The Study On Static And Dynamic Energy Efficient Optimization Techniques In MANET

P.Thiyagarajan, S.Senthilkumar

Abstract: Mobile Ad-Hoc Networks (MANETs) is ainfrastructure less network where nodes sharing the information with each other directly. Nodes in network join or leave at any time within communication range. The communication between MNs is identified through the routing process. Routing is employed for identifying the path between source and destination to transmit the necessary data packets. Routing protocols is used for efficient data packet transmission in MANET. Energy efficiency is the key concern in routing process due to less power in nodes. An optimization technique is the process carried out iteratively till finding the optimum solution. Many researchers carried out their research on energy efficient static and dynamic optimized routing protocols in MANET. But, the energy consumption and packet delivery ratio performance was not improved by existing techniques. In order to address these problems, different energy efficient static and dynamic optimization techniques were reviewed in this paper.

Index Terms: Mobile Ad Hoc Network, communication, static and dynamic optimization, routing, data packet transmission

I INTRODUCTION

MANET is a set of MN without any static substructure. MANET is the self-organizing system with dynamic topology that allows MN interaction in wireless manner without permanent infrastructure. Owing to inadequate resources like processing ability and storage space, it is essential to minimize the routing overhead in MANET with high packet delivery ratio. As battery power of node was limited, Node energy and network lifetime is an essential issue in MANET. Consequently, routing protocols considered the energy as the key resource for MN communication to enhance network lifetime (NL). The survey paper is ordered as: Section 2 describes the survey on different energy efficient static and dynamic optimized routing protocols in MANET, Section 3 shows experimental analysis of existing energy efficient static and dynamic optimized routing protocols in MANET, Section 4 describes existing energy efficient static and dynamic optimized routing protocol comparison in MANET. In Section 5, the drawbacks of existing protocols in MANET are discussed with future direction. The conclusion of the paper is given in Section 6.

II LITERATURE REVIEW

In [1], Ant-based efficient energy and balanced load routing (A-EEBLR) approach was introduced. A-EEBLR approach selected the next hop node. But, the routing time was not reduced using A-EEBLR approach.

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An Ad-hoc On-Demand Distance Vector (AODV) protocol with Ant Colony Optimization (ACO) was introduced in [2] to enhance the Quality of Service (QoS) in MANET. The finest route for data delivery was chosen based on pheromone value of path. But, the energy consumption ratio was not reduced. An ant colony-based energy control routing protocol (ACECR) was designed in [3] for improving NL and reducing MN's energy level. But, the neighboring node selection was not carried out in routing process. An efficient power aware routing (EPAR) method was introduced in [4] that distinguish the node capability by residual battery power. Less cost path was selected and data rate get controlled. The energy consumption gets reduced and node lifetime gets improved. The designed method identified the path with high lifetime. But, the packet delivery ratio was not improved. LASEERA protocol was designed in [5] for MANET. The designed algorithm reduced the energy consumption and attained better results in delay and delivery ratio. However, the designed method failed to minimize the routing overhead. An Intelligent Energy-aware Efficient Routing (IE2R) protocol was designed in [6] by multi-criteria decision-making approach for increasing the delivery with lesser delay. However, the designed approach has high latency in route path identification for large networks. In [7], Innovative ACO based Routing Algorithm (ANTALG) was introduced. ANTALG enhanced the throughput with lesser delay. But, the designed algorithm failed to improve the network lifetime because the algorithm failed to choose the energy efficient nodes.

III STATIC AND DYNAMIC ENERGY EFFICIENT OPTIMIZATION TECHNIQUES IN MANET

MANET is a set of MN that interacts without predetermined infrastructure. Due to flexible and dynamic environment, MANET is employed in various applications like military communication and disaster area communication. Energy is an essential criterion for decentralized network. In order to improve the network lifetime, best route selection is an essential issue for routing protocols in MANET. Routing is the method of choosing the selecting paths in network to transmit the data. In MANET, routing is a vital part of opting a path as well as sharing the information among the mobile nodes.

A. Ant-based energy efficient and load balancing approach for optimal path convergence in Mobile Adhoc Networks ACO is the meta-heuristic process depending on ant behavior with computational agents to find minimum distant path for finding the food location. A-EEBLR approach was introduced to select the next hop node depending on metrics. With help of QoSmetrics, selection of next hop is identified. The probability recognized the forward and backward ant agents for identifying multiple paths to perform transmission. ACO algorithm was employed for the data packet transmission. The ants seek destination node and stored the node information in pheromone table. The next hop node was preferred with help of metrics. The metric was chosen based on elapse time period for data transfer. The energy drain rate was chosen with help of an index value. The link quality was determined based on successful transmission rate and stop network clogging. In pheromone table, neighbor nodes and destination nodes are denoted in the rows and columns. A probability value was linked with node in pheromone matrix for next hop node selection. The routing was started by source node to find the path from source to destination node. At every intermediary node, forward ant was broadcasted to destination node.

B. Enhanced-Ant-AODV(EAA) for optimal route selection in mobile ad-hoc network A new mechanism combined AODV protocol with ACO for route selection to enhance the QoS. In designed mechanism, optimal route for data delivery was identified through path pheromone value determined based on number of hops and residual energy. The highest pheromone value path was chosen for data packet transmission. Enhanced_ANT_AODV(EAA) scheme was introduced for optimal route selection EAA identified an optimal route through link quality, residual energy and hop count. Every node maintained information in routing table. The minimal residual energy was available in the node for intermediary node consideration. When residual energy of node was lesser than threshold energy, it was not taken as intermediary node.

C. Energy routing protocol using Ant Colony for mobile ad hoc networks withvarious node mobility models ACO is functioned based on swarm intelligence for addressing optimization problems. ACO functioned with artificial ants that behave as the packets in MANET. The pheromone content selected the best path in network to transmit the data. The data was transmitted over multiple paths for same destination to achieve load balancing. ACO-based routing algorithm was introduced based on proactive and iterative behavior. The designed algorithm minimized variability and errors through choosing the trusted path. ACECR protocol identified optimal route through optimistic feedback. In ACECR protocol, routing was depending on hop count between nodes based on the node energy. When source node sent data packet to the destination, it verified their pheromone table. When pheromone table not include next node to destination node, source node discovered path. Source node transmit request packet termed as forward ant (Fant). When node collected Fant, it revised node list and record the node where Fant passed. Each node in networks sends Fant packet till destination. When Fant reached destination node, it generated backward ant (Bant). The destination sent Bant to source node along reverse route.

D. Optimizing Transmission Power and Energy Efficient Routing Protocol in MANETs EPAR method was introduced to distinguish nodes by residual battery power and energy spent during forwarding particular link. A data routing was carried out with high mobility. The minimal cost path was preferred and data rate get organized. The energy consumption gets reduced and node lifetime gets increased. The designed approach identified path having high lifetime for performing data communication. The designed method consumed lesser energy for efficient routing process. The throughput gets improved and the power utilization gets minimized.

E. A Stable and Energy-Efficient Routing Algorithm Based on Learning Automata Theory for MANET LASEERA was introduced for MANET based on new node stability measurement model with energy ratio function. LA theory was self-learning mechanism depending on stochastic process theory. LA improved results by prior knowledge to select the best one from limited set through repeated interactions. LA comprised three essential factors, namely random environment, automaton and feedback system. The automaton selected the action and environment respond to the action with help of feedback signal. Depending on automaton outcome, the feedback signal was partitioned into positive or negative signal. The automatons learned from feedback signal to identify the optimal action.

F. Intelligent energy-aware efficient routing for MANET MANET is a collection of active nodes moving in any direction. An IE2R was introduced with MCDM technique depending on entropy and Preference Ranking Organization METHod for Enrichment of Evaluations-II (PROMETHEE-II) method to identify the best route. MCDM technique and Intuitionist Fuzzy Soft Set IFSS) minimized the improbability and identified energy efficient route for addressing the decision-making problems. The nodes like simple node, junction node, fictitious node, source node and deceased node were used for route detection and maintenance to enhance NL. Route REQuest (RREQ), Route REPly (RREP), Route ERRor (RERR) and HELLO packet handled the route and performed communication without reducing neighbor counts. The selection of neighbor nodes was introduced depending on messages given by nodes. The route maintenance scheme handled the link and node failure. The selection of indicators and routes were carried out for energy efficient routing in MANET.

IV COMPARISON OF ENERGY EFFICIENT STATIC AND DYNAMIC OPTIMIZED ROUTING PROTOCOLS IN MANET& SUGGESTIONS

In order to compare the energy efficient static and dynamic routing protocols in MANET, number of MN and data packets is taken to conduct the experimentation. Different parameters are used for performing the energy efficient data packets routing in MANET.

A. Energy Consumption (EC)

EC is a quantity of energy consumed by the MN for routing the data packets from source node to destination

node. It is defined as the product of number of MNs and energy utilized by one MN. It is computed in joules (J). It is formulated as,

$$EC = N * Energy\ Consumed\ by\ one\ mobile\ node \quad (1)$$

From (1), 'N' denotes the number of MNs.

Table 1 Tabulation of Energy Consumption

Number of mobile nodes (Number)	Energy Consumption (Joules)					
	A-EEBLR approach	Enhanced_ANT_AODV scheme	ACECR Protocol	EPAR method	LA theory	IE2R Protocol
10	25	32	39	43	46	51
20	27	35	42	46	48	53
30	30	38	46	48	50	56
40	33	41	49	50	53	59
50	31	39	47	49	52	54
60	28	37	44	46	50	52
70	24	34	41	43	47	50
80	26	38	43	45	49	53
90	29	42	46	49	52	56
100	32	45	50	53	55	59

Table 1 describes the EC with respect to different number of mobile nodes varying from 10 to 100. Energy consumption comparison takes place on existing A-EEBLR approach, Enhanced ACO with AODV protocol, ACECR, EPAR method, LA theory and IE2R. The graphical analysis of EC is described in figure 1.

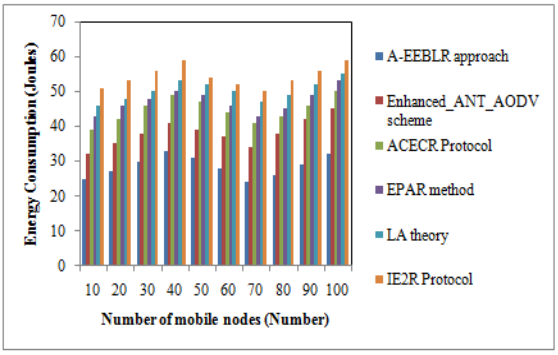

Figure 1 Measurement of Energy Consumption

Figure 1 explains the EC comparison for different number of mobile nodes. It is clear that the energy consumption using A-EEBLR approach is lesser when compared to Enhanced ACO with AODV protocol, ACECR, EPAR method, LA theory and IE2R protocol. This is due to the application of ACO algorithm for routing the data packets in energy efficient manner. The ant seeks for destination and preserves information of nodes in pheromone table. The pheromone table was matrix with energy efficient neighbor nodes and destination nodes were denoted for data packet transmission. This in turn helps to reduce the energy consumption. Finally, the energy consumption of A-EEBLR approach is 25% lesser than Enhanced_ANT_AODV scheme, 36% lesser than ACECR Protocol, 40% lesser than EPAR method, 43% lesser than LA theory and 48% lesser than IE2R Protocol.

B. Routing Time (RT)

Round Time is amount of time consumed for forwarding the data packets from sourceto destination.RT is defined as the difference of starting time and ending time of routing process. It is measured in terms of milliseconds (ms). It is given by,

$$RT = Ending\ time - Starting\ time\ of\ Routing \quad (2)$$

From (2), the RT is computed. When routing time is lesser, more efficient method is said to be..

Table 2 Tabulation of Routing Time

Number of Data packets (Number)	Routing Time (ms)					
	A-EEBLR approach	Enhanced_ANT_AODV scheme	ACECR Protocol	EPAR method	LA theory	IE2R Protocol
10	17	13	21	25	27	31
20	18	15	24	28	29	34
30	21	18	27	32	33	37
40	24	20	29	35	36	39
50	26	22	32	38	39	42
60	29	25	34	41	43	45
70	32	28	37	44	46	47
80	35	30	40	47	49	50
90	38	31	42	50	52	53
100	40	34	45	53	56	56

Table 2 explains the routing time with respect to different number of data packets varying from 10 to 100. Routing time comparison takes place on existing A-EEBLR approach, Enhanced ACO with AODV protocol, ACECR, EPAR method, LA theory and IE2R protocol. The graphical analysis of routing time is explained in figure 2.

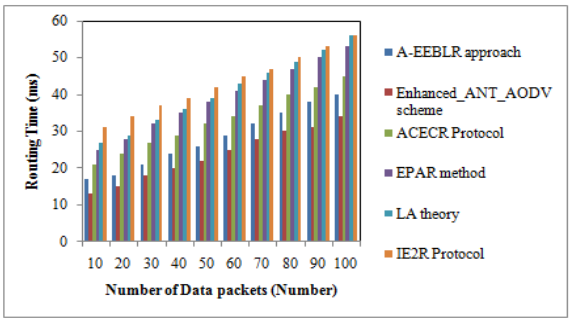

Figure 2 Measurement of Routing Time

Figure 2 illustrates the routing time comparison for different number of data packets. It is clear that the routing time using Enhanced ACO with AODV protocol is lesser when compared to A-EEBLR approach, ACECR, EPAR method, LA theory and IE2R protocol. This is because Enhanced_ANT_AODV scheme introduced with many factors for optimal route selection. Enhanced-Ant-AODV constructed an optimal route from the source node to destination node. Every node maintained the information in routing table for routing the packets with lesser time consumption. Finally, the routing time of Enhanced_ANT_AODV scheme is 16% lesser than A-EEBLR approach, 30% lesser than ACECR Protocol, 41%

lesser than EPAR method, 43% lesser than LA theory and 47% lesser than IE2R Protocol.

C. Packet Delivery Ratio (PDR)

PDR is ratio between number of data packets delivered and total number of data packets sent. It is measured in terms of percentage (%). It is formulated as,

$$PDR = \frac{Number\ of\ data\ Packets\ that\ are\ correctly\ Delivered}{Total\ Number\ of\ Data\ Packets\ Sent} * 100 \quad (3)$$

From (3), the PDR is calculated. When the PDR is higher, more efficient the method is said to be.

Table 3 Tabulation of Packet Delivery Ratio

Number of Data packets (Number)	Packet Delivery Ratio (%)					
	A-EEBLR approach	Enhanced_ANT_AODV scheme	ACECR Protocol	EPAR method	LA theory	IE2R Protocol
10	80	84	88	75	71	66
20	82	86	90	77	73	68
30	85	88	92	80	76	71
40	82	84	89	78	74	69
50	78	82	86	75	71	66
60	82	85	88	77	73	64
70	85	87	91	80	76	68
80	88	90	94	82	80	70
90	84	88	92	79	78	67
100	87	91	95	83	81	71

Table 3 explains the PDR with different number of data packets PDRcompareswith existing A-EEBLR approach, Enhanced ACO with AODV protocol, ACECR, EPAR method, LA theory and IE2Rprotocol. The graphical analysis of packet delivery ratio is illustrated in figure 3.

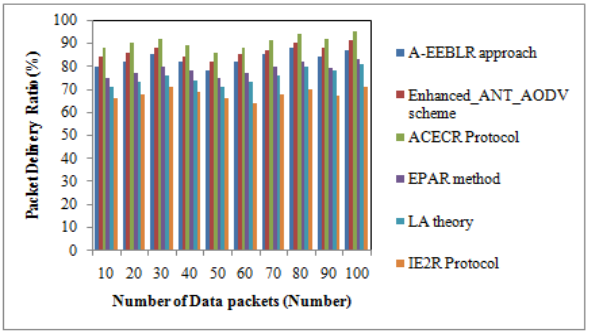

Figure 3 Measurement of Packet Delivery Ratio

Figure 3 describes the PDR comparison for different number of data packets. It is clear that packet delivery ratio using ACECR is higher when compared to A-EEBLR approach, Enhanced ACO with AODV protocol, EPAR method, LA theory and IE2R protocol. This is due to the application of ACO-based routing algorithm in different ways because of the iterative and proactive behavior. The proposed technique reduced the inconsistency and inaccuracies in networks viaopting the trusted path. This in turn helps to improve the PDR. Finally, the PDR of ACECR protocol is 9% lesser than A-EEBLR approach, 5% lesser than Enhanced_ANT_AODV scheme, 15% lesser than EPAR method, 20% lesser than LA theory and 33% lesser than IE2R protocol.

V DISCUSSION AND LIMITATIONS ON ENERGY EFFICIENT STATIC AND DYNAMIC ROUTING PROTOCOL IN MANET

A-EEBLR approach selected the next hop node depending on the metrics. The next hop probability detected forward and backward ant agents to identify optimal path for transmission. But, the routing time was not reduced using A-EEBLR approach. AODV protocol combined with ACO to increase QoS for route selection. The optimal route for data delivery was chosen by route pheromone value. The pheromone value of route was computed depending on end-to-end path reliability, congestion and residual energy of nodes. However, the energy consumption was not minimized. EPAR method classified nodes based on the residual battery power during data packets forwarding. The data routing is carried out with high mobility. The less cost path was selected and data rate get controlled. The throughput gets improved and power consumption gets minimized. But, the packet delivery ratio was not improved. ACECR protocol identified best route through positive character of ACO. When source node transmitted data packet to the destination, it verified pheromone table and identified next node in path. In ACECR protocol, routing choice was based on hop count between nodes. ACECR provided better results in balanced EC and NL. However, the neighboring node selection was not carried out in routing process. LASEERA was introduced for MANET with A new node stability measurement model. The node was presented with weighted value for LA. LA theory-based feedback mechanism for MANET environment selected the optimal one for proving the convergence. But, the designed method failed to minimize the routing overhead.IE2R was introduced with MCDM technique depending on entropy and PROMETHEE-II method to find the effective route. But, the designed approach has high latency in route path identification for large networks.

A. Related Works

A new bio-inspired integrated trusted routing protocol by ACO and physarum autonomic optimization (PAO) was designed in [8]. With several route paths, optimal one was chosen for effective routing in MANET. The optimization algorithm failed to find the energy-efficient nodes for routing the data packets. An ant colony optimization algorithm was designed in [9] to enhance the reliability of routing and packet delivery. However, ant colony optimization algorithm failed to minimize the overhead. An efficient and stable multipath routing was introduced in [10] for congestion awareness in MANETs. The bandwidth and delay were taken during the routing process. The network computed the residual energy and link stability of in network. The stability of the link LET was estimated and LET was estimated with the motion parameters. An energy efficient multipath routing algorithm was introduced in [11] with fitness function to identify the best route path. But, the designed algorithm failed to improve the performance for energy consumption and network lifetime. K-means cluster formation and firefly cluster head selection based MAC routing protocol was developed in [12] for MANET. But, energy efficient QoS aware hierarchical routing process failed to minimize the delay in data packets flow.

B. Future Direction

The future work of data packet transmission in MANET is carried out using the dynamic routing protocols. From the study, it is clear that the energy consumption and routing time consumption was less using dynamic routing protocols than the static routing protocols. So, we are planning to introduce the dynamic routing protocols in our future research works.

VI CONCLUSION

A comparison of different existing energy efficient static and dynamic optimization techniques in MANET is studied. From survival study, existingEnhanced_ANT_AODV scheme failed to reduce the energy consumption. The review explains that the neighboring node selection was not carried out in routing process. The routing time was not reduced using A-EEBLR approach. The wide range of experiments on existing techniques describes the performance of many energy efficient static and dynamic optimization techniques in MANET with its limitations. Finally from the survey, the research work can be carried out using dynamic routing protocols for energy efficient optimized routing in MANET.

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