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Tabu Search Optimization Based Routing Protocol To Improve Performance Of Manets

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Abstract

Ad-hoc networks are multi-hop networks made up of battery-powered portable devices that are oftenly used during emergency situations. MANETs are complex in nature, and link disruptions are common due to their continuously changing configuration and restricted activity level. MANET's main issue is with the energy/battery of nodes as well as the connections made between them. The connectivity of a link is analysed in link breakage forecasting, and an instantaneous warning is issued if a link breakage takes place. The issues resulting from these factors could lead to packet losses, which further reduces the network's throughput. This study outlines the tabu search optimization technique to address these issues for predicting link breakage in MANETs by optimizing routes between source and destination nodes. By designating particular movements as banned, TS restricts search and releases it using a short-term memory. The network simulator 2.35 was used to simulate both the proposed and the current technologies. Depending on the network's throughput, remaining energy, number of dropped packets and packet delivery ratio, overall performance was examined. The suggested strategy performs better than the current approach due to the routes' optimization, which took the nodes' mobility & remaining energy into account.

Keywords: MANET, Tabu search optimization, Link breakage, Routing.

I.INTRODUCTION

Mobile Adhoc Network is a wirelessly shared decentralized network and is a type of temporary wireless mobile network of nodes (routers) that operates without the assistance of a centralized administration. It is made up of routers that can freely move around and transmit packets on behalf of each other. It is known for routing properties, in which every node can be a "router, and it can forward traffic to other nodes in network. As shown in Figure 1, Laptops, cell phones and printers are examples of such devices. A link interruption can be caused by any unavailable node between source and destination nodes. This occurs when a node leaves its neighbor's distribution network or whenever energy of a node is inadequate to transfer a packet [1]. If a destroyed link is discovered, a new path will be chosen. In an active route, time required to choose a new path creates delay and packet loss, deteriorating performance of the network. AODV is examined in link drop scenarios due to its dynamic topology and low energy level. Because MANET does not have centralised administration, node acts as the modem. The unpredictability of node movement causes frequent data transmission in MANET [2].

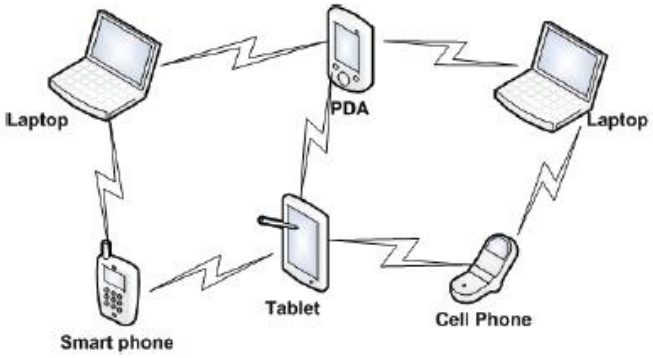

Figure 1: MANET [3]

The routing method used in MANETs are among these protocols listed below:

- **Proactive Routing protocols:** Proactive (table-driven) routing is a method in which every router builds its own routing table based on data learned by every node through information exchange among network routers. DSDV and OLSR upgrade routing tables regularly. Consequently, there exists higher routing overhead and costs.
- **Reactive routing protocols:** These are called on-demand routing protocols. Most significant advantage of these protocols is immediate availability of route. AODV and DSR don't store all routing information in tables [4]. When compared with proactive techniques, routing overhead is decreased, particularly in systems with low to medium traffic volumes.
- **Hybrid routing protocols:** These combine features of proactive and reactive protocols to take advantages of both. ZRP is an example of this kind of routing technique.

The benefit of MANET is that it gives free router access to Internet without the need for a wireless router. MANET can endure link failures since its routing and forwarding procedures are designed to handle such situations. Tabu search optimization technique address routing issues by optimizing routes among source and destination nodes. TSA is a meta-

heuristic problem-solving methodology for combinatorial optimization issues. Glover proposed it first, and Hansen expanded on it. TS employs a memory that allows it to recollect the current optimal answer as well as explore existing solutions and guide search movements [5]. The memory adaptation feature assists in realizing its course of action in order to effectively exploit the search space. Ability of TS to discover better alternatives allows it to incorporate intelligent search mechanisms to find new potential areas. When contrasted to memory-less methods like simulated annealing, use of adaptive memory aids TS in learning and creates a more versatile search strategy. Problems to be solved using TS are Traveling Salesman Issue, Minimum Spanning Tree, DNA Sequencing, Vehicle Routing and N-Queens Problem. The advantages of TSA are as follows:

- Can avoid local optimums by selecting non-improvement solutions
- Tabu List can be utilized to avoid loops and going back to old solutions.
- Suitable for both discrete and continuous solutions

The rest of this article includes following sections. Section II analyses the literature review. Section III gives proposed work. Section IV discusses the results. Section V gives the conclusion of this paper.

II. REVIEW OF LITERATURE

Frohlich et al. [6] created an ACO-based Dynamic Zone Routing Algorithm. Proposed solution is built on HOPNET, multi-hop and self-configuring combination reactive protocol for MANET that relies on ACO and ZRP. Development of routing techniques and protocols presents no. of challenges, and topology change affects longevity of WSNs. Dealing with variable setups becomes easier due to stability of routing methods. WSNs have more stringent asset accessibility requirements, and ADZRP structure must account for energy usage, memory, and bandwidth. ADZRP, like ZRP, concentrates on variable regions, which, when combined with ACO, enables us to participate with Wireless sensor constraints while enhancing route recognition and preservation through pheromones. Proposed algorithm surpassed original HOPNET in terms of packet delivery, communication overhead, and congestion control in topology change settings.

Bagwan et al [7] The emphasis is on developing a new QoS-aware MANET routing scheme. The suggested routing algorithm employs Ant Colony Optimization. ACO is a Swarm Intelligence method for dealing with mobility-aware routing in MANETs that is more practical. ACO uses nodes' current location and load variables as routing parameters to try to optimize network QoS performance. In suggested protocol, RSSI metrics were used to calculate distance among 2 nodes. This procedure is simulated and evaluated using NS3 in comparison to the AODV routing approach. When compared to AODV, QMAA achieved efficient QoS performance, according to numerical simulations.

Bikram et al [8] contrasted traits of several adhoc communication protocols, including AODV, AOMDV, DSR, DSDV and Power Aware AODV. Performance of above routing protocol is compared as per throughput, energy efficiency, and delay with respect to no. of nodes. These simulations are carried out using NS2.35. AODV outperforms other protocols in aspects of throughput, PAAODV outperforms other protocols in aspects of residual energy, and DSR outperforms other protocols as per packet delivery ratio and delay.

Zhang et al. [9] suggested an opportunistic routing protocol (OR-LqT) for MANETs that is based on channel quality and local configuration. To determine candidate set, author examines link connectivity by assessing node density, and authors select another routing path by prioritizing adjacent nodes on the basis of regions, local topography, and adaptive motion. In comparison to AODV and GPSR, OR-LqT reduces no. of dead-ends by 33.5 percent, PDR by 21 percent, delay by 22 percent, and overhead by 21 percent.

Kovoor et al [10] introduced opportunistic auto rate anthocnet procedure as a promising procedure for improving throughput in MANETs while adapting to modifications in routing strategy. On NS2, initial anthocnet procedure and recommended opportunistic auto rate anthocnet process are simulated to compare their success. Primary objective is to evaluate throughput of anthocnet methodology and proposed OAR Anthocnet framework under different network conditions. Results show that improved OAR-Anthocnet procedure has roughly twice throughput of anthocnet procedure due to its opportunistic existence.

Rajesh et al [11] devised routing Algorithm that minimizes no. of hops in a route, network overhead, and energy usage of network. This model is executed in ns2 by enhancing standard AOMDV protocol. They investigated suggested AOMDV-Range Routing and standard AOMDV at various network densities and evaluated performance for appropriate parameters. AOMDV-RR outperformed standard AOMDV in terms of network overhead, throughput, and energy usage. Their findings demonstrate a significant improvement in performance and cost savings.

Kavita et al. [12] investigate how AODV routing method is used to handle connection breakdowns caused by node mobility and energy usage. However, efficiency of AODV is evaluated by comparing its performance to E-AODV recommended in this article for link pauses using the ns2 simulator. When a large network size is available, along with strong node mobility, outcomes demonstrate that E-AODV outperforms AODV as per efficiency, latency, and PDR. In every case, E-AODV is more energy-efficient than AODV, and it also has a higher standardized routing load.

III. PROPOSED METHODOLOGY

The primary problem that occurs in MANETs is related to energy/battery of nodes and links formed among them. The battery of the nodes is on the limited side which needs to be spent in an efficient way. The nodes in the network are moving constantly in addition to which they come in and move out of the network in a decentralized manner; all these things lead to link breakage between them. The problems arising out of these may cause packet drops which furthermore results in lesser throughput of network. The conventional protocols like AODV etc do not address these issues as they focus more on creating the fresh and shortest route to destination node. The authors in

"Energy optimized route discovery in AODV" have contributed towards creating the route having the nodes with more residual energy. However, another issue of link breakage due to mobility of the nodes is not taken care of. To address these, we intend to make use of tabu search optimization algorithm to optimize the routes between source and destination node. We have studied various techniques that are focused on optimizing the performance of MANETs. In order to optimize the AODV routing protocol, we are using Tabu Search optimization and it is implemented in Network Simulator 2.35. Then, we compare existing and proposed technique based on throughput, packet delivery ratio, packet loss and remaining energy. The steps for proposed methodology are discussed below:

1) In mobile ad hoc networks, any node can join the network and leave it without any prior information. Therefore, one can say that the nodes in the network do not have valid routes to other nodes and these have to be created on demand. For instance, if any node has some data to forward to any other node in the network, it will make use of routing protocol to form routes. In suggested work, AODV protocol will be used by the node (having data to send) to formulate the path. It begins with broadcasting route request packets to all the neighbors in the communication range. The nodes which receive the packet check for the valid route to destination and in case of absence of the routes, the packets are forwarded in the entire region until the destination has been found.

2) At this stage, the destination node formulates all the routes to source node via which route request packet has arrived. In the proposed protocol, the Tabu search optimization will be used here to optimize the network performance which will largely depend on the quality of the route chosen to forward the data by the source node. In Tabu search, all the routes formulated will act as initial population. For this set of routes, the fitness function will be computed. This will incorporate the following parameters: residual energy and mobility of nodes. Mathematically, it will be:

$$f_p = \sum_{i=1}^{n} \frac{I.E}{R.E} + \sum_{i=1}^{n} \frac{N.S}{Max\ S} \quad \ldots\ldots\ldots (1)$$

Where R.E represents the residual energy, I.E represents the initial energy, NS represents velocity of the node and Max S represents the maximum speed.

3) Once the fitness function has been computed for all the initial solutions, the Tabu search will explore each one of the solution randomly. If fitness of the any solution is less the other solution, then it will be retained as best solution and other will be discarded. Therefore, at this point, destination node will send route reply to source node over optimal solution. At the source node, the best solution will be utilised to send information to destination node. Figure below depicts flow diagram of suggested methodology:

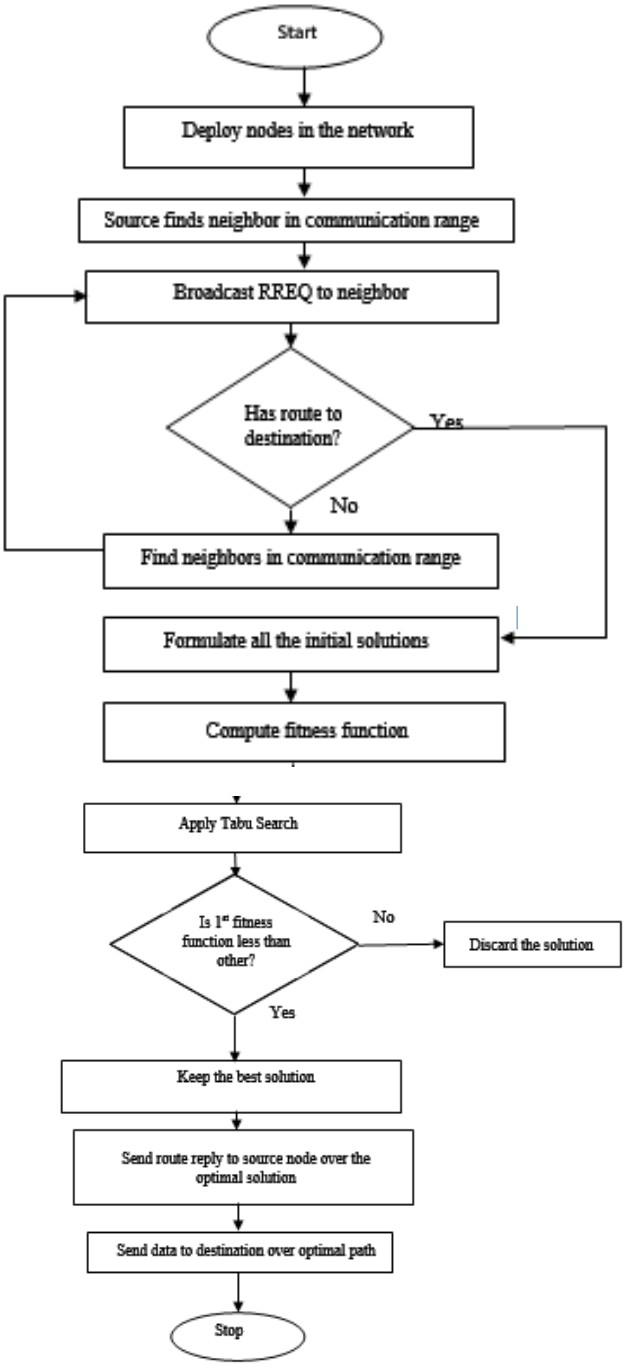

Figure 2: Flow diagram of suggested technique

IV. RESULTS AND DISCUSSION

The existing routing protocol which focuses on achieving energy efficiency as well as proposed protocol based on Tabu search optimization were implemented in network simulator 2.35. In network simulator, the basic network is created using tool command language and then the algorithms are implemented in awkward scripts. The network simulator comes with network animator where the real time simulation of the network can be viewed as well. After simulating network, performance was analyzed on the basis of throughput, packet delivery ratio, packet loss and remaining energy of network.

- **Average Residual Energy:** Energy is the primary resource used by nodes, and this determines how long the network will last.

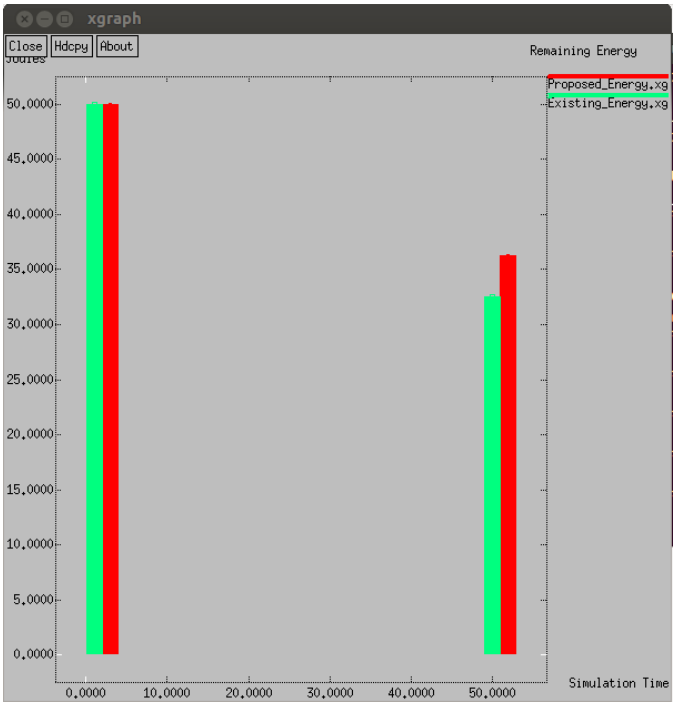

Figure 3: Remaining Energy Comparison

The above graph shows the comparison of remaining energy of network when existing and proposed protocols were simulated. Initially, network had average remaining energy of 50 joules, when simulation was completed, the network had more remaining energy with the proposed protocol than existing protocol. This also shows that lifetime of network was more with the proposed Tabu search optimization based routing protocol. The remaining energy of network was around 36 J for suggested protocol and 32 J for existing protocol.

- **Throughput:** It is the amount of data obtained at destination node in each unit of time. The below figure shows that proposed protocol had more throughput as compared to existing protocol.

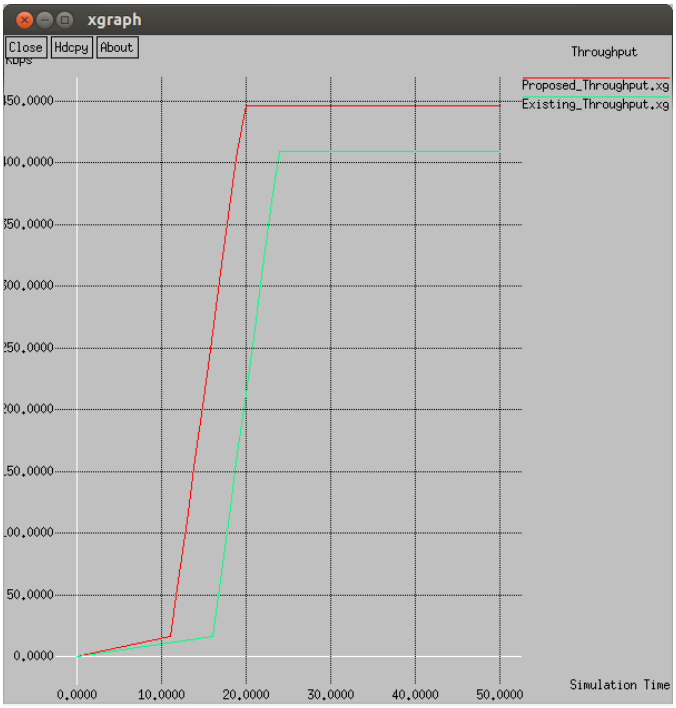

Figure 4: Throughput Comparison

The value of throughput was approx. 449 Kbps for the proposed protocol and approx. 405 Kbps for the existing protocol. This is because the proposed Tabu search optimization considers the mobility of nodes while optimizing routes between source and destination. This leads to lesser link breakages in network and consequently more data is delivered at destination node.

- **Packet Delivery Ratio:** The packet delivery ration represents percentage of sent packets which are successfully delivered in network. The above figure shows that the value of PDR was more for the proposed protocol i.e. approx. 80% then the existing protocol which had approx. 66% PDR. This means more packets were successfully delivered in the network for the proposed protocol. The reason is because the mobility of nodes has been considered while optimizing route for data transmission. The route having lesser mobility was preferred which leads to lesser link breakages in network.

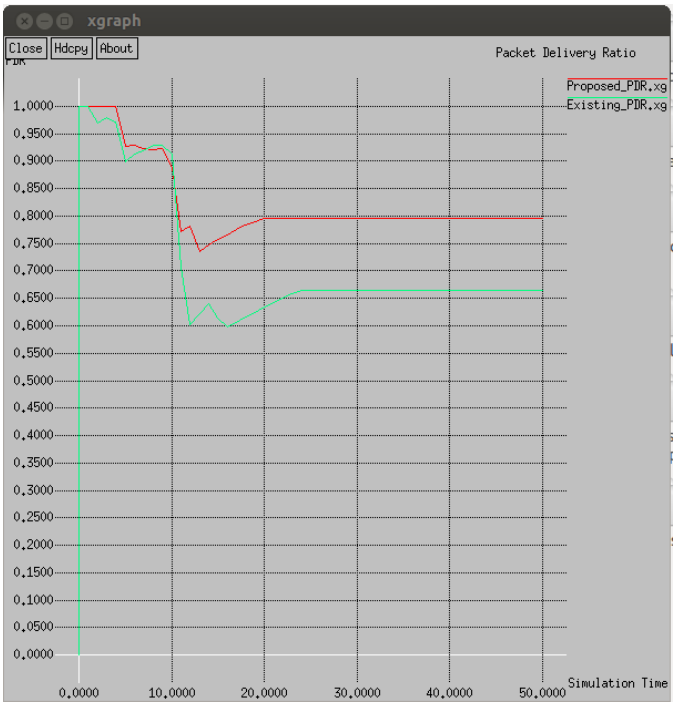

Figure 5: Packet Delivery Ratio Comparison

- **Packet Drop Ratio:** This reflects no. of packets that were dropped in network. As discussed in graph of packet delivery ratio, with the proposed scheme more packets delivered successfully in network leading to lesser packet drops. The same thing has been evident from this graph where the proposed scheme experienced only around 75 packet drops as compared to existing scheme where around 195 packets got dropped.

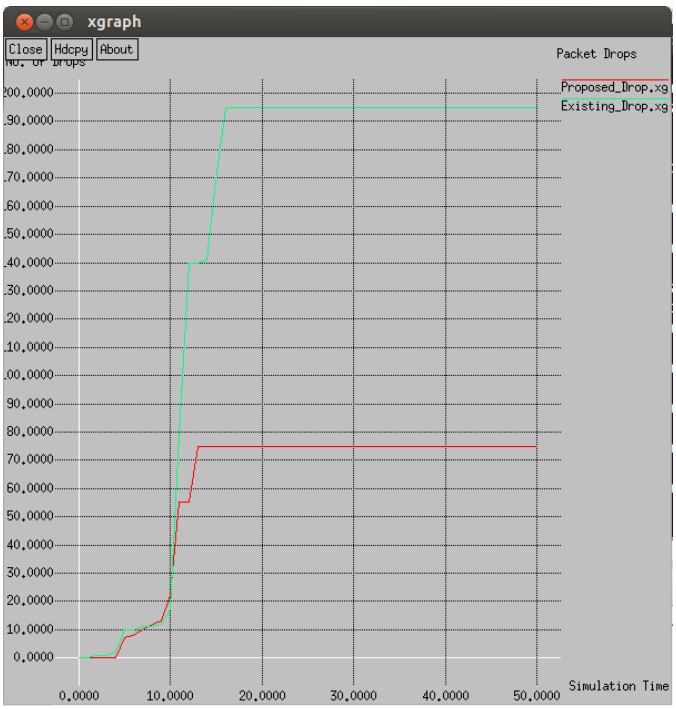

Figure 6: Packet Drops Comparison

V. CONCLUSION

A MANET is a network of mobile nodes that can communicate with each other without the requirement for infrastructure. Mobile ad hoc network suffer serious concerns when it comes to energy efficiency of the network and link break issues. The suggested protocol uses Tabu search optimization to optimize the route from source to the destination. As a consequence of link failure, network performance will be degraded. The purpose of this research is to understand various approaches proposed for link failure identification and avoidance in MANETs, with a focus on route migration due to link failure. The outcomes show that under suggested protocol, remaining energy of the network was 36 Joules, the throughput was 449 Kbps, packet delivery ratio was 80% and number of packet drops were approx. 75. Whilst on the other hand, under the existing scheme remaining energy of network was 32 Joules, throughput was 405 Kbps, packet delivery was 66% and number of packet drops were 195. This shows that suggested technique had outperformed existing scheme in context of these parameters. This is because the routes were optimized taking remaining energy and mobility of nodes into consideration. The routes having nodes with higher remaining energy and those moving at lesser speeds were preferred. This leads to lesser link breakages in network and consequently more data is delivered in the network.

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