Modeling of an Adaptive Energy Based Route Broadcasting Algorithm (AERBA) Using Route Optimization in MANET

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Abstract. Owed to the uncertain and dynamic behaviour of nodes over Mobile Ad-Hoc Networks (MANETs), the reliable route discovery and data delivery is considered as a challenging factor. With absence of centralized infra-structure and global broadcasting nature, nodes over the distributed environment rely over the neighborhood nodes. For reliable communication, the network needs to broadcast the routing direction to chose the appropriate neighborhood partner to make the functionality effectual during packet relying. Therefore, the evaluation process is determined to be a crucial factor. Various methodologies use the trust-based concepts for choosing the route broadcasting region and neighborhood nodes. However, those methods are identified with certain limitations and the evaluation is performed over single node. The inadequate consideration of these factors leads to the wider range of network model that leads to inappropriate broadcasting. This leads to packet loss, higher energy consumption due to re-transmission of packets. In this work, an Adaptive Energy-based Route Broadcasting Algorithm (AERBA) using Route Optimization (RO) is applied along with the route optimization approach to derive the global solutions. This leads to the trust establishment among the network nodes and pretends to fulfill the constraints related to broadcasting and energy consumption. The anticipated model facilitates appropriate evaluation over the potential nodes with multiple hops for balancing the route broadcasting and energy consumption. Simulation is carried out in MATLAB environment and the results demonstrate lesser energy consumption, higher delivery ration when compared with prevailing approaches.

Keywords: MANET; route broadcasting; neighborhood nodes; route optimization; reliable communication

1 INTRODUCTION

In MANET, during the process of route broadcasting towards sink nodes, route broadcasting with successive forwarders is considered to be an essential task for fulfilling consistent data delivery [1]. The distributed environment includes huge amount of nodes where routing packets needs to be provided with multiple hops specifically when the distance among the source node which initiates communication and sink node which is placed in some other region [2]. A reliable routing establishment with selection of nodes for forwarding is considered as an efficient routing strategy [3]. While considering the successive forwarder nodes, various efficient mechanisms are anticipated with prevailing literature. Some of the most common approaches are cluster-based technique where the cluster head are elected for aggregating the data from nodes over the network [4]. Although this approach has proved the benefits, there are some factors that are associated with it, i.e. energy consumed during selection of cluster head, re-election process, and broadcast updation respectively [5].Adaptive route establishment is based on successive node forwarder has been anticipated by considering various factors like packet delivery, packet loss, energy consumption, and throughput [6]. Other prevailing approaches are utilized based on forward selection approach through learning-based approach, game theory, and negotiation model [7]. Moreover, these techniques are adapted to network
model with creative nodes [8]. It is obvious that consideration of various factors during node selection process is extremely efficient than single factor consideration. Based on the literature, there are various studies that involved in multiple criteria for MANET that concentrates on various resources based factors like number of hop, and nodes residual energy [9]. It is not so appropriate for applications like military fields (inaccessible regions). These nodes are exposed in an unpredictable characteristic like fault reporting, security attacks and so on [10]. In some conditions, routing protocols are considered as a security factor towards forward selection. Moreover, the parameters like security and resources are not separately considered [11]. There are prevailing trust models that measures factors like energy, routing, and distances [12]-[13]. However, there are diverse factors that are not concentrated by the researchers. This work concentrates a novel an Adaptive Energy-based Route Broadcasting Algorithm (AERBA) using Route Optimization (RO). This model evaluates the multiple evaluations at multiple layers instead of single hop evaluation. The route broadcasting factors are considered with the selection of successive forwarders with the adoption of route optimization [14]-[15]. This leads to reduced energy consumption with better route establishment. The remainder of the work is modeled as: section 2 is background studies related to adaptive routing model for establishment, section 3 is adaptive route broadcasting with route optimization model, section 4 is numerical results and discussions, and section 5 is conclusion with future research directions.

2 METHODOLOGY

In the minimal energy based route broadcasting problem, the nodes have the ability to adjust transmission range to diminish energy consumption during message transmission until the network is guaranteeing the coverage. In real-time scenario, node movement, packet loss, path loss, fading path, etc to guarantee complete coverage is extremely ambitious and in some cases it is unnecessary. While forwarding enormous messages, it is worth the overhead required to pose a reliable broadcast algorithm. However, for unnecessary transmission, the full coverage of network is not guaranteed. Thus, it is saves the node from overhead derived from re-transmissions, acknowledgement and so on. This investigation does not consider full coverage; however, it concentrates on node optimization for message forwarding and energy consumption during transmission.

It is essential to compute distance among source and destination, the common approaches is considering signal strength/GPS service. Assume, all the network is provided with a GPS services. Hence, signal strength of packets is considered. There are some techniques where propagation path loss model for transmission channel is chosen and distance among nodes are evaluated. Received power is associated with the distance and not interested towards the distance where some energy losses during the transmission process. When the device nearer to source node (nearer to signal for signal weakening) will transmit message to the destination during the complex circumstances. There is no proper shape of coverage region based on the transmission. Therefore, the threshold denotes the power but not the distance. The threshold is termed as border threshold. This is expressed when the nodes are far away from source and nearer to transmission range. The nodes transmit beacons to make an alert; and the nodes that receive beacon should keep track of the neighboring nodes. While considering cross-layers, physical layer needs to inform upper layer regarding received beacons and the signal strength. Here, the algorithm can take further decision based on the available values. When transmitting the message, the receiver needs to validate the reception power. It considers only the border node and set the E2E delay.
2.1. Adaptive energy based route broadcasting

Here, an improved energy based route broadcasting algorithm is proposed which does not consider propagation path loss specifically. Received power is associated with message forwarding distance; even though there is not much interest towards the distance parameter. The point is to concentrate on energy lost/saved during the transmission. Consider a node nearer to source node, but there are some obstacles (buildings) which reduces the signal strength while forwarding the message to the destination region. With this constraint, it is known that there is no perfect shape for transmission range. Therefore, the threshold limit should be set which is not based on distance; however, for power. It is known as border threshold as it determines nodes far from source and nearer to transmission region.

In wireless transmission, electromagnetic wave propagates from space where signal power suffers from path loss attenuation that causes degradation of signal strength. The relationship among transmission power and reception power (destination) directly relies over the loss suffered during transmission as expressed in Eq. (1):

\[
\text{received power} = \text{transmitted power} - \text{loss}
\]

(1)

The nodes have to maintain and update the reception power of the corresponding neighbor in the provided list, i.e., when a device needs to broadcast a message, it has to ability to estimate the packet loss while suffering from traversing in opposite direction. When the packet loss is suffered due to propagation issues, the nodes have to compute the transmission power required to reach neighbor. When transmission power is reduced, the successive node that receives the packet with minimal reception power facilitates the proper decoding of message the destination and it leads to Eq. (2):

\[
\text{transmission power} = \text{loss} + \text{end} - \text{threshold}
\]

(2)

When the essential transmission power is evaluated based on stored reception energy using beacons, it is essential to compute node connectivity and update the data as the beacons are sent every 1 seconds. Here, an error margin (message forwarding) is considered to estimate transmission power. This is experimentally selected and packet loss is considered at the borders of the coverage region might suffer when nodes move for every one second. The value is 0.5 dBm. It is expressed as in Eq. (3):

\[
\text{new transmission power} = \text{transmission power} + \text{margin threshold}
\]

(3)

If the power is lesser than the default transmission power, the energy is saved during message forwarding. Hence, transmission range reduction decreases the energy consumption without distributing the network connectivity or broadcasting performance. It enhances the energy consumption in MANET based node connectivity and reduces device interference level in nearer region. Based on various investigations, it is noted that the transmission power influences various factors of network. For example, network connectivity and transmission range. The medium access performance completely based on number of nodes available over network capacity and so on. The nodes capacity is increased when transmission power is diminished with interference region (proportional to transmission range). Generally, connectivity is not reduced as the nodes pretend to diminish the transmission power by considering the neighborhood nodes region. The transmission power reduces by reducing the energy consumption; however it assists in reduction of message while handling the distance based broad-casting as a major constraint. When the node has only one neighbor and it is far away to transfer the message, then the information has to be re-transmitted. This happens even when the nodes are around the transmitting node. Thus, the process of transmission is terminated.
The energy received by the nodes is inversely proportional to delay. Here, delay is evaluated using the Eq. (4):

\[
\text{Delay} = \frac{-1}{\text{Receiver power} - \text{threshold} - 1}
\]

When the node is encountered with a delay, the node is considered as border nodes. Else, it is not considered as candidate to forward message. Hence, the delay is not set over there. The received message with reception power which varies based on the computed threshold and border threshold. Hence, it varies in the delay is computed using the Eq. (4). When the reception power is higher, the delay is longer. This is a vice-versa process.

2.2 Optimizing AERBA using Local Search

AERBA multi-objective population search based on local search algorithm that preserves the distributed populations. It work concurrently in various condition where the solution based on the available population is constantly enhanced by parallel processing of local search process. To enhance the solution in the given population, every local search process uses other solution to assisting the search. The finest solutions attained from local search process are stored with non-dominated solution. After the successive iterations, the finest solutions over the population are stored in external archive. The solutions are preserved in the archive only when it is a non-dominant solution. The solutions are enhanced for fixed amount of iteration without collaborating to avoid stagnation conditions. Based on the above algorithm, the local search is based on the three parameters given below:

1. The border_threshold value sets the forwarding node size. When the threshold value is higher; then the network resources, coverage, number of potential forwarders is also higher. This leads to collusion condition.

2. The message forwarding is based on the coverage region and the energy saved during the message reception. Thereby, huge energy is added to transmission power. When nodes’ marginal value is higher, then coverage is also higher with the energy.

3. The delay interval is set based on the waiting time and the protocol behaviors. The threshold is partitioned based on two delays: maximal delay and minimal delay. This is set based on the upper and lower levels of interval. When the delay is extremely higher, the time needed to transmit the message is also higher. When the time is lesser, it leads to higher probability of collision over the nodes. Fig 1 shows the functional flow of proposed AERBA model.

![Figure 1. Function flow of AERBA](image-url)
3. PERFORMANCE EVALUATION

In this work, while applying local search optimization module for the proposed model, the connectivity among the nodes are viewed among the network effectually for forwarding messages. The simulation is performed in MATLAB environment for evaluating solution of local search optimization algorithm. The monitoring modules simulate protocol configurations (each solution) on diverse networks. Fitness value is depicted as the average value attained from connected network. This work analyzes the behavior of AERBA over different networks. This gives the fitness value to optimization algorithm as input. The simulation setup is given as in Table 1.

| Parameters                  | Value             |
|-----------------------------|-------------------|
| Total devices               | 1000              |
| Speed                       | [0.2] m/s         |
| Area                        | 2000*2000 m       |
| Transmission power          | 16 dBm            |
| Direction change            | 20 sec            |
| Borders_threshold           | -90 dBm           |
| Margin_forwarding           | 0.5 dBm           |
| Threshold_setup             | -95 dBm           |
| Delay interval              | [0, 1] s          |

Table 2. Average energy used/message forwarding

| Approach  | 500   | 600   | 700   | 800   | 900   | 1000  | 1100  | 1200  |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|
| EDB       | 15.02 | 15.10 | 15.17 | 15.23 | 15.29 | 15.35 | 15.38 | 15.40 |
| AERBA-5   | 14.50 | 14.10 | 13.63 | 13.10 | 12.65 | 12.30 | 11.99 | 11.70 |
| % Energy saved | 11.50 | 20.94 | 30.19 | 39.20 | 45.68 | 50.69 | 54.52 | 57.16 |
| AERBA-10  | 14.99 | 14.95 | 14.86 | 14.63 | 14.30 | 13.89 | 13.40 | 12.98 |
| % Energy saved | 0.70  | 2.96  | 6.25  | 12.32 | 20.22 | 27.91 | 36.19 | 42.48 |
Table 2 message forwarding, and broadcasting time comparison. Here, Energy based broadcasting algorithm is compared with AERBA-5 and AERBA-10 as in Fig 2. The iterations are performed with 500, 600, 700, 800, 900, 1000, 1100, and 1200 nodes. AERBA-5 shows better coverage when compared to EDB, and AERBA-10. While AERBA-10 shows nominal coverage region, the forwarding message based deviation is higher for AERBA compared to broadcasting algorithm over the tree topology (BODYF), Delayed flooding with cumulative neighbourhood (DFCN), Simple flooding (SF), Weighed p-persistent broadcasting (WPB), and Speed Adaptive probabilistic flooding (SAPF) respectively. The deviations can vary based on the broadcasting region, forwarding message, and time for broadcasting. However, the proposed AERBA shows better trade-off in contrast to other models.

4. CONCLUSION

This work concentrates in designing an efficient energy based routing strategy in an adaptive manner over the heterogeneous environment. It comprises of efficient message dissemination over the denser network by eliminating the drawbacks identified in prevailing approaches. This problem is handled in two diverse perspectives with variable and fixed transmission range. However, an adaptive AERBA framework is used for optimizing, validating, and evaluating the anticipated model. Based on the simulation environment, this work anticipates an adaptive energy based route broadcasting algorithm for predicting the finest possible configuration and validation with the local search. The near optimal values are measured with the adoption of the proposed AERBA with local searching optimization. It considers coverage region, energy utilization, broadcasting time, and bandwidth measurements. The selection of optimal solution needs to ensure the multi-objective constraints. It should be measured in number of networks with diverse densities for examining the system performance on diverse scenarios.

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