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BIT NOISE-BASED DYNAMIC MANET ON-DEMAND ROUTING PROTOCOL (N-DYMO) FOR RELIABLE DATA TRANSMISSION

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Abstract: In a MANET no such infrastructure exists and the network may be changed dynamically in an unpredictable manner since nodes are free to move and each node has limiting transmitting power, restricting access to the node only in the neighboring range. The routing protocols find routes based on the shortest hop count. MANET takes advantage also due to dynamic topology, energy-constrained operation, limited physical security, bandwidth-constrained, and links. However, if the network is loaded with heavy traffic, the selected route can be unreliable in terms of stability, traffic, and high interference. Mobility may also be high in such randomly selected routes. In this paper, we propose a routing protocol that uses the link quality information that is calculated using the received signal's noise value to select the routes during the route discovery process. The proposed system here is the Noise-Based Dynamic MANET On-demand (N-DYMO) routing protocol. Packet Delivery Ratio, End-To-End Delay, and Routing Overhead are used as the metrics for performance evaluation in the proposed routing solution. Different routing protocols are studied, and their effects are elaborated by stating how these routings interrupt the performance of MANET. The objective is to study the effects of both routing protocols viz. DYMO & AODV, and explore the challenges of designing in the routing area for WSNs. Results of workload analysis are used to show that the system is well suited for high-performance WSN applications.

***Index Terms* - MANET, Routing Protocols, DYMO, AODV, DSR, EXata, RREQ, INFO, SINR.**

I. INTRODUCTION

Next-generation wireless AD-HOC networks are playing a bulging role in the rapid deployment of independent mobile users, effective and dynamic communication for military networks, emergency/rescue operations, and disaster relief efforts. AD-HOC networks do not have fixed topologies to cover a large area. These topologies may transform dynamically and unpredictably. Traditional routing protocols are generally used for internet-based wireless networks. These can't be applied straight to AD-HOC wireless networks; because some common assumptions are not effective in all cases for such dynamically changing networks and maybe not be true for mobile nodes. The accessibility of bandwidth is an important issue for AD-HOC networks. Thus, this kind of network presents a tough challenge in the design of routing protocols, where each node contributes to routing by forwarding data dynamically based on the network connectivity. It expands the scalability of wireless networks related to infrastructure-based wireless networks because of its decentralized nature. In dangerous locations: military conflicts, natural disasters, or emergencies instant, AD-HOC networks are best suitable due to minimal configuration and fast operation. A very fundamental characteristic of ad-hoc networks [4] is that they can configure themselves on-the-fly without the intervention of a centralized administration. The terminals in the ad hoc network can not only act as an end-system but also as an intermediate system (routers). It is possible for two nodes that are not in the communication range of each other, but still can send and receive data from each other with the help of intermediate nodes which can act as routers. This functionality gives another name to ad hoc networks as "multi-hop wireless network". AD-HOC networks can be classified into three categories based on applications; Mobile AD-HOC Networks (MANETs), Wireless Mesh Networks (WMNs), and Wireless Sensor Networks (WSN) [5]. The routing functionality is furthermore combined into the mobile nodes. Nodes are stressed by the effects of radio communication, with multipath fading, multi-user interferences, and shadowing. The design of network protocols for the MANET environment is highly complex. These networks need efficient distributed algorithms which are used to determine the connectivity of link scheduling, network organizations, and routing. The proficiency of routing algorithms in networks [6] depends on route computation. The shortest path based on network metrics from a source to a destination is generally the most desirable route in static networks, this idea is not ideally extended to MANETs. Many factors: extended power, quality of wireless links, path losses, fading, interference, and topological changes have to be considered to determine a new route. The networks should flexibly change routing paths to improve any of these effects. In Mobile AD-HOC Networks, the lack of considering any of these necessities may reduce the performance and reliability of the network [7].

II. *METHODOLOGY OVERVIEW*

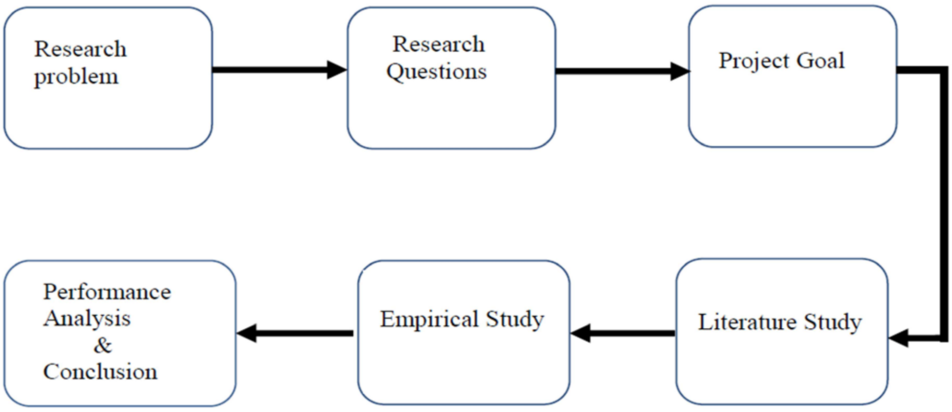

Fig. 2.1. Methodology overview

2.1 Problem

Existing reactive routing protocols, like DSR and AODV which is the shortest path (measured in terms of the numbers of hops) are used as routing metrics. Node mobility may cause radio links to breaking frequently, so the shortest path does not always mean the optimal path. The large distance between communicating neighbor nodes may raise the risk of radio link breaks. As soon as the link of any path breaks, this path needs to be repaired or replaced. Such rerouting operation increases routing overhead, thus degrading network performance.

2.2 Research Questions

a) Why routing is so important in wireless networks?
b) Why do we concentrate on AD-HOC networks instead of infrastructure-based wireless networks?
c) What are the limitations of existing routing algorithms to find out new routes in the MANET environments?
d) How does the DYMO routing protocol increase the performance compared to other On-demand protocols for network metrics?
e) How do DSR and DYMO routing protocols work in MANETs?
f) How does EXata play a major role in the simulation environment than other simulators to design and implement MANETs?
g) With literature study and analytical simulation results, how can we identify the characteristics and compare AODV and DYMO?

2.3 Project Goals

a) Finding the right routing path between source to destination using noise factor.

b) Reducing routing time of data transmission in DYMO routing protocol.

c) Increasing network performance of data transmission in DYMO routing protocol.

d) Studying Dynamic on-demand routing protocol for MANET environments.

e) Studying the strategy of the N-DYMO-MANET routing protocol has shown better performance than other routing protocols AODV, and DYMO.
f) Designing different scenarios of MANET in EXata version 2.0 and later choosing the DYMO-MANET routing protocol with different parameters, followed by collecting some simulation results for final analysis.
g) Studying different types of MANET routing protocols.
h) Increasing link stability of Routing path with DYMO Routing Protocol
i) In the concluding part, interpreting the simulation results as well as theoretical study which will help researchers working in the area.

2.4 Literature Study and Empirical Study

There are [8] different simulators; ns2, ns3 [9], QualNet [10] and OPNET [11], EXata [12] available for designing MANETs and analyzing their performance by collecting different simulation results. In our design and implementation part, we can use the EXata simulator. To run a project in EXata, the following steps have to follow which are shown in figure 2.2:

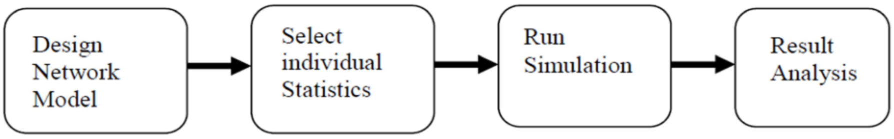

Fig. 2.2. A complete overview of the design project in EXata

III. PROPOSED METHOD

Since mobility can be high in such randomly selected routes. Therefore, keeping this in mind we can develop a new routing protocol that uses the noise value information of a link to decide whether to include or not the current link in the route discovery process. The results obtained from various simulations can be used to show the effectiveness of the proposed approach. The functionality of our proposed design can be divided into two phases:

A. RREQ (Route Request) Propagation Phase: In this phase, we can try to discover a route for a given destination in such a way that the discovered route consists of the links that have lower noise values so that the probability of their breakage is lower during the long communication process duration. To achieve this, we can use a noise-based route discovery process. In this phase, a route from the destination to the source can be created upon which the route reply message will travel from destination to source in unicast form.

B. RREP (Route Reply) Propagation phase: The above first phase is completed once the RREQ message is received by the destination node. When destination nodes receive several RREQ messages for the same communication flow, it uses one link to reply with the RREP message. This link is selected again as described in the provided algorithm.

We can make sure that the RREP message sent by the destination node will flow the reverse route that is created during the RREQ propagation phase. When the RREP is received by the source node we can plan to have a noise-based good quality forward route from the source node to the destination node. In the proposed N-DYMO protocol, each node selects a radio link with the lowest noise value from the available set of neighbor links it has during the route discovery process between a source-destination pair. An INFO field called noise info is added in the RREQ (Route Request) message of the DYMO routing protocol to pass the noise value from the physical layer of the received RREQ message to the network layer using a cross-layer design technique. The value of the noise of a received message is calculated using its received SINR (Signal to Noise Ratio) which is the signal-to-noise and interference ratio of a signal. The SINR is calculated as a ratio of received signal power to the interference power of interfering signals in addition to the noise received. The information about the noise of the received RREQ message is then used by the network layer during the route discovery process to select the route that consists of the links that have the lowest noise as compared to the other routes available between the source-destination pair for which the route discovery phase is initiated.

Two additional data structures can be used in the implementation process of our proposed N- DYMO protocol.

i. The first data structure is a modification in the DYMO protocols RREQ control message. In this, we can add an INFO field that is added by the physical layer whenever it receives an RREQ message. In the INFO field, the physical layer adds the noise information of the received RREQ message which is then extracted from it when this RREQ is reached at the network layer.

ii. The second data structure is the RREQ_BUFFER_TABLE which is created at each node during the route discovery process. The RREQ_BUFFER_TABLE has the following fields namely:

- Source address i.e., the source address of the RREQ received.
- Flooding ID i.e., the flooding of the received RREQ message
- RREQ msg i.e., the received RREQ message

Algorithm 1 is elaborated and implemented in the of EXata simulator to see the effectiveness and correctness of our proposed routing method using the simulation results generated during the simulation processes. Let's assume that the S is the source and D is the destination node in the network for which a route has to be discovered using our proposed N- DYMO routing protocol. As the source node (S) receives a data packet for transmission to a destination node (D), it will check its routing table for an active route. If an active route is available in the routing table of node S the data packet is transmitted towards node D using the next-hop address given in its routing table. On the other hand, if the routing table of node S does not have a valid entry for node D, it starts our proposed route. Node S initiates the RREQ message and broadcasts it in the underlying network. When an intermediate node which is also the neighbor node of the node S in this case receives the RREQ message at the physical layer it calculates the noise value of the received RREQ message. To calculate the noise as mentioned that SINR is used at the physical layer in which the intermediate node will use the ratio of the received signal power and the noise and interference in the received signal. The calculated noise value of the received RREQ message is then placed in the INFO field of the RREQ message and that RREQ message is then sent to the MAC layer from where it will reach our N-DYMO protocol which is at the network layer. Once the RREQ message is received, the node will moderate the RREQ message at each node in the network. With the insertion of the RREQ message in the buffer the node also starts a timer of

15 microseconds. Until this timer expires, this node will buffer all the duplicate RREQ messages it receives from its neighbor nodes. When the timer associated with RREQ storing buffer the node will sort the RREQ messages in the buffer with the RREQ message that has the lowest value is placed on top of the RREQ buffer. Once sorted, the node will extract the top RREQ message and process it. The node will reject all the remaining RREQ messages in the RREQ buffer. This process is done on all the intermediate nodes until the RREQ message reaches its destination node. When a destination node receives the RREQ message it also stores it in the RREQ message buffer and waits for the timer to expire. When the timer expires, the destination node extracts the RREQ message from the RREQ buffer with the lowest noise value. The node from which the selected RREQ message is received will be considered as the next-hop node toward the source of the received RREQ message. This next-hop node is then used by the destination node to forward the RREP message toward the source node. In this way, our proposed route discovery algorithm always selects the best quality radio link at each intermediate node during the route discovery process for the destination node and the destination will use the same route for the RREP message forwarding. Therefore, the highest quality route is discovered and used by the source node for the data communication process.

IV. NETWORK METRICS

a) Packet Delivery Ratio (PDR): It is the ratio of the application data packets that are received without any error at Destination Nodes to the total data packets generated by the CBR. Let's assume that S is the total number of packets sent from the Source Node and R represents the total number of packets received successfully at each Destination Node than the PDR is defined as follows:

$$PDR = \frac{Total\ Packets\ Sent\ (R)}{Total\ Packets\ Received\ (S)}$$

b) Average End-To-End Delay of Data Packets: As soon as the destination node receives a data packet, the Average End-To-End Delay of Data Packets is calculated. The delay of each received data packet is calculated by the destination node by using its sent timestamp and its received timestamp at the destination. At the end of the simulation, the total time of the data packets received at the destination is divided by the total number of received data packets. I calculate the average end-to-end delay (EED) for packets received by each destination node as follows:

$$EED = \frac{Accumulative\ Sum\ of\ Delay\ of\ Each\ Packet\ Received}{Total\ no.of\ Packets\ received\ by\ Destination}$$

c) Network Layer Control Overhead or Network Routing Overhead: The number of routing control messages that are transmitted per data packet delivered at the destination node is called the Network layer control overhead of a source-destination data flow. Network layer control overhead gives a measure of the efficiency of the protocol by telling how much extra load is put by the proposed method to implement its working in the network.

$$NRO = \frac{Total\ no.of\ Control\ Packets\ in\ Network}{Total\ no.of\ Control\ Packets\ in\ Network+Total\ no.of\ Data\ Packets}$$

d) Throughput: Total amount of packets which is received by a destination node is the measure of Throughput. It is measured in byte/sec or bit/sec. High throughput is highly desirable for any routing protocol.

V. MODELING OF A MANET IN EXata

To simulate a MANET while choosing a suitable routing protocol in the EXATA platform, we need to design a virtual network environment. To complete the empirical study, EXATA version 2.0 can be chosen which supports a total of six MANET routing protocols: AODV, DSR, GRP, OLSR, OSPFv3, and DYMO. We can also design a MANET with routing protocol TORA in OPNET.

VI. SIMULATION PARAMETERS FOR DYMO ROUTING PROTOCOL

Simulation area	1500 X1500 (m x m)
No. of nodes	70
Simulation time	1000 seconds
Traffic Type	TCP
Mobility Model	Random waypoint
Pause time	100 seconds
Mobility (m/s)	10 meter/second
Date Rate (Mbps)	11 Mbps
Communication Traffic	CBR
Simulation duration	200 seconds

Simulation Parameters For Dymo Routing Protocol

VII. PROPOSED ALGORITHM FOR DYMO ROUTING PROTOCOL

Variable used in the Algorithm:

'S':: Source node

'D':: Destination node

'Int_node':: Intermediate node

'R_buf':: RREQ message buffer

'n_rreq':: noise value of received RREQ message

'RT ':: Routing table of a node

```
    if S got data packet for D then
        if S not have route for D in its RT then
            S starts the N-DYMO protocols route discovery process;
        else
            S send packet to next-hop towards destination node D;if
          Receive a fresh RREQ or duplicate message then
                Physical layer of Int_node calculates the sinr and add
            it in the INFO field of RREQ message;Int_node store
            the RREQ message in its R_buf and set the timer if it's
            fresh RREQ;
           When Ti expire node Int_node extract the RREQ with the highest noise;Node
           Int_node rebroadcast the extracted RREQ and discard the R_buf;
           end
           if D receives the RREQ message then
              Int_node store the RREQ message in its R_bufand set
          the timer if it's fresh RREQ;
          When Ti expire node Int_node extract the RREQ with the highest SNR ;D gets the
          pervious hop address of the extracted RREQ message;
          D creates a RREP message and sends it towardsS using
          the previous hop selected in last step;
           End
           if S receives the RREP message then
          S updates its RT and sends the buffered data packet to D;end
  end
end
```

VIII. SILENT FEATURES OF THE PROPOSED METHOD

a) Finds accurate routing path between source to destination using noise factor

b) Reduces routing time of data transmission in DYMO routing protocol.

c) Increased network performance of data transmission in DYMO routing protocol.

d) Study on Dynamic on-demand routing protocol for MANET environments.

e) Study on the strategy of N-DYMO-MANET routing protocol which has shown better performance than other routing protocols AODV, DSR, DYMO.

f) Increased link stability of Routing path with DYMO Routing Protocol.

IX. CONCLUSION

In this work, we have proposed an efficient route discovery process that uses the link quality under consideration at each step during its reactive route discovery process. The proposed N-DYMO protocol shows that it is more effective for data transmission in moderate mobility and congested network than the traditional routing protocols in MANETs. The proposed Noise-based DYMO routing (N-DYMO) protocol uses the received signal power, interfering signal power, and noise over a link to identify whether it is a stable radio link or not during the route discovery process. We can analyze the proposed work with the help of simulation results that are generated using the well-known network simulator called EXata.

The results are generated on a large number of scenarios with various parameter values to show their effectiveness in all kinds of situations. Therefore, in the end, the path which is selected for the data transmission is the one that consists of radio links that have lower interference and low noise in conjunction with high received signal strength. Due to this, the possibility that the selected route will break sooner in the future during data transmission decreases.

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