IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Optimization of Routing Protocol for MANET using Bat Optimization Algorithm

Prof. Charan Pote (Assistant Professer, PCE)

Srushti Gulhane (Student, PCE)

Poorva Rahangdale (Student, PCE)

Nikita Asati (Student, PCE)

Shraddha Vaidya (Student, PCE)

Suhani Asati (Student, PCE)

Abstract: : Mobile ad hoc Network (MANET) can be portrayed collectively of remote portable hubs that structure an impermanent dynamic and free foundation organization or a focal organization office. High energy utilization is one of the principle issues related with the MANET innovation. The wireless mobile hubs utilized in this interaction depend on batteries on the grounds that the organization doesn't have a consistent force supply. In this way, the fast battery channel diminishes the life expectancy of the organization. This paper examined about streamlining steering convention propelled directing calculations like Bat Optimization Algorithm (BOA), Particle Swarm Optimization (PSO) and Ant Colony Algorithm (ACA) and use for distance improvement. In this paper, another Bat Optimized Link State Routing (BOLSR) convention is proposed to improve the energy utilization of the Optimized Link State Routing (OLSR) convention in the MANET. The balance between OLSR of MANET and Bat Algorithm (BA) is that the two of them utilize a similar system for discovering the way through conveying and getting explicit messages. This evenness brought about the BOLSR convention that decides the upgraded way from a source hub to an objective hub as per the energy elements of the hubs. The BOLSR convention is executed in a MANET reproduction by utilizing NS2 Software. The mathematical outcome and execution investigation unmistakably depict that our gave proposition directing convention produces better bundle conveyance proportion, diminishes parcel delay lessens overhead in got climate, BAT calculation and it is appropriate for MANET for accomplishing great Throughput, bundle conveyance proportion, delay and overhand. The aftereffects of the tests uncover that the BOLSR convention lessens the energy utilization and expands the life expectancy of the organization.

Keywords- *Bat Optimization Algorithm (BOA), Mobile Ad hoc network (MANET), Particle Swarm Optimization (PSO), Ant Colony Algorithm (ACA), Qos, optimized link state routing (OLSR), DSR, AODV.*

I. INTRODUCTION

Recently, optimization methods are Meta heuristics that are proposed to solve complex problems. Each meta-heuristic approach includes a set of search agents that discover the possible place primarily based on both randomization and a few special regulations. Particle swarm optimization (PSO) proposed by Eberhart and Kennedy simulates social behavior, and it is inspired by the movement of organisms in a bird flock or fish school. Truss optimization with dynamic constraints using a particle swarm algorithm can be found in the work of Gomes. Ant Colony Optimization (ACO) formulated by Dorigo et al. imitates foraging behavior of ant colonies. Due to their good performance and ease of implementation, these methods have been widely applied to various problems in different fields of science and engineering. Structural optimization is one of the active branches of the applications of optimization algorithms. One of the most recent meta-heuristic algorithms is the Charged System Search (CSS) proposed by Kaveh and Talatahari that uses the electric laws of physics and the Newtonian laws of mechanics to guide the Charged Particles (CPs) to explore the locations of the optimum. Bat-inspired algorithm introduced by Yang is another recent meta-heuristic algorithm which mimics the behavior of bats in detecting prey. In MANETs, direct correspondence between the source and the objective hubs is needed by steering conventions, for example, the Optimized Link State Routing (OLSR) and the Ad-hoc On-Demand

Distance Vector (AODV) directing convention. Hence, steering is significant to decide the necessary ideal way for the exchange of information between the source and the objective hubs. Different steering conventions delegated receptive, AODV , proactive, OLSR , cross breed, and zone directing board are accessible in the MANET. One of the regularly utilized calculations in taking care of steering issues is the bat calculation proposed by Yang. As well as tending to steering issues, this calculation can likewise settle numeric, designing, and advancement issues. This paper presents the incorporation of the Bat Algorithm (BA) with the OLSR convention to improve the way choice system by utilizing various boundaries.

Wireless networks have come to be an expanding number of celebrated inside the local area endeavor. They can give cell clients omnipresent correspondence ability and records get section to regardless of areas. Traditional remote organizations are oftentimes connected to a worried organization all together that the ATM (Asynchronous exchange Mode) or net associations might be drawn out to cell clients. This kind of Wireless people group requires a fixed string line spine foundation. All versatile hosts in a correspondence cell can accomplish a base station at the wire line network in one-bounce radio transmission. In corresponding with the conventional remote organizations, each and every kind of rendition, basically dependent on radio to radio multi-jumping, has neither fixed base stations nor a wired spine foundation. In some utility conditions, along with war zone interchanges, calamity reclamation and numerous others, the wired local area isn't generally accessible and multi jump remote organizations give the best practical way for correspondence and records get passage to. This kind of local area is known as portable impromptu organization (MANET). This paper presents 3 steering convention systems and a differentiation among them and recognized the strength and flimsy part.

A. Networks and Types of Network

Wireless networking is an arising innovation that permits clients to get to data and administrations electronically, paying little mind to their geographic position. Wireless networking can be characterized in two types.

1.1 Infrastructure Networks

Infrastructure network comprises of an organization with fixed and wired entryways. A portable host speaks with a scaffold in the organization (called base station) inside its correspondence span. The portable unit can move topographically while it is conveying. At the point when it leaves scope of one base station, it associates with new base station and starts conveying through it. This is called handoff. In this methodology the base stations are fixed.

1.2 Infrastructure Less (Ad hoc) Networks

In ad hoc networks all hubs are portable and can be associated powerfully in a self-assertive way. As the scope of each host's remote transmission is restricted, so to speak with has outside its transmission range, a host needs to enroll the guide of its close by has in sending bundles to the objective. So all hubs of these organizations act as switches and participate in revelation and support of courses to different hubs in the organization. Ad hoc Networks are valuable in crisis search-and salvage tasks, gatherings or shows in which people wish to rapidly share data and information. MANET is a kind of Ad-hoc network, is an assortment of autonomous portable hubs that can impart to one another through radio waves. The portable hubs that are in radio scope of one another can straightforwardly convey, though different hubs need the guide of transitional hubs to course their bundles. These organizations are completely appropriated, and can work at any spot without the assistance of any framework. This property makes these organizations profoundly adaptable and vigorous.

B. MANET (Mobile Ad- hoc Network)

An ad-hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration or standard support services. Examples :- Meetings, sensor networks and Walkie-Talkie in which we need to create network instantly.

MANET stands for "Mobile Ad-hoc Network." A MANET is a type of ad hoc network that can change locations and configure itself dynamically. Because MANETS are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection or another medium, such as a cellular or satellite transmission.

MANET is an autonomous system in which mobile hosts connected by wireless links are free to be dynamically and some time act as routers at the same time. All nodes in a wireless ad hoc network act as a router and host as well as the network topology is in dynamically, because the connectivity between the nodes may vary with time due to some of the node departures and new node arrivals.

The proper functioning of a MANET depends on the common hypothesis that network nodes are willing to forward others packets to enable otherwise impossible multi-hop communications. In MANET data must be routed via intermediate nodes. Nodes must route packets for other nodes to keep the network fully.

Characteristics of MANET:

- MANET is decentralized type of wireless network.

In MANET no centralized system is present with help of which any network is been created.

- MANET does not require pre-existing hardware infrastructure.

It does not rely on pre-existing hardware infrastructure such as router in wired network or access points in managed wireless network.

- MANET works on self configuring basis.

This are self configuring dynamic network in which nodes are free to move.

- It is On-Fly network.

It lacks the complexity of infrastructure setup and administration enabling device to create and join network "On the fly" anywhere anytime.

Applications of MANET:

- VANET(Vehicular ad-hoc network)

A VANET (Vehicular Ad Hoc Network), is a type of MANET that allows vehicles to communicate with roadside equipment.

- SPAN(Smart Phone ad-hoc network)

Smartphone ad hoc networks are wireless ad hoc networks that use smartphones. Once embedded with ad hoc networking technology, a group of smartphones in close proximity can together create an ad hoc network.

- Wireless Mesh Network

A **wireless mesh network** (**WMN**) is a communication network made up of radio nodes organized in a mesh topology. It can also be a form of wireless ad hoc network.

- Army Tactical MANET

Tactical Mobile Ad-hoc Network (MANET) is also widely used by modern military units especially for the autonomous maneuvering of unmanned vehicles and robots.

- Disaster Rescue ad-hoc network

Disasters often make conventional communication networks unusable, and we employ rescue agents using ad-hoc networks, which enable the agents to directly communicate with other agents in a short distance.

- Ad hoc Street Light Network to use wireless control of city street light for better energy efficiency, as part of a smart city architectural feature.

Advantages of MANET:

- High efficiency network.
- Cost Effective.
- Free of Radio waves.
- Quick and efficient delivery of information.
- Less Failure chances.
-

Disadvantages if MANET:

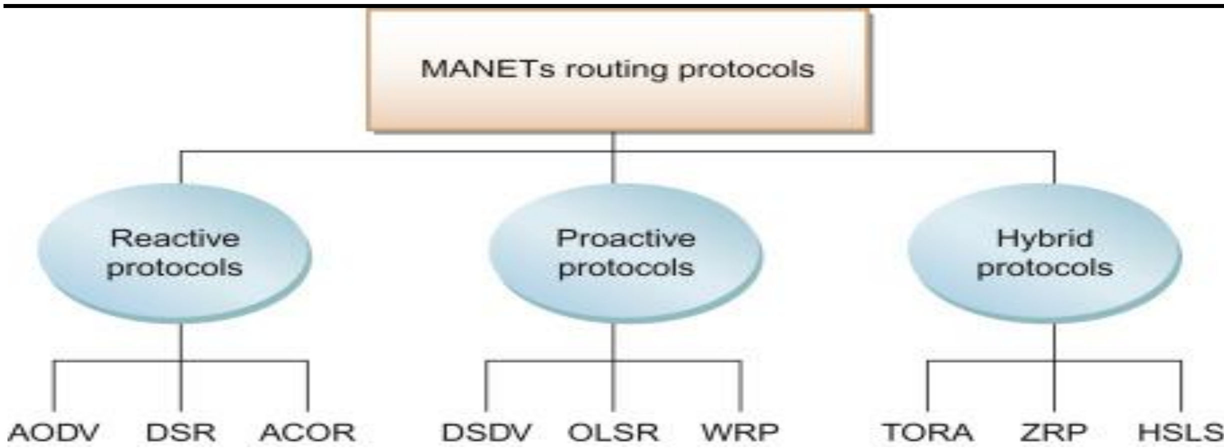
- Movable nodes (Mobile).
- Topology Changes every time.
- High Network Function.
- No central node.

ROUTING

Most routing protocols for mobile ad hoc networks (MANETs) can be categorized as being either reactive or proactive. This showcase demonstrates the configuration and operation of three MANET routing protocols with three example simulations, using a reactive (AODV), a proactive (DSDV), and a location-based (GPSR) routing protocol.

Forwarding of information packets from one network to another is called routing. It is a path selection process. It is performed in many types of networks. Routing is used in MANET.

There are three types of routing protocols.



- Proactive

These are also known as table-driven routing protocols. Each mobile node maintains a separate routing table which contains the information of the routes to all the possible destination mobile nodes.

Since the topology in the mobile ad-hoc network is dynamic, these routing tables are updated periodically as and when the network topology changes. It has a limitation that is doesn't work well for the large networks as the entries in the routing table becomes too large since they need to maintain the route information to all possible nodes. The proactive routing protocol is a routing form for flat and hierarchical. The bandwidth requirement and power management is high. Example of proactive protocols are DSDV (Destination sequenced distance vector protocol), OLSR (Optimised link state routing protocol) and WRP (Wireless routing protocol).

- Reactive

These are also known as on-demand routing protocol. In this type of routing, the route is discovered only when it is required/needed. The process of route discovery occurs by flooding the route request packets throughout the mobile network. It consists of two major phases namely, route discovery and route maintenance. The bandwidth requirement and power management is Low producing of routing protocol.

Examples of reactive protocols are DSR (Dynamic source routing) and AODV (Ad-hoc on demand vector routing).

- Hybrid

It basically combines the advantages of both, reactive and pro-active routing protocols. These protocols are adaptive in nature and adapts according to the zone and position of the source and destination mobile nodes. One of the most popular hybrid routing protocol is **Zone Routing Protocol (ZRP)**.

The whole network is divided into different zones and then the position of source and destination mobile node is observed. If the source and destination mobile nodes are present in the same zone, then proactive routing is used for the transmission of the data packets between them. And if the source and destination mobile nodes are present in different zones, then reactive routing is used for the transmission of the data packets between them. The bandwidth requirement and power management is medium.

Example of hybrid protocol is EIGRP (Enhanced interior getaway routing protocol).

Dynamic Source Routing (DSR)

Dynamic Source Routing (DSR) is a reactive protocol. It computes the routes when necessary and then maintains them. The key distinguishing feature of DSR is the use of source routing. In source routing the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header. When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a route discovery process to dynamically determine such a route. Route discovery works by flooding the

network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed.

C. AODV (Ad-hoc On Demand Vector)

AODV (Ad-hoc On-demand Distance Vector) is a loop-free routing protocol for ad-hoc networks. It is designed to be self-starting in an environment of mobile nodes, withstanding a variety of network behaviors such as node mobility, link failures and packet losses.

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is designed for use in ad-hoc mobile networks. AODV is a reactive protocol: the routes are created only when they are needed. It uses traditional routing tables, one entry per destination, and sequence numbers to determine whether routing information is up-to-date and to prevent routing loops. An important feature of AODV is the maintenance of time-based states in each node: a routing-entry not recently used is expired. In case of a route is broken the neighbors can be notified. Route discovery is based on query and reply cycles, and route information is stored in all intermediate nodes along the route in the form of route table entries. The following control packets are used: routing request message (RREQ) is broadcasted by a node requiring a route to another node, routing reply message (RREP) is unicasted back to the source of RREQ, and route error message (RERR) is sent to notify other nodes of the loss of the link. HELLO messages are used for detecting and monitoring links to neighbors.

AODV is a relative of the Bellman-Ford distant vector algorithm, but is adapted to work in a mobile environment. AODV determines a route to a destination only when a node wants to send a packet to that destination. Routes are maintained as long as they are needed by the source. Sequence numbers ensure the freshness of routes and guarantee the loop-free routing.

Routing tables

Each routing table entry contains the following information as destination, next hop, number of hops, destination sequence number, and active neighbors for this route and expiration time for this route table entry. Expiration time, also called lifetime, is reset each time the route has been used. The new expiration time is the sum of the current time and a parameter called active route timeout. This parameter, also called route caching timeout, is the time after which the route is considered as invalid, and so the nodes not lying on the route determined by RREPs delete their reverse entries. If active route timeout is big enough route repairs will maintain routes.

Control messages

• AODV defines 4 message types:

– Route Requests (RREQs)

– Route Replies (RREPs)

– Route Errors (RERRs)

_ Hello messages

Routing request

When a route is not available for the destination, a route request packet (RREQ) is flooded throughout the network.

Routing reply

If a node is the destination, or has a valid route to the destination, it unicasts a route reply message (RREP) back to the source. The reason one can unicast RREP back is that every node forwarding a RREQ message caches a route back to the source node.

Route error

All nodes monitor their own neighbourhood. When a node in an active route gets lost, a route error message (RERR) is generated to notify the other nodes on both sides of the link of the loss of this link.

HELLO messages

Each node can get to know its neighbor hood by using local broadcasts, so-called HELLO messages. Nodes neighbors are all the nodes that i t can directly communicate with. Al-though AODV is a reactive protocol i t uses these periodic HELLO messages to inform the neighbors that the link is still alive. The HELLO messages will never be forwarded because they are broadcasted with TTL = 1. When a node receives a HELLO message it refreshes the corresponding lifetime of the neighbor information in the routing table. This local connectivity management should be distinguished from general topology management to optimize response time to local changes in the network.

Route Discovery

Route discovery process starts when a source node does not have routing information for a node to be communicated with. Route discovery is initiated by broadcasting a RREQ message. The route is established when a RREP message is received. A source node may receive multiple RREP messages with different routes. I t then update its routing entries i f and only if the RREP has a greater sequence number, i.e. fresh information.

Link Breakage

Because nodes can move link breakages can occurs. If a node does not receive a HELLO message from one of his neighbors for specific amount of time called HELLO interval, then the entry for that neighbor in the table will be set as invalid and the RERR message will be generated to inform other nodes of this link breakage RRER messages inform all sources using a link when a failure occurs.

II. PREVIOUS WORK

A. Optimization

Optimization in the real-world applications usually involves highly nonlinear complex problems with many design variables and complex constraints. The objective of an optimization problem can usually be associated with the minimization of wastes, costs and times, or maximization of benefits, profits and performance (Mazhoud, Hadj-Hamou, Bigeon, & Joyeux, 2013). Due to the fact that traditional deterministic methods or algorithms do not cope well to solve a large number of problems in practice, especially when the objective function is multimodal with many local optima, scientists have turned their eyes to the Mother Nature, looking for new ideas and inspiration for problem-solving. Since then, over a dozen algorithms have been developed based on the inspiration from different natural processes. Particle swarm optimization (PSO) (Eberhart & Kennedy, 1995; Eberhart & Yuhui, 2001) and Ant colony optimization (ACO) (Dorigo, Maziezzo, & Colorni, 1996) are based on the swarm behavior. Most of these algorithms are swarm intelligence based algorithms because they try to mimic some of the key characteristics of swarming behavior of ants, birds, fish, insects and bats.

B. Particle Swarm Optimization (PSO)

Swarm Intelligence (SI) is a branch of EC wherein the dynamics of group is responsible for its survival. In SI, a group of individuals or particles cooperate with each other to find optimal solution for the problem in hand to date, several swarm intelligence models based on different natural swarm systems have been proposed in the literature, and successfully applied in many real-life applications.

The particle swarm optimization (PSO) algorithm is a population-based search algorithm based on the simulation of the social behavior of birds within a flock. The initial intent of the particle swarm concept was to graphically simulate the graceful and unpredictable choreography of a bird flock with the aim of discovering patterns that govern the ability of birds to fly synchronously, and to suddenly change direction with a regrouping in an optimal formation. From this initial objective, the concept evolved into a simple and efficient optimization algorithm.

In PSO, individuals, referred to as particles, are "flown" through hyperdimensional search space. Changes to the position of particles within the search space are based on the socialpsychological tendency of individuals to emulate the success of other individuals. The changes to a particle within the swarm are therefore influenced by the experience, or knowledge, of its neighbors. The search behavior of a particle is thus affected by that of other particles within the swarm. The consequence of modeling this social behavior is that the search process is such that particles stochastically return toward previously successful regions in the search space.

Each solution is considered as bird, called particle All the particles have a fitness value. The fitness values can be calculated using objective function All the particles preserve their individual best performance They also know the best performance of their group They adjust their velocity considering their best performance and also considering the best performance of the best particle.

Various steps involved in PSO algorithm are as:

Initialize the particle in a given search space.

1. Evaluate the performance of each particle.

2. Compare the particle's fitness value with best. If the value of particle is better than best then set this value as best

3. Update the position and velocity of particles.

Examples of swarm intelligence models are:

1. Ant Colony Optimization

2. Artificial Bee Colony

3. Birds Flocking

4. Fish Schooling

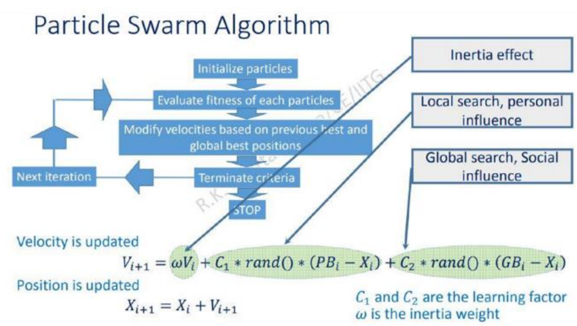
Swarm intelligence is defined as the collaborative performance of unconsolidated and auto organized assembly. These consist of elementary representatives interacting with the situation and among them. The representatives interact and haphazardly, without maintaining any rules. Globally the attitudes of these humble representatives turn out to be "intelligent". Food and nectar searching techniques of ants and bees respectively are instances of such behavior. The behaviors of swarms are similar to mobile ad-hoc networks (MANETs).

A swarm is a considerable number of alike, essential administrators partner locally among themselves, and their condition, with no key control to empower an overall interesting behavior to create. Swarm-based counts have starting late come up as a gathering of nature-spurred, masses based figuring that are fit for making insignificant exertion, snappy, and solid responses for a couple of complex issues. Swarm Intelligence (SI) is a branch of Artificial Intelligence that is used to show the corporative lead of social swarms in nature, for instance, underground creepy crawly states, honey bees, and feathered animal runs. In spite of the way that these administrators (swarm individuals or bugs) are

1. Identification and checking strategies for arranging QoS from end to end between sort out segments

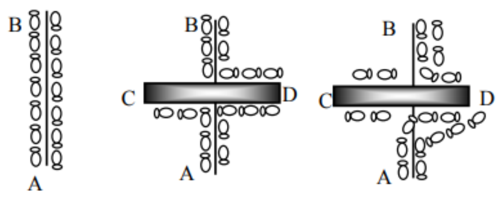
2. QoS inside a single framework part.

3. QoS technique, organization, bookkeeping capacity to control and direct end-to-end development over a framework.



C. Ant Colony Optimization

The ACO metaheuristic (problem independent techniques that can be applied to a broad range of problems) is based on generic problem representation and the definition of the ant's behavior. ACO adopts the scavenging behavior of real ants. When multiple paths are available from nest to food, ants do random walk initially. During their trip to food as well as their return trip to nest, they lay a chemical substance called pheromone, which serves as a route mark that the ants have taken. Subsequently, the newer ants will take a path which has higher pheromone concentration and also will reinforce the path they have taken. As a result of this autocatalytic effect, the solution emerges rapidly. To illustrate this behaviour, let us consider the experiment shown in the figure given below.



(a) (b) (c)

A set of ants moves along a straight line from their nest A to a food source B (Figure 1a). At a given moment, an obstacle is put across this way so that side (C) is longer than side (D) (Figure 1b). The ants will thus have to decide which direction they will take: either C or D. The first ones will choose a random direction and will deposit pheromone along their way. Those taking the way ADB (or BDA), will arrive at the end of the obstacle (depositing more pheromone on their way) before those that take the way ACB (or BCA). The following ants' choice is then influenced by the pheromone intensity which stimulates them to choose the path ADB rather than the way ACB (Figure 1c). The ants will then find the shortest way between their nest and the food source.

In most cases, an artificial ant will deposit a quantity of pheromone represented by $\Delta\tau i,j$ only after completing their route and not in an incremental way during their advancement. This quantity of pheromone is a function of the found route quality. Pheromone is a volatile substance. An ant changes

the amount of pheromone on the path (i, j) when moving from node i to node j as follows:

$\tau_{i,j} = \sigma \, . \, \tau_{i,j} + \Delta\tau_{i,j}$ …………………… (1)

where σ is the pheromone evaporation factor. It must be lower than 1 to avoid pheromone accumulation and premature convergence. At one point i, an ant chooses the point j (i.e. to follow the path (i, j)) according to the following probability:

$$P_{i,j} = \frac{(\tau i,j)^{\alpha} . (\eta i,j)^{\beta}}{\Sigma_{(i,k)\epsilon C} (\tau i,k)^{\alpha} . (\eta i,k)^{\beta}} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where,

• $\tau i,j$: is the pheromone intensity on path (i, j). • $\eta i,j$: is the ant's visibility field on path (i, j) (an ant assumes that there is food at the end of this path).

• α and β : are the parameters which control the relative importance of the pheromone intensity compared to ant's visibility field.

• C: represents the set of possible paths starting from point i ((i, k) is a path of C).

Network Routing Using ACO

Mobile ad hoc network routing is a difficult problem because network characteristics such as traffic load and network topology may vary stochastically and in a time varying nature. The distributed nature of network routing is well matched by the multi agent nature of ACO algorithms. The given network can be represented as a construction graph where the vertices correspond to set of routers and the links correspond to the connectivity among routers in that network. Now network route finding problem is just finding a set of minimum cost path between nodes present in the corresponding graph representation

General Characteristics of ACO algorithms for routing

The following set of core properties characterizes ACO instances for routing problems:

1) ACO provides traffic-adaptive and multipath routing.

2) It Rely on both passive and active information monitoring and gathering.

3) Makes use of stochastic components.

4) Not allowing local estimates to have global impact.

5) Setting up paths in a less selfish way than in pure shortest path schemes favouring load balancing.

6) Showing limited sensitivity to parameter settings

Proposed Algorithm

This paper proposes a Quality of Service routing algorithm. The proposed approach has two phases namely path discovery phase and path maintenance phase. When a source node has to pass data to a destination node with QoS requirements it starts with the path discovery phase. Once the path is found, the data transfer will take place. While data transmission is going on, it is also required to maintain the path to the destination. This is very much desirable and required in mobile ad hoc networks and hence is done in the path maintenance phase.

A. Path Discovery Phase

STEP 1: Let the source node S has data to send to a destination D with QoS requirements higher transmission rate, less delay and more bandwidth. A list of nodes that are progressively visited by the ant is called visited nodes list. This list forms the route R from the source node to destination node.

STEP 2: Initially choose the source node S. The visited nodes list will be initialized to source node (S).

STEP3: S initiates a Path_Request_Ant to destination D through all its neighbors which are in 1-hop distance from S. address, destination address, hop count and bandwidth.

STEP 4: After that the pheromone evaporation of all the 1-hop distance nodes will be calculated. Each node (i) maintains a table called "PMtab" a table of Pheromones specifying the quantity of available pheromone on each link (Vi ,Vj). This quantity is initialized to constant C.

STEP 5: Then we calculate the pheromone evaporation of all the 2-hop distance nodes.

STEP 6: At last we calculate the path preference probability value of each path from source S with the help of pheromone evaporation of every node. A node j from a set of adjacent nodes (j, k, …., n) of i is selected as MPR node such that it covers all the 2-hop distance nodes and its path preference probability is better than others.

STEP 6: If calculated path preference probability value is better than the in memory.

STEP 7: When the Path Request Ant reaches the destination, it will be converted as Path Reply Ant and forwarded towards the original source. The Path Reply Ant will take the same path of the corresponding Path Request Ant but in reverse direction.

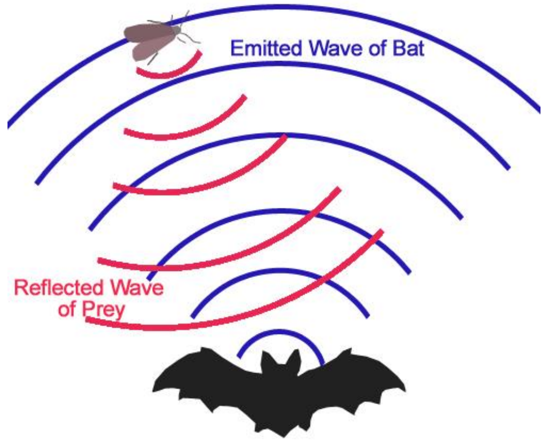
STEP 8: The path with higher path preference probability will be considered as the best path and data transmission can be started along that path.

B. Path Maintenance Phase

When the data transmission is going on, the paths are reinforced positively making it more desirable for further selection. Also when session is going on, the load on the selected path may increase causing more delay and less available bandwidth; Nodes might have moved causing link failures. In such case, the path preference probability will automatically decrease and hence alternate routes can be used which are found during route discovery phase. The alternate routes are also periodically checked for their validity even though they are not currently used.

D. Bat Colony Optimization

The bat algorithm (BA) proposed by Xin-She Yang (Yang, 2010b) is also a swarm intelligence based algorithm, inspired by the echolocation behavior of micro-bats. When flying and hunting, bats emit some short, ultrasonic pulses to the environment and list to their echoes. Their pulses vary in properties and can be correlated with their hunting strategies, depending on the species. Studies show that the information from the echoes will enable bats to build a precise image of their surroundings and determine precisely the distance, shapes and prey's location. The capability of such echolocation of micro-bats is fascinating, as these bats can find their prey and discriminate different types of insects even in complete darkness (Yang, 2010b).



Although the bat algorithm was proposed recently, there are already several variants of BA in the literature. Despite the fact that BA is a very powerful algorithm and can produce robust solutions on low dimensional problems, its performance diminishes significantly when the problem dimension increases, which is also true for other algorithms such as PSO and GA. Several studies reported that BA can be efficient to solve a diverse range of problems.

BAT Algorithm

Algorithm

1: The basic BA

1. begin

2. while (t < Max number of iterations)

3. Generate new solutions by adjusting frequency; 4. update velocities and locations [(1) to (3)];

5. if (rand > ri)

6. Select a location among the best locations

7. Generate a local location from the selected locations;

8. end-if

9. Generate a new location by flying randomly;

10. if (rand < li & f (xi) < f (~x))

11. Accept the new locations;

12. Increase ri and reduce ai ;

13. end-if

14. Rank the bats and find the current best ~x**;**

Bat Motion

Each bat is associated with a velocity $\boldsymbol{v}_i^t$ and a location $\boldsymbol{x}_i^t$, at iteration t, in a ddimensional search or solution space. Among all the bats, there exists a current best solution x_*. Therefore, the above three rules can be translated into the updating equations for $\boldsymbol{x}_i^t$ and velocities $\boldsymbol{v}_i^t$:

$$f_i = f_{min} + (f_{max} - f_{min})rand \quad (1)$$

$v_i^t = v_i^{t-1} + (x_i^{t-1} - x^*) f_i$ (2)

$x_i^t = x_i^{t-1} + v_i^t$ (3)

where β ∈ [0, 1] is a random vector drawn from a uniform distribution.

As mentioned earlier, we can either use wavelengths or frequencies for implementation, we will use $f_{min} = 0$ and $f_{max} = O(1)$, depending on the domain size of the problem of interest. Initially, each bat is randomly assigned a frequency which is drawn uniformly from $[f_{min}, f_{max}]$. For this reason, bat algorithm can be considered as a frequency-tuning algorithm to provide a balanced combination of exploration and exploitation. The loudness and pulse emission rates essentially provide a mechanism for automatic control and auto zooming into the region with promising solutions.

Variations of Loudness and Pulse Rates

In order to provide an effective mechanism to control the exploration and exploitation and switch to exploitation stage when necessary, we have to vary the loudness A_i and the rate r_i of pulse emission during the iterations. Since the loudness usually decreases once a bat has found its prey, while the rate of pulse emission increases, the loudness can be chosen as any value of convenience, between A_{min} and A_{max}, assuming $A_{min} = 0$ means that a bat has just found the prey and temporarily stop emitting any sound. With these assumptions, we have

$A_i^{t+1} = \alpha A_i^t, \ r_i^{t+1} = r_i^0[1 - \exp(-\gamma t)],$ ………(4)

where α and γ are constants. In essence, here α is similar to the cooling factor of a cooling schedule in simulated annealing. For any 0 < α < 1 and γ > 0, we have

$A_i^t \to 0, r_i^t \to r_i^0, as\ t \to \infty$……… (5)

In the simplest case, we can use $\alpha = \gamma$, and we have used $\alpha = \gamma = 0.9$ *to* 0.98 in our simulations.

Variants of Bat Algorithm

The standard bat algorithm has many advantages, and one of the key advantages is that it can provide very quick convergence at a very initial stage by switching from exploration to exploitation. This makes it an efficient algorithm for applications such as classifications and others when a quick solution is needed. However, if we allow the algorithm to switch to exploitation stage too quickly by varying A and r too quickly, it may lead to stagnation after some initial stage. In order to improve the performance, many methods and strategies have been attempted to increase the diversity of the solution and thus to enhance the performance, which produced a few good variants of bat algorithm.

Applications of Bat Algorithm

The standard bat algorithm and its many variants mean that the applications are also very diverse. In fact, since the original bat algorithm has been developed (Yang, 2010), Bat algorithms have been applied in almost every area of optimization, classifications, image processing, feature selection, scheduling, data mining and others.

Why Bat Algorithm is Efficient

A natural question is: why bat algorithm is so efficient? There are many reasons for the success of bat-based algorithms. By analysing the key features and updating equations, we can summarize the following three key points/features:

• Frequency tuning: BA uses echolocation and frequency tuning to solve problems. Though echolocation is not directly used to mimic the true function in reality, frequency variations are used. This capability can provide some functionality that may be similar to the key feature used in particle swarm optimization and harmony search. Therefore, BA possess the advantages of other swarm-intelligence-based algorithms.

• Automatic zooming: BA has a distinct advantage over other metaheuristic algorithms. That is, BA has a capability of automatically zooming into a region where promising solutions have been found. This zooming is accompanied by the automatic switch from explorative moves to local intensive exploitation. As a result, BA has a quick convergence rate, at least at early stages of the iterations, compared with other algorithms.

• Parameter control: Many metaheuristic algorithms used fixed parameters by using some, pre-tuned algorithm-dependent parameters. In contrast, BA uses parameter control, which can vary the values of parameters (A and r) as the iterations proceed. This provides a way to automatically switch from exploration to exploitation when the optimal solution is approaching. This gives another advantages of BA over other metaheuristic algorithms.

In addition, preliminary theoretical analysis by Huang et al.(2013) suggested that BA has guaranteed global convergence properties under the right condition, and BA can also solve large-scale

IV. CONCLUSION

This paper provides the comparative performance analysis of different nature inspired routing algorithms those are commonly utilized for efficient and optimized routing in Mobile Ad hoc network. For the performance analysis Quality of Service matrices such as Throughput, End to End Delay, Routing Overhead and Packet delivery ratio are considered. It is observed that Dolphin Echolocation algorithm is efficient for routing. Also the AODV routing protocol has been reviewed. As a reactive protocol AODV transmits network information only on-demand. Hence the efficient and optimized routing in MANET can be achieved with the help of Dolphin Echolocation algorithm.

V. REFRENCES

1. Yang, D.; Xia, H.; Xu, E.; Jing, D.; Zhang, H. An Energy-Balanced Geographic Routing Algorithm for Mobile Ad Hoc Networks. Energies 2018, 11, 2219.

2. Kaveh A, Farhoudi N. A unified approach to parameter selection in metaheuristic algorithms for layout optimization. J Constr Steel Res 2011;67:15453–62.

3. Elizabeth M. Belding-Royer. AODV Routing Protocol Implementation Design.

4. A. Maltz and Josh Broch, DSR: The Dynamic Source Routing protocol for Multi-Hop Wireless Ad Hoc networks.

5. Royer E.M. Perkins C.E. Ad-hoc on-demand distance vector routing. Proceedings of the 2nd IEEE

Workshop on Mobile Computing Systems and Applications, p.90, 1999.

6. The ns Manual available at http: //www. isi.edu/nsnam/ ns/doc.

7. Jubair, M.A.; Khaleefah, S.H.; Budiyono, A.; Mostafa, S.A.; Mustapha, A. Performance Evaluation of AODV and OLSR Routing Protocols in MANET Environment. Int. J. Adv. Sci. Eng. Inf. Technol. 2018, 8. [

8. David B. Johnson and David A. Maltz. “Dynamic Source Routing in Ad Hoc Wireless Networks”.

9. Gautam M. Borkar and Anjali R. Mahajan, “Secure Routing Environment with Enhancing QoS in Mobile Ad-Hoc Networks”, IJRITCC, ISSN: 2321-8169, Vol.: 5 Issue: 4, pp 370 – 376, April 2017.

10. Dorigo M, Blum C. Ant colony optimization theory: A survey. Theoret Comput Sci 2005;344(2–3):243–78.

11. Sharma, R.K.; Sharma, A.K.; Jain, V. Genetic Algorithm-Based Routing Protocol for Energy Efficient Routing in MANETs. In Next-Generation Networks; Lobiyal, D.K., Mansotra, V., Singh, U., Eds.; Springer: Singapore, 2018; Volume 638, pp. 33–40. ISBN 978-981-10-6004-5.