World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:9, No:3, 2015

IBFO_PSO: Evaluating the Performance of Bio-Inspired Integrated Bacterial Foraging Optimization Algorithm and Particle Swarm Optimization Algorithm in MANET Routing

K. Geetha, P. Thangaraj, C. Rasi Priya, C. Rajan, S. Geetha

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

***Abstract*—**This paper presents the performance of Integrated Bacterial Foraging Optimization and Particle Swarm Optimization (IBFO_PSO) technique in MANET routing. The BFO is a bio-inspired algorithm, which simulates the foraging behavior of bacteria. It is effectively applied in improving the routing performance in MANET. In results, it is proved that the PSO integrated with BFO reduces routing delay, energy consumption and communication overhead.

***Keywords*—**Ant Colony Optimization, Bacterial Foraging Optimization, Hybrid Routing Intelligent Algorithm, Naturally inspired algorithms, Particle Swarm Optimization.

I. Introduction

OVER the last few years, the fast development in the area of mobile computing is appropriate to the propagation of reasonable wireless devices. But recent devices, applications and protocols are exclusively alert on cellular or wireless local area networks (WLANs). The Mobile Ad Hoc Network (MANET) is a wireless network which is established by a set of mobile nodes. Routing is the vital part of the MANET. The routing performance of MANET is mainly influenced by end-to-end delay, power consumption and communication cost. The swarm intelligence (SI) technique proved the efficiency of bio-inspired algorithms by increasing quality of service in MANET routing [21].

MANET: Mobile Ad-hoc Network is a wireless network which is established by a set of autonomous self-organized mobile nodes on a shared wireless channel. Also known as a self-directed group of mobile devices (laptops, smart phones, sensors, etc.) to converse with all wireless links and combine forces in a dispersed manner in organize to offer the essential network functionality in the lack of fixed infrastructure. The process in which a packet of data is moved from source from to destination is denoted as routing. End-to-end delay, communication cost, power consumption and throughput influence the routing performance in MANET. The vital part of the MANET is its routing performances. The recent approaches of swarm intelligence algorithmic techniques are used in MANET to improve its routing efficiency. The swarm intelligence techniques have a significant impact on MANET routing by allowing better interaction of several simple agents to meet a global goal. The main issue of routing performance in ad hoc network includes nodes mobility and the autonomous nodes act as hosts with routers [19].

An imperative attention in the progress of extensible routing algorithms in enormous level MANET is to facilitate the overhead properties of the ascendable evaluation in routing. In regulate for the ad hoc networks to function as effectively as potential, suitable on-demand routing protocols have to be included, to locate efficient routes starting a source to a destination, moving node mobility into consideration. Current approaches of swarm intelligence techniques concern about local communication of numerous uncomplicated agents to convene a global objective has an impact on MANET routing.

NATURE INSPIRED ALGORITHMS: Nature provides some of the efficient ways to solve complex problems in real world. The algorithms which imitate processes inspired from nature are referred to as nature inspired algorithms.

Swarm intelligence is a concept in which the behavior of social insects like ants or bees is copied and with its help the communication is carried out exclusively through the environment. The social insects like ants, bees, wasps, and termites are live in colonies. In a social insect colony, every individual seems to act independently of others, but the colony functions as a planned unit [20]. The algorithm which has the combined working functions of two or more algorithms is defines as hybrid algorithms.

In this paper, nature inspired hybrid algorithms are used to solve the optimization problems in Mobile Ad Hoc Network (MANET). A wide number of survey works has been done on bio-inspired optimization algorithms. From those surveys [17] [18], we can know that some successful metaheuristic swarm intelligence algorithms conceived in the last few years are Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Bee Colony Optimization (BCO) algorithms. They are known to be population-based methods that make use of the global behavior that emerges from the local interaction of individuals with one another and with their environment.

Dr.P.Thangaraj, HOD, is with the Dept. of. CSE, Bannari Amman Institute of Technology, Tamil Nadu, India.

Mrs. K. Geetha, Assistant Professor, is with the Dept. of. IT, Excel College of Engineering, Tamil Nadu, India.

Ms. C. Rasi Priya, PG Scholar, is with the Dept. of. IT, K. S. Rangasamy College of Technology, Tamil Nadu, India (phone: 8056606155; e-mail: rasiksrct@gmail.com).

Mr. C. Rajan, Assistant Professor, is with the Dept. of. IT, K. S. Rangasamy College of Technology, Tamil Nadu, India (phone: 9865090665; e-mail: rajanksrct@gmail.com).

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

Some of the most commonly used Bio-Inspired algorithms with its description are given in Fig 1. This paper combines the foraging behavior of both Bacterial Foraging Optimization (BFO) algorithm and Particle Swarm Optimization (PSO) algorithms to solve optimization issues in MANET.

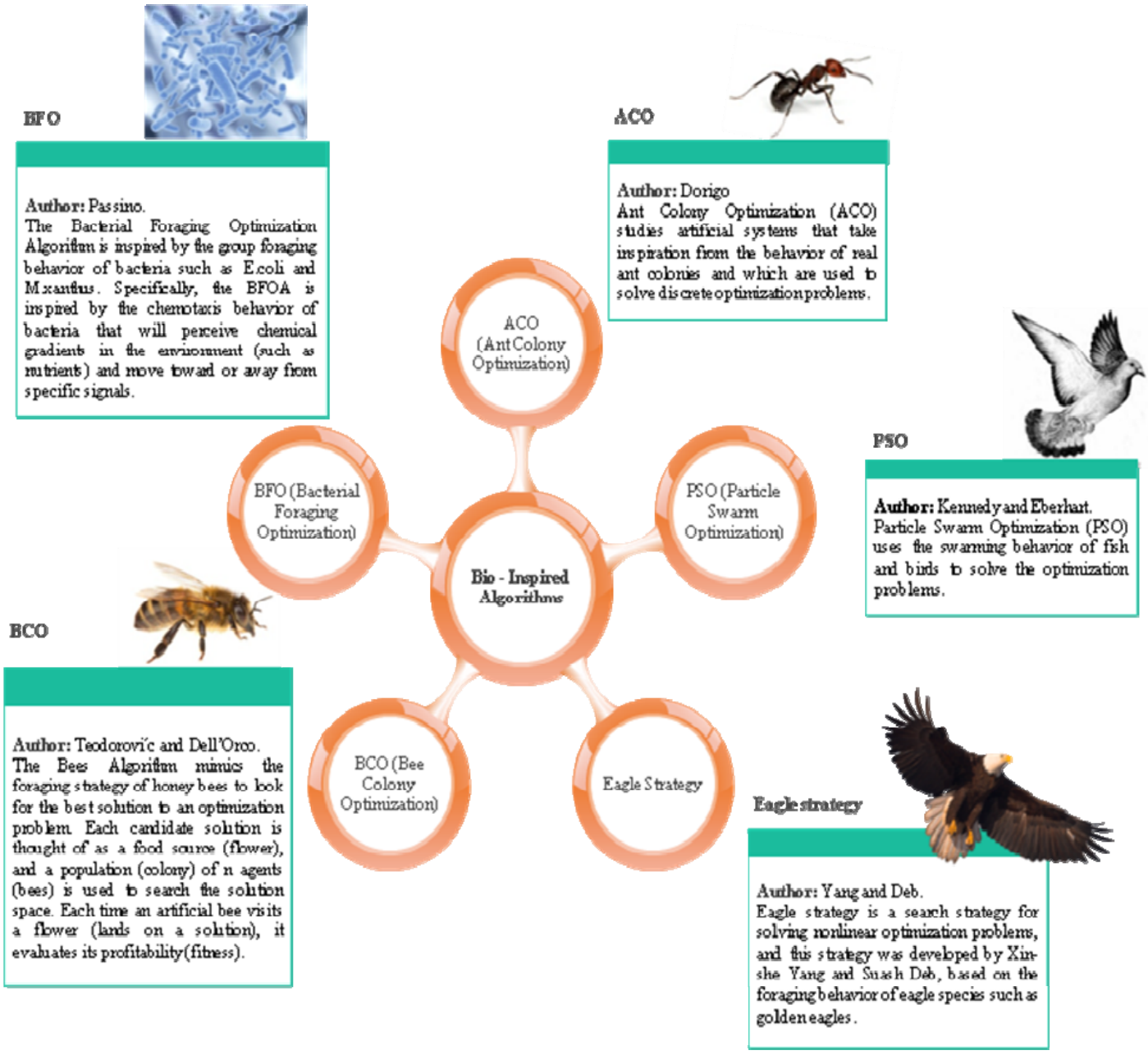

Fig. 1 Some Commonly used Bio-Inspired Algorithms

II. Literature Review

In [1], the authors described about on-demand routing algorithm, Enhanced Ant Colony Optimization (ACO) which is designed for Mobile ad-hoc networks (MANETs). Ant Colony Optimization algorithm is swarm intelligence based optimization Technique that is extensively used in network routing. The routing method tries to map the resolution ability of swarms to mathematical and engineering harms. The announced routing protocol is decidedly flexible, effective and scalable. The important hope of the protocol design is that it decreases the overhead in routing performance.

Dweepna Garg and Parth Gohil delivered that a Mobile Ad-Hoc Network (MANET) is a group of wireless mobile nodes, structure a transitory network without using middle access points, transportation, or centralized admin. The protocol is based on swarm intelligence. Ant colony algorithms are the subset of swarm intelligence and regard as the facility of easy ants to decipher complex problems by cooperation. The introduced routing protocol is well adaptive, efficient and

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

scalable. The important hope in the design of the protocol is to reduce the overhead for routing [2].

Narendhar, S. and Amudha, T. depicted that Bio-Inspired computing is the subset of Nature-Inspired computing. In this paper, Bacterial Foraging Optimization was hybridized with Ant Colony Optimization and a modern technique Hybrid Bacterial Foraging Optimization used to clarify Job Shop Scheduling Problem was proposed. The optimal solutions achieved by the proposed work of Hybrid Bacterial Foraging Optimization algorithms are much improved when compared with the solutions attained by individual Bacterial Foraging Optimization algorithm for recognized test problems of different sizes [3].

Abdullah Konak et al. described about the mobile ad hoc network (MANET) consist of the nodes preserve as equally routers, hosts and forward packets on favor of other nodes in the network [4]. This work concern the MANET to appearance a moment, self-directed telecommunication network exclusive of an existing transportation or a middle network control. This section allows a dynamic MANET management system to get better network connectivity by adopting prohibited network nodes called agents. A particle swarm optimization (PSO) algorithm is used to decide optimal area of the agents through both time step of network process.

Swagatam Das et al. [5] state that Bacterial Foraging Optimization Algorithm is broadly adapted as a global optimization algorithm of recent for allocated optimization and control. BFOA is motivated in the social foraging behavior of Escherichia coli. BFOA is also drained the attentions of researchers because of its effectiveness in resolving the real time optimization issues occur in different application domains. The basic biology behind the foraging strategy of *E. coli* is followed in an unexpected manner and handled as an optimization algorithm.

R. Vijay outlined the biology of bacterial foraging and the pseudo-code in design process [6]. This method presents a BFO to decide Economic Load Dispatch (ELD) issues. The outputs are gained for a check system with three and thirteen making units. The performance of BFO is combined with Genetic Algorithm (GA) and Particle Swarm Optimization (PSO). The output is visibly shown that the proposed method get better optimal solution as when compared to the different approaches.

Rehab F. Abdel-Kader briefed a topic on heuristic QoS multicast routing algorithm with bandwidth and interruption restrictions [7]. The proposed algorithm handles the separate particle swarm optimization (PSO) algorithm to optimally search the result space for the optimal multicast tree that satisfies the QoS necessity. A novel PSO operator is basically used to change the real PSO velocity and location updates regulations to get used to the discrete solution space of the multicast routing issues.

S. M. ELseuofi [8] explained a particle swarm optimization algorithm handled to resolve the quality of service routing issues. All multicast particle swarm optimization in the multicast particle swarm optimization system router will use an efficient aim of role that reproduce more than QoS metrics to estimate the multicast tree into one source node and one or more than destination nodes according to CoS (Class of Service).

Preeti Gulia and Sumita Sihag [9] depicted the topic on MANET, one of the latest emerging networks. MANET is a disorganized network in which nodes are autonomous and mobile. The mobility may leads to uncertainty in MANET. BFOA (Bacterial foraging optimization algorithm) is based on Bio-inspired Algorithm, is used for the proposed work. This simulation work of algorithm represents the behavior of bacteria, which will be applied in various methods.

Riya Mary Thomas states Bacterial Foraging Optimization method is adapted in optimization for grid computing gives their motivations into estimate the idea of basic evolution [10]. It has wide attention as a global optimization algorithm of recent desired for optimization and control. This algorithm is motivated by social foraging behavior of Escherichia coli. The bacterial foraging optimization (BFO) algorithm is a new progress of computation algorithm.

Xiaohui Yan et al. [11] delivered that bacterial foraging algorithm (BFO) as a currently proposed swarm intelligence algorithm motivated in foraging and chemo tactic phenomenon of bacteria. But its optimization capable is not so good combined and various algorithms as it have different shortages. The authors present an enhanced BFO Algorithm in this paper. In a novel algorithm a process techniques of bacteria is created.

In [12], the authors elaborated about the concept of bio-inspired bacterial foraging optimization algorithm (BFOA), which is mimicry of the process of frequent level of bacteria in *E. coli*, which is utilized to resolve the system of evaluation through rank minimization [12]. The simulation of BFOA effective nutrient foraging method called as chemo taxis to decrease the ingestion force per unit duration spend, the reprocess for calculation and the elimination-dispersal for platform modified in any type of basic calamities that are understand in the bacterial system.

Jing Dang et al. [13] briefly detailed the BFO algorithm is how can be created and implement to resolve metrics inference of an EGARCH-M method which is than utilized for calibration of an instability choose pricing method. The output into algorithm is view to be extendable and robust, proposing the possible of implementing the BFO for economic modeling.

Dian Palupi Rini et al. described Particle Swarm Optimization (PSO) is a generically motivated computational search and optimization technique improved in 1995 by Eberhart and Kennedy based on the social behaviors of birds flocking [14]. The essential variations numbers have been improved due to develop fast of concurrence and worth of result by the PSO. Another selection of PSO is one or more fit to process static and simple optimization issues. Alteration PSO is an improved for resolve the normal PSO issues.

Dong Chaojun and Qiu Zulian [15] explained particle swarm optimization (PSO) is a novel population intelligent algorithm and has well performance on optimization. Next, the quality of PSO algorithm and design of simulated annealing algorithm had been performed; the attention of metropolis law

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

by probability in the simulated annealing algorithm was initiated in the algorithm of PSO. The simulation output views that the drawback of acquiring in the local good point of quality of PSO was conquer efficient and the capability of total optimality are toned up.

Anant Baijal [16] demonstrates the paper on powerful implementation of three type of progress algorithms, namely-particle swarm optimization (PSO), Artificial Bee Colony (ABC) and Bacterial Foraging Optimization (BFO) algorithms to Final Load Dispatch (ELD). The output get view that ABC and BFO algorithms enclose to optimal energy cost and decrease computational time combined to PSO.

III. MANET Routing with Integrated Bacterial Foraging Optimization and Particle Swarm Optimization Technique

A hybrid MANET routing technique is based on Integrated Bacterial Foraging Optimization (BFO) and PSO (IBFO_PSO). Ad hoc network is unstructured network in which nodes are mobile and autonomous nodes act as hosts with routers mobility leads to routing issues in MANET. BFO is a bio inspired algorithm simulates behavior of bacteria effectively applied in improving the routing performance in MANET. PSO integrated with BFO reduces routing delay, energy consumption and communication overhead. The performance evaluation is done for IBFO_PSO against hybrid ACO_PSO technique. BFOA is mimicking chemo tactic movement of virtual bacteria in the problem search space individual bacterium communicate to other by sending signals. BFO is proficient in deal with the real time optimization problems. The Bacterial Foraging Algorithm's route search strategies are chemo taxis, reproduction, elimination and dispersal.

Architecture of IBFO_PSO:

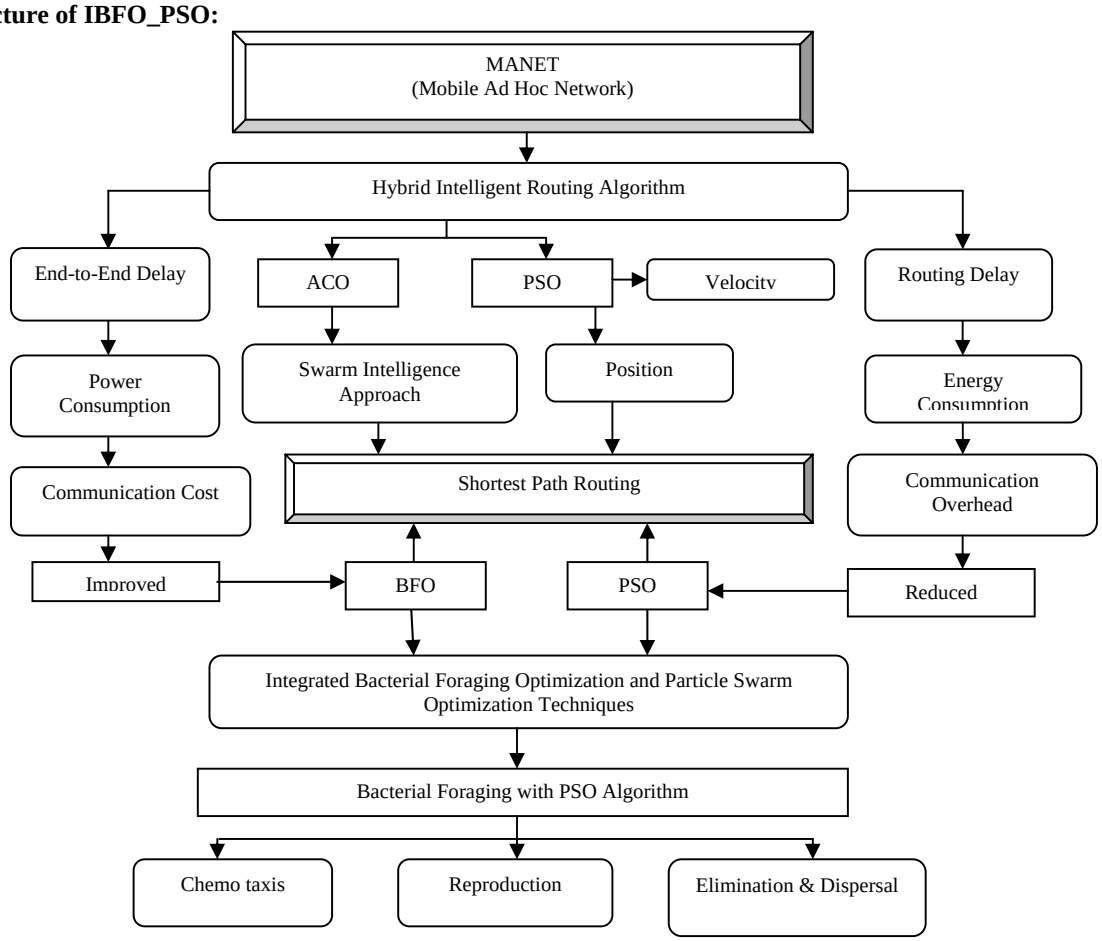

Fig. 2 Architecture Diagram of MANET Routing with Integrated Bacterial Foraging Optimization and Particle Swarm Optimization Technique (IBFO_PSO)

A. Mobile Ad-hoc Network Communication

The Ad-hoc Network Communication of each node forwards its data to other nodes willingly. Every node organized for encounters with a competitor directly or indirectly. The network communication is destination to next hop relations inform router particular destination can be reached optimally by sending packet to a specific node on behalf of next hop end route to final destination. When router receives a packet checks the address of the destination node on its routing table. This model based on the information in the

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

routing table router forwards the packet to the next hop or destination. The sender uses route to transmit the packet if a route is identified. This problem of sender may try to find a route using route discovery protocol if no route is found.

B. Hybrid ACO_PSO Routing

Hybrid model combines ACO and PSO techniques for route optimization in MANET. ACO technique is independent of routing issues. The outcomes obtained using the ACO technique can be improved with PSO. Hybrid routing intelligent algorithm model metrics E is the previous best position and E' is the current position. F is the optimum solution (minimal particles in this case) from among all of the best solutions.

C. BFO MANET Routing

BFO is a bio inspired algorithm (BFOA) steps for routing optimization process. This work simulates the behavior of bacteria effectively for improving multicast routing performance in MANET. The main process of bacterium progresses gets simple steps while searching for nutrient (chemo taxis). BFOA is mimicking chemo tactic movement of virtual bacteria (multicast routing search space) and individual bacterium communicates to other by sending signals (node communication). Bacterial Foraging Algorithm's route search strategies are chemo taxis, reproduction, elimination and dispersal. BFOA on multicast routing process done for minimize routing instability, minimize path loss rate and increase packet transmission rate.

D. PSO Multicast Routing

This work need to be optimized in multicast route selection of MANET. The PSO is an optimizer of multicast route with efficient usage of particles and adopting intelligent procedure for arriving alternate multicast route path. The PSO based develops performance in the routing messages. It is capable to adapt the frequent topology changes and minimize energy consumption on multicast route identification. For simulation initialize required the each particle is randomly produced. Initialize a populace of accidental solutions searches for optima by updating generations. The optimal agent population of composition is arrived with node positioning in ad hoc network area. It derive sub optimal multicast route based on the particle density in the region.

E. Hybrid BFO_PSO Routing

Hybrid BFO-PSO multicast routing improves quality of service provider in MANET. The PSO integrated to BFO provide lifetime of multicast route, sub optimal routes, route path link status, and available bandwidth of intermediate nodes. Each particle in PSO contains assigned location and velocity. Each node holds a local memory space to store the best position experienced by particle till then. All nodes also contain a total memory space for storing most excellent total position occurrence by particle till then. BFO's contribution on PSO is improves the search space in ad hoc area and minimize routing delay. This work identifies the node status in route path and faster information exchange among all the nodes. Even for a weak node in the ad hoc network of sub optimal multicast route path minimize are routing delay and communication overhead. Its communicate routes are deflected to the strong nodes.

BFO_PSO Routing Algorithm:

The proposed work implements the steps of BFO-PSO routing algorithm is given below:

Step1: Initialize the two source and two destination nodes

Step2: set packet is p and multiple routes is m

Step3: source node send packet to destination, if path i is discarded packet send through path i+1 varied route path.

S->P
P->i+1
i+1->P
P->D

Step4: source node send packet through the multiple route path to destination node.
Path from i to m.

S->P
P->i
i->P
P->D

Step5: Each node store the updated position of node every region in network is n=update (n+1)
$V(n+1)=V(n)+n1(P-X(n))+n2(P-X(n))$ where V is a velocity

$X(n+1)=X(n)+V(n+1)$ where X is a position

Step6: Destination send reply packet P to intermediate nodes, if intermediate node n is high energy node destination send P. node n is a strong node.

node =strong node

Step7: if intermediate node n is low energy node destination not send reply P. node n is a weak node.

node =weak node

Step8: source node send packet through high energy strong node path to destination and low energy weak node path is eliminated.

IV. Performance Results and Discussion

In this paper, the performance evaluations are done in terms of Multicast Routing Delay, Energy Consumption and Communication Overhead. The performance metric value in NS2 simulations are evaluated and analyzed. The performance evaluation is done for the following metrics: Multicast Routing Delay, Energy Consumption and Communication Overhead.

A. Multicast Routing Delay

Multicast routing describes the capability of communication network to recognize a single message from an application and to deliver copies of the message to multiple receivers at different location.

TABLE I
Node Density vs. Multicast Routing Delay (sec)

Node Density	Multicast Routing Delay (sec)	
	HRIA	IBFO_PSO
10	14	10
20	18	14
30	22	18
40	26	22

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf

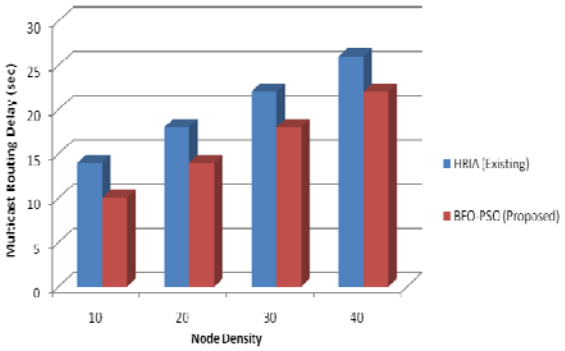

Fig. 3 Node Density vs. Multicast Routing Delay (Sec)

Fig. 3 demonstrates the Multicast routing delay. X axis represents the node density whereas Y axis denotes Multicast routing delay using both the high performance of MANET routing protocol. Fig. 3 shows better performance of BFO with PSO Algorithm in terms multicast routing delay than existing hybrid routing intelligent algorithm. When the node density is increased, multicast routing delay gets the value decreases accordingly. The BFO with PSO algorithm based routing protocol achieves higher resource availability rate variation when compared to the existing system.

B. Energy Consumption

A general expression to deal with the energy needs to transmit packet, where the recent consumption, utilize the voltage and time required transmitting the packet. The energy consumption rates were gained by comparing commercial products with the experimental results.

TABLE II
NODE DENSITY VS. ENERGY CONSUMPTION (JOULES)

Node Density	Energy Consumption (joules)	
	HRIA	IBFO_PSO
10	62	45
20	64	47
30	66	49
40	68	52

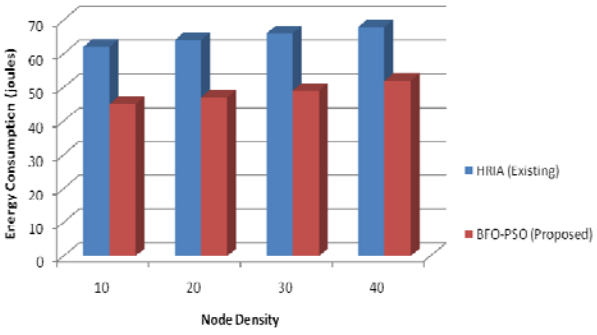

Fig. 4 Node Density Vs Energy Consumption (joules)

Fig. 4 demonstrates the Energy Consumption. X axis represents the node density whereas Y axis denotes energy consumption using both the high performance of MANET routing protocol. It shows that the energy consumed by the proposed method IBFO_PSO is lesser when compared with the existing HRIA algorithm. Thus from the Fig. 4, it is know that the efficiency of proposed algorithm is higher than the existing hybrid algorithm.

C. Communication Overhead

The payloads of data send to over a communications network needs sending added than just the desired payload data, itself. If the matching channel is collective control traffic and data traffic and channel capacity is limited, then extra control traffic often impacts data routing performance.

TABLE III
NODE DENSITY VS. COMMUNICATION OVERHEAD (%)

Node Density	Communication Overhead (%)	
	HRIA	IBFO_PSO
10	36	33
20	44	42
30	52	49
40	67	65

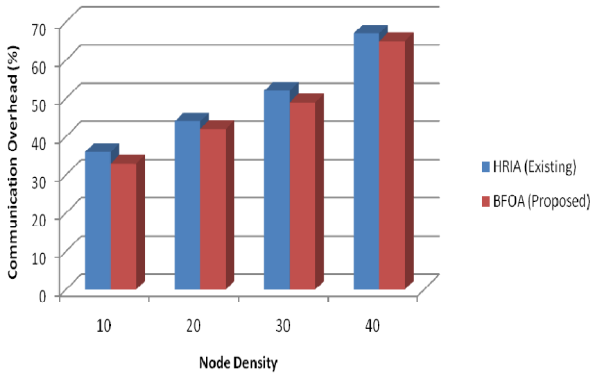

Fig. 5 Node Density Vs Communication Overhead (%)

Fig. 5 demonstrates the Communication overhead between existing and proposed algorithms. X axis represents the node density whereas Y axis denotes communication overhead using both the high performance of MANET routing protocol. Fig. 5 shows better performance of BFO with PSO Algorithm in terms multicast routing delay than existing hybrid routing intelligent algorithm. The communication overhead increases as per the increment in node density. It shows that the proposed IBFO_PSO algorithm has lower percentage of communication overhead when compared with the existing HRIA algorithm.

V. CONCLUSION AND FUTURE WORK

Finally, we can conclude that the process of BFO with PSO routing techniques based on QoS in MANETs are examined. The technique is applied for routing performance and reduces routing delay along with energy consumption. By applying this technique on MANETs, results obtained by IBFO_PSO are better when compared with the results of HRIA. This work improves the routing performance in metrics of multicast routing delay, energy consumption, and communication overhead. In future, BFO integrated with PSO motivate the process to medicinal data where permutation of bacteria

foraging and case based reasoning system can be used to diagnose the patient's diseases.

REFERENCES

[1] Manjula Poojary, B. Renuka, "Ant Colony Optimization Routing to Mobile Ad Hoc Networks in URBAN Environments", *International Journal of Computer Science and Information Technologies (IJCSIT)*, Vol. 2 (6), 2776-2779, 2011.

[2] Dweepna Garg and Parth Gohil, "Ant Colony Optimized Routing for Mobile Ad Hoc Networks (MANET)", *International Journal of Smart Sensors and Ad Hoc Networks (IJSSAN)*, ISSN No. 2248-9738 (Print), Vol-2, Iss-3,4, 2012.

[3] Narendhar. S and Amudha. T, "A Hybrid Bacterial Foraging Algorithm for Solving Job Shop Scheduling Problems", *International Journal of Programming Languages and Applications (IJPLA)*, Vol.2, No.4, October 2012.

[4] Abdullah Konak, Orhan Dengiz and Alice E. Smith, "Improving Network Connectivity in Ad Hoc Networks Using Particle Swarm Optimization and Agents", *International Series in Operations Research and Management Sciences* 158.

[5] Swagatam Das, Arijit Biswas, Sambarta Dasgupta, and Ajith Abraham, "*Bacterial Foraging Optimization Algorithm: Theoretical Foundations, Analysis, and Applications*".

[6] R. Vijay, "Intelligent Bacterial Foraging Optimization Technique to Economic Load Dispatch Problem". *International Journal of Soft Computing and Engineering (IJSCE)*, ISSN: 2231-2307, Volume-2, Issue-2. May 2012.

[7] Rehab F. Abdel-Kader, "An Improved Discrete PSO with GA Operators for Efficient QoS-Multicast Routing", *International Journal of Hybrid Information Technology*, Vol. 4, No. 2, April, 2011.

[8] S. M. ELseuofi, "Quality of Service Using PSO Algorithm", *International Journal of Computer Science & Information Technology (IJCSIT)*, Vol 4, No 1, Feb 2012.

[9] Preeti Gulia and Sumita Sihag. "Enhance Security in MANET using Bacterial Foraging Optimization Algorithm". *International Journal of Computer Applications* (0975 – 8887). Volume 84 – No 1, December 2013.

[10] Riya Mary Thomas, "Survey of Bacterial Foraging Optimization Algorithm", *International Journal of Science and Modern Engineering (IJISME)*, ISSN: 2319-6386, Volume-1, Issue-4. March 2013.

[11] Xiaohui Yan, Yunlong Zhu, Hao Zhang, Hanning Chen, and Ben Niu, "An Adaptive Bacterial Foraging Optimization Algorithm with Lifecycle and Social Learning", *Hindawi Publishing Corporation, Discrete Dynamics in Nature and Society*, Volume 2012, Article ID 409478, 20 pages.

[12] Gautam Mahapatra and Soumya Banerjee, "A Study of Bacterial Foraging Optimization Algorithm and its Applications to Solve Simultaneous Equations". *International Journal of Computer Applications* (0975 – 8887). Volume 72– No.5 May 2013.

[13] Jing Dang, Anthony Brabazon, Michael O'Neill, and David Edelman, "*Option Model Calibration Using a Bacterial Foraging Optimization Algorithm*", M. Giacobini et al. (Eds.): EvoWorkshops 2008, LNCS 4974, pp. 113–122, 2008.

[14] Dian Palupi Rini, Siti Mariyam Shamsuddinl and Siti Sophiyati Yuhaniz, "Particle Swarm Optimization: Technique, System and Challenges", *International Journal of Computer Applications* (0975 – 8887), Volume 14– No.1, January 2011.

[15] DONG Chaojun and QIU Zulian, "Particle Swarm Optimization Algorithm Based on the Idea of Simulated Annealing", *IJCSNS International Journal of Computer Science and Network Security*, VOL.6 No.10, October 2006.

[16] Anant Baijal, Vikram Singh Chauhan and T Jayabarathi, "Application of PSO, Artificial Bee Colony and Bacterial Foraging Optimization algorithms to economic load dispatch: An analysis", *IJCSI International Journal of Computer Science Issues*, Vol. 8, Issue 4, No 1, July 2011.

[17] Rajan. C, Shanthi. N, Rasi Priya. C and Geetha. K, "Investigation on Novel based Metaheuristic Algorithms for Combinatorial Optimization Problems in Ad Hoc Networks", *World Academy of Science, Engineering and Technology*, vol: 8; no: 6, 967-972, 2014.

[18] Rajan. C, Geetha. K, Rasi Priya. C and Sasikala. R, "Investigation on Bio-Inspired Population Based Metaheuristic Algorithms for Optimization Problems in Ad Hoc Networks", *World Academy of Science, Engineering and Technology*, vol: 9, no: 3, 102-109, 2015.

[19] Humayun Bakht, "*Computing Unplugged, Wireless infrastructure, Some Applications of Mobile ad hoc networks*", April-2003.

[20] Elisa Valentina Onet and Ecaterina Vladu, "Nature inspired algorithms and Artificial Intelligence", *Journal of Computer Science*, 2005.

[21] C. Rajan, K. Geetha, Crasi Priya, S. Geetha," Investigation on Novel Based Naturally-Inspired Swarm Intelligence Algorithms for Optimization Problems in Mobile Ad Hoc Networks", World Academy of Science, Engineering and Technology International Journal of Mathematical, Computational, Natural and Physical Engineering Vol:9, No:3, 2015.

Mrs. K. Geetha holds a M.E degree in Computer Science and Engineering from K. S. Rangasamy College of technology, affiliated to Anna University of Technology Coimbatore, Tamil Nadu, India in 2010. Now she is pursuing Ph.D at Anna University of Technology, Coimbatore. She is currently working as an Assistant Professor in the Department of Information Technology, Excel Engineering College. She has 8 years of teaching experience. She has published 8 international journals and presented three papers in the national and international Conferences. She is an active member of ISTE. Her Research interests include Mobile computing, Ad hoc Networks and Network Security.

Miss. C. Rasi Priya holds a B.Tech degree in Information Technology from K. S. Rangasamy College of technology, affiliated to Anna University of Technology Chennai, Tamil Nadu, India in 2013. Now she is an M. Tech student of Information Technology department in K. S. Rangasamy College of Technology. She has published 5 international journals, 1 national journal and presented three papers in International and National level Conferences. She is an active member of ISTE. Her Research interests include Bio-Inspired Networking, Mobile computing, Ad hoc Networks and Security.

Mr. C. Rajan received his B.E Degree in Computer Science and engineering from SSN College of engineering at University of Madras. Then he obtained his Master's degree in Computer Science. He is pursuing Ph.D at Anna University of Technology, Coimbatore. He is currently working as an Assistant Professor in the Department of Information Technology, KSR College of Technology. He has 10 years of teaching experience. He has presented 16 papers in various national and international journals. His research interests Multicasting Networks, Key Management and Network Security.

Open Science Index, Computer and Information Engineering Vol:9, No:3, 2015 publications.waset.org/10001863.pdf