Energy constrained routing in MANET using ACO

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***Abstract*— In mobile ad hoc networks (i.e. MANETs), nodes are mobile & have limited energy supply that can quickly deplete due to multi-hop routing activities, which may gradually lead to an un-operational network. In the past decade, the hunt for a reliable and energy-efficient MANETs routing protocol has been extensively researched. This paper proposes a novel Ant Colony Optimization based routing scheme for MANETs, and an its enhanced energy-constrained version, for which the routing decisions are facilitated based on the nodes' residual energy. These protocols were evaluated through simulations using NS2, showing that ACO+AODV outperforms E-AODV, in terms of network residual energy, number of drop packets, number of received packets and end to end delay in the network, where E-AODV is an energy-aware version of AODV.**

***Index Terms*— Mobile ad hoc networks (MANETs), multi-path routing, Ad Hoc On-demand Distance Vector (AODV), Ant Colony Optimization (ACO).**

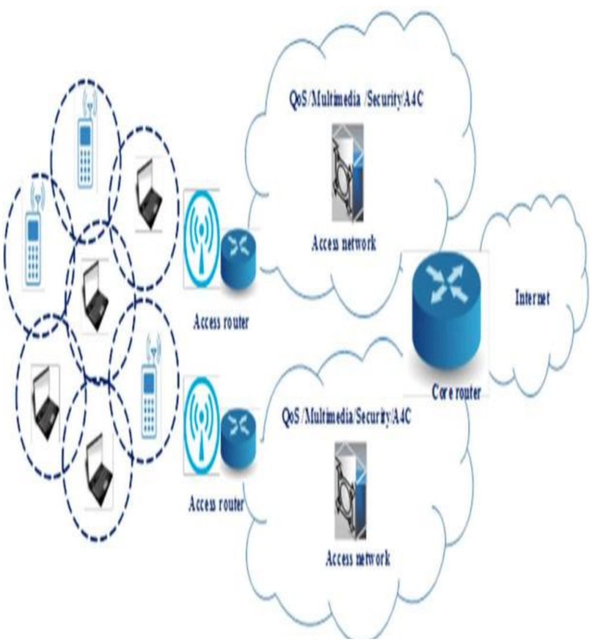
I. INTRODUCTION

MANETs are particular in the deployment of mobile devices without any existing infrastructure. Due to this feature, they are suitable for use in several applications such as disaster relief, military operations, to name a few. While moving, a node can also act as a router to forward the traffic, using multiple hops for establishing the connections among themselves. For every packet that a node forwards or receives, it is bound to lose some amount of energy. This drains the residual energy of nodes; therefore at some point, some nodes may die, hence, slowly depleting the networks lifetime. In this paper, we address the problem of designing routing algorithms for MANETs that can solve this issue by ensuring minimal energy consumption in the network.

Energy conservation in MANETs has been intensively studied in the literature using several routing techniques [1], most of which rely on controlling the transmission power of nodes, the residual energy of nodes, the load distribution in the network, or varying the transmission range of the nodes, to name a few. Among the Ant Colony Optimization (ACO) techniques that have been proposed to address the problem of adaptive routing in telecommunication networks. A group of concurrent agents update each other about the network topology, the routing information, and the network status as they explore the network in a non-coordinated manner, in an attempt to solve the adaptive routing problem. The focus on this paper is on proposing an energy constrained routing protocol for MANETs inspired from an ACO.

Several energy-aware routing protocols for MANETs have been proposed in the literature, some of which were based on ACO heuristics, surveyed various energy aware routing protocols for MANETs at the network and MAC layers, and studied the performance of some of them in terms of throughput, latency, routing overhead, and delay. Their scheme consists of a power-based cost function that allows the nodes to choose the best routing path during the route discovery process. Each node is assigned a power level and a corresponding cost value, calculated for each route found. To establish the connection with the destination node, the source node then chooses the route that has the minimum cost. A cost zoning concept is introduced in the route maintenance phase to adjust the cost of nodes in such a way that low power nodes are assigned very high costs and vice-versa, leading to energy-efficient routing paths.

The rest of the paper is systematized as follows. Section 2 briefly reviews related work about energy efficiency techniques, citing various techniques in MANETs. Section 3 involves the detailed explanation of the proposed methodology. Section 4 describes the implementation of the proposed system. Section 5 summarizes with a brief concluding remark and discussion of future work



A basic architecture of mobile ad hoc network (MANET).

II. RELEVANT LITERATURE

This section deals with work based on energy efficiency and link stability using various MANET routing protocols. Ssowjanya HariShankar and team [2] this paper proposes an AntNet-based routing scheme for MANETs (called MAntNet) and its energy-aware version (called E-MAntNet) as well as an energy-aware version of AODV (called E-AODV). It has been observed through simulations that: (1) the residual energy generated by the energy aware protocol E-MAntNet (resp. E- AODV) is comparable or higher than that generated by its plain version MAntNet (resp. AODV); (2) E-MAntNet (resp. E-AODV) generates an equivalent or lesser number of dead nodes compared to its plain version MAntNet (resp. AODV). However, the total connections established when using E-AODV falls off significantly when compared to AODV; (3) the number of connections established when using E-MAntNet (resp. E-AODV) is comparable to that obtained with MAntNet, its plain version (resp. E-AODV); and (4) when compared to E-AODV, E-MAntNet shows a better CE, an equivalent or better generated residual energy. Hence, for most of the studied performance metrics, it is reasonable to conclude that E-MAntNet outperforms MAntNet. Further to this Narayanan & Suresh [3], in this work, an ACO–EEOLSR protocol is introduced as an energy model. Initially, the route is discovered with respect to the estimation of neighbor routes along with the link stability authentication. Parameters such as energy, distance, and hop count are used as willingness nodes for link stability. After getting an ACK from link stability process, the hop count is estimated further. Finally, this system entails less energy consumption than the existing energy models. The experimental result shows better performance than the existing EE-OLSR model in terms of energy consumption, PDR, throughput, total remaining time, average network lifetime, and variance of energy. Vallikannu R, A. George & S.K. Srivatsa [4], in this paper, proposed ALEEP_with_ACO, a new ant colony based algorithm that uses the location of the nodes, ATP and energy aware metrics to increase the efficiency of routing. ALEEP_with_ACO is more reliable as it finds at least one energetic path to destination, unless there is a vertex connectivity node in the network or all the nodes in the network has reached threshold energy. Moreover, our algorithm uses a joint evaluation function where it reduces greatly power wasted by transmission by applying ATP and uses FANTs to determine eligible energetic possible paths. By using these methods energy consumption of network devices is reduced, thereby improving the lifetime of MANET. Most of the position based algorithms which use GPS failed in indoor MANET applications. The use of location information as a heuristic parameter resulted in a significant reduction of the time needed to establish routes from a source to a destination which is important for a reactive routing algorithm. The simulation showed that ALEEP_with_ACO is a scalable and energy efficient reactive routing algorithm which attempts to greatly improve MANETs lifetime compared to classical routing protocols and power aware protocols. Gurpreet Singh along with team [5], proposed a new Innovative ACO based Routing Algorithm (ANTALG) which has considered the random selection of source and destination nodes and exchanges the Ants (agents) between them. In general, ANTALG algorithm operates using reinforcement learning to define a model of optimal routing behaviour in MANETs. In such a model, optimal behaviour is not merely searching shortest-hop paths, but also considers the quality of the links which make up those paths. The learning strategy that we have designed is based on Ant Colony Optimization (ACO) algorithms. They have considered some of the unique features of Ants which are applicable to the routing problem. The movement of packets and Ant's agent through the network changes the routing policy and the paths which are used by future packets in a stochastic manner. We have found the ANTALG has better performance in comparison to HOPNET, AODV and ADSR protocols as shown in the results section using various performance evaluation metrics. Further to this, WANG Ya-li [6] along with team members presents an improved IAMQER, which can establish a route supporting multi-constrained QoS, increase network throughput and reduce network energy consumption by means of ant colony algorithm. Performance evaluation using Matlab simulator comparison with the shortest route algorithm and QoS AODV shows that the importance of considering the node forwarding packet capacity, the node queue length and the node residual energy in route establishing process and the transmit power adjusting scheme in data packets forward. In addition, paper defines a path evaluation function to evaluate the performance of routes and uses iteration and positive feedback of ant colony algorithm to establish a route, which can better make use of local information. Simulation results show that IAMQER algorithm proposed by this paper can not only reduce network energy consumption, thus prolonging the hot node lifetime, but also improve packet delivery ratio significantly in two constraints of average end-to-end delay and packet loss ratio, thus increasing network throughput.

On review of above papers we concluded on using ACO as optimization technique and as its not being applied directly for AODV we will be doing it and then comparing it to E-AODV which is energy aware AODV protocol.

III. PROPOSED ALGORITHM

Now, as energy is required in nodes for all the activities and to keep that node working, it is important to make routing process most energy constrained. And nodes selection to be done with certain criteria. So hereby it's obvious for opting reactive protocol along with multipath for searching route and uni-path for sending data packets. This shall be modified version of AODV protocol where route searching will be done with minimum entity in message format i.e. our hello packet which shall minimize energy requirement for sending these packets. Further nodes will be selected on basis of minimum energy level it has for transmission of data packets.

Three ants will be defined for this process:

Forward Ant (FA): It will take initial hello packets to discover route to destination

Reverse Ant (RA): It will be ant returning back to source after getting details of destination

Pursuing Ant (PA): It will carry data packets after route is established.

ACK i.e. acknowledgement from node that lies in between path of source to destination, will be accepted only from the node having minimum energy level or else FA will be rejected.

Algorithm steps for designed protocol

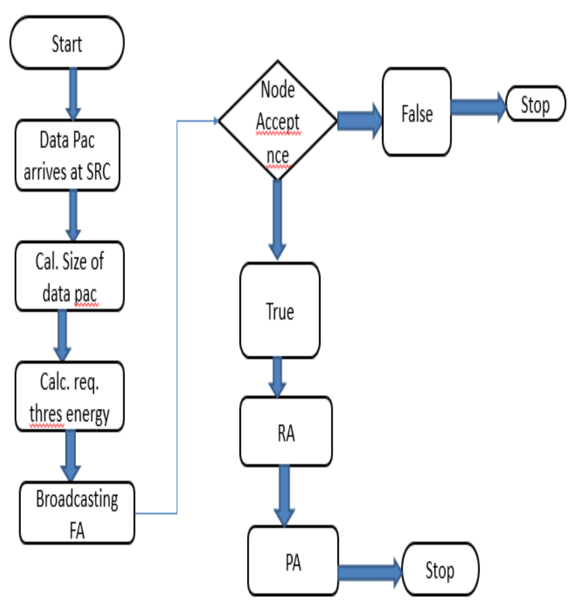
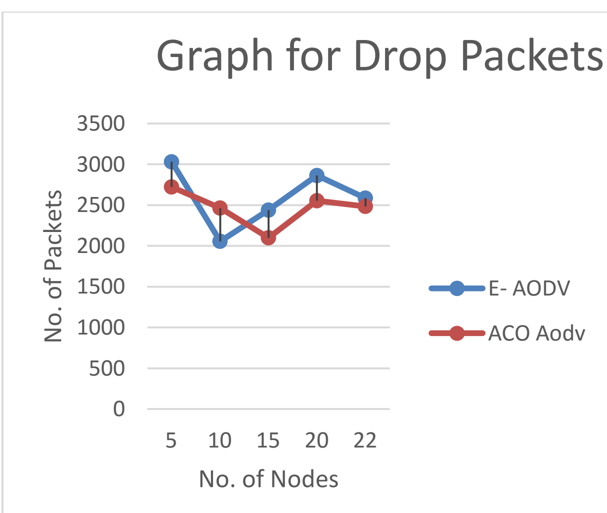


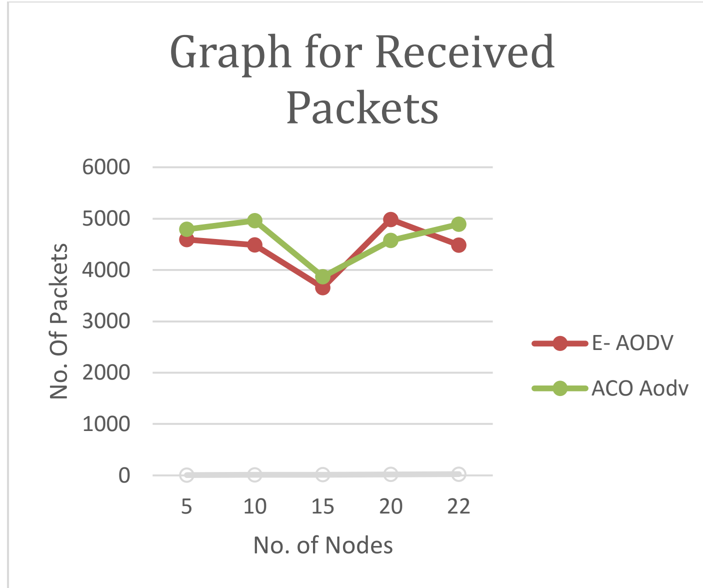
TABLE 1: SIMULATION PARAMETERS

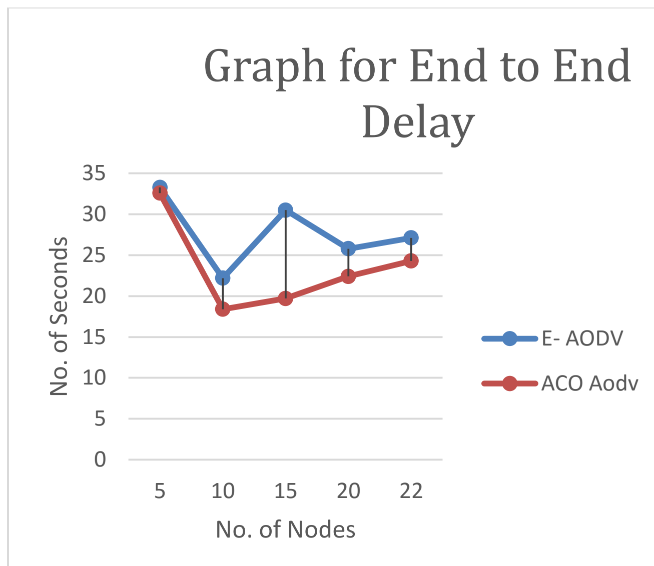
Mobility model	Random Way Point
Terrain dimension	1000 m x 1000 m
Radio propagation model	Two-ray ground reflection model
MAC protocol	IEEE 802.11
Node interface	Wireless
Traffic	CBR
Number of nodes	100 (or variable)
Simulation time	100 seconds
Initial node energy	20 Joules
Transmission power (T_x)	3 Watts (34.77 dbm)
Receiving power (R_x)	1.5 Watts
Transmission range	100 m (default), 25-200m (variable)
Antenna	1.5 Hz
Pause time	1 second
Node speed	1-10 m/s
Packet size	Control packet: 30-44 bytes; Data packet: 1000-1020 bytes

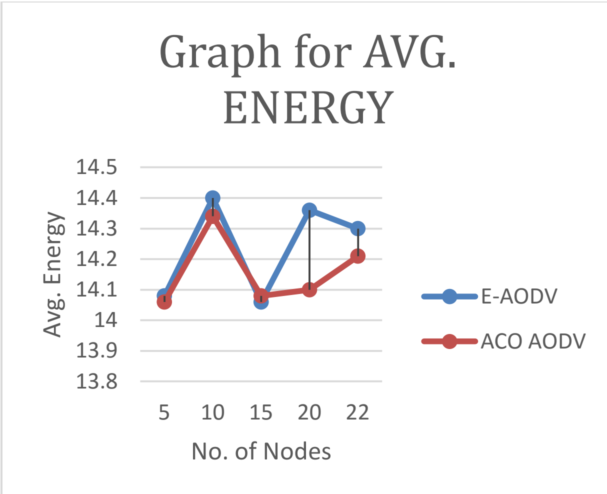
IV. PERFORMANCE ANALYSIS

NS (i.e. network simulator) is a name for series of discrete event network simulators, specifically: ns-1, ns-2 and ns-3. All of them are discrete-event computer network simulators, primarily used in research and teaching. It should encourage community contribution, peer review, and validation of the software.









V. CONCLUSION

By now we have depicted comparison to show that ACO is better optimization technique. Further, we have also shown comparative analysis between E-AODV i.e. energy aware routing protocol of AODV with our proposed algorithm i.e. ACO+AODV. We have presented results for few parameters that include drop packets, receive packets, end to end delay and Average energy. Further we plan to increase number of nodes and recheck with our proposed algorithm and increase network lifetime for providing better environment for real time applications.

REFERENCES

[1] A. H. Mohsin, K. A. Bakar, A. Adekiigbe, K. Z. Ghafoor, "A survey of energy-aware routing and mac layer protocols in MANETs: trends and challenges", Network Protocols and Algorithms, vol. 4, pp. 82-107, June 2012.

[2] Ssowjanya HariShankar, Issac Woungang, Sanjay Kumar Dhurandher, Issa Traore, Shakira Banu Kaleel, "E-MAntNet: An ACO-Based Energy Efficient Routing Protocol for Mobile Ad Hoc Networks", 29th International Conference on Advanced Information Networking and Applications, DOI no.: 10.1109/AINA 2015 162, pp. no. 29 to 36

[3] Kumar Narayanan, Suresh Gnana Dhas Christhudas, "ACO-EEOLSR: enhanced energy model based link stability routing protocol in mobile ad hoc networks", Taylor & Francis, ISSN: 0253-3839, DOI No.: 10.1080/02533839.2015.1082937

[4] Vallikannu R., A. George, S.K. Srivatsa, "Autonomous localization based energy saving mechanism in indoor MANETs using ACO", Elsevier, DOI: 10.1016/j.jda.2014.11.001

[5] Gurpreet Singh, Neeraj Kumar, Anil Kumar Verma, "ANTALG: An Innovative ACO based Routing Algorithm for MANETs", DOI: dx.doi.org/10.1016/j.jnca.2014.07.006.

[6] Wang Ya-li, Song Mei, Wei Yi-fei, Wang Ying-he, Wang Xiao-jun, "Improved ant colony-based multi-constrained QoS energy-saving routing and throughput optimization in wireless Ad-hoc networks", Science Direct, DOI: 10.1016/S1005-8885(14)60267-3

[7] Ankur Jain, Ritu Chaoudhary, "Improving The Quality of Services in Mobile Ad-hoc Network Using Ant Colony Optimization", International Journal of Advanced Research in Computer Science & Software Engineering, VOL. 4, Issue 6, June 2014, ISSN: 2277 128X.

[8] Gholamhasan Sajedy Abkenar, Arash Dana, Mohammad Shokouhifar, "Weighted Probability Ant-Based Routing (WPAR) in Mobile Ad Hoc Networks", Research Gate, Canadian Conference on Electrical & Computer Engineering January, DOI No.: 10.1109/CCECE.2011.6030571, January 2011.

[9] Shubham Sharma, Anant Ram, "Energy Efficient Path Formation Approach in Wireless Adhoc Network" Fifth International Conference on Communication System and Network Technologies, DOI No.: 10.1109/CSNT.2015.178, pp. 207-213.

[10] B.Nancharaiah, B.Chandra Mohan, "Modified Ant Colony Optimization to Enhance MANET Routing in Adhoc on demand Distance Vector", 2014 2nd International Conference on Business and Information Management, p.p. 978-4799-3264-1.

[11] Monisha Rani, Er. Amit Chhabra, "Modified LA to Optimize the performance of Mobile Ad Hoc Network, IJSEC, DOI No.: 10.4010/2015.340, Issue May, 2015 ISSN: 2321-3361.

[12] Shilpa Bade, Meeta Kumar, Pooja Kamat, "A Reactive Energy-Alert for MANET and its Impact on Node Energy Consumption", International Journal of Computer Application (0975-8887) Volume 7, Issue No. 8, June 2013.

[13] Bibhash Roy, Suman Banik, Parthi Dey, Sugata Sanyal, Nabendu Chaki, "Ant Colony Based Routing for Mobile Ad-Hoc Netwroks towards Improved Quality of Services", Journal of Emerging Trends in Computing and Information Sciences, Volume 3, Issue 1, January 2012, ISSN: 2079-8407.

[14] Aparna S Menon, S. Nikilla, " Selection of Energy Efficient and stable Routes over Multihop and Multiflow Mobile Ad Hoc Cognitive Network", International Journal of Advanced Research Trends in Engineering & Technology, Vol. 2, Issue 7, Feb 2015, ISSN: 2394-3777