the literature, most devices in a wireless ad hoc networks is battery powered. The power of battery is an important source in MANETS. The lifetime of the networks depends upon the power consumption of the nodes in the network. Routing algorithm must consume the battery power of the nodes of the MANET efficiently.

The power consumption in transferring data in MANETS is contingent upon the performance of the routing algorithm. Numerousalgorithm has been proposed in literature to deal with thestruggle like this. It’s been detected that there is a requirement to enhance the rooting process, so that the power node can be stored

In this thesis work an attempt has been made to find an optimal path that uses the battery life of the nodes efficiently. Genetic algorithm can be used to solve heuristic optimizationcomplications.In this paper is that the genetic algorithm new power aware routing protocol proposed. Here in the new algorithm that we used, tries to deal with two problems which are as follows:

1. Finding efficient route to transfer data between nodes of the MANET that consumes less power.

2. To provide alternate paths when one route get failed because of the mobility problem of mobile ad-hoc networks.

Chapter 3: Proposed Work

3.1 Basics of Genetic Algorithms

Genetic Algorithm (GA) is an optimization skill which uses special operators such as selection, reproduction and mutation to solve problems which are difficult to solve by using traditional techniques. GA works on some optimization function which may be a contraction function or expansionutility.The elementary idea of inherited processes forwarded from medical science have been taken, one of the characteristics of a population group to the next. Prior on the hereditaryprogression a difficulty must be able to be represented in genetic form so that genetic operators can be applied on it.

The basic genetic algorithm is as follow:

Begin

INITIALIZE inhabitants with arbitrarycontender solution;

EVALUATE each candidate;

Repeat'

SELECT parents;

RECOMBINE sets of parent

MUTATING the consequential child;

EVALUATE chidden;

SELECTINGsingular for afterwardpeers;

Unstill TERMINATON-CONDITON is fulfilled

End

The genetic algorithm is a special generate and experimentalmethod. That experimental process from a set of sample solution to the problem is called original inhabitants. This originalpopualtion isequippederratically. Then different genetic operators such as selection, recombination and mutation can be applied on the population repeatedly till some terminating criteria are not coordinated.Inherited Systemoptimization tools, and does not guarantee the best solution to the time. Generally GA work on rough figure and bequeath with optimal or near optimal solution in the specified time. The amount of time GA take to provide the solution depends on the convergence of the genetic algorithm. In literature there are methods that provide techniques to improve the convergence of genetic algorithms.

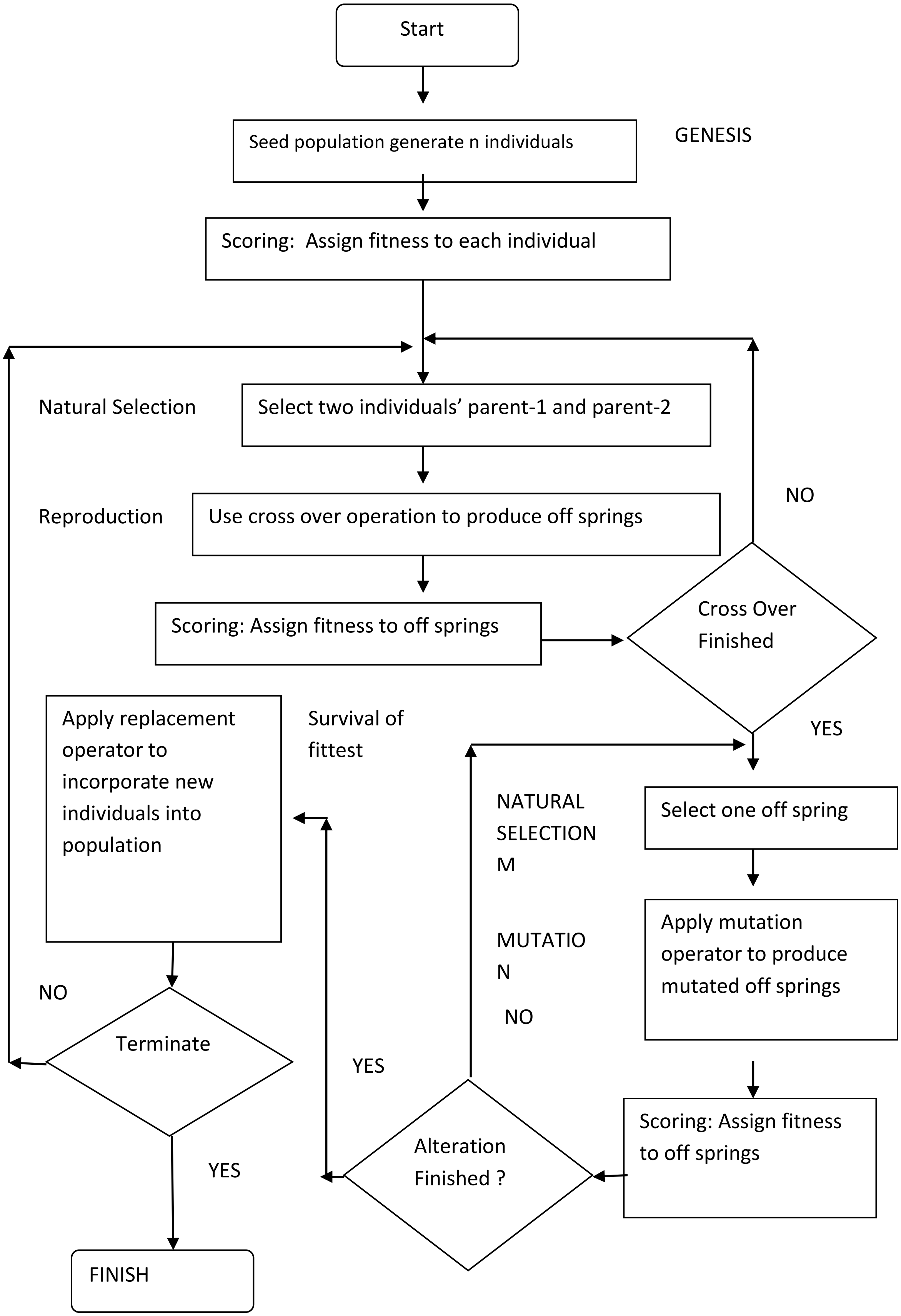


Figure 3.2 Flow Chart of genetic algorithm

Some features of genetic algorithm are as follows:

1. GA uses populations which is a set of candidate solutions.
2. GA uses genetic operations to generate new population.
3. GA is stochastic in nature.

There are some major components of this algorithm are as follows:

1. Representation of problem in genetic form (Initial population creation)
2. Calculating the fitness of different candidate solutions of the population.
3. Selecting parents to participate in recombination.
4. Applying crossover and mutation operators.
5. Survivor selection to create the next population.

3.2 Genetic Operators

1. Initialization

It is first step to apply genetic algorithm for any problem. The problem is represented in genetic form such that other genetic operators can be enforced on them. Diverse coding system used to signify a difficulty in the form of inherited. Usually used codingstructures are as follows:

Encoding Schemes-

1. Binary Encoding:

In binary encoding scheme a chromosome (Sample solution) is represented in the form of a stream of bits of zeroes and ones. Bit 1 specifies that a particular part of the chromosome is on and bit 0 represent particular part of the chromosome is inedible. Binary encoding will befitting to some problems such as Knapsack problem. Chromosomes of binary encoding can be represented as follows:

Chromosome 1 – 1 0 0 1 0 1 0 1 0 1

Chromosome 2 – 1 1 1 0 1 0 1 0 1 1

2. Permutation Encoding:-

In permutation encoding scheme every chromosome is a different combination of various fix values. All the values must exist at least and at most once in a chromosome in case of permutation encoding for example in Travelling SalesmenUnruly TSP. Chromosomes' 10 cities TSP difficulty, where 1 is the source of the city can be expressed as follows:

Chromosome 1 – 1 2 4 3 7 6 5 9 8 10 1
Chromosome 2 – 1 3 2 5 4 9 10 8 7 6 1

3. Value Encoding-

In value encoding the components of the chromosomes are some real values. This scheme is mostly suited to train a neural network for different synaptic weights. For example there are 10 synapses in a neutralsystem. The gene is:

Chromosome 1 – 0.25 0.31 0.56 0.48 0.93 0.75 0.86 0.31 0.11 0.19
Chromosome 2 – 045 06.8 07 04.6 03.3 04.4 079 09.5 022 06.3

2. Fitness' Function-

The fitness of a chromosome characterizes the quality of the chromosome. The fitness of every chromosome is calculated by using the objective function. For example the length of the path is the fitness in TSP problem. The profit earned by a chromosome is the fitness value in case of knapsack problem.

3. Selection-

In this operation some chromosomes have been selected from the population to participate in edgeprocess.Some random genetic engineering technology can be selected for the selection operation. Various popular parent selection techniques are as follows:

1) Roulette wheel selection
2) Rank Selection
3) Tournament Selection
4) Random Selection

4. Cross Over-

It is the most important operation in GA. The performance of GA mostly depends on cross over operation. In cross over operation some parents from the current population have been selected using any of the selection technique and new children have been generated by mixing these parents with apiece other. The most customary cross over operators are as follows:

1) One point cross over
2) Two point cross over
3) Uniform cross over

One Point Cross Over

In one point cross over a cross over point has been permanent. It generates 2children from a pair off two parents. To generate child -1 the first parent is copied in child one till cross over point and after cross over point second parent is copied in the child.

Parent 1	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0
Parent 2	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0

Offspring 1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0
Offspring 2	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0

Figure3.3: One point crosses over.

Parent 1 and parent 2 are two chromosomes participating in one point cross over. Off spring -1 and offspring -2 are two children generated by cross over.

Two Point Cross Over

In two opinions cross over, two cross over point have been selected. To generate child the bits from two different chromosomes have been selected between the cross over point. This figure will explain the course of two argumentirritableoar.

Parent 1	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0
Parent 2	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0

Offspring 1	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0
Offspring 2	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0

Figure3.3: two points cross over.

Uniform Cross Over

In unified crows' points, both parents have two children, a uniform distributed 1. The figure explaining the uniform cross over is as follows:

Parent 1	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0
Parent 2	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0

Figure3.4: Uniform cross over.

5. Mutation-

Mutation is an operation using which diversity has been maintained from one generation to another generation. After cross over the current population was alter. Realization of some parts of the mutant population is usually very 1-3% less have been randomly varying.Mutation rate refers to the amount of change occurred in the population to generate the succeedingpopulace. Generallyquantity of transformation is fixed to be fewer.Transformation is usually attained by a bit fledinhabitants.

The flip bit alteration is.

Original Offspring 1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0
Original Offspring 2	1	1	0	1	1	0	0	1	0	0	1	1	0	1	1	0

Mutated Offspring 1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	1	0
Mutated Offspring 2	1	1	0	1	1	0	1	1	0	0	1	1	0	1	0	0

InVersion:

Sometime inversion operation is also performed with cross over. In this operation the order in a single chromosome has been changed. This procedure is inspired by the biological process. The inversion operation is also an overhead in genetic algorithm.

For example

Chromosome -1: 1 5 3 4 2 7 9 8 10 1

In inversion two points can be selected and inverted. For example 3 and 4 values can be selected and inverted. The inverted chromosome is as follows:

Invitedchromosome -1: 1 5 4 3 2 7 9 8 10 1

3.3 Proposed Algorithm

In this thesis work a new power aware routing protocol in MANETs using genetic algorithm has been proposed. In the literature it has been found that Genetic systems can be used in routing protocols for mobile ad hoc set-up. Genetic algorithm can find thebest possible path between nodes of the MANET to transfer data. It can also be used to find an energy efficient path to transfer data between two nodes. In this thesis work a new algorithm using GA has been proposed to find energy efficient path(s) between two nodes. The proposed algorithm also finds alternate paths which can be used when any of the one links fails in the best path. The algorithm has been applied on a sample network of 30 nodes. The sample network is shown in figure-3.2.

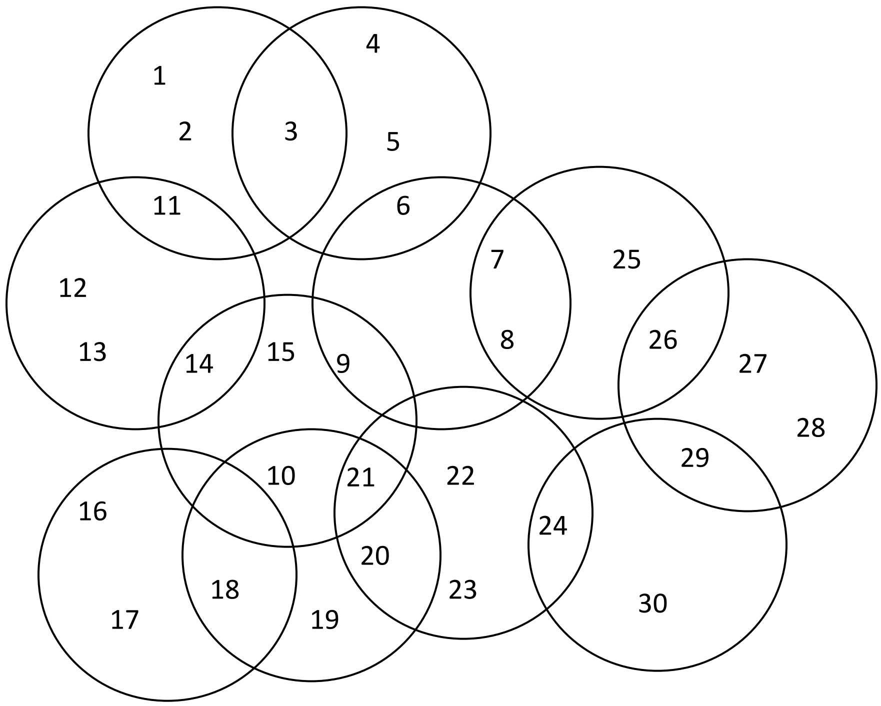


Figure3.6: A sample MANET of 30 nodes.

The network in terms of node and its national's relation is as follows:

Node No = 1 NationalsAre [01,02,03, 011]

Node No = 2 NationalsAre [001,002,003, 011]

Node No = 3 NationalsAre [001 002 003, 004, 005, 006, 011]

Node No = 4 NationalsAre [03,04,05, 06]

Node No = 5 NeighborAre [03, 04, 05, 06]

Node No = 6 Neighbor Are [003, 004, 005, 006, 007, 008, 009]

Node No = 7 Nationals Are [06, 07, 08, 09, 025, 026]

Node No = 8 Nationals Are [06, 07, 08, 09, 025, 026]

Node No = 9 Nationals Are [6, 7, 8, 9, 10, 14, 15, 21]

Node No = 10 Nationals Are [9, 10, 14, 15, 18, 19, 20, 21]

Node No = 11 Nationals Are [1, 2, 3, 11, 12, 13, 14]

Node No = 12 Nationals Are [11, 12, 13, 14]

Node No = 13 Nationals Are [011, 012, 013, 014]

Node No = 14 Nationals Are [11, 12, 13, 14, 15, 9, 10, 21]

Node No = 15 Nationals Are [9, 10, 14, 15, 21]

Node No = 16 Nationals Are [16, 17, 18]

Node No = 17 Nationals Are [16, 17, 18]

Node No = 18 Nationals Are [16, 17, 18, 19, 20, 21, 10]

Node No = 19 Nationals Are [18, 19, 20, 21, 10]

Node No = 20 Nationals Are [18, 19, 20, 21, 10, 22, 23, 24]

Node No = 21 Nationals Are [9, 10, 14, 15, 21, 1.8, 1.9, 2.0, 2.2, 2.3, 2.4]

Node No = 22 Nationals Are [20, 21, 22, 23, 24]

Node No = 23 Nationals Are [20, 21, 22, 23, 24]

Node No = 24 Nationals Are [20, 21, 22, 23, 24, 29, 30]

Node No = 25 Nationals Are [.07, .08, .025, .026]

Node No = 26 Nationals Are [7, 8, 25, 26, 27, 28, 29]

Node No = 27 Nationals Are [26, 27, 28, 29]

Node No = 28 Nationals Are [26, 27, 28, 29]

Node No = 29 Nationals Are [26, 27, 28, 29, 24, 30]

Node No = 30 Nationals Are [.24, .29, .30]

The proposed method to apply GA to find path(s) with minimum path lengths is as follows:

Let suppose node-1 is the sender node and node-30 is the receiver node and algorithm has to find an optimal path between these nodes. A sample population will be generated randomly to transfer data from node-1 and node-30. Let suppose the sample population is as follows:

Path 0 = 1, 11, 1.2, 1.4, 1.0, 2.0, 2.2, 2.4, 3.0

Path 1 = 1, 2, 3, 5, 6, 9, 7, 8, 26, 27, 28, 29, 30

Path 2 = 1, 2, 1.1, 1.4, 1.0, 1.8, 2.1, 2.0, 2.2, 2.4, 3.0

Path 3 = 1, 2, 11, 12, 14, 10, 9, 15, 21, 23, 24, 30

Path 4 = 1, 2, .3, .4, .5, .6, .8, .9, .7, .25, .26, .29, .30

Path 5 = 1, 3, 5, 6, 8, 26, 29, 30

Path 6 = 1, 3, 1.1, 1.2, 1.4, 1.0, .9, .6, .7, 2.5, .8, 2.6, 2.8, 2.9, 3.0

Path 7 = 1, 11, 13, 14, 21, 9, 10, 18, 19, 20, 24, 30

Path 8 = 1, 3, 4, 6, 7, 8, 25, 26, 28, 27, 29, 30

Path 9 = 1, 2, 3, 5, 4, 6, 9, 14, 10, 19, 21, 24, 30

Path 10 = 1, 3, 40, 50, 60, 80, 206, 209, 300

Path 11 = 1, 2, 3, 4, 6, 8, 7, 9, 10, 18, 21, 24, 30

Path 12 = 1, 3, 40, 50, 60, 70, 205, 206, 208, 209, 300

Path 13 = 1, 3, 6, 70, 2.5, 80, 2.6, 207, 2.8, 2.9, 3.0

Path 14 = 1, 3, 40, 50, 60, 90, 80, 2.5, 2.6, 2.9, 3.0

Path 15 = 1, 2, 30, 11, 14, 10, 18, 20, 24, 30

Path 16 = 1, 2, 30, 50, 60, 90, 80, 70, 2.6, 2.9, 3.0

Path 17 = 1, 3, 1.1, 1.3, 1.4, 1.5, 1.0, 90, 70, 80, 2.6, 2.9, 3.0

Path 18 = 1, 3, 1.1, 1.4, 2.1, 2.0, 2.4, 3.0

Path 19 = 1, 3, 5, 6, 8, 26, 25, 7, 9, 10, 15, 21, 24, 30

It has been assumed that every node knows it's nationals by sending route request and route response messages. Let suppose two candidate solutions generated randomly are as follows:

Path-7 [1, 11, 13, 14, 21, 9, 10, 18, 19, 20, 24, 30]
Path-3 [1, 2, 11, 1.2, 1.4, 1.0, 90, 1.5, 2.1, 2.3, 2.4, 3.0]

New children can be generated by using one pondlimit.In a two-node common route has been selected as point cross. For example node-10 is the node selected for one pondlimit.First of all a -1 in children from a parent node has been copied to node 10, 10 -2 replicate from the parent node of all the nodes. Child 1 will also be produced in the same manner. By applying these procedure two children generated from parents' route-1 and route-2 are as follows:

Child1 = [1, 11, 13, 14, 21, 9, 10, 9, 15, 21, 23, 24, 30]
Child2 = [1, 2, 11, 1.2, 1.4, 1.0, 1.8, 1.9, 2.0, 2.4, 3.0]

This crossover operation can be applied on more parents in the population to generate more children. Then these newly generated children will be added in the population and extended population will be sorted on the cost of the route to transfer data. The same procedure of selection and crossover can be applied many times till the solution converges.

Proposed Algorithm

1. Initialize the prototypicalsystem.It discovers all nodes and their nationals in ad-hoc.
2. Initialize the cost matrix to find the cost to transfer packet from one node to another.
3. Initialize a sample population of 20 paths randomly.
4. Calculate the cost of each path in the population.

5. Select parents' paths which will participate in crossover to generate new paths.
6. Perform cross over and generate new children.
7. Calculate cost of the newly generated children.
8. Add new children (which are not in population) in the population.
9. Sort population on the cost of the paths and select next population of best 20 paths (paths with minimum path length).
10. Repeat steps 5-9 measures to stop does not reach.

The algorithm has been implemented in java and result istrained.Execution and details discussed in subsequent chapters.

Chapter-4:Implementation Details

4.1 CLASSES USED IN THE IMPLEMENTATION AND THEIR DETAILS

We have used following classes to implement the proposed work described in previous chapters:

1. Recite Documents
2. Node
3. Path
4. Network

The details of the classes used in the implementation are as follows.

1. ReciteDocuments

The purpose of this class is to read integer or string data from the user.

Table 4.1 Details of class ReciteDocuments

Class Name		Purpose
Data Members	NA	
Member Functions	public static String readString(String message)	Read a string from the user.
	public static void presenter ToContinue()	To read an enter key from the user for further processing.
	Public static itreciteDigit (String message)	Read an integer from the user.

2.Node

This class is used to store the details of a node in the network. The members of this class are as follows.

Table 4.2 Details of class Node

Class Name : Node		Purpose
Data Members	intnode_no;	Store no of the node.
	ArrayListlist_of_neighbours = new ArrayList();	Store a list of nodes which are neighbor of this node.
FollowerTask	Node(intnodes_noArreyLists lists_of_nationals2)	Constructor.

4. Path

This class stores the details of a path from sender node to receiver node. The members are as follows of this new class.

Table 4.3 Details of class Path

Class Name : Path		Purpose
Data Members	ArrayListlist_of_node_numbers_in_the_path = new ArrayList();	It stores the nodes that have to be followed in the path.
	intno_of_nodes_in_path;	Stores count of number of nodes in a path.
	intpath_cost;	Stores cost to transfer a packet through this path.
	intpath_index;	Store index of the path in the list of paths.
Members Function	Route(Path p2)	Construction
	Path(ArrayListlist_of_nodes)	Constructor.

	void display_path()	Display the path.

4. Network

This class stores the information of the complete network. It stores all the information of the nodes in the network. This class also accomplishes the genetic operations to find an optimal path between source and destination.

Table 4.4 Details of class Network

Class Name : Network		Purpose
Data Members	ArrayListlist_of_nodes = new ArrayList<Node>();	List of nodes in the network.
	ArrayList visited = new ArrayList();	This stores the list of visited nodes.
	ArrayListnotvisited = new ArrayList();	This stores the list of not visited nodes.
	ArrayList path = new ArrayList();	Stores all the paths in the population.
	intcost_matrix[][] = new int[100][100];	Store cost to transfer packet from one node to another.
	ArrayList paths = new ArrayList<Path>();	Store a list of all paths.
	intpath_count;	Store no of paths.
	intsource_node,destination_node;	Stores source and destination node numbers.
Member Functions	Network()	Constructor
	void read_source_and_destination()	Read source node and destination node numbers

		to transfer packet.
	void initialize_network()	Initialize the network. It initialize the no of nodes and the cost matrix.
	void display_whole_network()	It display the all the nodes in the network.
	void search_neighbours_of_a_node(int node_no2)	Find nationals of a node.
	booleangenerate_path(int n1,int n2)	It generate a random path between source and destination.
	booleancheck_target_node_in_list_of_neighbours_of_current_node(ArrayListlist_of_neighbours,int n2)	Check whether target node is directly reachable from the current node or not.
	booleanchek_node_in_visited(intgiven_node)	Check whether a particular node is already visited or nor to avoid loops.
	ArrayListreturn_array_list_of_neighbours_of_a_node(intgiven_node)	Return a list of nationals of a node.
	void generate_random_cost_matrix()	Generate random cost matrix that will store cost to transfer packet from one node to another.
	void display_cost_matrix()	Display the cost matrix.
	void generate_paths()	This method generate the random paths for the initial population.

	void generate_path_matrix()	This method generate the path matrix.
	intreturn_cost_for_a_path(Path p)	This method calculates and returns cost to transfer packet through a path.
	void display_path_matrix()	Display the path matrix.
	void write_cost_matrix_to_file()	This method write the cost matrix in a file.
	void read_cost_matrix_from_file()	This method read the cost matrix from the file.
	voidsproduce_arbitrary_paths()	This technique produces a arbitrary route.
	void generate_mutated_new_paths()	Generate paths after mutation.
	void add_mutated_paths_in_initial_population()	Add mutated paths in the population.
	void perform_mutation()	Perform the mutation operation.
	void set_mutation_position_list()	Set paths which will be mutated.
	booleans check_node-1_node-2_node-3_belongs to samead-hoc(int node-1.int node-2.int node-3)	Check whether given three nodes belongs to the same adhoc or not.
	invalidpresentation_alteration_place_lists()	Demonstrate the list of paths which will be

		mutated.
	void calculate_to_add_next_population()	Calculate the population for the next population.
	booleancheck_path_in_initial_population_return_true_if_found(Path new_child)	Check whether a path exist in current population or not.
	invalidcategory_original_popultaion_and_take_finest_child_nexus_population2()	This method sort all the paths of the current population on the basis of their cost to transfer packet from source to destination.
	void add_new_children_in_initaial_population()	Add new generated children in the population.
	void do_cross_over()	Perform cross over operation.
	intgenerate_random(int n1)	Generate a random number.
	void generate_initial_population()	Generate an initial population of path.
	void display_inintail_population()	Display generated initial population.

Chapter-5:Results and Analysis

5.1 RESULTS OF IMPLEMENTATION

The proposed algorithm has been implemented in java on a sample grid of thirty nods.It is divided into 11 ad-hoc in the realization of these 30 nodes. A class node stores all the information about a node such as its node number, list of its nationals etc. The node number and list of its nationals is shown in figure 5.1.

In proposed genetic algorithm the average number of active nodes to transfer a packet from source to destination is less. Also the energy consumed to transfer data from source to destination is also less. Let there are 11 ADHOCS and 30nodes.all the way during experiments, we have instigate that, because there are fewer nodes in the network is not the active node, and energy consumption is very low.Through experiments, we have found that, because there are fewer nodes in the network is not the active node, and energy consumption is very low.Let us assume that we have results in the following table.

Total number of nodes in the network	No of active nodes in transferring data	Energy consumed in transferring the data
12	4	60
15	4	60
17	5	65
20	8	105
23	8	105
25	9	130
30	11	155

The graph comparing the number of nodes in the network and energy consumed is as follows:

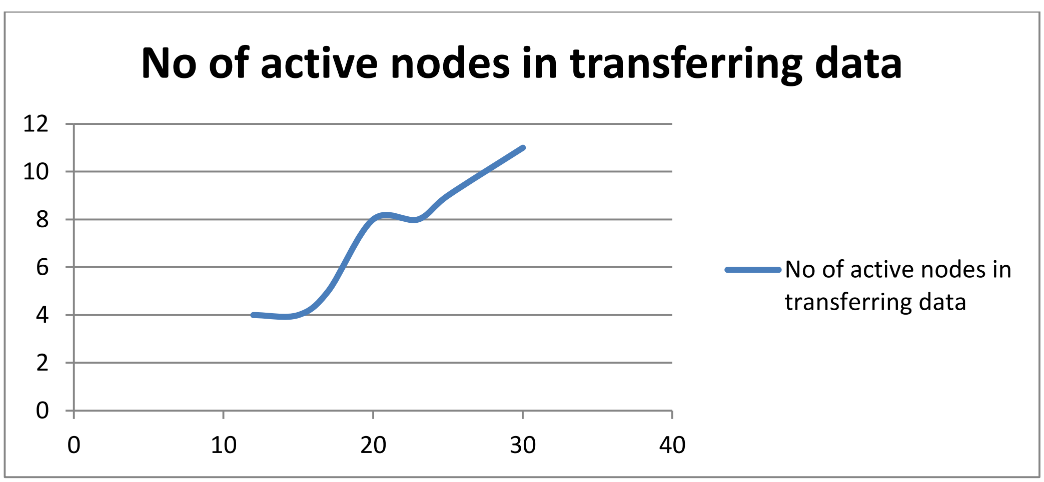


Figure1: Total number of nodes in the network Vs no of active nodes

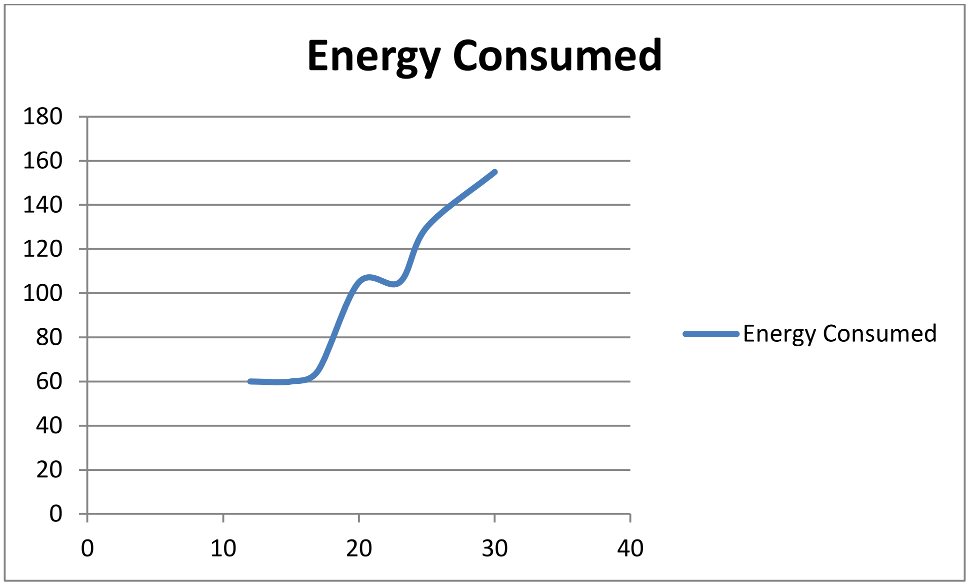


Figure2: Total number of nodes in the network versus Energy consumed in transferring data

Snapshot-1: The sample network of 30 nodes and ad-hoc.

```
Output - RoutingGA (run)
run:

 Node   = 1   Friends   1 2 3 11
 Node   = 2   Friends   1 2 3 11
 Node   = 3   Friends   1 2 3 4 5 6 11
 Node   = 4   Friends   3 4 5 6
 Node   = 5   Friends   3 4 5 6
 Node   = 6   Friends   3 4 5 6 7 8 9
 Node   = 7   Friends   6 7 8 9 25 26
 Node   = 8   Friends   6 7 8 9 25 26
 Node   = 9   Friends   6 7 8 9 10 14 15 21
 Node   = 10   Friends   9 10 14 15 18 19 20 21
 Node   = 11   Friends   1 2 3 11 12 13 14
 Node   = 12   Friends   11 12 13 14
 Node   = 13   Friends   11 12 13 14
 Node   = 14   Friends   11 12 13 14 15 9 10 21
 Node   = 15   Friends   9 10 14 15 21
 Node   = 16   Friends   16 17 18
 Node   = 17   Friends   16 17 18
 Node   = 18   Friends   16 17 18 19 20 21 10
 Node   = 19   Friends   18 19 20 21 10
 Node   = 20   Friends   18 19 20 21 10 22 23 24
 Node   = 21   Friends   9 10 14 15 21 18 19 20 22 23 24
 Node   = 22   Friends   20 21 22 23 24
 Node   = 23   Friends   20 21 22 23 24
 Node   = 24   Friends   20 21 22 23 24 29 30
 Node   = 25   Friends   7 8 25 26
 Node   = 26   Friends   7 8 25 26 27 28 29
 Node   = 27   Friends   26 27 28 29
 Node   = 28   Friends   26 27 28 29
 Node   = 29   Friends   26 27 28 29 24 30
 Node   = 30   Friends   24 29 30
```

Figure 5.1: A sample network of 30 nodes.

Snapshot-2: An initial population of 20 nodes with their cost to transfer packet from source to destination.

In this work a random population of paths from source to destination is generated. An initial population of 20 paths has been taken. A figure5.2 display a random initial population of 20 paths from source node 1 to destination node is 30 and the cost to get across this packet has also been calculated. A random weight matrix is used to find the cost between two nodes. This cost matrix is used to fins the total cost in a path to transfer packet. This cost is also shown in figure 5.2.

```
Path  0 =  [1, 3, 11, 12, 13, 14, 15, 21, 22, 24, 30]        Cost =  152
Path  1 =  [1, 2, 11, 13, 12, 14, 15, 21, 24, 30]        Cost =  151
Path  2 =  [1, 3, 11, 12, 14, 15, 9, 21, 10, 19, 20, 22, 24, 30]        Cost =  181
Path  3 =  [1, 2, 11, 12, 13, 14, 9, 10, 18, 20, 23, 24, 30]        Cost =  185
Path  4 =  [1, 11, 13, 14, 9, 7, 26, 28, 29, 30]        Cost =  169
Path  5 =  [1, 11, 12, 14, 21, 20, 23, 24, 30]        Cost =  128
Path  6 =  [1, 11, 14, 9, 7, 26, 27, 28, 29, 30]        Cost =  150
Path  7 =  [1, 11, 14, 21, 10, 18, 19, 20, 23, 22, 24, 30]        Cost =  174
Path  8 =  [1, 3, 5, 4, 6, 9, 10, 20, 19, 21, 22, 24, 30]        Cost =  204
Path  9 =  [1, 11, 12, 14, 10, 19, 20, 21, 22, 23, 24, 30]        Cost =  183
Path 10 =  [1, 2, 11, 12, 14, 21, 18, 19, 10, 9, 8, 6, 7, 26, 27, 28, 29, 30]        Cost =  255
Path 11 =  [1, 2, 3, 11, 13, 14, 21, 15, 9, 10, 19, 20, 24, 30]        Cost =  217
Path 12 =  [1, 3, 5, 6, 7, 25, 26, 28, 29, 30]        Cost =  125
Path 13 =  [1, 2, 3, 4, 6, 7, 9, 8, 26, 29, 30]        Cost =  167
Path 14 =  [1, 3, 2, 11, 14, 15, 21, 22, 20, 24, 30]        Cost =  162
Path 15 =  [1, 3, 5, 6, 8, 9, 14, 15, 21, 24, 30]        Cost =  127
Path 16 =  [1, 3, 2, 11, 13, 14, 9, 21, 18, 10, 20, 23, 24, 30]        Cost =  177
Path 17 =  [1, 2, 11, 3, 5, 4, 6, 8, 25, 7, 26, 28, 29, 30]        Cost =  232
Path 18 =  [1, 2, 11, 12, 13, 14, 21, 9, 7, 26, 28, 27, 29, 30]        Cost =  229
Path 19 =  [1, 11, 14, 21, 18, 20, 24, 30]        Cost =  137
```

Figure5.2: The random paths in the population and their cost to transfer packet.

Snapshot–3: Cross over operation.

Cross over is an important operation in genetic algorithms. A pair of two paths generates new children paths in this operation. The parents have been selected randomly and then these parents participated in the cross over. The process of edge has been explained in detail in last chapters. Figure 5.3 shows the cross over operation.

Output - RoutingGA (run)

```
Cross Over No = 0
parent1 = 4  [1, 11, 13, 14, 9, 7, 26, 28, 29, 30]        Cost =  169
parent2 = 13  [1, 2, 3, 4, 6, 7, 9, 8, 26, 29, 30]        Cost =  167
Node Selected For Cross Over = 7
Child1 =   [1, 11, 13, 14, 9, 7, 9, 8, 26, 29, 30]        Cost =  188
Child 2 =   [1, 2, 3, 4, 6, 7, 26, 28, 29, 30]        Cost =  148


Cross Over No = 1
parent1 = 9  [1, 11, 12, 14, 10, 19, 20, 21, 22, 23, 24, 30]        Cost =  183
parent2 = 7  [1, 11, 14, 21, 10, 18, 19, 20, 23, 22, 24, 30]        Cost =  174
Node Selected For Cross Over = 20
Child1 =   [1, 11, 12, 14, 10, 19, 20, 23, 22, 24, 30]        Cost =  142
Child 2 =   [1, 11, 14, 21, 10, 18, 19, 20, 21, 22, 23, 24, 30]        Cost =  215


Cross Over No = 2
parent1 = 1  [1, 2, 11, 13, 12, 14, 15, 21, 24, 30]        Cost =  151
parent2 = 5  [1, 11, 12, 14, 21, 20, 23, 24, 30]        Cost =  128
Node Selected For Cross Over = 14
Child1 =   [1, 2, 11, 13, 12, 14, 21, 20, 23, 24, 30]        Cost =  185
Child 2 =   [1, 11, 12, 14, 15, 21, 24, 30]        Cost =   94


Cross Over No = 3
parent1 = 1  [1, 2, 11, 13, 12, 14, 15, 21, 24, 30]        Cost =  151
parent2 = 6  [1, 11, 14, 9, 7, 26, 27, 28, 29, 30]        Cost =  150
Node Selected For Cross Over = 14
Child1 =   [1, 2, 11, 13, 12, 14, 9, 7, 26, 27, 28, 29, 30]        Cost =  224
Child 2 =   [1, 11, 14, 15, 21, 24, 30]        Cost =   77
```

Figure5.3: Cross over operation to generate new children.

5.2 COMPARATIVE ANALYSIS

Table 5.1 shows a comparative study of various routing protocols on 7 different factors. It can be observed that GA based routing protocol has all the properties similar to table driven directingpractice.Table-driven directing practice table must maintain their storage network information.When path is found to be referenced from one node to another table to find the route. GA based proposed routing protocol also maintain a table similar to table driven directingprotocols'.The core improvement is that it crafts many paths to direct facts from a source to end. It makes the system more reliable as if there is any problem in sending the data via best route, the alternate routes provided by GA based routing protocols can be used. Another advantage of GA based routing protocol is that complexity in finding the route does not increases rapidly with number of lump.Since the discovery of genetic algorithm coding solution by the evolution of technology, the cross so that it is suitable for large-scale network. So 7th property which is network suitable for is also improved as compared to table dedicatedways.

Table5.1: Comparison of various routing protocols

S.N.	**Protocol Property**	**DSDV**	**DSR**	**AODV**	**Proposed GA Based protocol**
1	Table driven/ Source Routing	Table driven	Source Routing	Table driven and Source Routing	Table Driven
2	Route Discovery	Periodic	On Demand	On Demand	Periodic
3	Network Overhead	High	Low	Medium	High
4	Multiple Routes	No	Yes	No	**Yes**
5	Reactive/ Proactive	Proactive	Reactive	Reactive	Proactive
6	Routing Overhead	Medium	Low	High	Medium
7	Network Suitable For	Less number of nodes	Up to 200 nodes	Highly Dynamic	**Highly Dynamic**

Chapter 6: Conclusion and Future Work

New genetic system used in this paper has been proposed to find the saving in wireless ad hoc network routing protocol. A new way to apply one point crossover has been proposed to generate children. The algorithm works on initial population of paths to transfer data from source to destination. On this initial population different genetic operations has been applied and this initial population improves. The proposed algorithm gives us a set of paths to transfer packet from source to destination. It can be concluded that genetic algorithms can be used to find optimal path that uses power of nodes efficiently to transfer packets in MANETS. The algorithm not only provides us optimal paths but also a list of paths which consume power slightly more than the best optimal paths. As MANETS are dynamic in nature so a link between two nodes may break at any time. In that case the alternate paths can be used to transmission ofparcels.Thus, the system is essentially a more reliable.

In future the algorithm can be implemented on a network of more than 100 nodes and its performance can be checked. The work can be further optimized by applying different parent selection techniques such as tournament selection, roulette wheel selection, ranked selection etc. Different cross over operators such as two point crossover and multipoint cross over can also be applied and results can be tested.

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