A Novel AODV-Based Algorithm to Improve MANET Efficiency and Performance

Khandaker Takdir Ahmed[1], Dr. Tarek Hasan Al Mahmud[2], Md. Jashim Uddin[3], Mustakim Musully Pias[4]

Abstract— Network performance and security are important issues that are covered in both academic and industrial research. Every application is reliant on the network's effectiveness and performance. The protocols and procedures used for routing are crucial. In many respects, the AODV routing protocol is regarded as a standard, largely because the demands for efficiency in diverse applications are rising. The literature has a variety of methods for enhancing performance. Numerous factors, including data node density and mobility, were taken into account in certain studies. Throughput and route resilience are two essential factors that affect the network's overall effectiveness and performance and are evaluated in this research study. This research proposes a new version of enhanced AODV that uses an iterative method to check for each parameter and modify the values until the desired threshold level of efficiency is attained. For each network parameter, various categories of the solution are explained. The upgraded routing protocol looks promising and can be further extended to include new modes for higher efficiency and lower power consumption, according to simulation results of the proposed algorithm on a network tool.

Index Terms— AODV, Network Performance, Network Simulation, New Algorithm, OMNeT++ tool, Route Resilience, Routing Protocol, Throughput.

1 INTRODUCTION

WIRELESS communication technology is advancing gradually and rapidly. Individuals desire the ability to access their network terminals (laptops, PDAs, etc.) at even a considerable distance [1]. Users have the option to go wherever they want with wireless connectivity. There are many distinct wireless networks, each with its technique of connecting the nodes. They are divided into fixed infrastructure and ad hoc wireless networks [2].

Due to the proliferation of mobile devices that rely on wireless networks, MANET technology is one of the most promising research domains. Subsequently, the unique characteristics of MANET technology provide significant prospects for wireless network improvement [3]. On the other hand, due to its link with severe obstacles, MANET has become one of the most lively and active study domains in communication and networks. For a good reason, MANETs have become a popular network type. It is a network that is easy to set up. Unlike conventional networks, they can be set up at any location. However, regardless of the appealing applications, MANET's capabilities pose many obstacles that must be thoroughly investigated [4].

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MANET is an autonomous distribution network composed of only mobile terminals [5]. It is expected to be used as one of the communications means when the base station is no longer available in such a disaster. It is utilized to communicate when the base station is no longer available in such a disaster. Many MANET protocols have been proposed to date are designed and assume that the destination IP address is already familiar. However, when a victim seeks help via a MANET in an emergency or a disaster, the destination's IP address may not be aware. In such a case, broadcast messages to an unspecified number of terminals seem adequate, but excess-posted messages may make the limited wireless bandwidth flooded.

Unlike the usual wireless network, MANET does not have particular nodes such as access points, base stations, and routers. So, each MANET node has the functions of an access point and a router, i.e., detection of neighboring nodes, management of the routing table, and the operation of the client terminal, i.e., data transmission and reception. These functions are carried out based on a MANET protocol's routing protocol. Therefore, MANET's performance and property greatly depend on the MANET protocol.

A variety of technologies in the large field of networking are developing virtually daily. Networks are now capable of transmitting a lot of data quickly across wireless and internet mediums. One type of wireless network, in particular, is wireless ad hoc networking. The main characteristic of this network is that, unlike wired networks, it is not dependent on any one architecture or equipment. Each node has the ability to send and receive data using routing. There is no set order in which the nodes are assigned sender and receiver, thanks to this feature of the nodes. The networks may transmit information thanks to routing algorithms, and nodes are assigned automatically based on the routing mechanism. The main benefit of an Ad-Hoc network is that the infrastructure needed to set it up isn't as complicated as other networks. The nodes can

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now join and leave the network at any time without encountering any obstacles [6]. When the nodes are mobile, wireless Ad Hoc networks can configure without any external infrastructure or links to the dynamic networks. In addition to unicast, multicast routing is possible in mobile ad hoc networks.

The rest of the work are structured as follows:
In Section 2, the Literature Review of this research work. In Section 3, give an overview of AODV. In Section 4, give the details of about methodology. In Section 5, Results and Discussion. The conclusion is shown in Section 6.

2 Literature Review

In MANETs, routing protocols fall into two main groups. Depending on the mechanism employed, these protocols are categorized. Routing tables are used by proactive protocols, which are particular in their operation. The routing table must contain the details of each route and data packet in order for the proactive mechanism to function. Routing tables and route data must be updated due to MANET's dynamic nature. A proactive routing protocol is the Destination Sequenced Distance Vector (DSDV) Routing Protocol. The second type is a reactive protocol, where the demands from the data packet are taken as the initiative to find the outside and send the data rather than the routing table being kept with the necessary information. As soon as the requests are started, the route discovery process begins. This technique has various benefits, particularly in terms of resource utilization, since no specific routing protocols are stored at all times in the tables. Ad-hoc, A common routing protocol used in MANET, is called on-demand distance vector (AODV) routing [10].

There is a wealth of literature on AODV and routing protocols. To quantify effectiveness, a variety of methods and parameters are employed. Researchers employ certain measures to evaluate the effectiveness and performance of each routing mechanism. These protocols have a variety of applications, making it difficult to compare them all and determine which approach is the most suitable. It is difficult for the researchers to examine all the applications that use a routing protocol because not all comparison metrics use the same application. Throughput, route discovery, and packet delivery are a few of the often-utilized metrics [11].

For every application, wireless network performance is of utmost importance. Due to the benefits, it offers, AODV has received substantial research; many of these studies have focused on increasing efficiency through the use of control strategies and parameter modifications. In a new control system suggested in the literature, the routing condition is provided prior to the initialization of the data packet. The condition is managed by a congestion management system that examines the values entered into the routing table. Simulated findings showed that understanding the values of the routing table is crucial since it allows for the analysis of routing details and the potential for packet drops. Understanding routing tables is essential for enhancing condition management, but it can also increase throughput and reduce drop rates [12].

The transmission range and its relationship to node density were examined in a research study that was planned and carried out. The density of the node is influenced by the transmission range, and it was discovered that the new enhanced method's delay was reduced when compared to AODV as density increased. This research study's findings apply better to applications with higher node densities. The region and node density are not taken into account in this research study, although previous research has shown that factors like packet delivery and network speed can have a big impact on how efficiently the system works [13].

The AODV routing system can be easily expanded to IoT applications and is not just limited to Ad Hoc networks and wireless sensor networks. Researchers in this sector frequently compare the AODV routing protocol with other protocols for a particular application. Drop rate and packet delivery rate are regarded as effective metrics for assessing efficiency. In the literature, dynamic routing methods have been developed to handle certain issues such node mobility. The research study results have also been contrasted with other procedures, such as OLSR, and it was discovered that AODV performs better [14].

When there are too many data packets in the network and it is overloaded, the routing protocol's RREP and RREQ packets are transmitted, which increases traffic. The system's performance and functionality decline. The study literature supports the use of a variety of metrics, but the two crucial criteria — route resilience and throughput — are a consistent theme in many studies. An improved AODV design with throughput, route robustness, and power consumption parameters is suggested by this study.

3 OVERVIEW OF AODV

3.1 AODV (Ad hoc On-Demand Distance Vector)

AODV is the reactive type MANET protocol. Figure 1 shows the route establishment process of the AODV. When a new destination requires a route, the root node broadcasts a route request packet to determine the endpoint route. A node that accepts the route request packet directly from the source node generates a (reverse) route to the root node and re-broadcasts the route request packet when it is not the endpoint [7]. By repeating this re-broadcasting, the route request packet is forwarded to the endpoint.

When the endpoint node accepts the route request packet, it unicasts the route reply packet to the last node by using the (reverse) route. The node that accepts the route reply packet generates the (forward) route to the node that sent the route reply packet and unicasts the route reply packet by using the (reverse) route [8]. By continuing this process, the route is formed successfully when the route reply packet reaches the root node. Intermediate nodes (except the root and endpoint node) put the information about neighbor nodes to the "precursor list" when it unicasts the route reply packet. If the intermediate node already has the route information to the des-

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tination, there is a case that the node sends back the route reply packet. Note that the intermediate nodes do not rebroadcast the once received route request packet to prevent excess packet flooding [9].

4 Proposed Methodology

The two design criteria for the improved network are throughput and route resilience. These factors are gauged using message rate, communication rate, and data rate metrics. To see if the routes are open for data transmission, go to the first step. The various nodes and the direction that the data packets will go are represented by data values in the round table. Depending on the network's configuration, the routing table's data may or may not be accessible [15]. If the route is not listed in the table, the discovery process is started, starting with the initialization of the potential mathematical calculations for finding the new route. The next step is to verify the communication range if the routes are present in the table.

The throughput is measured when a small number of test packets are sent via the communication connection. The threshold value is contrasted with the preferred throughput value. In order for communication and data packets to continue during the session, it is imperative that the throughput be higher than the threshold number, as illustrated in figure 1. The communication range is extended until the value rises above the threshold if the throughput is below the threshold.

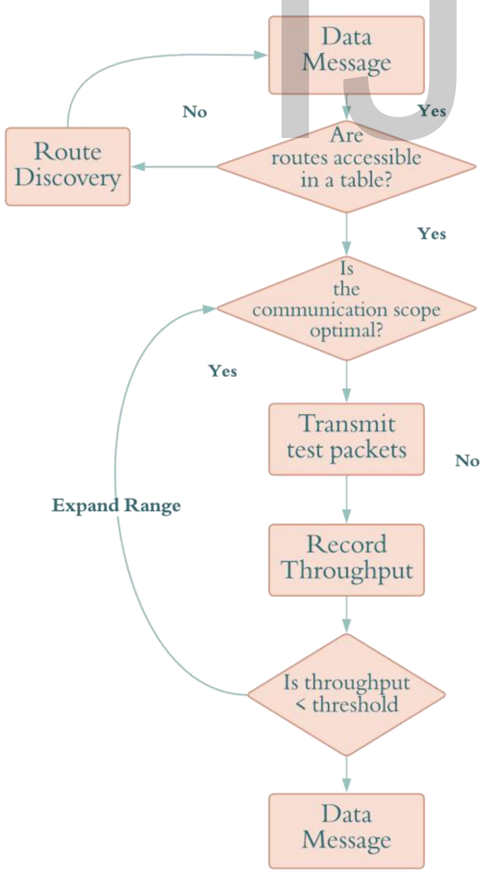

Fig. 1. Communication Range optimization using a new algorithm

The start time and acknowledgment time of the data packet are recorded in a new, improved method that has been developed. To increase efficiency, this data is contrasted with the data rate standards that employ noiseless channels. When the required starting time is established, the data rate for the initial phases is calculated. Figure 2 illustrates how the throughput is calculated after determining the data rate and compared to the threshold level. The feature of the updated algorithm is that the signal levels are only increased for improved communication after checking the data characteristics. When there are specific adjustments to be made to the communication range and message rate, the route discovery process shouldn't be advertised to all nodes [16]. The control packet payload is raised, and the network is inundated with extra data packets if the route discovery process is publicized. The routing table should always be updated as a result of the route discovery. To improve the current technique significantly, the first step is to determine whether the roots are present in the routing table before moving on to the node's reachability. Figure 3 illustrates how to examine a different route if the node is not reachable. If there isn't an option, the process of route discovery is started. This improved flowchart adds the condition of determining whether another route is accessible, which improves the algorithm's efficiency by delaying route discovery until it is no longer absolutely necessary [17].

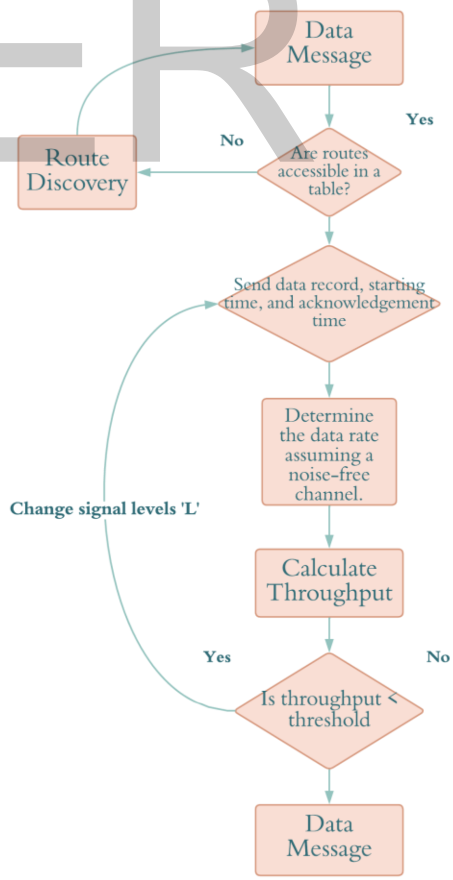

Fig. 2. Enhanced data rate with a new algorithm

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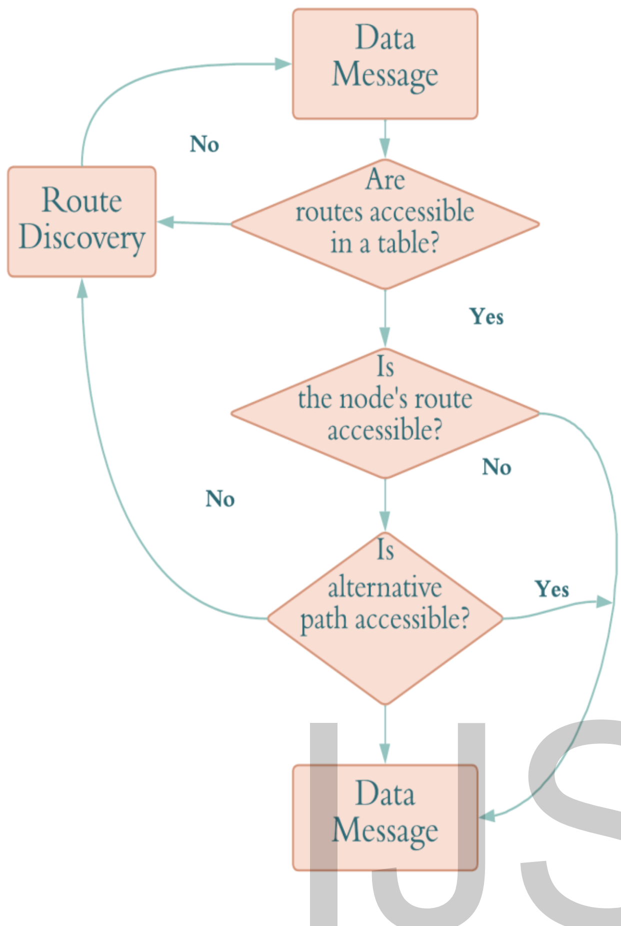

Fig. 3. Route Resilience using a new algorithm

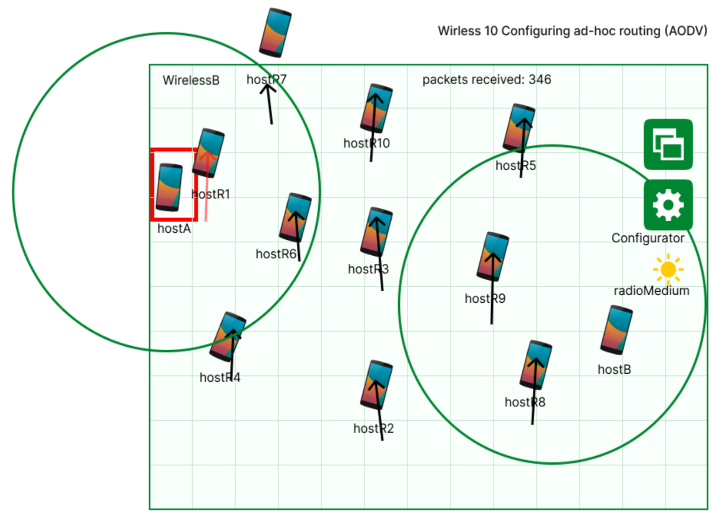

Fig. 4. 346 packets received in the default network

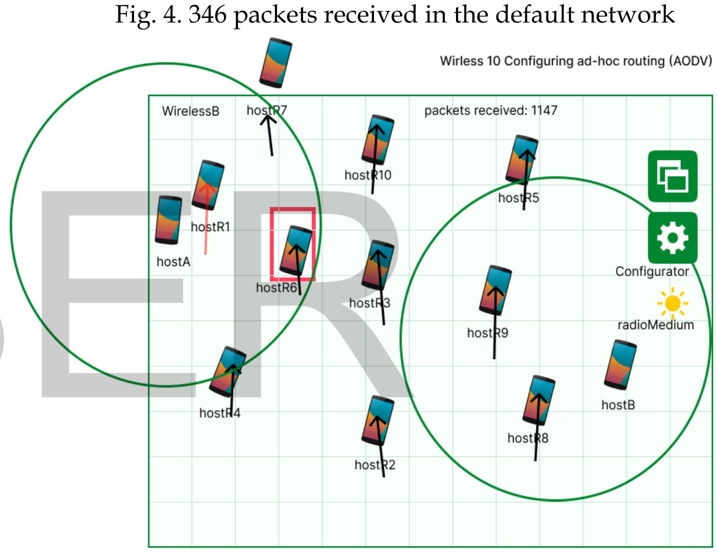

Fig. 5. 1147 packets received in enhanced network

5 Result & Discussion

On the OMNeT++ tool, the proposed routing protocol based on AODV is simulated. The tool includes a number of libraries, and designing and coding are done using the C++ programming language. This software program is free to use for educational and non-commercial endeavors. There were 1682 packets sent in all during the exercise. Following is a discussion of the findings.

Default Network: 1682 packets were sent, and 346 packets were received.

Enhanced Network: 1682 packets were sent, while 1147 packets were received.

The default Network and improved network simulation are used to test throughput. With 346 and 1147 received packets, respectively, the network diagrams of the basic and improved networks are illustrated.

For the upgraded network, the number of intermediate nodes is altered, and a comparison is provided for various intermediate nodes [16]. The number of intermediate nodes was raised from 25 to 100. As illustrated in figure 6, it is evident that as the number of intermediary nodes rises, the number of packets received also declines.

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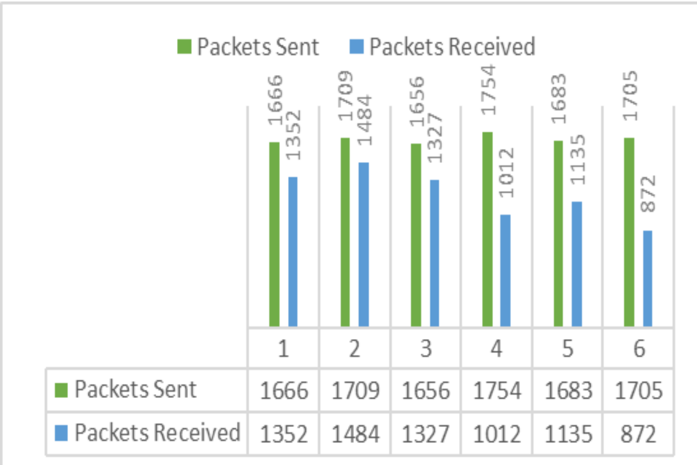

Fig. 6. Throughput comparison for different intermediate nodes

Additionally, the communication range was examined using simulation, with a message size of 1000B and a comparison of the data packets delivered and received.

From about 1 m to 500 m, which is a higher communication range, it was discovered that the throughput values were rising.

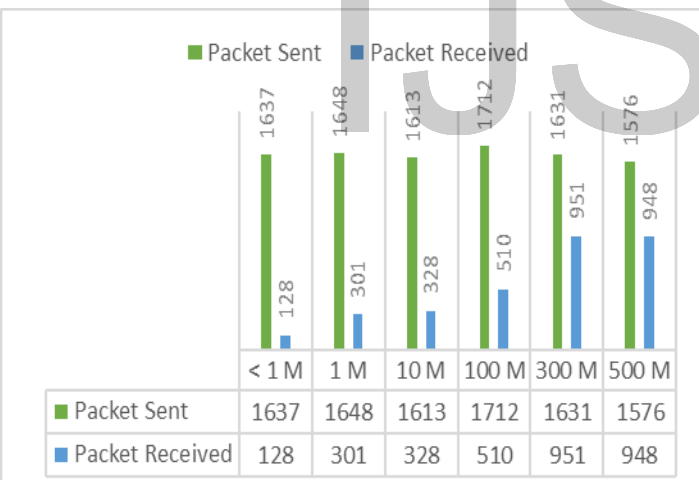

Fig. 7. Communication range and packets received.

Plotted is a graph that contrasts the packets delivered and received at various data rates, from 1 Mbps to 10 Mbps. The graph amply demonstrates that when data rates rise, the number of data packets received rises continuously (figure 7). The network exhibits an iterative character and is found to function effectively. Only smaller networks can benefit from AODV, but larger networks with several nodes have been proven to benefit more from the upgraded network.

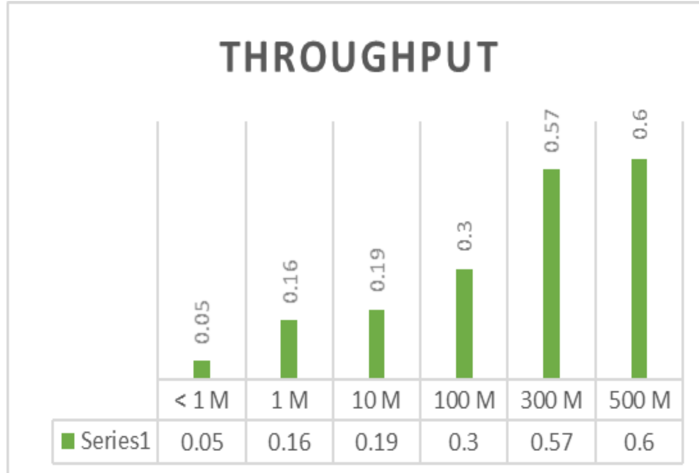

Fig. 8. Throughput comparison for varying communication range

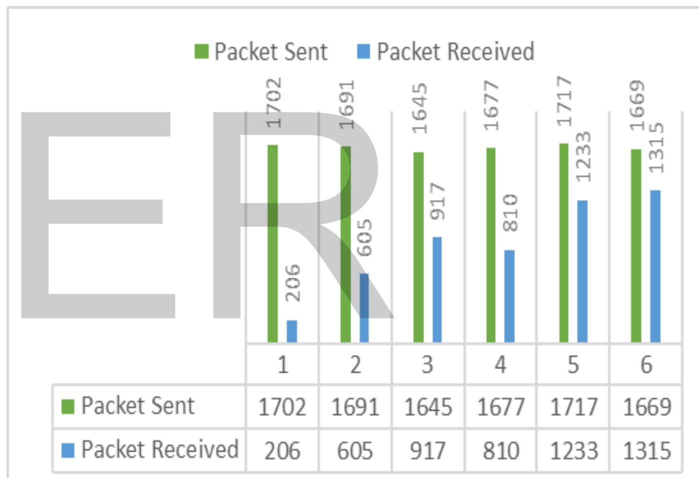

Fig. 9. Data rate and packet received

6 Route Resilience

The idea of route resilience is utilized to boost efficiency by boosting throughput. Checking for alternative routes is the strategy utilized in this situation. The simulation demonstrates the effectiveness of the suggested upgraded algorithm's search for alternate routes in increasing throughput. In comparison to the default network's throughput of 0.19614, the upgraded algorithm produced a throughput value of 0.43719.

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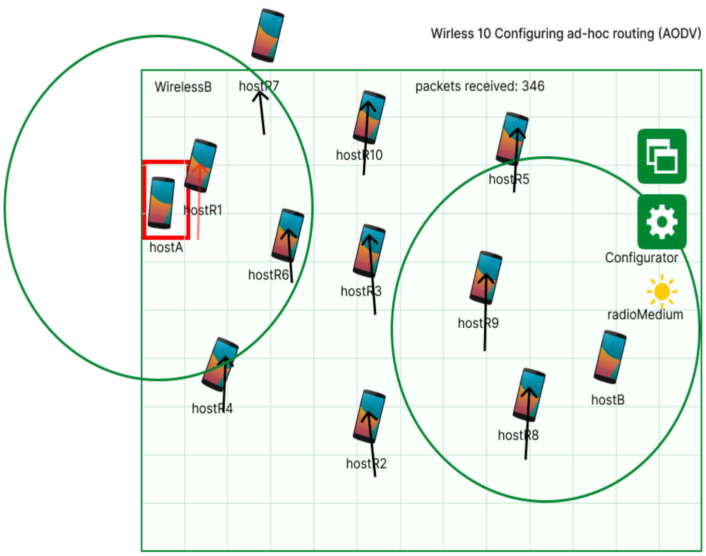

Fig. 10. 346 packets in the default network for route resilience

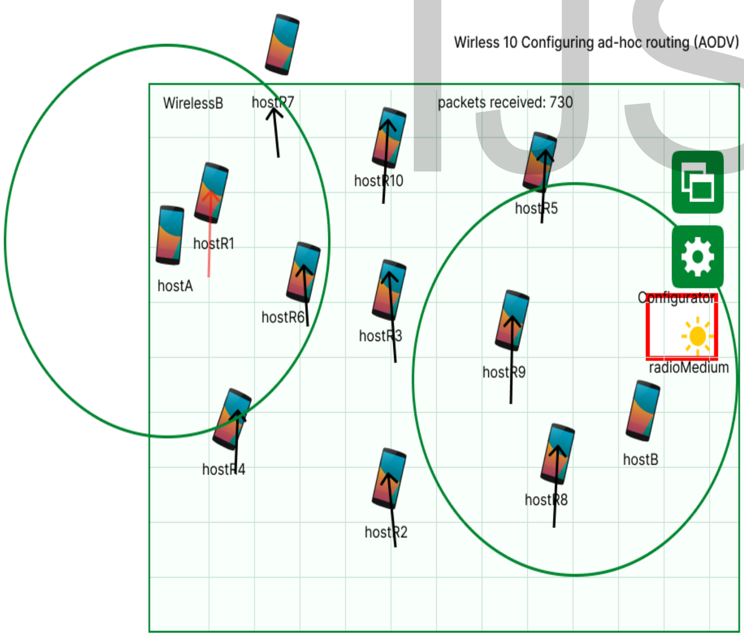

Fig. 11. Enhanced Network - 730 Packets Received for route resilience

Default Network - Number of packets sent – 1682, Number of packets received – 346.
Enhanced Network - Number of packets sent – 1644, Number of packets received – 730.

Conclusion

This study suggests a fresh improvement to the existing network and simulates the outcomes by changing a number of parameters. In order to improve the method utilizing an iterative process and increase efficiency and throughput, this research study replicated the current AODV routing protocol while taking specified characteristics into account. In this study, throughput and route robustness are examined. Throughput has significantly increased while considering the route resiliency parameter. The parameter of power usage is thought to be the study's future focus. On MANETs and wireless sensor networks, low power operations are possible.

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