European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 4, 2020

ENHANCED PETAL ROUTING ALGORITHM FOR MOBILE AD HOC NETWORK

[1]J.Johnsi, [2]R.Nagalakshmi, [3] K.R. Sughashini, [4] V.Sunanthini,[5] R.Lakshmi
[1,2,3,4,5]Assistant Professor, Department of EIE, Easwari Engineering College, Chennai
johnsilovi@gmail.com

ABSTRACT
During the process of discovering route in MANET, path request broadcast and path response packets are the necessary operations to locate the consistent route from the cradle point or node to the end node. In these situations, intermediate node which may or may not belong to the route discovery process will also update the route table and re-broadcast the route discovery packets to its neighboring nodes. Finally the best possible path is found which has a minimum of hopping to reach the destination. This will increase overhead and worsens routing performance in turn. The proposed Enhanced Petal Ant Routing (The EPR) algorithm offers low overhead by optimizing FANT and BANT transmissions in the route discovery process. This is a improvement from SARA and has features taken from petal routing. The algorithm is simulated on NS2, against the ACO framework called SARA and classic routing protocols such as AOMDV and AODV. The simulation results shows that EPR further reduces overhead by eliminating redundant forwarding FANT compared to other routing algorithms.

KEYWORDS
EPR, Petal routing, SARA, Ant based routing, MANET

1. INTRODUCTION

MANET ordinarily encompasses a sizably voluminous number of versatile remote hubs. These nodes can move aimlessly and have the competency for joining or taking off the organize at any time. Due to the expeditious magnification of contrivances on Internet of Things (IoT), a sizably voluminous number of messages are sent during information exchange in dense areas. This can cause congestion, resulting in incremented transmission delay and withal packet loss. This quandary is more earnest in more sizably voluminous networks with more network traffic and high mobility which will enforce the dynamic architecture. To solve this quandary, we introduce a bandwidth-vigilant routing scheme (BARS) which can eschew congestion by monitoring the remaining bandwidth capacity in network paths and the available space in the queues to store the information. The magnitude of bandwidth must be resolute and withal available and consumed bandwidth along with the cache left afore sending messages. The BARS utilize the comment mechanism to personalize the traffic source to adjust the data rate according to the availability and queue of the routing path. We Run simulations utilizing NS2.35 in Ubuntu, neighborhoods node configuration, publishing, navigation, message initiation and C language to modify AODV. The capacities, comes about extracted from Perl script utilization following to illustrate BARS prevalence of channels within the terms of parcel dispersion rate, Throughput and culminate-to-end delay, and potential swarmed hub for inactive and energetic topologies.

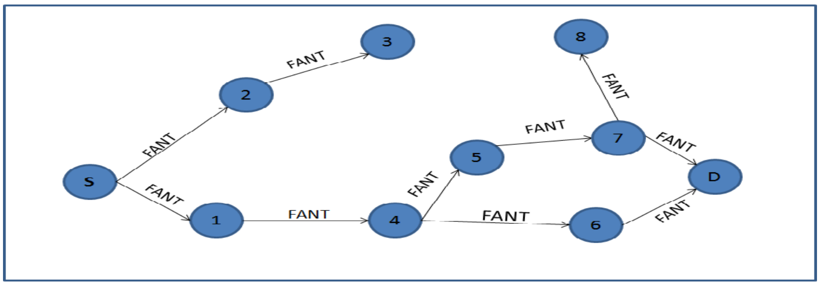


Figure 1. FANT Transmission by ANT Routing

An ad hoc mobile network (MANET) [1] may be a network that composes a set of versatile nodes without any centralized administration. MANET is self-configured, self-organized and self-managed. MANET can have a dynamic topology. MANETS may be a extraordinary sort of framework without remote advertisement hoc organize. In MANETS, each node will acts as a router and have joining and clearing out the arrange with high versatility at the same time [3]. Due to high versatility nodes, the network topology is subject to visit changes and directing for such a circumstance gets to be difficult. The design of mobile ad hoc protocols directing is an cosmically challenging assignment due to hindered transmission capacity, hindered control and inconstant deportment of radio channels and hub versatility [4].

The main challenge of routing protocols for MANETS is ascertaining that nodes can cull an ideal path to route traffic from cradle point to envisioned end point. Many routing protocols have been suggested for routing quandaries such as AODV [5], AOMDV [6], DSR [7], DSDV [8], TOHIP [9], S-AODV [10], and S-DSDV. [21], ... etc., but many researchers have designated in the literature that the Ant have the better potential of finding an efficient and shortest path that is much more optimal than other routing algorithms by utilizing a deposit chemical substance called pheromone [2 indexing]. The Researchers optically canvassed the deportment of authentic ants and inspired them to design incipient ant routing protocols for MANET, such as ACO [11], ARA [12], SARA [13], HOPNET [14], ANTnet [15], Ant {18} [16], ANTALG [17] etc.

In popular population-predicated met heuristic algorithm ACO, when the source requires a path for reaching the destination, the source broadcasts a special type of packet called Forward Ant [FANT] to its neighboring nodes, which replicates and retransmits the FANT till it influences the end point. The destination node then ravages the FANT and responds with a special packet denominated Rearward Ant [BANT] through the intermediate nodes. According to the author [18], since the packet FANT replicated by all the nodes of the network so the network will be flooded with control information will abbreviate its performance. Figure 1 illustrates the FANT propagation of Ant routing algorithms. As the network grows, the immensely colossal number of network nodes joins the transmission FANT and BANT, which significantly increases the overhead and deteriorates its performance [13].

The mechanism of flooding this BANT and FANT transmission in the network are the disadvantage and time required will increase to discover the route during the revelation of the route [13]. The goal of all routing protocols for data transmission is finding the reliable shortest and optimal path in between end nodes, but even if a network is loaded with an immensely colossal number of nodes, the most routing protocols cull minimum hops to establish the squattest possible route from the cradle point to the end point and eliminate all other nodes during route revelation. The flooding FANT of packets for all redundant nodes during route revelation greatly increases the adscititious routing table update time and increases overhead. Hence, our proposed work is to minimize FANT transmission during route revelation and to truncate overhead.

2. LITERATURE SURVEY

Fernando Correia, Teresa Vazao [13] proposed an enhanced work of the ACO work which uses the transmission concept Controlled Neighbor (CNB) mechanism to control packet flooding during path creation and uses a deep search procedure to retrieve the path while repairing the path.

Petal Routing [19] is a routing algorithm for MANET. In this routing approach amalgamates the concept of the multipath and geographic routing algorithm, in which network nodes are addressed predicated on geographic location and not on the substructure of the IP address without routing principle. In network all the data packets are flooded, but the nodes that are within the petal region are sent again to the neighboring nodes.

3. ENHANCED PETAL ROUTING (EPR) ALGORITHM

In this section, details of EPR architecture constructs similar to other routing algorithms. Algorithm EPR is an improved version of Simple Ant Routing Algorithm (SARA) [13] and combines the few features of Petal routing [19]. EPR consists of 3 phases, namely Route discover, Route maintenance and Route repair.

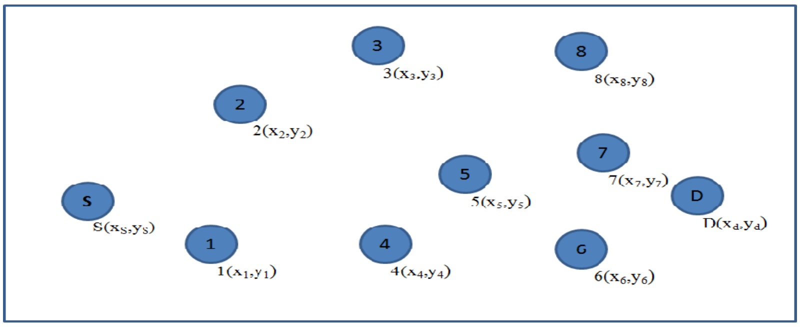


Figure 2. Network Diagram

Route Discovery

In the route revelation phase, EPR calculates the width of the petal (Pw), engender incipient routes by transferring a special package called petal forward Ant [P _ FANT] by source and Petal Rearward Ant [B_FANT] by destination. A P_FANT is a minute packet consisting of Pw and a unique sequence number for every packet. One appearance key to this process is to calculate petal area between the terminus nodes and to rebroadcast the P _ FANT is described below. With this the overhead is minimized by eliminating transmissions redundant P_FANT and P_BANT during route revelation. Thus maximize packet generation ratio and minimize overhead. Consider the Figure 2, Source noted S (xs, ys), Destination D (xd, yd) and the intermediate node i (xi, yi) where i = 1,2,3, .., n. The proposed work combines the geographic routing concept [20]. The coordinate (x, y) of a mobile node represents (longitude, latitude) respectively. Each node is uniquely addressed inside or outside the petal by geographic locations and by node identifier. When source (S) requires a path to the destination (D), source calculates the Pw by following 3 steps.

Step 1: obtain nodes location dynamically and compute the distance (d) from S and D

$$d = \sqrt{((x_d - x_{s)} + (y_d - y_s))}$$

Step 2: Compute and obtain (h, k) using (2)

$$h = (x_s + x_d) /2, \ \ k = (y_s + y_d)/ 2$$

Step 3: Compute petal region or width of the petal (P_w) between S and D using (3) as shown in Figure 3.

$$P_w = \Pi ab$$

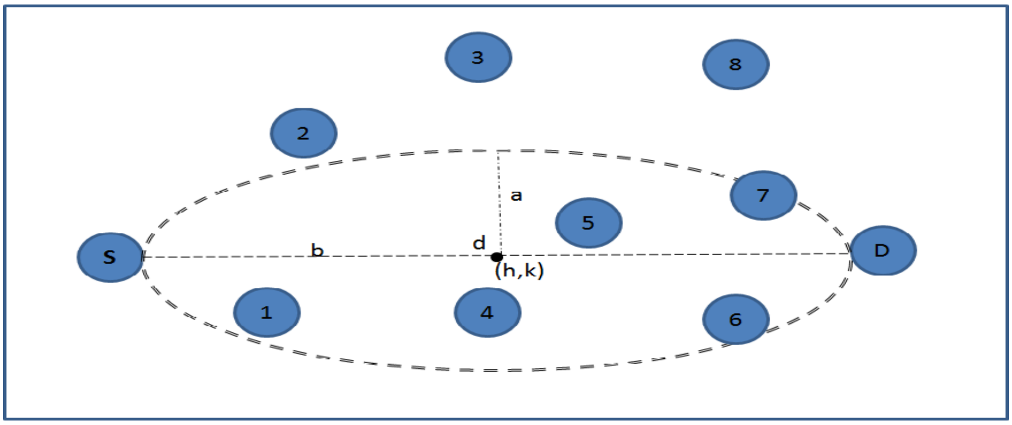


Figure 3. Petal Calculation

Once the petal region is calculated, and the source (S) begins to broadcast P_FANT the packet to the network. From Figure 3, S have a contiguous node, i.e. node (1) and node (2), since The node will receive P_FANT according to the source node for first time, the node checks P_w in P_FANT and checks if the node is located inside the petal region or outside the petal region. EPR (4) is used to check whether the node is located inside the petal or outside the petal area.

$$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} \leqq 1$$

Figure 4. EPR P_FANT Transmission

The node that is inside Pw, will accept P_FANT, updates the pheromone value, the destination address, the next jump and retransmits P _ FANT to the neighboring nodes subsequent. The Node that is not inside Pw will expunge P_FANT and does not participate in path revelation process. The process is perpetuated until it is reaching the destination (D). When the P_FANT is reaching the destination, the destination will extract the information from P_BANT via the shortest path. Upon receiving the packet, inchoation commences transmitting the data through the shortest updated path from each intermediate node in network. Thus EPR truncates overhead by eliminating redundant transmission FANT in the network. Thereby increases the packets engendered by the source, more packet received by the destination and provides better performance than SARA, AODV, and AOMDV.

Figure 4 and Figure 5 schematically show the EPR route recognition process. The Major improvements to SARA for designing EPR are in the receiver section FANT (p) of the algorithm. The P_FANT transmission mechanism of EPR is explained in the following pseudocode.

Route Maintenance

This next phase in EPR is for upkeeping of route to keep track of route improvements and active route during communication. In ARA, no special package is created for route maintenance. But in SARA, a Super FANT is created for asymmetric traffic. Algorithm EPR also updates the active route while the date session is running and works similarly to routing algorithm SARA

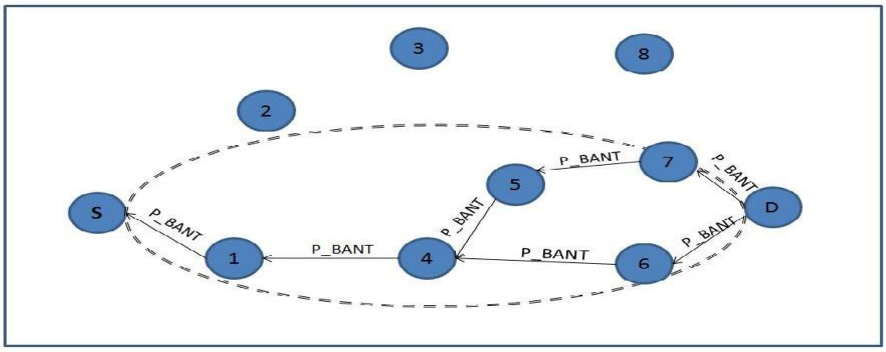


Figure 5. EPR P_BANT Transmission

Channel	-	Wireless
Mobility model	-	Random way Point
Network Interface	-	Wireless
NS2 Version	-	NS2.35
Interface Queue	-	Drop Tail
No. of Nodes	-	15,30,50,75,100,150
Simulation Area	-	1000X1000m
Tx Range	-	250m
Simulation Time	-	160s
Data Packet Size	-	512 bytes
Initial node Energy	-	100 Joules
Rx Power	-	35.28 e-3
Tx Power	-	31.32 e-3
Ideal Power	-	712-e6
Transport Protocol	-	TCP

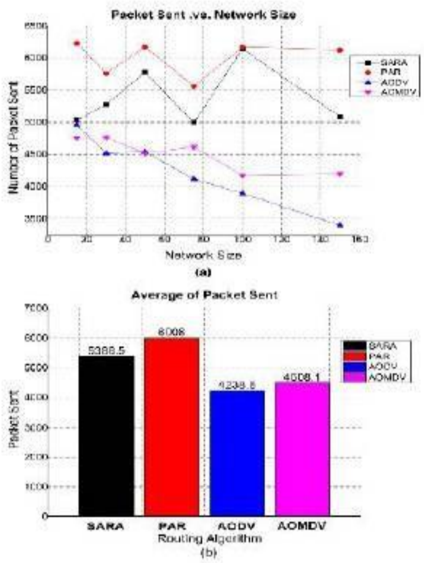
Table 1. Simulation Parameters

Route Repair

The EPR initiates the route repair process when it detect a broken link between two. Since nodes are very dynamic and mobile in nature, the broken link state can occur at any time interval. This may be due to node deactivation, circumscribed bandwidth or congestion, or evaporation of pheromones during data transmission. To fine-tune the route, EPR finds an alternate link in its broken link routing table. If there is any other link between source and the destination, it will send the packet through this path otherwise, if route repair procedure fails while finding another path to the destination, the source commences an incipient one route revelation process on receive error message.

4. SIMULATION EXPERIMENT SETUP USING NS2

The simulation is performed with the Ubuntu Linux. The proposed work and SARA, Fernando Correia et.al [NS2 version 2.31] have been implemented in NS2 version 2.35 from the author. Also provided is Comparison with classic routing such as AODV and AOMDV of the NS2 packet. In NS2 the implementation of SARA code has been enhanced to reduce overhead by eliminating redundant FANT transmission during the path discovery process.



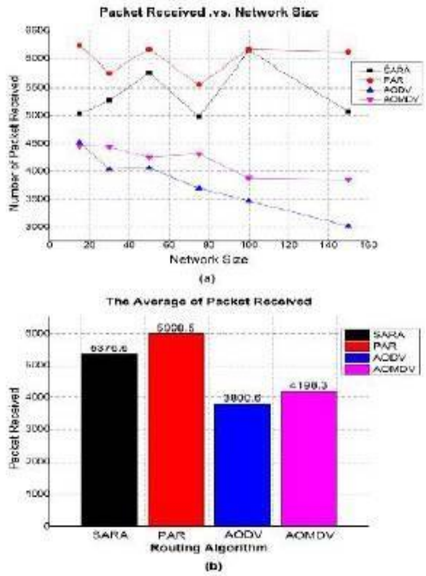


Figure 6. packet sent Comparison
(a)Network Size vs. Packet generated
(b)The average number of packet generated

Figure 7. packet received Comparison
(a) Network Size vs. Packet Received
(b) The average number of packet received

The simulation is performed for two different environments (simulation environment A, simulation environment B) as described in 4.2 and 4.3.

Metrics considered for evaluation

The following are considered to evaluate and to compare the performances of EPR, SARA, AODV and AOMDV.

Packets sent	-	Total number of packets generated by all sources.
Packets Received	-	Total number of packets that are received by all destinations.
Packet Delivery Fraction/Ratio (PDF/PDR)	-	Ratio of “packet received by all destinations to those generated by all sources”.
End to End Delay	-	Average time interval taken for a packet to transmit and receive successfully from source to destination
Throughput	-	Total number of packets delivered per unit time. It is measured in kbps
Overhead	-	Represents ratio between the amount of routing message generated and forwarded across the network
Energy Consumption	-	Represents total amount of the energy consumed by all mobile nodes and measured in joules.

Simulation Environment A

In The first time an environmental experiment is set up, a network of moving nodes is loaded and configured at the same celerity. In every simulation test, nodes are engendered desultorily, contain only one source and the destination, and move in the arbitrary waypoint mobility model. The simulation is performed for 160 seconds and the knot moves at a celerity of 0 m / s up to highest celerity of 10 m / s. The number of nodes and paramount Parameters are described under Table 1.

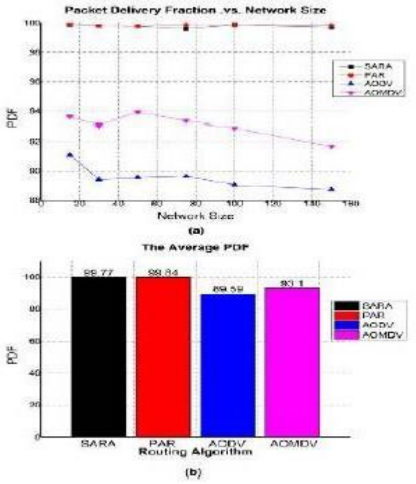


Figure 8. Packet Deliver Ratio Comparison
(a)Network Size vs. PDF
(b)The average PDF

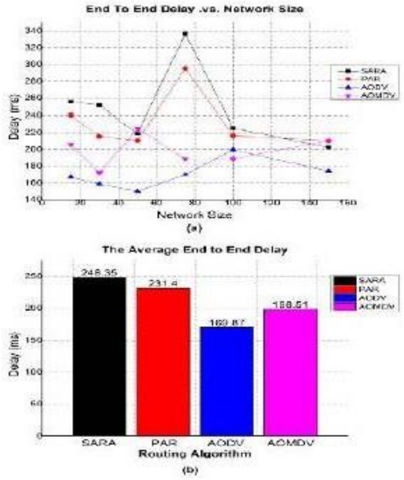


Figure 9. End to End Delay Comparison
(a) Network Size vs. End to End Delay
(b) The average End to End Delay

The simulation results are tabulated and are shown in Table 2, Table 3, Table 4 and Table 5 of the annex. In each set of graphs, the performance of the proposed job and other algorithms such as SARA, AODV and AOMDV for various numbers of nodes is shown in the line graph (a) and the average performance of all routing algorithms are shown in the bar graph (b).

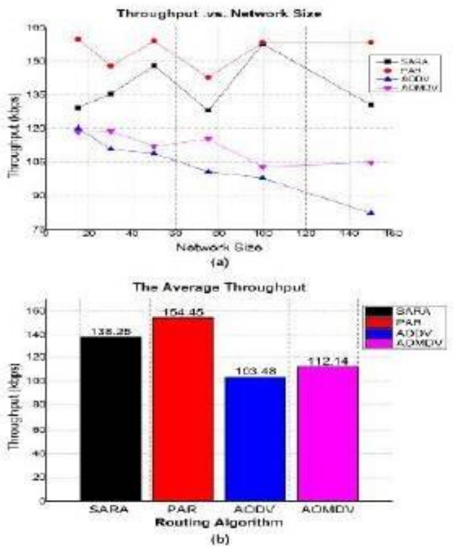


Figure 10. Throughput Comparison
(a)Network Size vs. Throughput
(b)The average Throughput

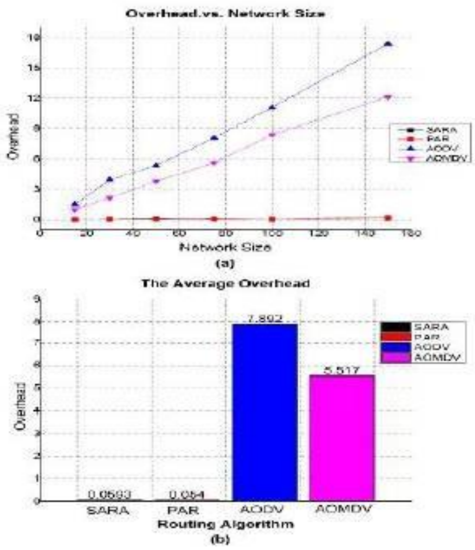


Figure 11. Overhead Comparison
(a) Network Size vs. Overhead
(b) The average Overhead

The graph in Figure 6 (a) (b) shows performance of the four of those different routing algorithms in terms of the packet engendered by the source. The proposed EPR engendered more packets than SARA, AODV and AOMDV. From the graph of Figure 6(b), the EPR engenders 11.496 % more number of packets than SARA, 41.7449 % more number of packets than AODV and 33.271 % more number of packets than AOMDV.

The diagram in Figure 7 (a) (b) shows four of those routing algorithms performance in cognation to packets received by the destination. The suggested EPR receives more packets than SARA, AODV and AOMDV.

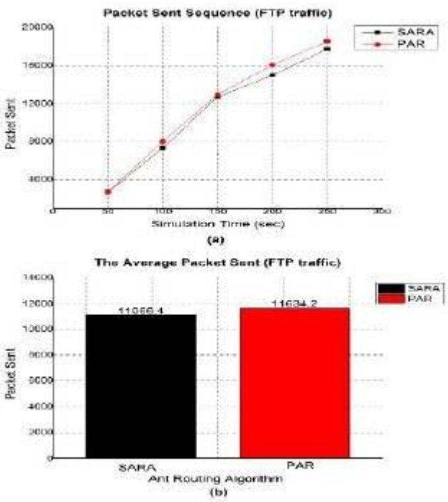
From the graph of Figure 7(b), the EPR receives 11.496 % more number of packets than SARA, 57.846 % greater number of packets than AODV and 42.8411 % more number of packets than AOMDV.

The graph in Figure 8 (a) (b)) shows four of those routing algorithms performance in terms of Packet Distribution Fraction (PDF). The performance EPR proposed well with more preponderant PDF than SARA, AODV and AOMDV. From the graph of Figure 8(b), the average PDF of EPR is 0.070 % more than SARA, 11.441 % more than AODV and 7.23 % more than AOMDV.

The graphs in Figure 9 (a), (b)) shows four of those routing algorithms performance in terms of end-to-end delay. The terminus-to-end delay of EPR is less than SARA but more preponderant than AODV and AOMDV. From the graph of Figure 9(b), the average end to culminate delay is 6.825 % less than SARA, 36.22 % more than AODV and 16.568 % more than AOMDV.

The Graphs in Figure 10 (a)and(b) show throughput performance of four routing algorithms. The Proposal EPR provides better productivity when compared to SARA, AODV and AOMDV. From the graph of figure 10(b), the average throughput 11.7179 % more than SARA, 49.32 % more than AODV and 37.729 % more than AOMDV.

The graphs in Figure 11 (a), (b) show the performance of four of those routing algorithms in terms of overheads. The proposed EPR minimizes overhead by eliminating redundant transmission FANT when locating the path compared to SARA. From graph, Figure 11(b), the average overhead is 8.93 % less than SARA, 99.315 % less than AODV and 99.02 % less than AOMDV.



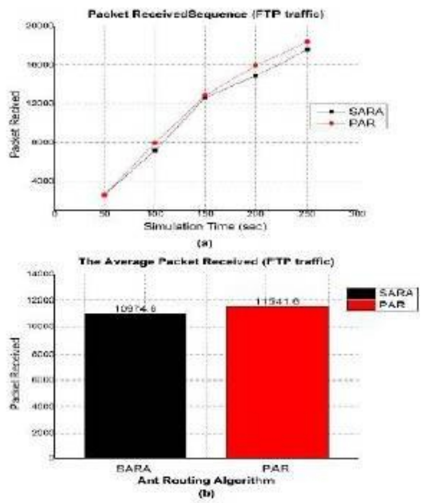


Figure12. Packet Generated Comparison (a)Network Size vs. Packet Generated

(b)The average Packet Generated

Figure 13. Packet Received Comparison (a) Network Size vs. Packet Received
(b) The average Packet Received

Simulation Environment B
In the second experimental setup of the simulation environment, a network with 104 moving wireless nodes is charged in a 1000 x 1000 flat space and consists of four sources of type FTP/TCP and four targets. All The nodes change their position during the simulation run with the exception of the target nodes, where the target nodes were placed in middle of the scenario. The radio propagation range of each node is 200 m. The Each data packet has a size of 1000 bytes. The simulation is carried out for 50, 100, 150, 200 and 250 seconds

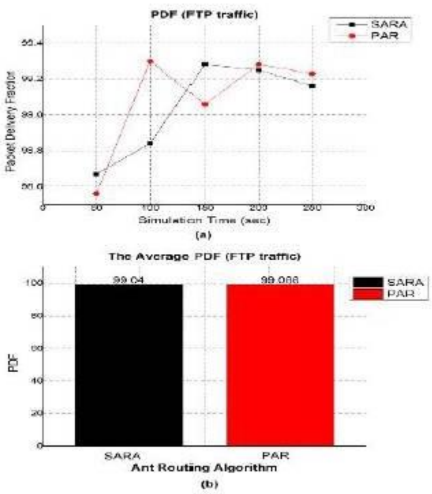


Figure 14. Packet Deliver Fraction Comparison.
(a) Network Size vs. PDF
(b) The average PDF

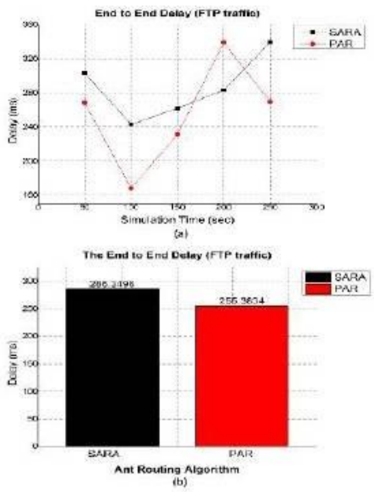


Figure 15. End to End Delay Comparison
(a) Network Size vs. End to End Delay
(b) The average End to End Delay

The Figure 12 (a), (b) shows two said routing algorithms performance in the terms of packets engendered by simulation-time sources. The proposed EPR engenders more packages than SARA. From the graph of Figure 12(b), the EPR engenders 5.13 % more number of packets than SARA.

The Figure 13 (a), (b) shows the two said routing algorithms performance in the terms of the packets received by the destination. The proposed EPR receives more packets than SARA. From the graph of Figure 13(b), the EPR receives 5.14 % more number of packets than SARA.

The Figure 14 (a), (b) shows the two said routing algorithms performance in the terms of performance PDF. The suggested EPR which is better when compared to SARA. Even despite EPR You engender and receive more packages, the percentage Packet Distribution Fraction of EPR is better in most cases when compared to SARA. From the graph of 14(b) the average PDF of EPR is 0.046 % more than SARA.

The Figure 15 (a), (b) shows the two routing algorithms performance in terms of end delay. In most cases, EPR shows enhanced performance by truncating the terminus-to-end delay. From the graph of Figure 15(b), the average end to culminate delay is10.814 % less than SARA. The performance based on throughput of the two routing algorithms is shown in the graph in figure 16(a), (b).In case of SARA the throughput is minute low. From the graph of Figure 17(b), the average value of throughput of EPR is 6.593 % more than SARA.

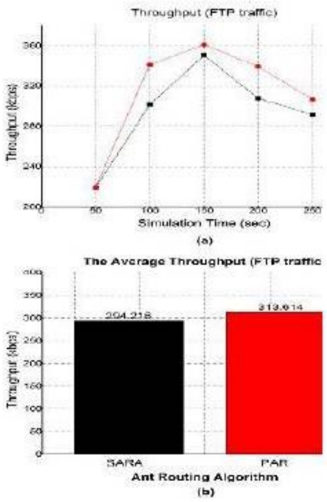


Figure 16. Throughput Comparison
(a)Network Size vs. Throughput
(b)The average Throughput

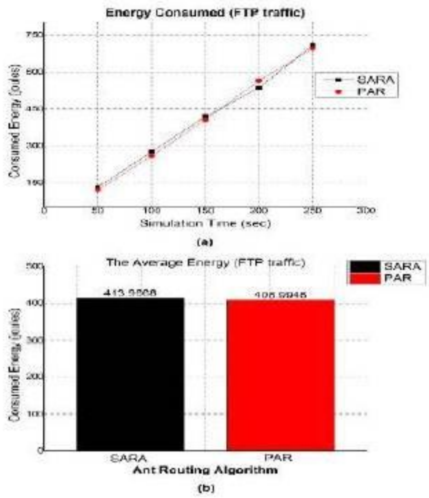


Figure 17. Energy Consumed Comparison
(a) Network Size vs. Energy Consumed
(b) The average Energy Consumed

The diagram in Figure 17 (a), (b) shows the two routing algorithms performance in terms of consumed energy in relation to the number of nodes and the simulation time. The Energy consumption of SARA is high compared to EPR. From the graph of Figure 17(b) the EPR consumes 1.2010 % less amount of energy than SARA.

5. CONCLUSION

EPR (Enhanced Petal Routing) is an ant-predicated routing procedure designed for multi-hop ad hoc mobile networks that extracts some characteristics of petal routing to calculate petal width (Pw) and makes P_FANT and B_FANT to propagate to establish the path between end nodes within the petal region Algorithm. The EPR has been prosperously simulated utilizing NS2. The performance of EPR has been evaluated predicated on different metrics and different simulation environments. The Simulation outcomes of both environments exhibits that EPR performs healthier in terms of packets engendered by sources, packets received by destinations, fraction of packet distribution, provides good performance and abbreviates overhead. EPR increases network life by minimizing end-to-end delay and the magnitude of potency consumed, especially in the case of SARA.

APPENDIX

The routing protocols performance of has been studied based on the size of the network. We performed the experimental tests 15 times and only the average value is taken into account in each case. The experimental results are showing that the proposed model is working better than the routing protocol SARA, AODV and AOMDV. Table 2, Table 3, Table 4, Table 5 shows the analysis results of SARA, EPR, AODV and AOMDV. Table 6, Table 7 shows the analysis results of SARA and EPR for 104 wireless mobile nodes respectively.

ISSN 2515-8260 Volume 7, Issue 4, 2020

Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Overhead	Consumed Energy
15	5037	5031	99.88	255.339	129.38	0.012	68.6692
30	5277	5267	99.81	251.408	135.47	0.033	144.3165
50	5782	5769	99.78	218.957	148.25	0.066	227.9218
75	4996	4977	99.62	336.584	128.07	0.052	340.3608
100	6148	6140	99.87	225.367	157.82	0.026	440.9279
150	5091	5076	99.71	202.467	130.56	0.167	657.3948
AVG	**5388.5**	**5376.6**	**99.77**	**248.35**	**138.25**	**0.0593**	**313.26**

Table 2. Results of SARA routing algorithm

Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Overhead	Consumed Energy
15	6239	6234	99.9	240.509	159.98	0.002	68.1111
30	5769	5758	99.82	215.263	148.03	0.031	138.04503
50	6178	6165	99.80	210.640	159.06	0.035	230.2721
75	5567	5559	99.88	295.164	142.87	0.67	325.4615
100	6176	6167	99.87	216.426	158.44	0.01	444.9250
150	6128	6119	99.86	210.410	158.44	0.152	645.7724
AVG	**6009.5**	**6000.333**	**99.855**	**231.402**	**154.47**	**0.15**	**308.7645**

Table 3. Results of EPR routing algorithm

Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Overhead	Consumed Energy
15	4961	4520	91.11	166.907	120.13	1.479	51.0281
30	5419	4041	89.42	158.572	110.84	3.936	123.672
50	4540	4066	89.56	150.093	108.84	5.342	190.0928
75	4119	3693	89.66	170.03	100.86	8.088	294.2147
100	3893	3467	89.06	199.449	97.91	11.097	401.5922
150	3400	3017	88.74	174.209	82.3	17.413	617.8012
AVG	**4238.6**	**3800.6**	**89.59**	**169.87**	**103.48**	**7.892**	**279.733**

Table 4. Results of AODV routing algorithm

Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Overhead	Consumed Energy
15	4763	4459	93.62	206.31	118.52	0.998	65.505
30	4768	4438	93.08	172.063	118.88	2.152	135.1011
50	4522	4249	93.96	224.969	112.16	3.798	185.7059
75	4621	4314	93.36	188.46	115.39	5.611	325.1866
100	4173	3877	92.91	188.665	103.02	8.393	401.5922
150	4202	3877	91.69	210.605	104.88	12.15	617.801
AVG	**4508.1**	**4198.5**	**93.1**	**198.51**	**112.14**	**5.517**	**288.48**

Table 5. Results of AOMDV routing algorithm

Simulation Time (s)	Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Consumed Energy
50	104	2640	2605	98.67	303.269	219.5	131.753
100	104	7263	7179	98.84	243.274	301.65	247.971

150	104	12732	12640	99.28	261.995	350.45	418.055
200	104	14986	14888	99.25	283.553	307.7	535.815
250	104	17711	17562	99.16	339.657	291.78	709.25
AVG	**104**	**11066.4**	**10974.8**	**99.04**	**286.349**	**294.216**	**413.9668**

Table 6. Results of SARA routing algorithm for 104 nodes

Simulation Time (s)	Network Size	Packets Sent	Packets Received	PDF	EED	Throughput (kbps)	Consumed Energy
50	104	2641	2591	98.56	268.517	219.95	120.792
100	104	7980	7934	99.3	168.221	341.23	257.882
150	104	12968	12846	99.06	231.339	360.91	405.871
200	104	15940	15940	99.28	339.26	339.26	564.782
250	104	18385	18385	99.23	269.58	306.72	695.647
AVG	**104**	**11634.2**	**11539.2**	**99.086**	**255.383**	**313.614**	**408.9948**

Table 7. Results of EPR routing algorithm for 104 nodes

6. REFERENCES

[1] Singh, Gurpreet, Neeraj Kumar, and Anil Kumar Verma. "Ant colony algorithms in MANETS: A review." Journal of Network and Computer Applications 35.6 (2012): 1964-1972.

[2] A survey of multicast routing protocols for mobile ad-hoc networks. IEEE Communications Surveys and Tutorials 2009;11(1):78–91

[3] Chakeres, Ian D., and Elizabeth M. Belding-Royer. "AODV routing protocol implementation design." Distributed Computing Systems Workshops, 2004. Proceedings. 24th International Conference on. IEEE, 2004.

[4] Perkins, Charles E. Ad hoc networking. Addison-Wesley Professional, 2008.

[5] Taneja, Kavita, and R. B. Patel. "Mobile Ad hoc Networks: Challenges and Future." Proceedings National Conference on Challenges and Opportunities in Information Technology, RIMT-IET, Mandi Gobindgarh. 2007.

[6] Marina, Mahesh K., and Samir R. Das. "Ad hoc on-demand multipath distance vector routing." ACM SIGMOBILE Mobile Computing and Communications Review 6.3 (2002): 92-93.

[7] Johnson, David B., and David A. Maltz. "Dynamic source routing in ad hoc wireless networks." Mobile computing. Springer US, 1996. 153-181.

[8] Perkins, Charles E., and Pravin Bhagwat. "Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers." ACM SIGCOMM Computer Communication Review. Vol. 24. No. 4. ACM, 1994.

[9] Zhang, Yujun, et al. "TOHIP: A Topology-Hiding Multipath Routing Protocol in Mobile Ad Hoc Networks." Ad Hoc Networks (2014).

[10] [10] Manjunath, Manjaiah D.H "Spatial AODV (S-AODV) Routing Algorithm for Mobile Ad Hoc Network" Proceeding of the Second international Conference on Emerging Research in Computing, information, Computer and Application [ERCICA - 2014]"

[11] A. Colorni, M. Dorigo et V. Maniezzo, Distributed Optimization by Ant Colonies, actes de la première conférence européenne sur la vie artificielle, EPRis, France, Elsevier Publishing, 134-142, 1991.

[12] Gunes, Mesut, Udo Sorges, and Imed Bouazizi. "ARA-the ant-colony based routing algorithm for MANETS." EPRallel Processing Workshops, 2002. Proceedings. International Conference on. IEEE, 2002.

[13] Correia, Fernando, and Teresa Vazão. "Simple ant routing algorithm strategies for a (Multipurpose) MANET model." Ad Hoc Networks 8.8 (2010): 810-823.

[14] Wang, Jianping, et al. "HOPNET: A hybrid ant colony optimization routing algorithm for mobile ad

hoc network." Ad Hoc Networks 7.4 (2009): 690-705.
[15] Dorigo M, Di Caro G. AntNet: a mobile agents approach to adaptive routing, Technical report, IRIDIA- Free Brussels University, Belgium, 1997.
[16] Marwaha, Shivanajay, Chen Khong Tham, and Dipti Srinivasan. "Mobile agents based routing protocol for mobile ad hoc networks." Global Telecommunications Conference, 2002. GLOBECOM'02. IEEE. Vol. 1. IEEE, 2002.
[17] ANTALG: An Innovative ACO based Routing Algorithm for MANETS
[18] Fernando Correia, Teresa Vazao, Simple ant routing algorithm, in: International Conference on Information Networking, 2008. ICOIN 2008, January 2008, pp. 1–8. 1
[19] Biswas, Trisha, and Rudra Dutta. "Spatially Diffuse Pathsets for Robust Routing in Ad Hoc Networks." Global Telecommunications Conference (GLOBECOM 2011), 2011 IEEE. IEEE, 2011.
[20] Das, Saumitra M., Himabindu Pucha, and Y. Charlie Hu. "Performance comEPRison of scalable location services for geographic ad hoc routing."INFOCOM 2005. 24th Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings IEEE. Vol. 2. IEEE, 2005.
[21] Manjunath, Manjaiah D.H "Spatial DSDV (S-DSDV) routing algorithm for mobile ad hoc network" International Conference on Contemporary Computing and Informatics (IC3I) Proceedings IEEE, 2014.
[22] Manjunath M, , and Manjaiah D.H. "Stipulated Region Based Routing (SRR) algorithm for Mobile Ad Hoc Network", 2015 International Conference on Soft-Computing and Networks Security (ICSNS), 2015.
[23] "Emerging Research in Computing, Information, Communication and Applications", Springer Science and Business Media LLC, 2016
[24] S B Ashoka, M Hanumanthappa, M Manjunath. "Comparity Study of Traditional and Nature Inspired Routing Algorithms for Mobile Adhoc Network", 2018 International Conference on Soft-computing and Network Security (ICSNS),2018