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Routing Promotion by Intermediate Relays (RPIR) for Successful Mobile Ad-hoc Networks Communication

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ABSTRACT

Introducing the proactive promotion of relaying in MANETs is the main intent of this paper for successful communication. The motive is to obtain a reactive protocol and perform hop by hop routing to achieve communication among Mobile Ad-hoc Networks (MANETs). The most prevalent communication research strategies aim at providing efficient link failure reducing and recovering from the same. However, choosing the most efficient next node does all the good to the communication process thereby showing great progress in the performance. In this paper, the Routing Promotion by Intermediate Relays (RPIR) mechanism allows the node to promote its best efficient metric to show themselves as efficient next nodes. The simulation analysis of the proposed RPIR mechanism is achieved using the network simulator.

Keywords: mobile ad-hoc networks, network simulator, routing, link failure.

1. INTRODUCTION

Mobile Ad-hoc Network (MANET) form a self creating, self organizing and self administering wireless networks by the collection of mobile devices. Routing is an essential component of communication networks, which defines the act of moving information from source node to destination node in an inter network. Efficient dynamic routing is a challenge in such networks.

In MANETs, the router connectivity may change frequently leading to the multi-hop communication model that can allow communication in the network without the use of any Base Station/Access Point. A dual-mode MS can operate in both the infrastructure and MANETs modes using the WLAN interface. MANET can change its locations and configure itself in the network as it is a type of ad-hoc network. All nodes in this network are mobile nodes and they use wireless connections for communicating with various nodes in the network.

Ad-hoc routing protocols can be classified into two types: proactive protocols and reactive protocols. Proactive protocols are also called as table driven protocols since the updated routing information is maintained even before it is required. Since proactive protocols need to update the node entries for all the nodes in the routing table, they are not suitable for larger networks. Reactive protocols are also called as source initiated protocols. If there is no communication in the network for reactive routing protocols, the routing information is not required to maintain at the network nodes.

Routing is considered as one of the major problems of networking for delivering data from source to destination [8]. Wireless ad-hoc networks are also called as Mobile ad-hoc multi-hop networks without predetermined topology or centralized control. This is because MANETs are characterized of having a

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multi-hop, dynamic and potentially rapid changing topology. The aim of such networks is to provide capabilities to areas with limited or no existing communication infrastructures. Mobile nodes using wireless communications usually form MANET. It uses a peer-to-peer multi-hop routing instead of a static network to provide connectivity of the network.

This rest of this paper is organized as follows. Section 2 describes the related work. In Section 3, proposed method (i.e.) Routing Promotion by Intermediate Relays (RPIR) for Successful Mobile Ad-hoc Networks Communication is presented. The simulation results and comparative performance analysis is given in section 4. The conclusion is presented in Section 5.

2. RELATED WORKS

A considerable research effort has observed in recent years on improving the performance of intermediate relays for successful mobile ad-hoc communication.

CORMAN uses light weight proactive source routing protocol [1] that enables each node to have a complete knowledge about routing the data to all other nodes in the communication network at any time. The information of the route carried by the nodes can be attuned when a data flow is forwarded towards their destination by intermediate forwarders. It does not rely on external information sources to enlarge the ExOR applicability to mobile multi-hop wireless networks. It incurs a smaller overhead than ExOR as it includes forwarder lists that are shorter in data packets in the network. The challenges of CORMAN include route calculation overhead, forwarder list adaptation and robustness against link quality variation.

COR allows all the qualified nodes to participate in the packet forwarding [2]. It simultaneously uses context information such as link quality, residual energy and geographic progress of nodes to make routing decisions in the network. To improve the performance of the network, COR exploits the relative mobility of nodes. The source will broadcast the packet which includes the location of both the source and the destination. By using this information, the neighbour nodes which receive the packet checks about its location that is nearer to the destination.

The Analytic Hierarchy Process (AHP) theory was used by CAOR for adjusting the context information weight to adapt the protocol behaviour at runtime that is based on their instantaneous values [3]. AHP is an important multi-criteria solution of decision making that decomposes a complex problem into simpler sub-problems. According to the pair wise comparison of the criteria, it considers a set of criteria and generates weights for each evaluation criterion. It also uses the active suppression mechanism to control the duplicate transmissions. This mechanism has three parts: DFD based forwarder selection exploits manifold context information to choose a forwarder, AHP exploration to dynamically adapt the context information weight according to their real-time values and duplicate transmission is reduced by lightweight active suppression mechanism.

In wireless networks, when a sender transmits a packet, because of the broadcast nature the packet reaches to manifold receivers. In link correlation, the correlations are dependent [4]. In OR, only the node with highest priority forwards the packet to the next hop. The subset of nodes is selected by the sender as forwarders and the priority will be assigned for all the nodes in the network. When the sender transmits a packet to the next-hop, it includes an ordered candidate forwarder set in its header. Each node should respond with an acknowledgement when the manifold node receives a packet. The candidates defer their ACKs according to their priorities to avoid the feedback implosion in the network.

The first Cooperation Optimal protocol for Multi-rate Opportunistic routing and forwarding achieves the social efficiency [5]. The probe messages are integrated with a cryptographic module for measuring the link loss probability. The source node and the intermediate node send the probe message as soon as the session starts from source to destination. Each intermediate node and the destination node reports the probe messages that are received to the source node. The source node calculates the link loss probabilities from this probe messages. By comparing the two types of node behaviour such as following and deviating, the selfish behaviour of the nodes can be identified. In deviating, the selfish node may send the incorrect number of probe messages or it will report only the part of probe messages while measuring the link loss probability.

A unicast type multi-hop local repair protocol recovers the lost links efficiently while increasing network reliability, minimizing the number of control messages, increasing utilization and shortening the repair delay [6]. Meanwhile, the optimal number of hops of neighbour table is also analyzed. Numerical results indicate that the multi-hop local repair approach performs better than other repair approaches in fixed successful rate, control message overhead and network utilization.

ECONOMY is an Opportunistic Routing (OR) protocol that is free from duplicate transmission [9]. OR utilizes overheard packets and simultaneously takes several routes into consideration. ECONOMY uses token passing along a path that relays can hear from one another to eliminate duplicate transmission in the network. When a token arrives, the relay is allowed to transmit the unacknowledged packets in accordance with the acknowledgement information within the received token. ECONOMY prevents duplicate transmission while keeping the advantages of OR in the communication network.

CCACK is a NC based OR protocol that has attracted due to their minimal coordination overhead but they suffer performance degradation in forceful wireless environments with constantly changing levels of channel gains, background traffic and interference [10]. This scheme allows nodes to acknowledge network coded traffic to their upstream nodes in a simple way, oblivious to loss rates and with practically zero overhead.

Transmit Diversity based Co-operative Opportunistic Routing (TDiCOR) proficiently exploits multiuser and transmit diversity to improve the overall throughput in wireless multi-hop networks [11]. It uses distributed transmit diversity to increase the robustness of acknowledgements and data transmissions while preserving the opportunistic feature by using many candidates for packet relaying. TDiCOR outperforms traditional routing in typical outdoor scenarios in terms of throughput in indoor scenarios with high shadow fading and without consuming additional bandwidth or hardware resources.

In the existing algorithm, Position based Opportunistic Routing (POR) [7], takes full advantage of the broadcast nature of wireless channel and opportunistic forwarding. The wireless links may be lost in such ad-hoc networks due to mobile nodes on the multicast tree that are unreachable, which causes broken paths, low network reliability and low packet delivery rate.

3. ROUTING PROMOTION BY INTERMEDIATE RELAYS (RPIR) ALGORITHM

Consider an ad-hoc network such that there are n number of nodes. All the nodes in the communication network have the same communication range and each node can move around within the communication network. The nodes that can communicate within its transmission range are called as neighbours. The nodes that are not in communication range can be communicated via a multi-hop path. The ad-hoc network is all connected and each node has at least one neighbour.

In this section, Routing Promotion by Intermediate Relays (RPIR) algorithm is designed. The assumptions made for the design of the RPIR are as follows:

- There will be a number of individual multi-hop communications for each source to destination communication.
- Each node has a list of neighbours from which the next hop will be selected.
- The requirement in each neighbour list must satisfy the type of communication from the current hop to the next hop.

On-demand ad-hoc routing is taken as the base protocol which includes the phases of route discovery and route maintenance

3.1. Route discovery phase

In the route discovery phase, the source node broadcasts a Route Request (RREQ) packet to every node in the network. If the destination node receives the RREQ to itself, it will reply a Route Reply (RREP) packet back along the incoming path of the RREQ. The network topology of RPIR is shown in figure 1.

3.1.1. Route Request

Consider node S (source) wishes to find a route to node D (destination). Without loss of generality, assume that there are three intermediate nodes between S and D. The source node first checks the route cache. If the route required is available in the cache, the source node will include the routing information inside the data packet before sending it. Otherwise, the source node initiates the discovery process by broadcasting the route request packets. The RREQ includes the source address, the destination address, the broadcast ID, hop count and the sequence number of the source and the destination. Sequence numbers are required to make certain loop-free and updated routes. A node discards RREQs that it has seen before to reduce the flooding overhead. The RREQ also starts with a Time-To-Live (TTL) value. If the destination is not found, the TTL is increased in following RREQs.

3.1.2. Route Reply

Each node maintains a cache to keep track of RREQs it has received. The cache stores the path back to each RREQ originator in the network. When the destination or a node that has a route from the source to the destination and receives the RREQ, the destination sequence numbers it currently knows are checked and the one specified in the RREQ are checked. To guarantee the freshness of the routing information, a RREP packet is created and forwarded back to the source only if the sequence number of the destination is equal to or greater than the one specified in RREQ. Each intermediate node along the route updates its next-hop table entries with respect to the destination node upon receiving the RREP packet.

Each node computes its QoS value, energy and the distance of the node from the base station. Each node makes it a high priority to be selected as the next intermediate node and pushes into the top of the list

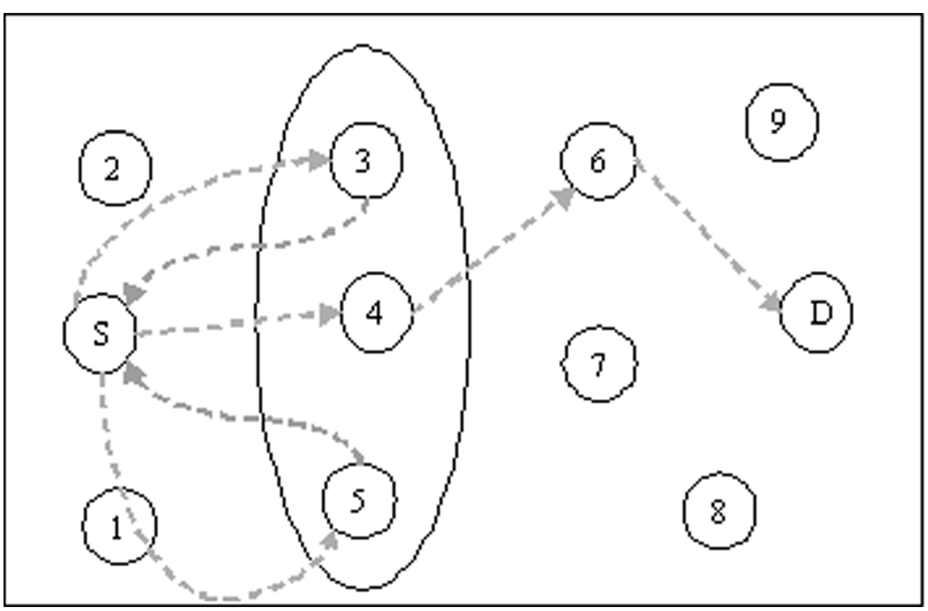

Figure 1: Network topology of RPIR

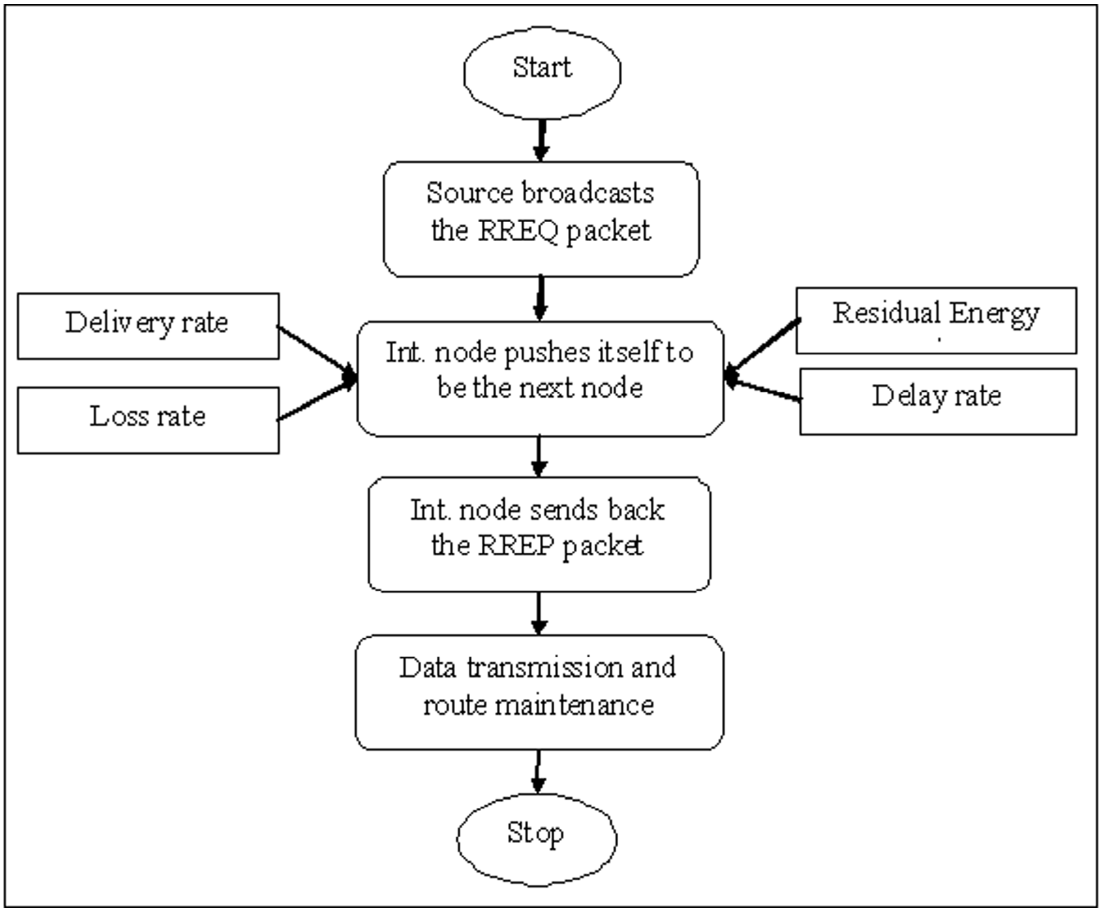

Figure 2: Flowchart of RPIR mechanism

among the number of parameters (packet delivery, packet delay, packet loss, residual energy, distance) that make the selection of the next intermediate node. The next intermediate node is selected based on the parameter such that it can be stable and efficient in data transmission. Once the path is selected, the data is transmitted from the source to destination through the selected path in the communication network.

3.1.3. Route Maintenance

Maintaining a route is considered as a tedious process. Only the routes that are active in the communication network can be maintained. The data packets are communicated form source to destination when the route is in active mode. When the source stops sending data packets on that particular path or link, the links are said to be timeout. A Route Error (RERR) message will be send to the source node to inform that the destinations are now unreachable, if a link break occurs while the route is active.

Maintaining a route includes maintaining a multicast tree for the life of the multicast group. There is a probability that there can be large number of link breakages along that route, since the routes are mobile.

4. PERFORMANCE EVALUATION

The performance of RPIR is analyzed by using the Network Simulator version-2 (NS2). NS2 is an open source programming language written both in C++ which is used in back end and Object Oriented Tool Command Language (OTCL) which is used in front end. NS2 is a discrete event time driven simulator which is used to mainly model the network protocols. The nodes are distributed in the simulation environment in the communication network. The parameters used for the simulation of ETLEEC are shown in Table 1. The simulation of the proposed ETLEEC has 50 nodes deployed in the simulation area 1000×1000m.

Table 1
Simulation parameters of RPIR

Parameter	*Value*
Channel Type	Wireless Channel
Simulation Time	50 s
Number of nodes	50
MAC type	802.11
Traffic model	CBR
Simulation Area	1000×1000
Transmission range	250m
Network interface Type	WirelessPhy
Mobility Model	Random Way Point

The nodes communicated with each other by using the communication protocol User Datagram Protocol (UDP). The nodes moved randomly within the simulation area by using the mobility model Random Way Point (RWP). The radio wave is propagated by using two ray ground propagation models. The traffic in the network is handled using the traffic model Constant Bit Rate (CBR). All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the RPIR is evaluated by using the parameters packet delivery rate, packet loss rate, average delay, throughput, residual energy and network lifetime.

4.1. Packet Delivery Rate

Packet Delivery Rate (PDR) is the ratio of number of packets delivered to all receivers to the number of data packets sent by the source node. The PDR is calculated by the equation 3.

$$PDR = \frac{Total\ Packets\ Received}{Total\ Packets\ Send} \tag{3}$$

The figure 3 shows the PDR of the proposed scheme RPIR is higher than the PDR of the existing method POR. The greater value of PDR means the better performance of the protocol.

4.2. Packet Loss Rate

The Packet Loss Rate (PLR) is the ratio of the number of packets dropped to the number of data packets sent. The formula used to calculate the PLR given in equation 4.

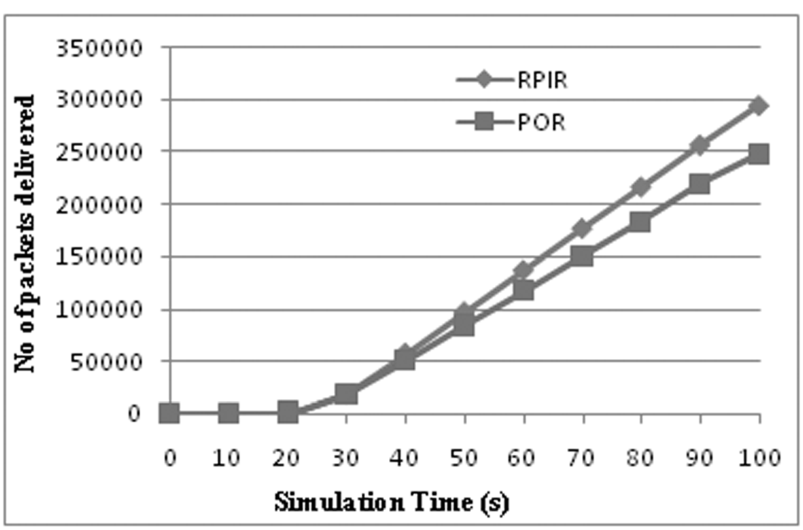

Figure 3: Packet Delivery Rate

$$PLR = \frac{Total\ Packets\ Dropped}{Total\ Packets\ Send} \tag{4}$$

The PLR of the proposed scheme RPIR is lower than the existing scheme POR in Figure 4. Lower the PLR indicates the higher performance of the network.

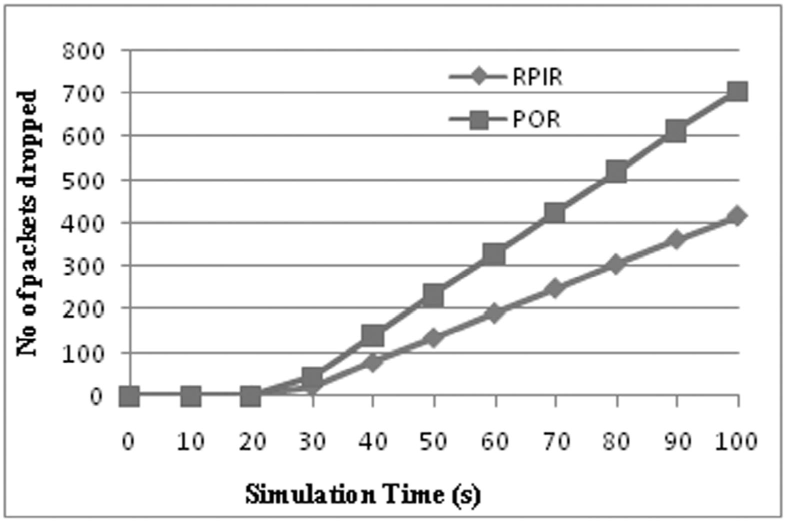

Figure 4: Packet Loss Rate

4.3. Average Delay

The average delay is defined as the difference between the current packets received time and the previous packet received time. The delay in the network degrades the performance of the network. The average delay is measured by equation 5.

$$Delay = \frac{\sum_{0}^{n} Pkt\ Send\ Time - Pkt\ \mathrm{Re}\,cvd\ Time}{Time} \tag{5}$$

Figure 5 shows that the delay value is low for the proposed scheme RPIR than the existing scheme POR. The minimum value of delay means that higher value of the throughput of the network.

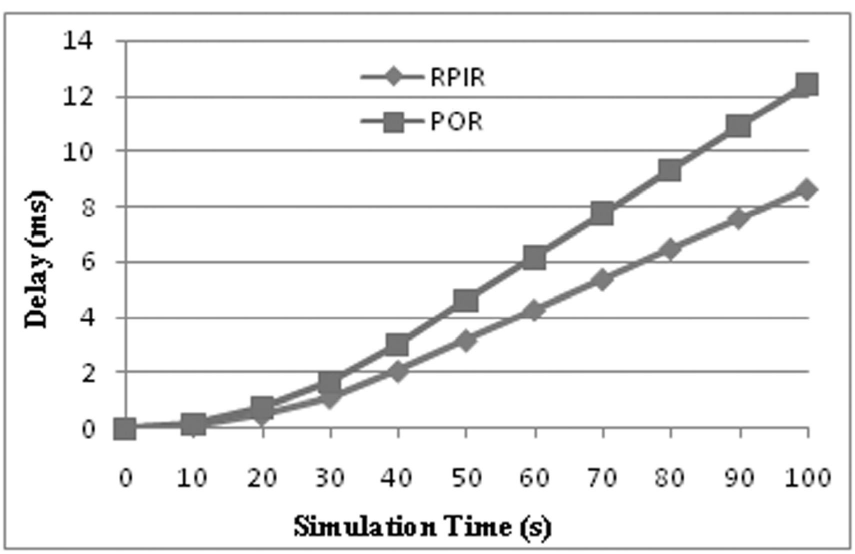

Figure 5: Average delay

4.4. Throughput

Throughput is the average of successful messages delivered to the destination. The average throughput is estimated using equation 6.

$$Throughput = \frac{\sum_0^n Pkts\ Received\,(n) * Pkt\ Size}{1000} \tag{6}$$

Figure 6 shows that proposed scheme RPIR has greater average throughput when compared to the existing scheme POR.

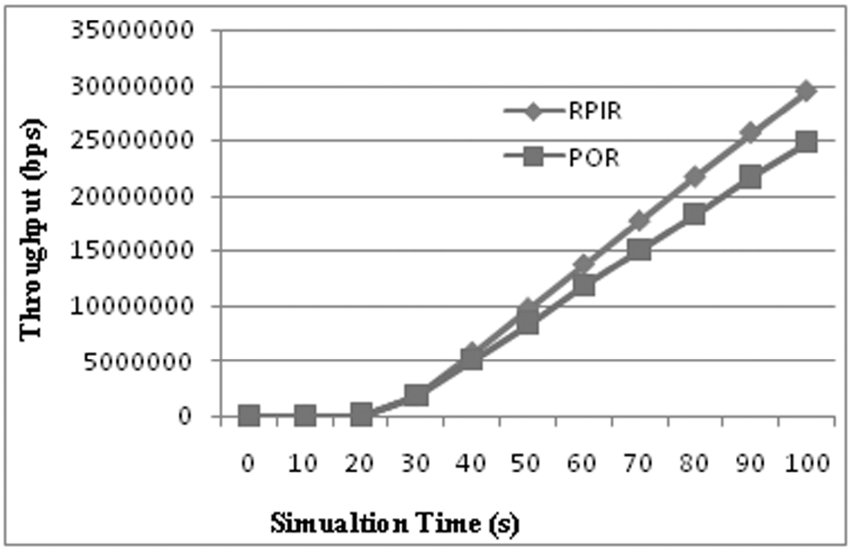

Figure 6: Throughput

5. CONCLUSION

Proactive promotion of relaying in MANETs is introduced for successful communication. In this paper, the Routing Promotion by Intermediate Relays (RPIR) mechanism allows the node to promote its best efficient metric to show themselves as efficient next nodes. Hop by hop routing is performed to achieve communication among MANETs. Simulation analysis shows that the proposed RPIR mechanism provides better routing mechanism using the network simulator.

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