Journal of Theoretical and Applied Information Technology
10th October 2014. Vol. 68 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AN EFFICIENT MULTI-PATH ROUTING ALGORITHM BASED ON HYBRID ARTIFICIAL BEE COLONY ALGORITHM FOR WIRELESS MESH NETWORKS

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ABSTRACT

The number of services obtainable by wireless network has been improved for recent years. It motivates to the improvement of new wireless technologies. New technologies are required to satisfy the requirements or necessitated of the users regarding wireless services. The newly developed wireless technology with mesh topology is known as wireless mesh networks (WMN). Routing is one of the most significant problems handled by every WMN technologies during data transmission .In Wireless Mesh Networks (WMN), the Multi-path routing is one of the mainly significant problems occurred throughout data transmission process based on their ability of the link for multiple paths. To overcome the problem of the multipath routing earlier work presents a Dijkstra's Algorithm (DA) for route setup and ant colony based optimization (ACO) algorithm for route examination. But the algorithm used for route examination have lower meeting time in ACO and worst-case running time in DA for route setup .In order to solve the above mentioned issues in this work presents an Filter-Kruskal algorithm for first route setup from source to destination path . The multiple routes path are examined and maintained based on the hybrid artificial bee colony (HABC) algorithm. The routes explored for data transmission are chosen based on their expected honey bee values. If any failure occurs in this HBAC route examination step it is forwarded to route maintenance system. Proposed FKAWMNet efficiently solves multipath routing problem in wireless mesh networks (WMN). The simulation results of the proposed FKAWMNet show that proposed work achieves a higher packet delivery ratio, lesser end to end delay and lesser routing overhead than the existing routing protocols such as DAWMNet and AntHocNet. So the proposed FKAWMNet achieves highly reliable communication, assurance of load balancing and easily applicable to topological changes without node failure.

Keywords: *Multi-path routing, Industrial wireless mesh networks, Filter-Kruskal algorithm (FKA), Hybrid Artificial Bee Colony (HABC)*

1. INTRODUCTION

Wireless mesh network technology is one of the most normally used [1-3] technology in recent years. Recently several numbers of developments have been performed for these types of Networks based on the category of WMN and interesting technology to solve numerous problems based on broadband access to networks [4]. In WMN, each other and every node in the networks are easily connected to each other in wireless mode by using existing technologies. Conventional networks such as WSN, MANET and etc, provides only low number of access points for each communication between the users in the network .It becomes major problem in traditional networks. This problem is solved by using WMN, since it offers more number of access points to each communication between users in the WMN. The every node in the wireless mesh networks (WMN) is linked to each other in larger area. The illustration of the WMN is shown in Figure 1. In WMN consists of set of static mesh routers .Using the static mesh routers, we extend the reach of precise internet gateway results for each mobile users in the WMN. Multi-hop routes are dynamically formed by using static mesh routers among mobile client and the internet gateway is illustrated in Figure 1.In generally mesh routers perform two types of interaction ,one for performing broadcast communication among mesh

Journal of Theoretical and Applied Information Technology
10th October 2014. Vol. 68 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

clients and other one of communication among mesh routers .

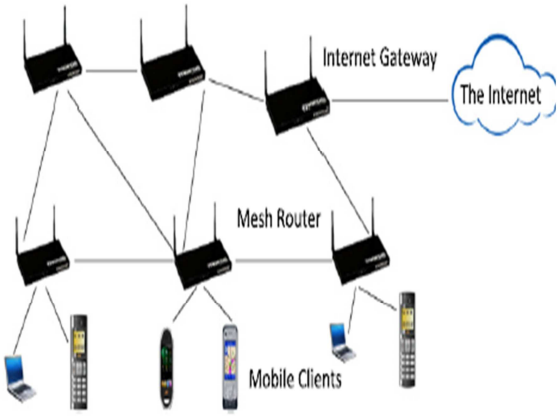

Figure. 1. Wireless Mesh Network Architecture

In WMN include set of static mesh routers that perform multihop transmission, communication between mobile clients. Mobile client may be anything such as WiFi card, WiFi phone, WiFi connected devices etc. In WMN mesh nodes have two combinations of connections such as wired and wireless connections. If the nodes in the network include wired connections, it straightforwardly connects to the internet and provide as gateways to the mesh clients. Generally WMN takes less time to installation and protection cost, because of the self regulation process ability and offers dependable services [5]. WMNs have been implemented to several number of academic and industrial operation, such as Champaign-Urbana Community Wireless Network (CUWiN) [6], SMesh [7], Solar MESH [8], Wireless Mesh Network for Next Generation Internet (WING) project [9] etc. It is also easily applicable to small and larger number of several areas such as university campuses, and health care organization, where Ethernet installation is cost-effectively prohibitive.

Several number of routing algorithm have been developed in previous work for WSN, it can be categorized into three ways such as proactive algorithm [10], reactive algorithm [11], and hybrid algorithm [12]. However, this method becomes not easy task to resolve the difficulty of multiple path route selection for mobile nodes.

The above mentioned problem is solved via using multipath route routing algorithm. In earlier work several numbers of multi-path routing algorithms have been proposed to solve the difficulty of multipath route selection. Some of the multipath routing algorithm developed in earlier works are multi-path dynamic source routing [13], split multi-path routing [14], and ad hoc on-demand multi-path distance vector (AOMDV) [15].These types of routing algorithms is named as shortest path algorithms. Solving the multipath route selection difficulty along with the concern about the quality of service (QoS) for WSN becomes more challenging issue.

In order to overcome the problem of WSN, WMN provide a Multi-hop broadcast communication to mesh clients and thus satisfy QOS requirements such as End-to-end delay, Packet delivery ratio and number of packets over headed in WMN. The main objective of the proposed routing algorithm is to decrease the communication delay and achieves extremely reliable communication without elevated flooding.

In this paper presents a novel multipath routing algorithm for WMN named as FKAWMNet (Filter-Kruskal algorithm wireless mesh networks).In the proposed hybrid multipath routing algorithm be the combination of two major algorithms such as Filter-Kruskal algorithm (FKA) and the Hybrid Artificial Bee Colony (HABC) algorithm. Route setup results are achieved by applying the Filter-Kruskal algorithm, route setups results are examined and maintain by using swarm intelligence based HABC algorithm in WMN. An FKAWMNet aim is to decrease the communication delay and achieves extremely reliable communication without elevated flooding. Simulation results of the proposed FKAWMNet extremely performs well when compare existing DAWMNet (Dijikstras algorithm wireless mesh networks) and AntHocNet(Ant colony based mobile adhoc networks) in terms of measuring the results of end-to-end delay, packet delivery ratio, and routing overhead in number of packets.

2. LITERATURE SURVEY

In earlier years, several numbers of works have been carried out for solving the routing problem in wireless adhoc networks and wireless mesh network, each and every one of the methods use a specific routing algorithm to solve the routing problem. Routing algorithm based on the wireless adhoc network is different from routing algorithm based on wireless mesh networks, but each of the routing algorithms solves single path, multipath routing problems .Before preceding the work first need to study the existing routing algorithm to solve routing problem. In earlier work many of the research papers suggest an efficient routing protocol for solving the problem of routing in

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

adhoc network, that may directly operate the network multipath freely without consideration of performance of the network [16] .Alternating path also suggested by another routing protocol ,but without maintaining of accurate process (e.g. [17]).

Several number of work use a route coupling [18] based measure for solving routing problem in adhoc networks .In route coupling assess the routes of adhoc networks with less coupling value. In routing coupling measure each and every route is dependent to every other router in the network and it doesn't solve the cost maintenance difficulty for low-coupled rate results in an on-demand protocol. Most of the existing route coupling methods uses link-state pro-active protocols.

Most of the existing multipath routing methods discussed above solves multipath routing problem on adhoc networks, but these methods number of routes to small number, normally two or three to send and receive packets, in efficient manner .In order to overcome the problem of existing routing protocols methods, in previous M. Marina et al [19] develop an on demand routing protocol named as Ad hoc On-demand Multipath Distance Vector (AODV)AOMDV, which permit k number of multipath for every routes with k link-disjoint Route Reply (RREPs).In this method the current best route path is selected quickly and other one of the path are selected based on the results from k link disjoint Route Request(RREQ) in mobile adhoc networks (MANET).This methods is particularly appropriate for solving the difficulty of multipath route selection rather than single path route selection based on the calculation of Loop freedom. Loop freedom is measured based on the hop count values of the broadcasting communication. Link–disjointness route is computed for multipath routing based on the property of the flooding.

The extension of the multipath routing method is also developed in earlier by consideration of Split multipath routing [20] .In this methods creates two paths based on the reply request (RREQ) for particular period of the time (duration of the session) and selects most highest disjointless property results from first path .It is particularly developed to solve the bandwidth restriction problem in mobile wireless adhoc network to achieve highest accuracy and efficiency with less bandwidth usage . In existing multiple path routing methods uses a link-state routing methods or distance based vector methods to solve the problem of routing along with satisfaction of QOS requirements, these methods are not well-matched for ad hoc networks. In order to overcome this problem SMR was proposed by S.-J. Lee et.al [20], it creates multiple paths and makes use of numerous disjoint paths. By finding multiple route paths it reduces route recovery process and control message overhead problem. In this work the protocol uses a packet based allocation method to allocate data packets into numerous paths of active sessions.

Due to the developments of usages of wireless sensor networks, it requires a quick access of the broadband communication between one access points to another access point; WMN is one of the most suitable methods for solving the problem of path selection and providing quicker access of the networks. In Laurent Paquereau et.al [21] developed an ant colony based multipath routing method for WMN ,the recorded internet gateway information are considered as ants and it is named as pheromone trails consequently, information of ant is updated simultaneously.

In earlier work several numbers of works uses an ant colony system for solving routing problem such as ant-based dynamic routing algorithm [22] and ant routing algorithm (ARA) [23], to Wireless Sensor Networks (WSN). But the major difficulty of the ACO algorithm is that slow convergence rapidity when compare to other optimization algorithm and it is also same for solving route finding problem, these problems are solved by using other route finding and optimization methods in this work. The proposed ,method attains higher convergence rapidity for route finding based on Filter-Kruskal algorithm (FKA) and, HABC algorithm is responsible for route investigation.

3. METHODOLOGY

In WMN, nodes in the network generally consist of lesser battery power, lesser memory consumption, based on this information the routing algorithm have expanded the WMN into a larger area with no transmission communication support [24]. In order to meet extremely demand requirements for reliable communication in routing algorithm, in this work presents a hybrid multi-path routing algorithm for WMN is called as FKAWMNet, combines the Filter Kruskal Algorithm (FKA) and HABC algorithm. The route setups are achieved by applying Filter Kruskal Algorithm (FKA), examination and maintenance of the route setups are performed by applying HABC algorithm. Before applying route setup algorithm to find the shortest path in the WMN, initially first performs the initialization process of WMN, then applying Filter Kruskal Algorithm (FKA) in

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

network manager stage to find shortest paths to each end node. After that the shortest path routes are examined by using HABC in the route examination stage during transmission of data between mesh clients. Multipath routing information from one node to other nodes is stored in the routing tables and data transmission is carried out based on this routing table information for each node in the WMN. All the nodes in the WMN maintain a group of routing table to manage the data transmission communications between nodes. Some of the additional tables required to gather information of nodes during communication those tables are neighbor table and graph table. Path exploration table update examined information food sources results from HABC for all nodes in WMN.

(1) Neighbor table. This table maintains information of all nodes which is possible to make straight communication among nodes .The neighbor table for each nodes is created after the initialization of the Wireless Mesh Network (WMN).

(2) Graph table. Graph in the networks are used to find route messages from source to destination nodes in the WMNs. Each and every node in the graph doesn't contain information of entire route, but it contains information of earlier and next node to reach destination for broadcasting a packet. Data communication among one to another nodes is performed based on the graph ID for each nodes is mentioned in the graph table. The regular bee path exploration updated results for routes in graph table are used as the important key factor for best route selection results in WMN.

(3) Path exploration table: In path exploration table stores the food sources information from source node i to reach destination node all the way through intermediate node j. It also contains information about the middle nodes in the route (path) selected results from FKA and calculate regular fitness value (fit_i^d) to each node in the route setup results or a Probability value$Prob_i^d$. The fitness value results for each node is used to approximate the accurate path route setup values of each node in WMN and to decides which route setup results is optimal for data transmission process . The fitness value of each node in the route is bootstrapped continuously based nearest neighbor nodes information during route examination stage in HBAC. The bootstrapped value of the each node is temporarily stored in path exploration table and updates each iteration in HABC. The goodness value of each route is calculated based on the cost value is considered as fitness value for route path results from FKA. In this work the cost of the each route is calculated based on the calculation distance value between nodes in the WMN (graph structure). The cost of a route setup (Fitness value) for nodes in the WMN is expressed using the following equation:

$$fit_i^d = c_i^j = d_i^j \quad (1)$$

where c_i^j denotes the cost of route value results from source node i to middle node j in the WMN, d_i^j is the distance between nodes i and j.

3.1 First Route Setup by Filter -Kruskal Algorithm

In WMN all the nodes in the network may send their data from source to destination. Finding the exact route path for data transmission to meet QOS requirements becomes one of the challenging issues, in order to perform route setup process, in this work presents a Filter –Kruskal algorithm (FKA), it finds shortest route path results in WMN. In filter Kruskal algorithm (FKA) nodes which don't under the shortest path in MST or already selected edges in the graph structure is filtered initial stage itself.

Nodes in the Wireless mesh network is represented as graph $G = (V, E)$.In this work the minimum spanning tree(MST) of a graph is used to represent WMN , $G = (V, E)$ where V and E represents the group of vertices and the group of edges, correspondingly. The MST shortest path route results are founded based on their minimum weight values of edges in the graph .The weight values of the edges in the graph are calculated based on their distance between two nodes in the WMN (G). $E = (u, v)$ denotes the different set of edge values in the graph G that fall within minimum weight value range T , the results of the shortest paths edges $\{u, v\}$be the safe state. If the range of the weight value is exceeding to minimum weight value range T then the system is unsafe state the edges in the network not taken for shortest path estimation. To store so far best results in the MST Kruskal method in this work additionally adds a Union-Find operation which combines two different edges results. The procedure of the Filtering Kruskal algorithm [25] , is represented below .Initially the weight values of the edges are sorted using quick sort algorithm and their move path from one node to another node by increasing the weight values starts from small to high. Filtering removes the edges whose weight values are fall with the same component of the route same component of the T. This procedure is repeated until the all edges in the nodes within the minimum

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

weight constraint is achieved so far without formation of cycle in the MST for WMN.

Procedure

Kruskal

$(E, T: is\ a\ spanning\ tree\ of\ minimum\ weight\ with\ Sequence\ of\ edge\ , P: Union\ find)$

sort E by increasing edge weight

for each $\{u, v\} \in E$ do

if u, v are in different components of P then

add edge $\{u, v\}$ to T

join the partitions of u and v in P

Procedure

Filter

Kruskal$(E, T:$

$Sequence\ of\ Edge, P: Union\ Find)$

if $m \leq kruskal\ Threshold(n, |E|, |T|)$ then

Kruskal(E, T, P)

else

pick a pivot $p \in E$

$E_{\leq} := \langle e \in E : e \leq p \rangle$

$E_{>} := \langle e \in E : e \leq p \rangle$

Filter Kruskal(E>, T, P)

Function Filter$(E, P: UnionFind)$

Return

$\langle \{u, v\} \in E, u, v$ are in different components of P$\rangle$

Once the shortest route path is established from source to destination node in FKA results, then the path exploration table of all nodes of the selected route path and the graph table of the source node i are created to all nodes in WMN. The Cost of the route is calculated based on the fitness function (bf_{ij}^{d}) for a route in the WMN and this route setup path is added to graph table for data transmission

$$BF_{ij}^{d} \leftarrow \phi_{ij} fit_{ij}^{d} + (1 - \phi_{ij})(c_i^j)^{-1} \quad (2)$$

where $\boldsymbol{\phi_{ij}}$ regularization parameter to speed the ABC algorithm for route examination $\boldsymbol{\phi_{ij}}$ is maintained at 0.7 and c_i^j is defined as shown in Equation (1).The route examination process is completed; the network manager holds information regarding shortest path route and sends routing information to remaining nodes in the WMN occupy their individual graph ID place in the graph table to reach destination nodes and neighboring nodes. This procedure is called as target way query. Based on the individual Graph ID in the graph table identification of exact direction becomes easy when compare to other methods thus reduces the memory capability of every one of the node, thus avoiding unnecessary multi-hop exploration progression.

3.2 Route Exploration By Hybrid Artificial Bee Colony Optimization (HABC)

Multiple unnecessary or unusual paths in the WMN for data transmission is avoided in this route examination and maintenance stage .This process is applied or extended from route setup stage in FKA. Route examination stage consists two major steps to examine routes in WMN such as namely Route examination and Path exploration table update. On route exploration stage the main objective is to extend the existing route nodes information (food source information) into the network through using "keep-alive" messages. Path exploration table update the current path (food source information) by using HABC. In this work the highest probability value of the bees (nodes) for shortest routes are examined; it is then terminated if it is less than earlier shortest path examination results or if it is higher than is selected as best examined route path results ,thus updates path exploration table . Then cycle is formed based on this route examination results, then next cycle is activated based on the topological changes or timer.

3.2.1. "Keep-alive" message

In WMN each nodes in the network exchanges their multi-path route discovery information to their adjacent nodes by using "keep-alive" messages. The major objective of this keep alive message is to explore a new silent links, determine new adjacent nodes by continuing time synchronization. Messages are constantly sent to node once per miniature only and thus avoid power utilization problem in WMN. In route examination stage once the existing nodes obtains new route information regarding routes to reach destination nodes in the WMN , keep alive message are automatically sent to their nearest (adjacent) nodes . It should take more than one seconds to perform this message sending process during data transmission. Each one of the keep alive message carries five routes information to destination path almost. The procedures of sending keep alive messages are stooped in the WMN once it reaches to their default configuration.

3.2.2. Route exploration

In route examination stage nodes in the route setup results are considered as input to the route examination process to reach destination node in WMN .During this process fitness value of the each

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

nodes is calculated based on the node i receives a "keep-alive" message from network manager and move towards intermediate node j, best bootstrapped cost values are stored $\mathbf{BFS_{ij}^{d}}$, in Equation (3). It indicates that the best route value results from node i to node j are determined and the cost value of the route from node i to node j is also calculated. The resultant value of these two factors are named as bootstrapped value $\mathbf{BU_{ij}^{d}}$, to update best route examination position in HABC phase. The accurate formula to calculate the bootstrapped value $\mathbf{BU_{ij}^{d}}$ is specified in Equation (4).

$$BFS_{ij}^{d} = fit_{jk}^{d} \frac{fit_{jk}^{d}}{\max_{k \in N_j}(fit_{ij}^{d})} \quad (3)$$

$$BU_{ij}^{d} = [(BFS_{ij}^{d})^{-1} + (1 - \phi_{ij})^{-1} c_i^{j}]^{-1} \quad (4)$$

In this work presents a Hybrid Artificial Bee Colony (HABC) for route examination based on their updated food source information (route node information) and their corresponding location of each node in the route. In order to improve the speed of the ABC method, in this work presents an orthogonal initialization [26] for initialization of the population that is the initialization of route setup results from FKA in WMN, to improve the speed of the ABC method. The HABC algorithm optimally examines the route setup path results for WMN points. In generally ABC algorithm , the major category of bees are presented to find the optimal results such as employed bees, onlooker bees and scout bees. Employee bees are responsible to utilize the information of all nodes in the route setup path food source and selected route setup path information are sended to onlooker bees about the quality of the optimal route exploration food source sites. Onlooker bees choose the best route exploration results based on the calculation of the probability value and food source information results from employee bees. If none of the route exploration results are not found in onlooker bee phase then scout bee randomly selects a new route setup path from FKA and searches new route exploration food source information find a new route exploration food source .The number of nodes in the route setup path discovered from FKA is equal to the number of food source. The location of a route exploration food source represents the optimal route path exploration results, and the nectar quantity of a route exploration results are calculated based on the fitness function. Denote the route exploration SN, the location of the i^{th} (nodes) route exploration food source as x_i $(i = 1, \ldots, SN)$. In this step the Bee's route exploration are founded based on their updated bee values using BU_{ij}^{d} , then velocity of their selected route nodes bee values are updated using the equation (5).A candidate nodes route examination food source position is generated based on the earliest route examination food source results in the memory ,it can be generated as follows ,

$$v_{ij} = x_{ij} + \phi_{ij}(x_{ij} - x_{kj}) \quad (5)$$

where $k \in \{1, 2, \ldots, SN\} = \{1, \ldots GID_n\}$ represents the graph IDs to each node in the WMN . $k \neq i$ and $j \in \{1, 2, \ldots, D\}$ be the randomly selected number with D dimensional space, $\phi_{ij} \in [-1, 1]$. An onlooker bee (Nodes in the WMN) decide a route exploration results based on their calculation of probability value to each nodes in the route, which is given by,

$$Prob_i^{d} = \frac{fit_{ij}^{d}}{\sum_{i=1}^{SN} fit_{ij}^{d}} \quad (6)$$

where $\boldsymbol{fit_{ij}^{d}}$ is the fitness value of the i^{th} node route exploration in HABC. In onlooker bee stage if the above selected route examination is abounded then scout bee selects a new route examination food source according to the following equation,

$$x_{ij} = x_j^{min} + rand(0,1)(x_j^{max} - x_j^{min}) \quad (7)$$

Where x_j^{min} and x_j^{max} be the lower and upper estimated nodes values in the j^{th} dimension space. The major problem of the ABC algorithm are slower convergence rapidity, because of the random initialization of the bees population, in order to overcome these problem in this work presents a hybrid artificial bee colony algorithm for route exploration.

3.3 Orthogonal Initialization

In this work initialization of population consists of number of nodes with path discovered results from FKA. Each and every route discovered from FKA is considered as input for ABC population. Orthogonal propose is one of the most best suitable methods for solving initialization problems. Here, generates initial population for route setup results from FKA by using the orthogonal initialization method. Orthogonal initialization methods is based on two major methods such as orthogonal array and quantization technique, which is detail mentioned in [25].In orthogonal initialization steps differential evolution (DE) is one of the most significant technique to resolve initialization population problem, it creates new population for each route setup individuals by calculation of vector differences value among randomly selected route path setup population members. Based on the DE

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

property the results of the ABC algorithm with newly initialized route path setup, bee examine the route exploration results based on the following equation,

$$v_{ij} = x_{ij} + \phi_{ij}(x_{ij} - x_{r_1,j}) + \psi_{ij}(x_{r_2,j} - x_{r_3,j}) \quad (8)$$

where r_1, r_2 *and* r_3 be the randomly chosen integer values for initial population $\{1, 2, \ldots, SN\}$ generation , ϕ_{ij}, $\psi_{ij} \in [-1,1]$ are random number. As shown in (8), the route exploration food source candidate solution results of current route setup results is different from earliest one ,but the major problem of this step is that the accuracy of the system is not increased ,in order to increase the accuracy of the route examination results ,the above mentioned equation (8) is altered in the following form .

$$v_{i,m} = x_{i,m} + \phi_{i,m}(x_{i,m} - x_{r_1,m}) + \psi_{i,m}(x_{r_2,m} - x_{r_3,m}) \quad (9)$$

Hybrid artificial bee colony algorithm

Input: Initialize the route exploration food sources by orthogonal initialization, and evaluate the population, $trail_i = 0, (i = 1, \ldots, SN)$, $cycle = 1$

Repeat

Step 1: Search the new route exploration food source for employed bees according to (5) and evaluate its quality. **Step 2:** Apply a greedy selection process and select the better route exploration solution between the new route path food source and the old route path one.

Step 3: If solution of the current route exploration doesn't improve $trail_i = trail_i + 1$, otherwise $trail_i = 0$

Step 4: Calculate the probability according to (6) and apply roulette wheel selection scheme to choose a route exploration food source for onlooker bees.

Step 5: Search the new route exploration food source for onlooker bees according to (9) and evaluate its quality.

Step 6: Apply a greedy selection process and select the better route exploration solution between the new route path food source and the old route path one.

Step 7: If solution of the current route exploration doesn't improve $trail_i = trail_i + 1$, otherwise $trail_i = 0$.

Step 8: if $max(trail_i) > limit$, replace this current route path food source with a new randomly produced route path food source by (7). Memorize the best route exploration solution achieved so far. $cycle = cycle + 1$.

Until$(cycle = Maximum\ Cycle\ Number)$

In data transmission all the examined routes are not used, nodes with highest route examination probability values based route are used for data transmission along with graph ID(GID) from the graph table .

3.2.3. Route maintenance for topological changes

Topological changes are made based on their number of fault nodes presents in the WMN or environmental factors which doesn't match to the current WMN. Maintaining of the route in the topological network plays major significant roles in the WMN, since any of the changes made in the network effects the route examination results .In generally changes made in the network topologies are adding a new node in the network, removing fault node in the network, moving path from one to another node etc,.. To adjust to this abovementioned process in route maintenance stage, each one of the steps is performed separately based on their different topological changes.

Joining of new nodes

If the nodes want to add or joined to the existing WMN, it should apply to join the network based on their information collected from "Advertise" messages .The advertise messages are sended by other nodes which is not in the part of route path. After the new nodes are added to WMN then Connection establishment is performed to one node to another node, if the distance value of the nodes not exceeded within communication range. The route information of the newly added node is examined by using route examination stage in HABC. From these results, the network manager selects several numbers of routes to transmit their data from source node to a destination node in WMN.

Nodes moving

If the nodes moves from one place to another place, keep alive messages are sended to all nodes to update the position of the nearest nodes in moving stage. In this stage the network manager perform route examination stage based on their network conditions specified by user. If the particular node moved with smallest distance value there is no need for route examination stage, or else if the node moves to long distance there is a need for route examination and route examination is performed by applying HBAC, since the distance between the node and adjacent nodes is modified. If any of the broken is occurred in this stage then

Journal of Theoretical and Applied Information Technology
10th October 2014. Vol. 68 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

network manager is triggered to route maintenance stage.

(1) Select some other route which is already available in the Path exploration table, then the alternatively selected routes is automatically added to the graph table.

(2) If the no other routes are presented for path exploration table then route examination is performed again. If any of link failure occurs in the route examination stage, it is also affects bee values for route examination process , thus, the possibility of route maintenance depend on the precise conditions

Node failure

If the particular node doesn't receive message from adjacent node and it exceeds time keep alive interval, then Alarm graph route failed message command are automatically sended to network manager .Then the network manager updates their failure node information to all nodes in the WMN. If any of the broken is occurred in this stage then network manager is triggered to route maintenance stage, the procedure of the route maintenance is same as like in node moving stage.

4. RESULTS AND DISCUSSIONS

The performance of the proposed FKAWMNet is estimated by performing the model experimentation using Ns2 simulator. In order to perform simulation experimentation nodes are randomly selected within the range 100, 200, 300, and 400 nodes in a square area with area distance end to end of 10 units. Data transmission communication is performed among two nodes based on their distance values which may be less than or equal to $\sqrt{2}$ units. The following parameters are mostly used to analysis the results of the algorithm in WMN are given below.

1. End-to-end delay measure the delay time taken for sending packets from source to destination during data transmission communication path.
2. Packet delivery ratio is defined as number of packets which is effectively received at the destination without loss of any packets or failure, if the packet delivered ratio of the system is high it becomes more secure and highly efficient
3. Overhead in number of packets is defined as the association among the number of packets controlled throughout data transmission communication and the totally delivered packets at the receiver side.

The above mentioned three metrics are used to analysis the results of methods for comparison. The performances comparison results of the end to end delay between the methods such as FKAWMNet, DAWMnet and AntHocNet is illustrated in Figure 2a, it shows that the proposed FKAWMNet, has less end-to-end delay than the other approaches DAWMNet and AntHocNet

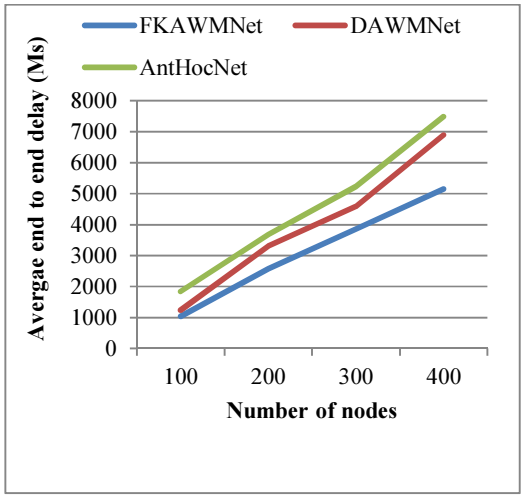

Figure 2.(a) Average end to end delay

The packet delivery ratio of the proposed FKAWMNet and existing DAWMnet and AntHocNet results are illustrated in Figure 2b. It shows that the proposed FKAWMNet has high packet delivery ratio when compare to existing approaches DAWMNet and AntHocNet.

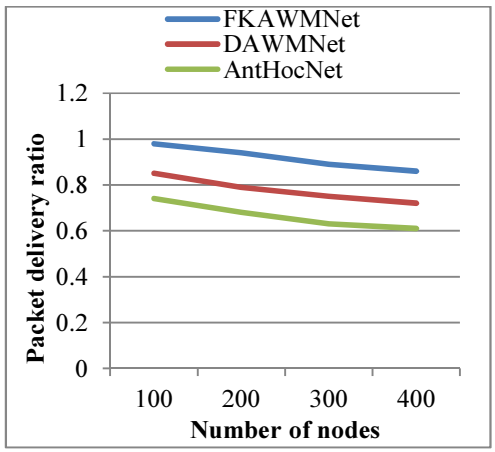

Figure 2.(b) Packet delivery ratio

The Overhead in number of packets of the proposed FKAWMNet and existing DAWMnet and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AntHocNet results are illustrated in Figure 2c. It shows that the proposed FKAWMNet has less Overhead in number of packets when compare to existing approaches DAWMNet and AntHocNet.

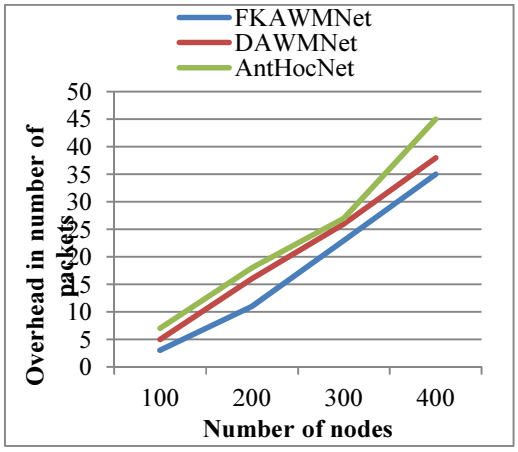

Figure 2.(c) Overhead in number of packets.

5. CONCLUSION AND FUTURE WORK

In this paper presents a hybrid multipath routing algorithm for WMN. The WMN becomes more consistent by using mesh connections between nodes, it achieves less cost estimation for on-demand path discovery results over multiple links in WMN. Proposed works two major steps is carried out ,one for multipath route routing based on Filter Kruskal Algorithm(FKA) and route exploration based on the Hybrid Artificial Bee Colony(HABC) for best route maintenance also developed .The enhanced FKAWMnet and HABC achieves higher route setup results and enhances the route examination results by removing redundant routes . The simulation results of the proposed FKAWMNet show that proposed work achieves a higher packet delivery ratio, lesser end to end delay and lesser routing overhead than the existing routing protocols such as DAWMNet and AntHocNet. So the proposed FKAWMNet achieves highly reliable communication, assurance of load balancing and easily applicable to topological changes without node failure.

REFRENCES

[1] S.Huang and Q.Zheng, "Research of capacity optimizing model on wireless mesh networks", *In Computer Science and Information Technology, 2009, ICCSIT 2009, 2nd IEEE International Conference on*, pp. 569–572, 2009.

[2] S. Lei, Z. Cheng and Z. Chenghui, "Analysis and optimization model of cognitive wireless mesh networks", *In Industrial Control and Electronics Engineering (ICICEE), 2012 International Conference on*, pp. 1426–1429, 2012

[3] Y. Zhu, H. Liu, Y. Guo and W. Zeng, "Challenges and opportunities in supporting video streaming over infrastructure wireless mesh networks", *In Multimedia and Expo, 2009. ICME 2009, IEEE International Conference on*, pp. 1548–1549, 2009.

[4] S. Kumaran and C. Semapondo, "Hybrid wireless mesh network for universal access: Opportunities and challenges", *In Telecommunications (AICT), 2010 20 P. Owczarek, P. Zwierzykowski Sixth Advanced International Conference on*, pp. 390–397, 2010

[5] I.F. Akyildiz, X. Wang and W. Wang, "Wireless mesh networks: a survey", *Computer Networks* 47 (4) (2005) 445–487.

[6] Cuwin webpage, http://www.curwireless.net/.

[7] Smesh webpage, http://smesh.org/.

[8] Solarmesh webpage, http://owl.mcmaster.ca/todd/SolarMESH/.

[9] Wing webpage, http://www.wing-project.org/.

[10] H.Narra ,Y.Cheng , E.K. Çetinkaya, J.P. Rohrer and J.P.G. Sterbenz, "Destination-sequenced distance vector (DSDV) routing protocol implementation in ns-3", *Proceeding SIMUTools '11 Proceedings of the 4th International ICST Conference on Simulation Tools and Techniques,* pp. 439-446,2011.

[11] C.E. Perkins and E.M. Royer, "Ad hoc on-demand distance vector routing", *in Proceedings of IEEE Workshop on Mobile Computing Systems and Applications (WMCSA' 99), (New Orleans)*, pp.25–26 February 1999, pp. 90–100

[12] Z.J. Haas and M.R. Pearlman, "The zone routing protocol: a hybrid framework for routing in ad hoc networks", *in Ad Hoc Networking, ed. by C.E. Perkins (Reading, MA, Addison-Wesley, 2001)*, pp. 221–254.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[13] A. Nasipuri, R. Castaneda, S.R. Das, "Performance of multipath routing for on demand protocols in mobile ad hoc networks", *Mob. Netw. Appl. 6(4),* 2001, pp.339–349.

[14] S.J. Lee, M. Gerla, "Split multipath routing with maximally disjoint paths in ad hoc networks", *in Proceedings of IEEE International Conference on Communications, ICC 2001*. vol. 10, Helsinki, 11–14, June 2001, pp. 3201– 3205

[15] M.K. Marina and S.R. Das, "On-demand multipath distance vector routing in ad hoc networks, in Proceedings of Ninth International Conference on Network Protocols", *ICNP 2001. California, 11–14 November 2001*, pp. 14–23.

[16] H. Rangarajan and J. Garcia-Luna-Aceves, "Using labeled paths for loop-free on-demand routing in ad hoc networks," *in MobiHoc*, 2004.

[17] T. Goff, N. Abu-Ghazaleh, S. Phatak, and R. Kahvecioglu, "Preemptive routing in ad hoc networks," *in Mobile Computing and Networking*, 2001, pp. 43–52.

[18] S. Roy, D. Saha, S. Bandyopadhyay, T. Ueda, and S. Tanaka, "Improving end-to-end delay through load balancing with multipath routing in ad hoc wireless networks using directional antenna," *in Proc. IWDC 2003: 5th International Workshop, LNCS v2918*, Jan. 2003, pp. 225 – 234.

[19] M. Marina and S. Das, "On-demand multipath distance vector routing in ad hoc networks," *in Proc. ICNP, 2001*, pp. 14–23.

[20] S.-J. Lee and M. Gerla, "Split multipath routing with maximally disjoint paths in ad hoc networks," *in IEEE ICC, 2001*, pp. 3201–3205.

[21] L.Paquereau, B.E. Helvik, "Ant-Based Multipath Routing for Wireless Mesh Networks", *Applications of Evolutionary Computation Lecture Notes in Computer Science Volume 6625*, 2011, pp 31-40

[22] Y. Lu, G.Z. Zhao and F.J. Su, "Adaptive ant-based dynamic routing algorithm", *in Proceedings of 5th World Congress on Intelligent Control and Automation (WCICA 2004), vol. 3, Hangzhou, 15–19 June 2004*, pp. 2694–2697

[23] M. Gunes, U. Sorges and I Bouazizi, "ARA—the ant-colony based routing algorithm for MANETs", *in Proceedings of the International Conference on Parallel Processing Workshops (ICPPW02), Vancouver, 20–23 August 2002*, pp. 79–85

[24] G. Koh, D. Oh and H. Woo, "A graph-based approach to compute multiple paths in mobile ad hoc networks", *in Lecture Notes in Computer Science (LNCS), vol. 2713 (171), ed. by C-W Chung et al. (HSI, 2003),* pp. 323–331.

[25] R. Paredes and G. Navarro, "Optimal incremental sorting. In 8th Workshop on Algorithm Engineering & Experiments", *SIAM, 2006*, pp.171–182.

[26] W. Leung, Y. P. Wang, "An orthogonal genetic algorithm with quantization for global numerical optimization", *IEEE Transactions of Evolutionary Computation*, 2001, 5 (1): pp.41 – 53