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R3E: Reliable Reactive Routing Enhancement In Mobile Ad-Hoc Networks

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***Abstract*- One of the major technical challenges in wireless networks is providing reliable and efficient communication under fading channels, especially in Mobile Ad-hoc Network (MANET) with dynamic and harsh environments. In this work, our focus is to increase the resilience to link dynamics for MANET. Enhanced R3E is designed such that it will be set of reasons given in support of an idea for the existing reactive routing protocols to combat the channel variation by utilizing the local path diversity in the link layer. As a new addition to the cooperative forwarding design space in MANET. A biased back off scheme has introduced during the route-discovery phase to find a robust guide path, which can provide more cooperative forwarding opportunities. Through extensive simulations, We demonstrate that compared to other protocols, R3E remarkably improves the packet delivery ratio, while maintaining high energy efficiency and low delivery latency.**

***IndexTerms* - MANET, AD-HOC Network, Routing, AODV, NS2**

I. INTRODUCTION

Recent advances in computer networking have introduced a new technology for future wireless communication, a mobile ad hoc network (MANET).The term MANET (Mobile Ad hoc Network) refers to a multihop packet based wireless network composed of a set of mobile nodes that can communicate and move at the same time, without using any kind of fixed wired infrastructure. MANET is actually self organizing and adaptive networks that can be formed and deformed on-the-fly without the need of any centralized administration. Otherwise, a stand for "Mobile Ad Hoc Network" A MANET is a type of ad hoc network that can change locations and configure itself on the fly. Because MANETs are mobile, they use wireless connections to connect to various networks. This can be a standard Wi-Fi connection, or another medium, such as a cellular or satellite transmission.

A Mobile Adhoc Network is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others needs the aid of intermediate nodes to route their packets. Each of the node has a wireless interface to communicate with each other. These networks are fully distributed, and can work at any place without the help of any fixed infrastructure as access points or base stations.

Fig. 1 Structure of MANET

II. LITERATURE REVIEW

We initial expose relevant analysis work associated with signal strength based mostly routing. Then, we are going to specific however our approach combines each the signal strength and energy metrics, to search out reliable path for communication and extend the network life. Most of the routing algorithms planned for painter is predicated on reactive routing strategy, during which route is established only if there is a necessity to transmit a packet.

1.1 Routing Protocols

Ad-Hoc network routing protocols are commonly divided into three main classes; Proactive , reactive and hybrid protocols as shown in figure 2.

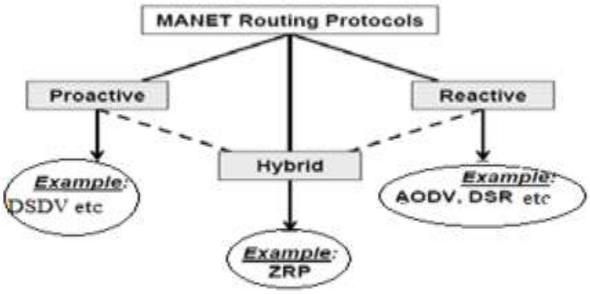

Fig. 2 Classification of Routing Protocols

Proactive Protocols:

Proactive, or table-driven routing protocols. In proactive routing, each node has to maintain one or more tables to store routing information, and any changes in network topology need to be reflected by propagating updates throughout the network in order to maintain a consistent network view. Example of such schemes are the conventional routing schemes: Destination sequenced distance vector (DSDV). They attempt to maintain consistent, up- to-date routing information of the whole network. It minimizes the delay in communication and allow nodes to quickly determine which nodes are present or reachable in the network.

Reactive Routing Protocols:

Reactive routing protocols are designed to reduce the bandwidth and storage cost consumed in table driven protocols. These protocols apply the on-demand procedures to dynamically build the route between a source and a destination. Routes are generally created and maintained by two different phases, namely: route discovery and route maintenance. Route discovery usually occurs on-demand by flooding an RREQ (RouteRequest) through the network, i.e., when a node has data to send, it broadcasts an RREQ. When a route is found, the destination returns an RREP (Route Reply), which contains the route information (either the hop-by-hop information or complete addresses from the source to the destination) traversed by the RREQ. Several reactive routing protocols have been suggested and used for MANETs, Ad Hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR), Temporary-Ordered Routing Algorithm (TORA).

Hybrid Protocols:

They introduces a hybrid model that combines reactive and proactive routing protocols. The Zone Routing Protocol (ZRP) is a hybrid routing protocol that divides the network into zones. ZRP provides a hierarchical architecture where each node has to maintain additional topological information requiring extra memory.

2.2 Network Simulator

NS is an object oriented simulator, written in C++, with an OTcl interpreter as a frontend. NS uses two languages because simulator has two different kinds of things it needs to do. On one hand, detailed simulations of protocols require a systems programming language which can efficiently manipulate bytes, packet headers, and implement algorithms that run over large data sets. For these tasks run-time speed is important and turn-around time (run simulation, find bug, fix bug, recompile, re-run) is less important.

Network Simulator 2.33 (NS2)

Network Simulator (NS2) is a discrete event driven simulator developed at UC Berkeley. It is part of the VINT project. The goal of NS2 is to support networking research and education. It is suitable for designing new protocols, comparing different protocols and traffic evaluations. NS2 is developed as a collaborative environment. It is distributed freely and open source. A large amount of institutes and people in development and research use, maintain and develop NS2.

III. Proposed System

We propose a Reliable Reactive Routing Enhancement (R3E) to increase the resilience to link dynamics for MANETs. Our design inherits the advantages of opportunistic routing, thus achieving shorter end-to-end delivery delay, higher energy efficiency, and reliability. R3E is designed to augment existing reactive routing protocols to combat the channel variation by utilizing the local path diversity in the link layer.

3.1 Objectives of Proposed System

- Provide the solutions to reliable route discovery and efficient cooperative forwarding problems.
- Simple yet effective cooperative forwarding scheme.
- Compatible with most existing reactive routing protocols in MANET

3.2 Biased Backoff Scheme

Fig. 3 illustrates the biased backoff scheme. Any node that forwards the RREQ will calculate the backoff delay by assuming itself as a guide node, and considering the last-hop node as its upstream guide node. For example, nodes A, B, and C receive an RREQ from the source S. When node C calculates its backoff delay, it considers itself as a guide node and S as the upstream guide node. From the local neighbor table, C knows that A and B are helper nodes. Then, it can calculate the value of backoff delay. In Fig. 3, the label {0.8,0.6} beside the helper node A means that P_{sa} = 0.8and P_{ac} = 0.6 . At node C, the backoff delay is about 0.57*T*. Compared with A and B, C has a shorter backoff delay. When C's backoff timer first expires, the RREQ is rebroadcasted. Consequently, node C has a higher priority to forward the RREQ. Similarly, node F forwards the RREQ before D and E. Thus, the RREQ that travels along the path[S ->C ->F] arrives at the Dest first.

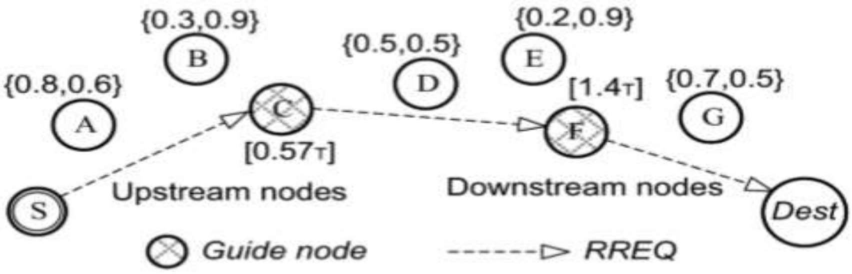

Fig. 3 Example illustrating the biased backoff scheme

IV. REQUIREMENT ANALYSIS

4.1 Hardware Requirements

- Processor : Pentium –IV
- Speed : 1.1 GHz
- RAM : 256 MB(min)
- Hard Disk : 20 GB
- Floppy Drive : 1.44 MB
- Key Board : Standard Windows Keyboard
- Mouse : Two or Three Button Mouse
- Monitor : SVGA

4.2 Software Requirements

- Operating System : Fedora-8
- Tool : Network Simulator-2.32
- Front End : OTCL (Object Oriented Tool Command Language)
- Back End : C++

V. SYSTEM DESIGN

5.1 System Architecture

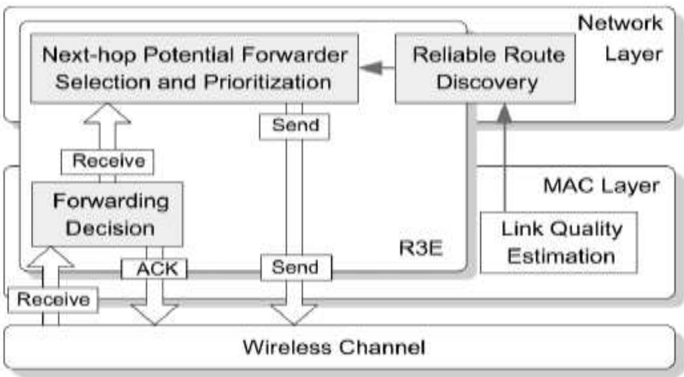

Fig. 4 Functional architecture overview of R3E

Fig. 4 illustrates an overview of the functional architecture of R3E, which is a middle-ware design across the MAC and the network layers to increase the resilience to link dynamics for MANET. The R3E enhancement layer consists of three main modules, the reliable route discovery module, the potential forwarder selection and prioritization module, and the forwarding decision module. The helper node and potential forwarder are interchangeable in this work.

The reliable route discovery module finds and maintains the route information for each node. During the route discovery phase, each node involved in the cooperative forwarding process stores the downstream neighborhood information, that is to say, when a node serves as a forwarder, it already knows the next-hop forwarding candidates along the discovered path. The other two modules are responsible for the runtime forwarding phase. When a node successfully receives a data packet, the forwarding decision module checks whether it is one of the intended receivers. If yes, this node will cache the incoming packet and start a backoff timer to return an ACK message, where the timer value is related with its ranking in the intended receiver list (called forwarding candidate list). If there is no other forwarder candidate with higher priority transmitting an ACK before its backoff timer expires, it will broadcast an ACK and deliver the packet to the upper layer, i.e., trigger a receiving event in the network layer. Then, the potential forwarder selection and prioritization module attaches the ordered forwarder list in the data packet header for the next hop. Finally, the outgoing packet will be submitted to the MAC layer and forwarded towards the destination.

5.2 Algorithms

Algorithm 1 : How a node v_j handles the RREQ received from node v_i.

Procedure: void *RecvRREQ (Packet *p)*
if Non-duplicate RREQ **then**
    if v_j is the destination node **then**
        Send out RREP;
    else
        $CN(i,j) = N(i) \cap N(j)$;
        //get common neighbor set $CN(i,j), v_k \in CN(i,j)$;
        Sort $CN(i,j)$ descendingly ordered by $P_{ik}P_{kj}$;
        $H(i,j) = \{cn_1\}, CN(i,j) = CN(i,j) - \{cn_1\}$;
        // cn_1 is always the first item of $CN(i,j)$;
        While $CN(i,j) \neq \emptyset$ **do**
            if CheckConnectivity$(H(i,j), cn_1)$ **then**
                // cn_1 is within the transmission range of any node in $H(i,j)$;
                $H(i,j) = H(i,j) \cup \{cn_1\}$;
            end
            $CN(i,j) = CN(i,j) - cn_1$;
        end
        Calculate t_{ij} and call Backoff(t_{ij}, p);
        //schedule a timer whose value is t_{ij}, then call forwardRREQ(p) when the timer expires;
    end
else
    Drop p;
end

Algorithm 2: How a node v_j handles the RREP received from its downstream guide node v_i.

Procedure:void *RecvRREP (Packet *p)*
if *Non-duplicate RREP* **then**
    if $v_j == v_{i-1}$ **then**
        //v_j is the selected next-hop & guide node v_{i-1};
        Mark myself as a guide node;
        Record v_i and $H(i-1,i)$;
        Get RREP's next-hop node id v_{i-2};
        Attach v_i, $H(i-1,i)$, v_{i-1} and $H(i-2,i-1)$ to RREP;
        /* v_{i-2} is v_{i-1} 's upstream guide node; the helper set is ordered descendingly by the PRR toward the downstream guide node;*/
        Call forwardRREP p;
    else if $v_j \in H(i-1,i)$ **then**
        // v_j is a helper in $H(i-1,i)$;
        Record v_{i+1}, $H(i,i+1)$, v_i and $H(i-1,i)$;
        Drop p;
    else
        Drop p;
    end
else
    Drop p;
end

VI. EXPERIMENTAL SETUP

6.1 Fedora8 Terminal

Fedora8 terminal is used to run the TCL program . When we want to run NAM file or to show the result of TCL file give the path of file in terminal using cmd ns type the path of TCL file.

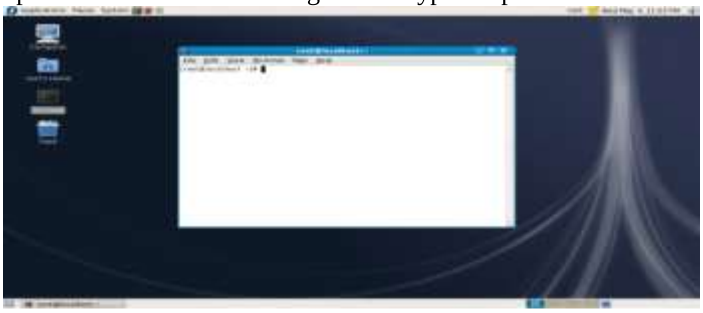

Fig. 5 Snapshot of Terminal

6.2 Network Animator (NAM)

Nam is a Tcl/TK based animation tool for viewing network simulation traces and real world packet trace data. The design theory behind nam was to create an animator that is able to read large animation data sets and be extensible enough so that it could be used indifferent network visualization situations.

Fig. 6 Snapshot Of Network Animator (NAM)

VII. SIMULATION RESULTS

7.1 System Snapshots

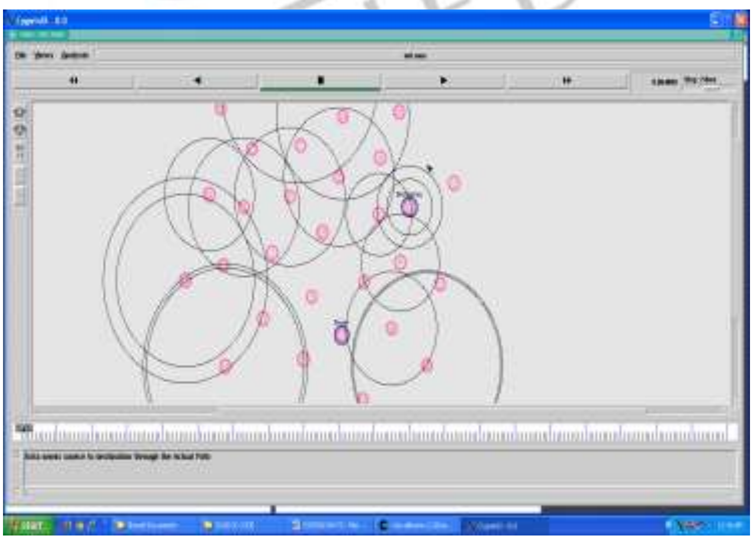

Fig. 7(a) Data sends Source to Destination through Actual Path

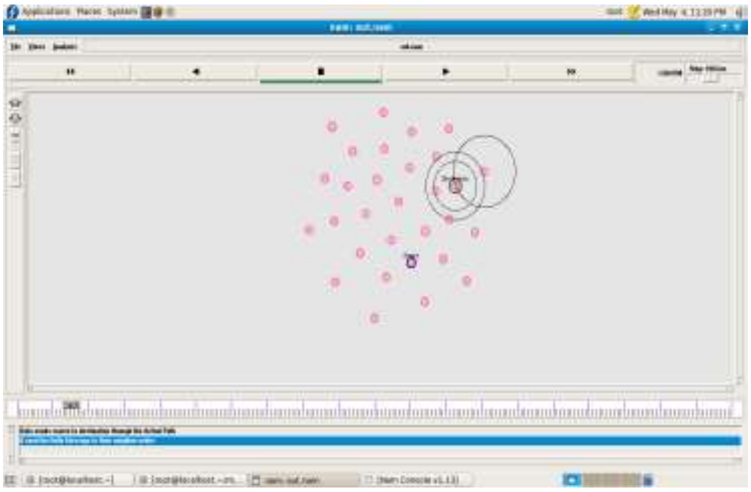

Fig. 7(b) Node 0 send Hello message to their neighbor nodes

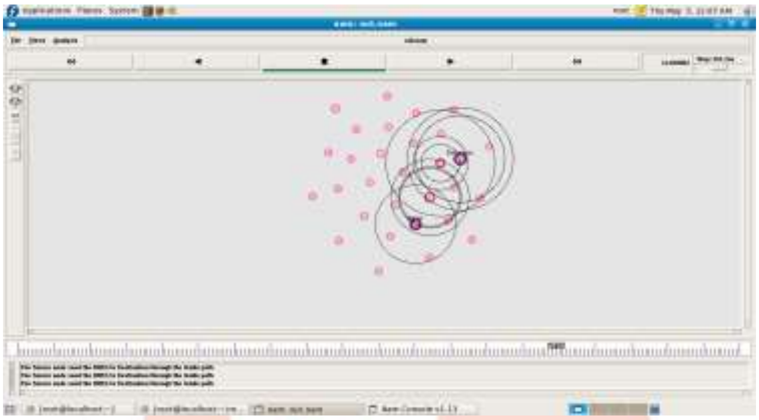

Fig. 7(c) Source node sends the RREQ to Destination through the Guide path

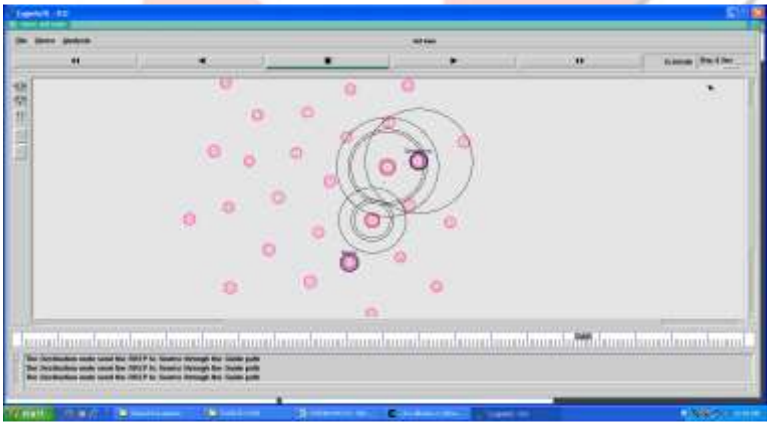

Fig. 7(d) Destination node sends the RREP to Source through the Guide path

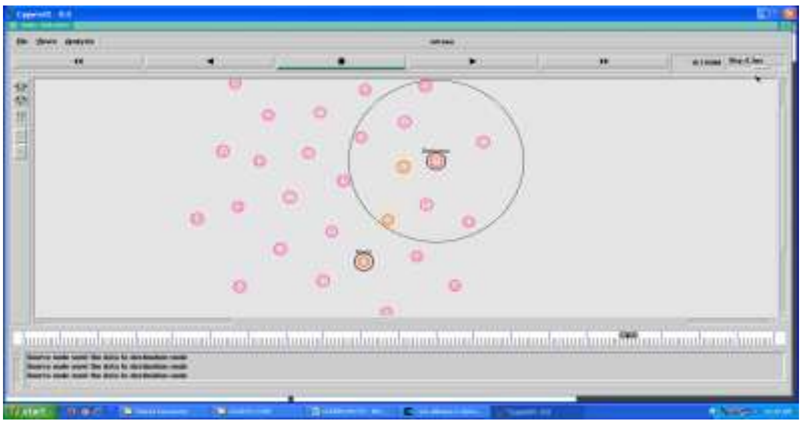

Fig 7(e) Source node sends the data to destination node

7.2 Trace Format

Run the script, and we can get the out.tr. As mentioned before, out.tr is used to keep track of action of the network. Now Let us see what the output trace is

s 55.032641812 1 AGT | 26 ack 40 [0 0 0 0] ||- [1:0 0:0 32 0] [1 0] 0 0
r 55.032641812 1 RTR | 26 ack 40 [0 0 0 0] ||- [1:0 0:0 32 0] [1 0] 0 0
s 55.032641812 1 RTR | 26 ack 60 [0 0 0 0] ||- [1:0 0:0 32 2] [1 0] 0 0
r 55.034847281 2 RTR | 26 ack 60 [13a 2 1 800] ||- [1:0 0:0 32 2] [1 0] 1 0
f 55.034847281 2 RTR | 26 ack 60 [13a 2 1 800] ||- [1:0 0:0 31 0] [1 0] 1 0
r 55.036972761 0 AGT | 26 ack 60 [13a 0 2 800] ||- [1:0 0:0 31 0] [1 0] 2 0

A letter that can have the values r, s, f, d for "received", "sent", "forwarded" and "dropped" respectively.
The second field is the time.
The third field is the node number.
The fourth field is MAC to indicate if the packet concerns a MAC layer, it is AGT to indicate a the transport layer packet, or RTR if it concerns the routed packet.
It can also be IFQ to indicate events related to the interference priority queue.
After the dashes comes the global sequence number of the packet.
At the next field comes more information on the packet type.
Then comes the packet size in bytes. The 4 numbers in the first square brackets concern mac layer information.
The first hexadecimal number specifies the expected time in seconds to send this data packet over the wireless channel.
The second number stands for the MAC-id of the sending node.
The third is that of the receiving node.
The fourth number, 800, specifies that the MAC type.
The next numbers in the second square brackets concern the IP source and destination addresses, then the ttl (Time to Live) of the packet.
So the procedure can be expressed as: It is first sent by the TCP agent at node 1,then received by the routing protocol of the same node and sent from there with an additional header. It is then received and forward by node 2. Then it is finally received by node 0.Let see another form:

M 15.00000 1 (490.00, 285.00, 0.00), (45.00, 258.00), 5.00

M stands for giving a location or a movement indication. The first number is the time, the second is the node number, then comes the origin and destination locations, and finally is given the speed. So this means node 1 begin move from (490.00, 285.00, 0.00) at 15.00 to (45.00, 258.00) with the speed of 5.00.

7.3 Graphical Representation

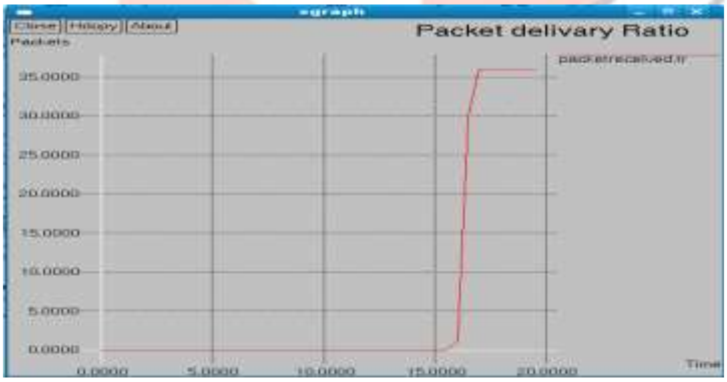

Fig. 8(a) Xgraphs for Packet Delivery Ratio

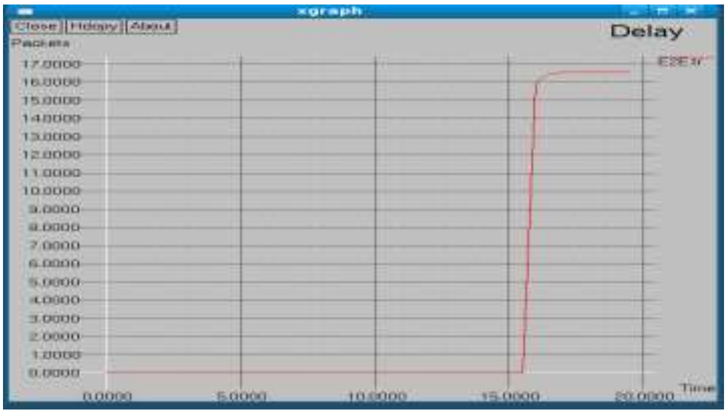

Fig. 8(b) Xgraphs for End-to-End delay

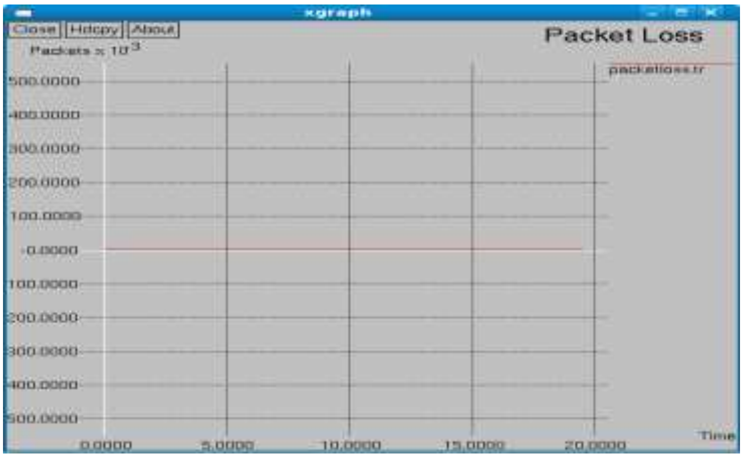

Fig. 8(c) Xgraph for Packet lost

VIII. Conclusion

In this work, We presented R3E, which can augment most existing reactive routing protocols in MANET to provide reliable and energy-efficient packet delivery against the unreliable wireless links. We introduced a biased backoff scheme in the route discovery phase to find a robust virtual path with low overhead. Without utilizing the location information, data packets can still be greedily progressed toward the destination along the virtual path. Therefore, R3E provides very close routing performance to the geographic opportunistic routing protocol.

We extended AODV with R3E to demonstrate its effectiveness and feasibility. Simulation results showed that, as compared with other protocols, AODV-R3E can effectively improve robustness, end-to-end energy efficiency, and latency.

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