Analysis of Opportunistic Routing in Wireless Ad-Hoc Networks using Firefly with d-AdaptOR Algorithm

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Abstract: Opportunistic routing (OR) protocols become a new routing paradigm that hasbeen proposed to give efficient delivery of data and to overcome routing limitations using dynamic ad hoc networks.In ad hoc networks, this most preferred routing technique tries to address two major problems of unpredictable node mobility and unreliable link qualityusing the broadcasting of the wireless medium. Different conventional IP forwarding, OR fetches in opportunistic data forwarding in which an intermediate node refers a forwarding table for a next hop that allows multiple candidate nodes in the forwarding region to perform on the broadcasted data packet. In MANET, it has utilized the reliability of data delivery with reduced delay. When the network congestionarises then the delayto be replaced by time-invariant quantities, the heuristics in would become a special case of d-AdaptOR in a network with deterministic channels and with no receiver diversity.In this paper, the hybrid algorithm (Firefly with d-adaptOR)is compared and analyzed, and then it selects shortest route for transferring the packets of data from transmitter node to the receiver node for increase the transmission reliability of sensor networks, life time of the throughput, network, and reduce the delay. Here, the experimental result illustrated and compared with the existing method, the hybrid algorithm provides better result.

Keywords: Mobile Ad hoc network, Opportunisticrouting,Ex-OR, Firefly and d-adaptOR

I. INTRODUCTION

In MANETs, itkeeps on varying with the movement of the mobile devices in the network and also it does not provide for static optimization most of the time. The most pre-existing routing protocols choose a fixed pathway, but in ad hoc networks, links between pairs of nodes tend to modify over time. This may affects the stability of the predetermined route. Opportunistic routing(OR) approach maximizes link stability by expressing the new idea, in such case if the each node has multiple neighbors waiting to transmit; it will be a stable route at any specified time.The robustness and effectiveness of the OR focuses several recent applications in wireless networks.OR is mainly proposed to address the unreliable communication in multi-hop wireless networks by utilizing the broadcast advantages of wireless communication [1, 2, 3].The main perception of OR does not commit to a fixed route before data transmission [4, 5]. If a source node wants to transmit a data packet to a specificreceiverdevice, it broadcasts the data packet into the wireless network. Using MAC interception, this packet is obtained by each node during its transmission time.The device selects the closest nodeto discover the best route to the destination, using this way can easily choose the best forwarder device. Thus, data forwarding keeps dynamic in nature and no need to maintain predetermined routes. Finally, the OR provides an improved mechanism for the delivery of the data packet at the destination in ad hoc networks with highly mobile nodes.

Hybrid Routing Protocol is termed as mainly two protocols proactive routing protocol and reactive routing protocol [6]. Proactive routing protocol has performed in minimal latency management. Reactive routing protocol refers huge overhead at the time of execution. For this reason a hybrid protocol is proposed to overcome the drawbacks of both reactive and proactive protocols. In such that, the hybrid routing protocol used to solve the less overhead problems and avoidance of latency so that it uses the table maintenance mechanism of proactive protocol and route discovery method of reactive protocol. Therefore, hybrid protocol can be helpful to utilize large networks which have a huge number of nodes. The broad networks are partitioned into set of zones where the reactive scheme is used for performing routing inside zone and proactive approach is used to perform the outside zone [7]. A number of OR protocols have been proposed, each protocol has tried to address one or more problems concerning data transfer in ad hoc networks [8].This paper will provide the best comparative analyses of the latest OR protocols in wireless ad hoc networks with highly mobile nodes.

II. COMPARATIVE ANALYSIS

To resolve the optimization issues of the meta-heuristic technique built and it utilizes the simulation performance of the fireflies. A number of research works have proven the accuracy of the outputs and the high standard evaluation of the optimization techniques solved by FA (Firefly Algorithm). This exact feature can be very helpful in the establishment of neighbor tables in MANETs in which the node can be recognized based on the intensity, but may ends into a deadlock situation if FA is used solely.

The hybridization of two algorithms are Firefly and d-daptOR that are used to optimize the route detection in the deployment of MANETs in which the efficiencies of both the algorithms are performed for enhancing the routing algorithm and then compare with other opportunistic algorithms.

2.1 ExOR:

ExOR routing protocol implemented for wireless multi-hop networks to optimize RoofNet testbed with the support of Research University at the Massachusetts Institute of Technology [9]. The routing techniques and MAC (Media or Medium Access Control) protocols were integrated using ExOR;the packets are broadcast at layer 3. It has to progress the routing performance by utilizing opportunistically over unstable extensive-range communication. After collecting a setof packetsand that has individuallyrecognized using a BatchID, the sender broadcasts each packet in the batch, listing the forwarding nodes in a priority manner using the packet's header address. Using ETX metric sets the priority order to the destination [10].Particularly, the expected number of transmissions required to forward a packet along a route, can be referred to map to a distance from the destination, therefore, the higher the priority, the lower the metric. Toperform withthe nodes that are "closer" neighbor to the destination than the transmitter are involved in the potential forwarder set. Bitmap refers to the maps of pixels to carry each packet and that have been obtained by the sending node or nodes with higher priorities. A forwarder node broadcasts each packet but no forwarder by means ofprivileged priority has acknowledged receipt of it. ExOR has provided as better routing performance. It is a forwarder can receive the whole set of packets in an efficient way;so that nodes have to be stored fragments of the batch will require to schedule their transmissions. ExOR determines the duration of five packet times while the number of higher priority nodes prioritized in the forwarder list so that each forwarder follows a forwarding timer till that the end of transmission. It can be utilized a prediction of the time at which the node shouldinitiatethe forwarding packets from its packet buffer.After complete that the schedule cycle, the batch maps requirebeing updated using negative acknowledgments even if the destination has take delivery of 90% of the batch, and it is transmitted using traditional routing, since the overhead would be forbidding otherwise. Finally, the central coordination and scheduling processtakes place between forwarders and the destination, in such case, ExOR arises high overhead during the transmission time even if the group of packets to transmit is small as in burst and short-lived flows, or the number of candidate forwarders is large.

2.2 d-AdaptOR

Earlier than continue with the explanation of d-AdaptOR and provide the following notations [11]. Let σ^irepresent the set of potential reception outcomes because of a transmission from node $i \in \Theta$, i.e. $\sigma^i = \{S : S \leq N(i), i \in S\}$. Let $N(i)$symbolize the set of neighbors of node i. Refer to σ^i as the state space for node i's transmission. Additionally, let $\sigma = \cup_{i \in \Theta} \sigma^i$. Let A(S) = S U {T} denote the space of all permissible actions available to node i upon successful reception at nodes in *S*. Finally, for each node *i* define a reward function on states S $\in \sigma^i$ and potential decisions $a \in A(S)$ as,

$$g(S,a) = \begin{cases} -c_a \text{ if } a \in S \\ R \text{ if } a = T \text{ and } d \in S \\ 0 \quad \text{if } a = T \text{ but } d \notin S \end{cases}$$

Detailed description of d-AdaptOR

To start up the initialization, the operation of d-AdaptOR can be expressedin four stages of transmission, reception and acknowledgement, relay, and adaptive computation in the sequence of order as shown in below steps [12]. While each of the stages uses for simplicity of presentation and that assume a sequential timing. Use n^+ to stand for some (small) time after the start of n^{th} slot and $(n + 1)^-$ refer to some (small) time before the end of n^{th} slot such that $n < n^+ < (n + 1)^- < n + 1$.

- **Initialization:** For all $i \in \Theta$, $S \in \sigma^i$, $a \in A(S)$, initialize $\Lambda_0(i, S, a) = \nu_{-1}(i, S, a) = N_{-1}(i, S) = 0$, $\Lambda^i_{max} = 0$, while $\Lambda^T_{max} = -R$.

Table 1: Notations used in the description of the algorithm

Symbol	Definition
S^i_n	Nodes receiving the transmission from node i at time n
a^i_n	Decision taken by node i at time n
A(S)	Set of variable actions when nodes in S receive a packet
N(i)	Neighbors of node I including node i
g(S,a)	Reward obtained by taking decision a when the set A of nodes receive a packet
$\nu_n(i, S, a)$	Number of times up to time n, nodes S have received a packet from node I and decision a is taken
$N_n(i, S)$	Number of times up to time n, node S have received a packet from node i
$\Lambda_n(i, S, a)$	Score for node I at time n, when nodes S have received the packet and decision a is taken
Λ^i_{max}	Estimated best score for node i

- **Transmission Stage:** During this transmission, at any time *n* wherein node *i* transmit if it has a packet [13].
- **Reception and acknowledgement Stage:** This stage composes the reception of the packet transmitted by node *i* is acknowledged by all the nodes in S^i_n. Let the set of nodes (random order) symbolize S^i_n that have received the packet transmitted by node *i*. The delay assumption for the acknowledgement phase is small enough (the duration of the time slot not more than that), in such case node *i* infers S^i_n by time n^+[14]. All nodes $k \in S^i_n$, the ACK packet of node *k* to node *i*comprises the EBS message Λ^k_{max}. Based on this reception and acknowledgement phase, the counting random variable initialization N_n is incremented as follows:

$$N_n(i,S) = \begin{cases} N_{n-1}(i,S) + 1 & \text{if } S = S^i_n \\ N_{n-1}(i,S) & \text{if } S \neq S^i_n \end{cases}$$

- **Relay Stage:** Node *i* chooses a routing action $a^i_n \in A(S^i_n)$ in accordance with the following (randomized) rule parameterized by $\epsilon_n(i,S) = \frac{1}{N_n(i,S)+1}$:
  - With probability $(1 - \epsilon_n(i,S))$, $a^i_n \in argmax_{j \in A(S^i_n)} \Lambda_n(i, S^i_n, j)$ is chosen,
  - With probability $\epsilon_n(i, S^i_n)$ $a^i_n \in A(S^i_n)$ is chosen uniformly with probability, $\frac{\epsilon_n(i,S^i_n)}{|AS^i_n|}$.

Node *i* sends FO, a control packet includes the information about routing decision a^i_n at some time strictly between n^+ and $(n + 1)^-$. Even if $a^i_n \neq T$, then node a^i_n prepares for forwarding in next time slot, while nodes $j \in S^i_n$, $j \neq a^i_n$ expunge the packet. If termination action is chosen, i.e. $a^i_n = T$, all nodes in S^i_n expunge the packet.

Based on selection of a routing action, the counting variable ν_n is updated.

$$\nu_n(i,S) = \begin{cases} \nu_{n-1}(i,S,a) + 1 & \text{if } (S,a) = (S^i_n, a^i_n) \\ \nu_{n-1}(i,S,a) & \text{if } (S,a) \neq (S^i_n, a^i_n) \end{cases}$$

- **Adaptive Computation Stage:** At time $(n+1)^-$, after being done with transmission and relaying, node *i* updates score vector $\nu_n(i, ., .)$ as follows:
  For all $S = S^i_n$, $a = a^i_n$,

$$\Lambda_{n+1}(i,S,a) = \Lambda_n(i,S,a) + \alpha_{\nu_n}(i,S,a) \times \left(-\Lambda_n(i,S,a) + g(S,a) + \Lambda^a_{max}\right),$$

Otherwise,

$\Lambda_{n+1}(i, S, a) = \Lambda_n(i, S, a)$.

Moreover, node i updates its EBS message Λ^i_{max} for future acknowledgements as:

$$\Lambda^i_{max} = max_{j\in A(S^i_n)}\Lambda_{n+1}(i, S^i_n, j).$$

2.3 Firefly Algorithm

Firefly Algorithm (FA) is arising swarm intelligent technique which utilizes bioluminescence behavior of fireflies in nature [15, 16]. A firefly in the search space communicates with the neighboring fireflies/prey via its brightness, that influences prey (brightness) attraction and mate selection. The parameters of FA utilized in this algorithm are given as follows.

γ - Absorption coefficient of light

α' - Randomization parameter

B_i - Brightness of the firefly i

At_{ij} - Attractiveness of the link (i, j)

FA has implemented to resolve MANET routing issue. The attractiveness of the links is successfully initialized. The firefly swarm is located in the source node with the initial brightness assigned. Here, RREP packets imitate the fireflies. The additional parameters correlated with the algorithm viz., the attractiveness and brightness are consisted in the header of RREQ packet as illustrated below reference. Brightness is updated after allmovestherefore the attractiveness of the current node and the receiver node (next-hop node from the neighbor list) is updated [17]. RREQ packets transmit across the network and once the destination node is arrived, RREP packet is transmitted to the source node after which the final preferred route is obtained. The RREP and RREQ packet format for FA is

Source Address	Destination Address	Brightness	Attractiveness	Hop Distance	Cost	Delay	Load	Reliability	....

Algorithm:

If node i == S, then

//Source node

For all nodes j in $|NH_i|$

Send RREQ in broadcast mode

Initialize Brightness of RREQ randomly, $B^0_{RREQ} = Random$

$F_p=0$

End For

If RREQ received

Drop RREQ

// Sender received the packet

End If

If RREP received

Start the CBR traffic session

End If

Else

If RREQ received

k = RREQ_SRC;

//Sender of RREQ - source/intermediate node

i =Receiver of RREQ

// not the source node

If check_neighbor_list(k)==0

$NH_i=NH_i \cup \{k\}$

End If

Calculate

$$w_{ki} = \overline{de}_{ik} + \bar{c}_{ik} + \bar{l}_{ik} + \bar{d}_{ik} - \bar{r}_{ik}$$

$$At_{ki} = w_{ki} + B_{RREQ} + \alpha'(rand - 0.5)$$

If $At_{ki} > At_{ij}$

j=k //replace the new node k with the existing next-hop node j

$$B_{RREQ} = B^0_{RREQ}\, e^{-\gamma w^2_{ki}}$$

$F_p += w_{ki}$

Else

$F_p += w_{ij}$

If i==D

//Destination reached

Send RREP in unicast mode to S to its next-hop j

Else Forward RREQ to all j in NH_i

// Intermediate node

End If

End If

If RREP received and i $\neq D$ // Intermediate node

Forward RREP to next-hop node of i

End If

End If

2.4 Hybrid algorithm for Routing (Firefly with d-adaptOR)

Hybrid Firefly with d-adaptOR algorithm is mainly used to chosen the best path for data transmission, also FA referred a route detection technique [18]. Using this technique, the best path is chosen by exploiting the perception of FA. To recognize the best transmission range over the networks utilize with the support of the firefly optimization algorithm. The fireflies carries over from one location to another location so as to estimate nodes and evaluates more transmission range during less time of the interval. After recognizing the optimal path, the Unilateral-(Uni-) approach is utilized for the mobile adhoc networks. Utilizing that approach the nodes handlewith slower moving speed devoid of losing the network performance. This scheme is applied in both group mobility and entity mobility of nodes.

The main aim of this hybrid algorithm is to improve the energy efficiency with less computation overhead in MANETs [19]. To consider the distance between the nodes denote r in the algorithm. The paths establishments in the first phase are considered as a FA. The parameters such as energy, bandwidths are considered as parameters of the algorithm. The fitness value of the algorithm is considered as a residual energy. As a total energy cost of light intensity is utilized for particular route or path from sender to receiver. The light intensity of the proposed system is directly proportional to the fitness of the algorithm $(x) \propto (x)$. Depending upon the light intensity the path's are chosen and specified as input to the attractiveness. The four factors of the algorithm are Initialization, Attractiveness Function, Movement of Firefly, Transmission Stage, Reception and acknowledgment stage, and Adaptive Computation Stage, Fitness value, Light intensity calculation.

- Initialize all the nodes.
- Discover the shortest path using firefly functions.
- The attractiveness of fireflies is proportional to their brightness or light intensity. The brightness or light intensity is decreased as the distance between fireflies increase. Therefore, the attractiveness of a firefly is determined by the following [13, 14].

$$\beta = \beta_0 x e^{-\gamma r^2}$$

Where the distance between any two fireflies symbolizes by r, the attractiveness at $r = 0$ is β_0 and a light absorption coefficient denotes γ. The distance between any two fireflies x_i and x_j is stated as follows [13]:

$$r_{ij}\left\|x_i - x_j\right\| = \sqrt{\sum_{k=1}^{d}\left(x_{i,k} - x_{j,k}\right)^2}$$

where $x_{i,k}$ is the k-th component of the spatial coordinate $x_i$of i-th firefly and d is the number of dimensions.

- Movement of Firefly: Firefly i is attracted toward the other brighter firefly j, after that its movement is described as below equation [20]

$$x_i = x_i + \beta_0 x e^{-\gamma r_{ij}^2} x\left(x_j - x_i\right) + ax\left(rand - \frac{1}{2}\right)$$

In equation (3), x_i is current position, $\beta_0 x e^{-\gamma r_{ij}^2} x\left(x_j - x_i\right)$ is the brightness of the firefly and the last term represent random motion. The experimental result of FA is developed by Yang, and the location of fireflies [21].

- Transmission Stage: For packet transmission, this stage occurs at time n in which node i transmit the packet.
- Reception and acknowledgment Stage: The random batch of nodes symbolizes Si that has received the packet sent by node i. The successful reception of the packet sent by node i is acknowledged to it by all the nodes in the Si. The delay performance for the acknowledgment phase is small enough (the duration of the time slot not more than that), in such case node i infers Si by time n. All the nodes the ACK (Acknowlegement) packet of node j to node i comprises the EBS message. Based on the stage of the counting random variable $N_n$is increased.
- Relay Stage: The node i chosen a routing action in accordance with the randomized rule parameterized by forwarding probability. The node i transfers control packet which includes information about routing decision at some time strictly between two intervals. The counting variable is updated based on selection of routing action.
- Adaptive Computation Stage: The node i updates score vector at time (n+1), after

being complete with transmission and relaying process. EBS message updated by node i for future acknowledgments.

- Fitness value: The residual energy of a node by computing the total energy consumed by a node whenthat handle one of the following states [22]:

  IDLE: Performing this state the node is idle mode

  CCA_BUSY: Handling this state the node is busy

  TX: Processing this state the node only transmits packets

  RX: During this state the node only receives packets

  SWITCHING: This state performs the nodes switches from one channel to another.

  For each node n_i the residual energy (n_i) is computed as:

  $(n_i) = E_{curent}(n_i) - E_{con}(n_i)$

  where, $E_{curent}(n_i)$ and $E_{con}(n_i)$ indicate the current energy of the node n_i and the energy consumed by the node n_i, in a respective manner. On the verge, the current energy is set to the initial energy of the node. A attractiveness of the path represents (n_i). Because the consumed energy of each node n_i is influenced by the node is (i.e., CCA BUSY, IDLE, TX, RX, SWITCHING), the following equation is used to determine its consumed energy as:

  E_{con} (n_i) = Current (n_i) $*$ Voltage (n_i) $*$ Duration where, Current (n_i) is the current in Ampere and it is based on the state where the node n_i is, Voltage (n_i) voltage is the supply voltage in Volts and Duration is the interval that passed because the last energy update.

- Light intensity calculation: For each node n_i an energy cost function $C(n_i)$ is assigned that is given by:

  $$C(n_i) = \frac{E_{init}(n_i)}{R(n_i)}$$

  Therefore, the total energy cost for a route p commencing source node n_S to destination node n_D, is given by:

  $$E_p = \sum_{n_i \in p, n_i \neq n_D} C(n_i)$$

The chosen route l will be the one that satisfies the following property:

$$E_l = \min\{E_p : P \in V\}$$

Where, V is the set of all the possible routes.

III. EXPEREMENTAL RESULT

In ad hoc environment, the efficiency of the hybrid system is evaluated for the efficient routing analysis of the hybrid algorithm and the existing one has been carried out. This routing analysis has been completed in order to route the number of packets more effectively. To be taken into consideration and comparing various performance parameters. By using NS2 simulator analyzed the CBR (Constant Bit Rate) as a traffic source with 50 mobile nodes are randomly distributed within 1500 m * 1500 m network coverage; the network topology may possibly random modification during the nodes' distribution and their movement are random performance. The communication range of the nodes was set into 200 m, for each node, the initial energy level was set to 100 joules of the network. For analyzing the simulation performance of the two-ray ground propagation model is utilized. The simulation time is set at 1000 seconds. To check the performance of the routing protocols are highly dynamic in ad hoc networks, the optimization of the protocols perform with highly mobile nodes. The transmission speed of the nodes is differed from a minimum of 1 m/s to various maximum limits in the topology setup to optimize Mobility is initiated in the network with the Random Way Point mobility model. Parameters have been performed for analyzing the algorithm results in Wireless Mesh Network (WMN):

- **End-to-end delay:** To determine the network delay time that has taken from transmitter to receiver during data transmission communication path.
- **Packet delivery ratio:** It refers the packets that can be resultantly obtained at the point of destination with no packet or failure loss, considering system packet delivered ratio is high then both security and also the efficiency is high.
- **Throughput:** To analyze the total amount of data transmitted from sender node to receiver node or processed in a particular amount of time.
- **Network Lifetime:**This refers the requisite time to exhaust the battery of *n* mobile nodes.

- **Routing Overhead Ratio:** This routing overhead considersthe total number of routing packets, which is used to divide the overall number of data packets to be delivered. An effect on the network's robustness performs in terms of the bandwidth utilization and battery power consumption of the nodes.
- **Energy Consumption:** During the simulation time,theenergy consumption refers to the amount of energy that is spent by the network nodes. To optimize each node's energy level handle at the end of the simulation.

End-To-End Delay:

The comparison of delay demonstrates in Figure 1. The FF with d-adaptOR, Firefly, d-adaptOR and ExOR algorithms are compared and analyzed in below figure clearly. When the packet size increases as 64, 128, 256, 512, 1024 bytes, the end-to-end delay also enhances. The E2E delay in FF with d-adaptOR routing protocol enhances from 14.8 ms to 25 ms, in the Firefly protocol it increases from 18.64 ms to 44 ms and finally, in the d-adaptOR protocol it increases from 21.63 ms to 42 ms. The FF with d-adaptOR routing protocol has performed better as it compared than Firefly, d-adaptOR and ExOR in terms of end-to-end delay.

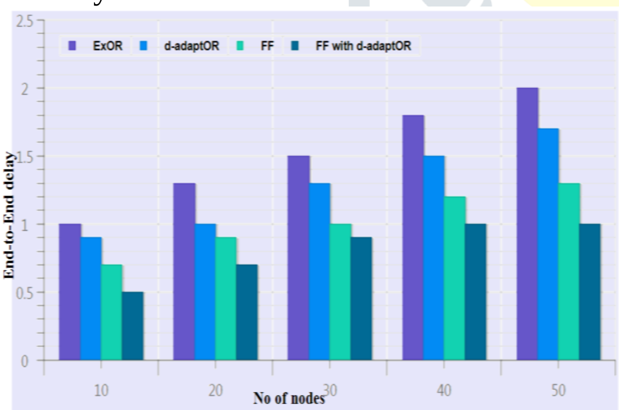

Figure 1: Graph of End to end delay

Packet Delivery Ratio (PDR)

PDR of the FF with d-adaptOR, Firefly, d-adaptOR and ExOR algorithm results are shown in Figure 2. The FF with d-adaptOR depicts the high packet delivery ratio even if compare and analyze to other approaches Firefly, d-adaptOR and ExOR. It illustrated that even if the number of nodes enhances the PDR of the FF with d-adaptOR algorithm is furthermore increases.

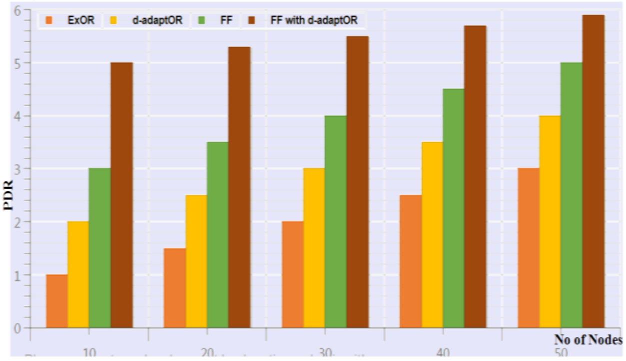

Figure 2: Comparison of PDR

Throughput

The graph between Throughput and Simulation Time of the network clearly illustrates in Figure 3. The graphical representation compares Firefly, d-adaptOR, ExOR and FF with d-adaptOR, algorithms. In case of FF with d-adaptOR algorithm the throughput of the network is constant state and more than the throughput evaluated using the d-adaptOR, Firefly, and ExOR algorithms.

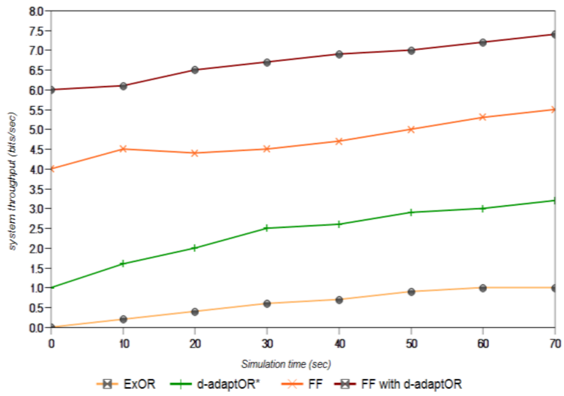

Figure 3: Throughput of the Network

Network Lifetime

The main comparison of network lifetime depends upon simulation time that has shown in Figure 4 shows. In this figure x axis show the simulation time and y axis shows the number of exhausted nodes for Firefly, d-adaptOR, ExOR and FF with d-adaptOR, when unreliable the simulation time. The FF with d-adaptOR exhausts 0 nodes in 50 seconds and 2 nodes in 250 seconds, the, Firefly exhausts 0 nodes in 50 seconds and 3 nodes in 250 seconds, while, the d-adaptOR utilizes 2 nodes in 50 seconds but 6 nodes at the same timing. The FF with d-adaptOR, Firefly maximizes its network lifetime as it routes the traffic to the nodes having higher energy in the network. In such case, if the energy of these nodes get exhausted the topology has the property of storing information about various energy efficient routes and therefore it transfers the traffic to next energy efficient shortest path, thus enhancing the network lifetime.

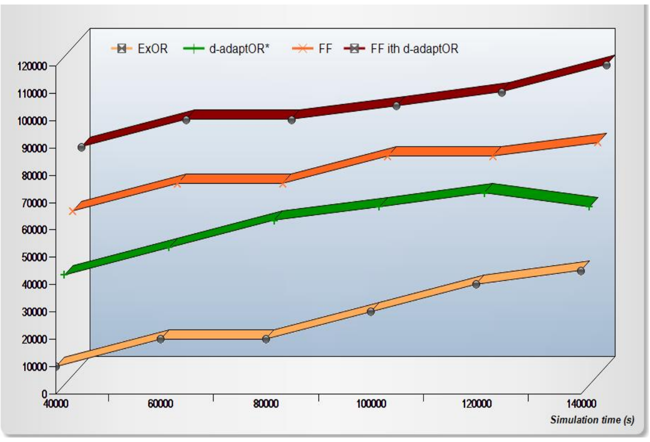

Figure 4: Graph of network lifetime

Routing overhead

The major variation of routing overhead ratio performs over Firefly, d-adaptOR, ExORand FF with d-adaptOR where shown in Figure 5. When the node speed maximizes as (0, 2.5, 5, 7.5, 10) m/s, the routing overhead ratio enhances too. The FF with d-adaptOR raises from 18.12% to 55.6%, Firefly enhances from 19.2% to 63.64% and ExOR maximizes from 21.79% to 69.92%. The FF with d-adaptOR protocol has better performance than , d-adaptOR and ExOR protocols in terms of routing overhead ratio because, it establishes stable routes, strong and the possibility of route failure becomes almost minimal with less route discovery process.

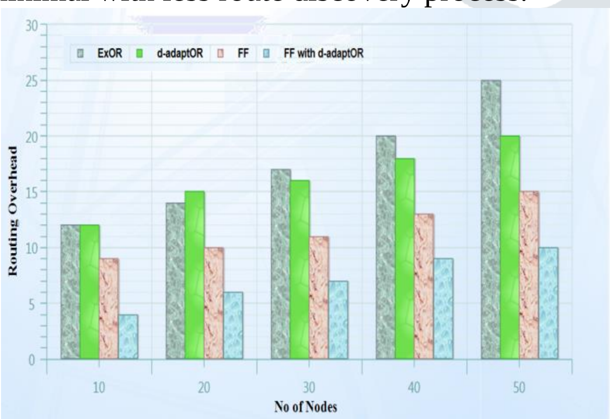

Figure 5: Routing Overhead

Energy consumption

In Figure 6, the mobility speed ranges from 5 to 25 are plotted in the x-axis with the unit of interval 5, in which that the y-axis is plotted energy consumption ranging from 20 to 120 joules with the unit interval of 10. Figure 6 compares and analyzes energy consumed by FF with d-adaptOR to deliver the packet to the receiver, with Firefly, d-adaptOR and ExOR. The FF with d-adaptOR routing protocol designed and choose tofind the most stable route toward the destination using the available multiple paths. The route chosen by FF with d-adaptOR could be the best routing pathway and consumes less energy than other routes, with the shortest route and storage optimization and time consuming, where the other protocols simply select the shortest path without check whether its quality of results so that the issues occurs retransmission and route failure. Because of retransmission and route failurevast amount of energy is wasted by Firefly, d-adaptOR and ExOR. The protocol FF with d-adaptOR consumes less energy for delivering data packets to the destination than Firefly, d-adaptOR and ExOR where illustrates clearly in Figure 6.

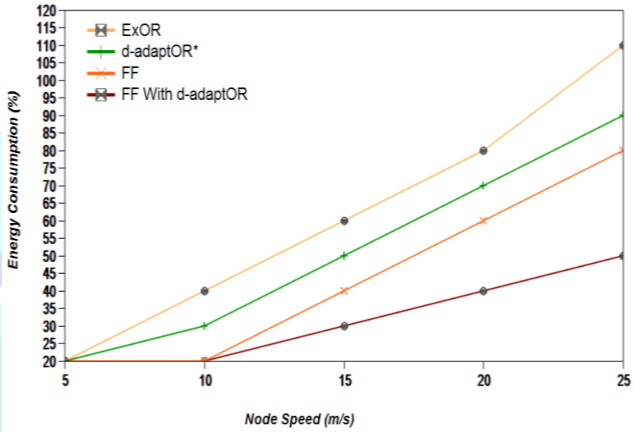

Figure6: Energy consumption over node speed

IV. CONCLUSION

To determine the optimal path for traffic flow with minimum resource utilization in shortest path routing is a significant network optimization issue was occurred during the transmission. In this paper, discussed and conferred a firefly based routing technique for optimized transmission over MANETs. It is a reactive routing algorithm which provides firefly between each pair of a node and its neighbor. The next hop is chosen a path (each time) to be established. This selection made using existing firefly algorithm. To analyze and evaluate the performance and behavior of OR protocols in highly mobile ad hoc networks. Simulation results illustrated that the hybrid FF with d-adaptOR algorithm has performed much better than Firefly, d-adaptOR, and ExOR inPDR, E2E, energy consumption, throughput and routing overhead and better network lifetime those parameters are analyzed in an efficient way.

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