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An Empirical Study of Reactive Routing Protocols Based Optimization Techniques for MANET

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***Abstract*:** Mobile Ad-hoc Network (MANET) is a rapidly changing network having collection of mobile nodes. The connection links between pair nodes are not certain because the nature of changing topology and infrastructure less in MANETs and Thereby there are various issues and restrictions which influence the performance of the network like mobility, overhead, battery drainage, delay and interference.; so MANET is subjected to recurrent link failures that will lead the network to route failure. It is in demand for the routing protocols to decide routes imperishable connectivity supplying persistent data transition without compromising quality of service and load balancing. All the routing protocols are utilized to manage the process of routing through the connection of nodes in the Mobile Ad-Hoc Network. Reactive routing protocols are used, when the source needs to send a packet to destination so the process of searching route will initialize, till it discovers the optimal path. The reactive routing protocols flood in the network for discovering the route of destination and they are not perfect in the term of bandwidth, but the reactive protocols are scalable in the change of network topology. Ad-hoc on-demand distance vector (AODV) and Dynamic routing Protocol (DSR) are reactive routing protocols which predominantly utilized in MANET for making routing resolutions because of their performance in terms of throughput, packet delivery ratio, delay, and number of hops when compared to other protocols, but AODV is shown better performance because it often concentrates to less reliable routes leading to high control overhead and packet loss. In this paper we discuss a general review of modified reactive routing protocol based on optimization algorithms for mobile Ad hoc networks.

***Keywords*:** MANET, Reactive routing protocols, Optimization techniques.

I. Introduction

The concept MANET [1] was derived from a Latin word which means "for this purpose only". The MANET is integration of mobile nodes communicating with each other, without depending on any constant infrastructure. The nodes act both as a router and as a host, the topology of the network will be changing speedily and determination is taken in a distributed manner. The MANETs encounters challenges like, the dynamic movement of nodes in the network topology, the bandwidth, also the multi hop routing and finally, the limited batter resources. MANET has a limited battery power to transmit the packet data from the source to destination ,and because the dynamic locomotion of the network topology ,there is an additional effort done by the nodes and that makes the battery power decrease and ,that affects life time of network in MANET[2]. So the major challenge is, how to manage the energy of each node in the network, which will increase the period of communication between the nodes, and promote the efficiency and lifetime in MANET. The energy exhausted through the process of connection between the nodes in MANET by: Receiving, Sleeping, Idle and Residual energy. If the route in network is not found then the route discovery will start again till it finds the destination node and this will consume the battery power and cause overhead [2].

II. Mobile Ad Hoc Network Routing Problem

Mobile Ad-Hoc Networks (MANETs) nodes are typically prominent by their limited processing, power, and memory resources as well as high degree of mobility. The wireless mobile nodes may dynamically enter the network as well as leave the network. Due to the limited transition range of wireless network nodes, multiple hops are usually needed for a node to exchange data with any other node in the network. Thus routing is a critical issue to the designing of a MANET [3]. Routing algorithms in imitative wired networks are algorithms that usually request periodic routing advertisements to be transmitted by each router. Which are obviously not efficient for the type of dynamic changes which may happen in an ad-hoc network Also, routers in

imitative networks in general do not move around and only rarely leave or join the network. the changing topology in an environment with mobile nodes, will not only move periodic recompilation of routes but the overall assemblage to stable routes may be not possible due to the high-level of mobility [3].

III. Ad-Hoc on-Demand Distance Vectoring (AODV)

AODV is a status -of-the-art routing protocol that takes on a completely reactive strategy: it found a route on-demand at the beginning of a connection session, and utilizes it till it cuts, after which an unprecedented route found is started. AODV takes on a very different technique to save routing information. It utilizes conventional routing tables, one entry per destination [4–7]. Without source routing, AODV bases on routing table entries to broadcast a route replay (RREP) back to the source and, posteriorly, to route data packets to the destination. AODV utilizes sequence numbers preserved at each destination to decide the freshness of routing information and to stop routing loops. In this protocol all routing packets are carrying these sequence numbers. A significant merit of AODV is the conservation of timer-based statuses in each node, concerning usage of distributive routing table entries. A routing table entry is expired if not utilized recently. A group of predecessor nodes is preserved for each routing table entry, indicating the group of neighboring nodes which utilize that entry to route data packets. These nodes are announced with route error (RERR) packets when the next hop link breaks. In turn, each predecessor node will forward the RERR to its own group of predecessors, thus effectively deleting all routes using the broken link. Route error diffusion in AODV routing protocol can be envisaged conceptually as a tree whose root is the node at the point of washout and all sources utilizing the failed link [8].

IV. Dynamic Source Routing (DSR)

The Dynamic Source Routing Protocol [9] is reactive routing protocol which is based on the source routing. The source broadcast the packet to his neighbours and the neighbours forward the packet to the next hop till it reaches the destination. The DSR depends on two processes, the first one is routing discovery, when the source wants to find the path to destination ,in the beginning it will check the route cache and if it is not available, then it will broadcast contains source address, destination address, request Id and path. If a source knows the Packet already, it will be cancelled. Otherwise, the route looks up its route caches to find a route to destination, If it's not found, it supplements its address into the packet, for rebroadcast, If a route is found in its route cache, then it will send a route reply packet, which is sent to the source by route cache or the route Discovery. The second is route maintenance, when the source route forward the packet, the intermediate nodes which is transmitting will be responsible to preserve the route and confirm that the packet has been received by the next hop along the source route.

V. Comparative of AODV and DSR in MANET

AODV and DSR maintained higher PDR due to their on demand nature and their fast recovery when the nodes were depleting their energy. They succeeded to manage the higher load, although higher numbers of packets were dropped. However in case of average energy consumption, number of nodes alive and average end to end delay AODV outperforms DSR protocol. DSR proved to be a reliable choice where work efficiency is concerned [10]. As number of nodes is increasing, the delay in AODV also increases. The opposite is true for DSR which decreases in delay when number of nodes increases. Throughput of AODV is always very high compared to DSR when number of nodes is increasing. Hence AODV performs better in stressful networks where node density is very high. With increasing number of nodes, DSR performs poorly. In brief it is recommended to use AODV when node density is very high and use of DSR in low node densities [11].

VI. Optimization techniques in MANET Routing Protocols

Swarm optimization techniques are used in Mobile Ad-Hoh Network for finding the best and optimal solution from the possible outcomes. There are diverse optimization techniques that have applied in MANET and given a high performance and better results. Their main concern is focusing on the optimization approaches which make the network more reliable, efficient and without any loss of original link during data transition [12].By these optimization techniques, it will be easier to find the eligible solution from all outcomes [13]. Several Optimization approaches can be utilized to find the optimal and best solution. For optimization biologically inspired algorithms is the category of algorithms that like with the performance of nature. By these algorithms diverse problems can be solved due to their advantages: First, to reach a solution, we don't have to follow any mathematical approaches. Second, results come very fast and are accurate [14].

VII. Review of Literature

AM Abdel-Moniem [15] presented algorithm called as Multi-Route AODV Ant routing algorithm (MRAA) which is based on both the standard Ad-hoc On-demand Distance Vector (AODV) protocol and ant colony optimization (ACO). The modified routing protocol is highly adaptive, efficient and scalable. The main goal in the design of the protocol was to minimize the routing overhead, response

time, end-to-end delay and increase the performance. MRAA used to find multiple disjoint routes between a source node and a destination. The performance of both the proposed algorithm and conventional AODV routing protocol is compared in terms of end-to-end delay, throughput, Network Load, sent routing traffic, received routing traffic, number of dropped data packets. In the traditional AODV, a source node accomplishes a route discovery process whenever an existing route is broken. In the proposed protocol, however, a source node can send data packets to its congruous destination through one of backup routes pre-established.

Nadilma C. V. N. Pereira [16] proposed a computational intelligence algorithm, called Particle Swarm Optimization (PSO), which Enable to find elect resolutions in all deemed search space in order to minimize average data packet delivery delay sent over the network. The optimization technique is proposed to find the best set of parameters in the resolution. To be more specific, The AODV routing protocol is modified to make resolution to recover from the failure of route either in source node or at the failure of link predecessor node executing the connectivity notion and utilizing weights for each argument deemed in the resolution function. The values for each weight were discovered through Particle Swarm Optimization (PSO) basic form. The modified AODV showed better performance than the conventional AODV routing protocol for all the metrics on the investigated scenarios. The results pointed that depending on the topology of network, user application and parameters, it can be appropriate for AODV routing to use computational intelligence algorithm. Besides there is a new function for AODV algorithm proposed using the connectivity concept to determine between source and local remedy when a link break happens.

Richa Kalucha [17] the present process utilizes the artificial bee colony (ABC) algorithm to discover the Black Hole Attack. The Scout bees are utilized to search the black hole node. The Employed bee used to inform the network for the Black Hole node. And finally Onlooker bees take care of the Black Hole Node is not in the routing. ABC improves the lifetime of network and provides an effective multi-path data transition in efficient manner.

The evaluation of the implementation showed that the artificial bee colony based algorithm in terms of Packet Delivery Ratio, end-to end delay and throughput was better than existing process.

Jinil Persis Devarajan [18] proposed a routing algorithm F-AODV which is combining the notions of AODV routing protocol and Firefly Algorithm (FA) which is inspired by flashing behaviour of firefly insects for MANET. Through the comparison between the modified AODV routing protocol and the original AODV the performance of AODV routing protocol based firefly algorithm was favourable of the outcomes in terms of overhead, delay, packet delivery rate and resource (power, bandwidth) utilization.

Hua Yang [19] presented a genetic algorithm Based AODV routing protocol and took the consideration of the performance of intermediate nodes to improve the routing to get a more suitable route to optimize the network performance. The proposed algorithm GA-AODV has a significant enhancement over AODV in average delay, packet received rate, and routing recovery frequency and show better implementation than traditional AODV routing protocol.

Hong Tang [20], at el proposed a novel AODV routing protocol based on improved genetic-ant colony algorithms by introducing genetic algorithm (GA) to enhance ant colony algorithm, and combining with the features of AODV routing protocols in Mobile Ad Hoc network. At first, the suggested algorithm takes utility of the global speedily searching capability in genetic algorithm to get the optimization resolution set of path and converts it to the initial information pheromone division of ant colony algorithm. Then, the updating rules of pheromone in ant colony algorithm are enhanced; both the remaining energy of nodes and the link delay in the operation of searching route are taken into account. Finally, a sensible and effective optimal path in an adaptive chosen way is found by utilizing the positive finding merits and the ability of fast search. The comparison of the performance between the GA, Ant-AODV and the traditional AODV routing protocol, demonstrated that the new proposed algorithm is not only increased the search divergence of the path, but also minimized the average end-to-end delay. Meantime, this new modified algorithm may enhance the data packet ratio and protracts network lifetime.

Subhrapratim Nath [21] suggested a hybridization of the Ant Colony Optimization (ACO) and the Firefly Algorithm (FA) for (AODV) routing protocol to maximize the efficiency in the transition of the signals in a MANET system and thereby meaning to substantially reduce the losses, so incurred utilizing merely the AODV Routing Protocol and defeat obstacles of Ant Colony Optimization ACO based AODV. A comparative reviews on the suggested hybrid algorithm with the current routing algorithms (AODV and ACO based AODV) thereby guaranteeing reduction of network load by avoiding re-discovery tries between the nodes. The proposed algorithm dissolves the delays and the uncertain nature of the MANETs over extended range of topologies. And works in tandem with the exist AODV protocol to enhance better and a more certain network schema to handle MANET.

Clodomir J. Santana Jr [22] investigates the application of bio-inspired Swarm-based algorithms - Particle Swarm Optimization (PSO) and Artificial Bee Colony (ABC) to optimize the capability of the Ad Hoc On-Demand Distance Vector (AODV) routing protocol to recover broken connections that occur due to the mobility of nodes in Mobile

ad-hoc networks (MANETs). We use the algorithms as mentioned earlier to calculate the weight of a function based on the number of hops traveled by the package, the number of hops to reach the destiny, source node connectivity and the predecessor node connectivity. The results pretended that the proposed approach with both ABC and PSO algorithms are capable of getting better outcomes than the traditional AODV protocol concerning routing overhead, delay, and packet delivery ratio. Since PSO algorithm has lower computational cost than ABC and utilizes only one fitness evaluation per iteration, while ABC utilizes two.

Prasath. N [23] proposed algorithm used to locate optimal paths between communicating nodes, conventional DSR algorithm is modified based on multiple objectives and called as Link Quality Load Balanced Dynamic Source Routing (LQLB-DSR). Solutions got utilizing LQLB-DSR is suboptimal due to dynamic variation of network parameters. To defeat an Artificial Fish Swarm Algorithm (AFSA) to achieve deserved Quality of Service (QoS) is suggested. The comparison result between AFSA-DSR and traditional DSR routing protocol showed there is improvement in performance of the proposed routing protocol. Fish Swarm optimization was selected due to its faster convergence and easier computation. Numerical outcomes demonstrate that throughput of AFSA DSR maximize PDR by an average of 31% than traditional DSR. End to end delay and retransmission tries minimized considerably which is statistically significant. The number of hops to destinations increased in both versions of modified DSR compared to conventional DSR which may require further investigation.

Mustafa Tareq [24] the main goal of proposed algorithm BEEDSR is to optimize the energy consumption in DSR routing protocol which will lead to optimize the lifetime and efficiency of network. BEEDSR is suggested based on artificial bee colony (ABC) and it is inspired from the natural bee food hunting behavior to defeat the energy problems caused from overload packet from source to destination nodes. The artificial bee colony DSR routing technique is concentrating on determining the optimal routing path. The advantage of this optimization algorithm is its simplicity; it can easily integrate into current ad-hoc routing algorithm without influencing other communication protocol layers. The performance of BEEDSR algorithm is superior than other protocols in terms of energy preservation and delay regression relating to node speed and packet size. Outcomes for BEEDSR pretend noticeable improvements under wide network parameter settings, such as node speed and packet size.

N. Prasath [25] proposed F-DSR to discover the best paths between the communicating nodes, conventional DSR algorithm is modified by using the Fire fly algorithm. In recent times a population based method named as Firefly algorithm is stimulated by the surveillance of real firefly and its brightness behavior, So firefly algorithm is used for the proposed method on MANET which enhance the DSR routing performance with well-organized packets send from the source to destination node. Optimal route is found based on node mobility, link quality, and end to end delay. The performance of the conventional DSR, link quality based DSR for choosing a route and proposed firefly algorithm for optimal route discovering are compared by the parameters such as throughput, end to end delay, number of retransmitted packets and the number of hops to the destination.

Table1. Reactive Routing Protocols Based Optimization Techniques

Modified Reactive Routing Protocol & Year	Optimization Technique	Motivation
ACO-AODV (MRAA) 2010	Ant Colony Optimization	Used to find multiple disjoint routes between a source node and a destination to decrease the routing overhead, response time, end-to-end delay and maximize the performance.
PSO-AODV 2012	Particle Swarm Optimization	Enable to find elect resolutions in all deemed search space in order to minimize average data packet delivery delay sent over the network.
ABC-AODV 2014	Artificial Bee Colony	Decrease the lifetime of network and provides an effective multi-path data transmission in efficient manner.
F-AODV 2015	Firefly Algorithm	Optimizing the execution in terms of resource (power, bandwidth) utilization, overhead, packet delivery rate and

		delay.
GA-AODV 2016	Genetic Algorithm	Taking the consideration of the execution of intermediate nodes to develop the routing to get a more suitable route and optimize the network performance.
AFSA-DSR 2016	Artificial Fish Swarm Algorithm	Utilized To locate optimal paths between communicating nodes, modified based on multiple objectives and called as Link Quality Load Balanced Dynamic Source Routing (LQLB-DSR). Solutions obtained using LQLB-DSR is suboptimal due to dynamic variation of network parameters.
BEEDSR 2017	Artificial Bee Colony	Defeat the energy problems caused from overload packet from source to destination MANET nodes.
FADSR 2018	Firefly algorithm	To find the optimal paths between the communicating nodes based on link quality, node mobility and end to end delay.

VIII. Conclusion and Future Work

The perceptions and recommendations made from the MANET route optimization are presented below:

- The fast evolution in the field of mobile computing is driving a new alternative way in which mobile devices form a self-creating, self-administering and self-organizing wireless networks called Mobile Ad hoc Networks and due to the dynamic movement and infrastructure less of network in MANETs that will cause many challenges like mobility, overhead, battery drainage and delay.
- In order to deliver efficient, reliable, robust and scalable routing in MANET, it is in demand to take into consideration Quality of Service (delay, cost, hop distance), load balancing, energy-aware (signal strength, remaining power, route lifetime) routing objectives.
- Swarm intelligent algorithms, such as GA, ACO, PSO, ABC algorithms and FA are found to be possible search algorithms to resolve problems with good convergence features and find the optimal path, when the heuristic information related to each algorithm is appropriately determined.
- Reactive routing protocol is suitable in concept of routing because it is scalable in the change of network topology.
- AODV and DSR routing protocol are considering a predominant reactive routing protocol which have best performance and outperform the others protocols. But AODV has the advantages over DSR in terms like average energy consumption, number of nodes alive and average end to end.
- Routing in MANET using AODV protocol is found to reduce delay, however, with low throughput and packet delivery ratio. Also the protocol is found to have disconnected data transition even when the routes still existent. The routing overhead is high because of the frequent change of route. This is mainly due to the insufficient routing criteria deemed in making routing decisions.
- For future direction, there is a plan to propose a multi-objective optimization algorithm for reactive routing protocol to improve the efficiency and lifetime of network with well-organized packets transfer from the source to destination node and demonstrate a good performance comparing to other swarm intelligent algorithms.

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