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Improved Proactive Source Routing Protocol Based Broken Link Management System for MANET

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Abstract:

The network layer has received a lot of attention while conducting research on MANETs. Unlike wired networks, a Message transmitted in a wireless network may be over heard by nodes which do not intend to receive the Message thereby resulting in interference. Thus one of the main goals of wireless networking is to make the wireless links as good as wired links. Opportunistic data forwarding represents a promising solution. However it has not been widely used in mobile ad hoc networks because of the absence of an efficient routing scheme with strong source routing capability. In order to support opportunistic data forwarding in MANETs, EPSR (Enhanced Proactive Source routing) has been proposed which can maintain more network topology information to facilitate source routing so that Message can be properly routed to the destination. Moreover it has much smaller overhead when compared to proactive protocols. It yields better Message deliver fraction and lesser delay when compared to the existing protocols. The tests are done using computer simulation in Network Simulator 2 (ns-2) which indicates that EPSR is better when compared to existing protocols.

Key word:

source routing, proactive, reactive, MANE.

Introduction:

In mobile ad-hoc networks there is no infrastructure support and no centralized administration. Thus a node destined to receive a Message might be out of range of a node which is transmitting the Message. There might be many intermediate nodes present between the source and destination node. As all the nodes may not be within the transmission range of each other, thus they require other nodes to forward data .Considering this a routing procedure is always needed to find a path so as to forward the Messages appropriately between the source and the destination in such a manner that a Message correctly reaches the required destination. However in the case of ad-hoc networks, each node must be able to forward data for other nodes considering the problems that arise due to dynamic topology which is unpredictable connectivity changes. A routing protocol governs the way that two communication entities or nodes exchange information or Messages. It helps in establishing a route from source to destination, makes decision in forwarding the Message to next node and also helps in maintaining route or recovery in case of route failure. Many routing protocols have been proposed earlier to meet different objectives.

Related works:

Larsson [3] proposed a four-way handshake approach as the coordination protocol in his Selection Diversity Forwarding (SDF). In SDF, if a node has a Message to transmit, it just broadcasts the Message to every neighbour. Then, every neighbour overhearing the Message successfully will send back an ACK with their local information to the transmitter. The transmitter makes a decision based on the ACKs and sends a Forwarding Order (FO) to the best forwarder candidate.

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Once the selected relay node receives the FO, it will send the Forwarding Order ACK (FOA) back to the transmitter and then proceed next forwarding. This process continues until the final destination is reached. However, the ACKs and FOA may get lost in the wireless environment, and either one loss will lead to unnecessary retransmissions. The other is that such a gossiping mechanism wastes a good deal of resources and introduces more delay. Its overhead needs to be significantly reduced before it can be implemented in practical networks.

In EXOR[5] ,when a source node has a Message that it wishes to deliver to a distant destination, the source broadcasts the Message. Some sub-set of the nodes receives the Message. The nodes run a protocol to discover and agree on which nodes are in that sub-set. The node in the sub-set that is closest to the destination broadcasts the Message. Again, the nodes that receive this second transmission agree on the closest receiver, which broadcasts the Message. This process continues until the destination has received the Message..Even though, the MAC sub layer can determine the actual next-hop forwarder to better utilize the long-haul transmissions, However in order to support opportunistic data forwarding in a mobile wireless network as in ExOR, an IP Message needs to be enhanced such that it lists the addresses of the nodes that lead to the Message's destination. This requires a routing protocol where nodes see beyond merely the next hop leading to the destination

OLSR[4] operates as a table driven, proactive protocol, i.e., exchanges topology information with other nodes of the network regularly. Each node selects a set of its neighbour nodes as "multipoint relays" (MPR). In OLSR, only nodes, selected as such MPRs are responsible for forwarding control traffic, intended for Diffusion into the entire network. MPRs provide an efficient mechanism for flooding control traffic by reducing the number of transmissions required.Even though OLSR is an optimization over LS routing protocols and it could support source routing, it includes interconnectivity information between remote nodes, which is hardly useful for a particular source node, and this incurs prohibitively large overhead which is fairly high for load sensitive MANETs. DSR[12], however, takes a different approach to on demand source routing. In DSR, a node employs a path search procedure when there is a need to send data to a particular destination. Once a path is identified by the returning search control Messages, this entire path is embedded in each data Message to that destination. Thus, intermediate nodes do not even need a forwarding table to transfer these Messages. Because of its reactive nature, it is more appropriate for occasional or lightweight data transportation in MANETs. If we wish to support opportunistic data forwarding in a MANET with constantly active data communication between many node pairs, the reactive nature of DSR renders it unsuitable. DSR also has a long bootstrap delay and are therefore not efficacious for frequent data exchange, particularly when there are a large number of data sources.AODV [14] allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication. AODV allows mobile nodes to respond to link breakages and changes in network topology in a timely manner. When links break, AODV causes the affected set of nodes to be notified so that they are able to invalidate the routes using the lost link. Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV. These message types are received via UDP, and normal IP header processing applies. This means that such messages are not blindly forwarded.As long as the endpoints of a communication connection have valid routes to each other, AODV does not play any role. When a route to a new destination is needed, the node broadcasts a RREQ to find a route to the destination.

AODV has not been designed for source routing; hence, it is not suitable for opportunistic data forwarding. The reason is that every node in these protocols only knows the next hop to reach a given destination node but not the complete path.Path finding algorithms[15] eliminate the counting to infinity problems by using the predecessor information. Predecessor information can be used to infer an implicit path to a destination. Using this path information, routing loops can be detected. However ,the route update strategy as in the PFA, where routing updates are triggered by topology changes is reasonable for the PFA in the Internet, where the topology is relatively stable, but this turns out to be fairly resource demanding in MANETs because of the amount of the information stored and exchanged.

Design of Enhanced Proactive Source Routing Protocol:

The main aim was to develop a routing protocol which could support opportunistic routing in such a manner that it can maintain entire topology information to correctly

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route Message from source to destination Moreover, the overall overhead should be comparatively low when compared to previous routing protocols. The Messages should be successfully delivered to the destination with minimum delay and minimum Message loss. The EPSR (Enhanced Proactive Source routing) protocol proposed in order to meet the objective. In EPSR, every node maintains a breadth-first spanning tree (BFST) of the entire network rooted at itself. The nodes periodically broadcast the tree structure to their best knowledge in each iteration. Based on the information collected from neighbours during the most recent iteration, a node can expand and refresh its knowledge about the network topology by constructing a deeper and more recent BFST. This knowledge will be distributed to its neighbours in the next round of operation On the other hand, when a neighbour is deemed lost, a procedure is triggered to remove its relevant information from the topology repository maintained by the detecting node .As source routing is taking place, each node can update the details about neighbour nodes and filter the unnecessary Messages. In case of any link failure, an immediate link failure detection technique is required so that minimum Message loss occurs.

This can be done by keeping a check on link availability. In order to get the link availability information, a cross layer operation has been used i.e. a node can use the basic CSMA/CA protocol to send the data without any collision. To make communication the CSMA/CA protocol uses the RTS/CTS/ACK sharing. For each data transmission the node need to check the clearance detail from the receiver node by collecting the CTS signal. And if the data is delivered in indented receiver then the sender can get proof of data reception by the acknowledgement sharing. By connecting the MAC layer with the network layer the node can monitor the data delivery. If the data is not delivered or there in no clearance information from the neighbour receiver then MAC layer of sender can know the link is broken. In this way the MAC layer will share this failure information to the network layer. Once the failure message is received in network layer then the routing information of the neighbour and destination which depends on the broken neighbour will be deleted. If the routing table is modified then route has to be refreshed. So the node will then check the destination details with old hop count and if the old hop count is less than half of total route then the intermediate node will start the route searching by broadcasting route request. Due to the proactive nature of our base work, the nodes can get know the destination availability.

So the intermediate node can give the reply back to the node which searches the route to destination. Once reply received the node can update new route and then the data sharing will be done. In case, the node is far away from the destination, then the node will share the route error message to the neighbours about unreachable destination details. And if the error message is received from neighbour then the node will deletes the broken neighbours from the routing table. If the node is source of data Message then the node need to be start the searching process about broken destination So in the proposed work the reactive nature has been added to a proactive routing protocol to rebuild instant route. This novel technique can improve the QOS in MANET when compared to proactive routing. A tree-based routing protocol which has been put forward has been inspired from OLSR and PFA. In order to reduce the communication overhead incurred by PSR's routing agents and make EPSR more suitable for MANETs , the following strategy is adopted:

A combined route update strategy is adopted that takes advantage of both "event-driven" and "timer-driven" approaches. Specifically, nodes would hold their broadcast after receiving a route update for a period of time. If more updates have been received in this window, all updates are consolidated before triggering one broadcast. Even though each node has the full-path information to reach all other nodes, for it to have a very small footprint, EPSR's route messaging is designed to be very concise. It uses only one type of message, i.e., the periodic route update, both to exchange routing information and as hello beacon messages. Rather than packaging a set of discrete tree edges in the routing messages, the messages include neighbour information in the form of hops.

System Architecture:

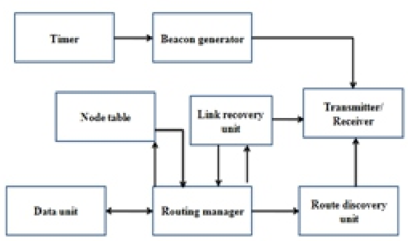

Figure 1

Timer: It is used to create periodic triggers.

Beacon generator: Based on the triggering the beacon generator will send the beacon message outside by using the transmitter.

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Data unit: The data unit will generate the data Message.

Routing manager: The data Message generated will be forwarded to the routing manager and the routing manager will trigger the route discovery unit based on route availability information.

Link Recovery unit: It recovers the link in a reactive manner whenever a link is found to be broken and informs the routing manager.

Node table: It is a table which is maintained at every node and contains information about its immediate neighbours.

Algorithm

1) Initialize the Hello timer H_{tim}
2) In n node, If $H_{tim}.Exip = True$
    a. Initialize $Table_{neigh}.dst$
    b. If $Filtering = False$
        i. Create the broadcast packet Pkt
            1. $pkt.src = n$
            2. $pkt.type = Hello.Norm$
            3. $n \cup pkt.Path$
            4. Foreach $Nd \in Table_{neigh}$
                a. If $Nd \exists pkt.neigh$
                    i. $Nd \cup pkt.neigh$
        ii. Broadcast pkt
    c. Resched $H_{tim}.Exip = Time_{now} + Rand_{time}$
3) If Pkt recv in node n
    a. If $pkt.type = Hello.Norm$
        i. If pkt not duplicate
            1. $update(Table_{neigh} \leftarrow pkt.info)$
            2. $n \cup pkt.path$
            3. Set time $filtering$
            4. Rebroadcast pkt
    b. If $pkt.type = Hello.Routerecov$
        i. If $Node_{failed} = Node\_active$
            1. Send pkt_reply
        ii. Else
            1. $Table_{neigh} = Table_{neigh} \backslash Node_{failed}$
    c. If $pkt.type = reply$
        i. $update(Table_{neigh} \leftarrow pkt.info)$
4) If $link = Failed$
    a. $Table_{neigh} = Table_{neigh} \backslash Node_{failed}$
    b. Send $Hello.Routerecov$

Result Analysis:

The performance of EPSR is studied using computer simulation with Network Simulator 2 version 2.34 (ns-2). EPSR is compared against OLSR , LPSR which are fundamentally different routing protocols in MANETs . Our tests show that the EPSR offers a high Message delivery fraction when compared to LPSR and OLSR and it has an advantage over delay too when compared to the other two routing protocols. The overhead of EPSR is also low when compared to OLSR. As EPSR provides global routing information at such a small cost, it offers similar or even better data delivery performance.

We select a two-ray ground reflection propagation model in our simulation to present a consistent and comparable result. We select a 1-Mb/s nominal data rate at the IEEE 802.11 links to study the relative performance among the selected protocols.With the default physical-layer parameters of the simulator, the transmission range is approximately 250 m, and the carrier sensing range is about 550 m. We compare the performance of EPSR with that of OLSR and LPSR. The reasons that we select these protocols that are different in nature are as follows. On one hand, OLSR and LPSR are proactive routing protocols. OLSR makes complete topological structure available at each node whereas in LPSR, each node maintains a spanning tree of the network. Similarly EPSR also makes a BFST of entire network available at each node. LPSR and EPSR both support source routing, which do not require other nodes to maintain forwarding lookup tables. In modelling node mobility of the simulated MANETs, we use the random waypoint model to generate node trajectories. In this model, each node moves toward a series of target positions. The rate of velocity for each move is uniformly selected from [0, vmax]. Once it has reached a target position, it may pause for a specific amount of time before moving toward the next position. This mobility model may eventually lead to an uneven node distribution in the network. That is, the nodes' density in the central area of the network may be higher than that at the network boundary. This uneven node distribution coincides with the real case in our daily life.

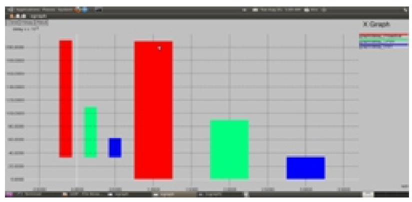

Figure 2: Bar graph depicting PDF against different technologies.

The above figure depicts a bar graph which compares Message delivery fraction of the three protocols in percentage.PDF is the percentage of the number of delivered data Message to the destination. This illustrates the level of delivered data to the destination. The x-axis represents PDF in '%' while the y-axis represents the technology used. The PDF of EPSR is the highest when compared to the other protocols i.e. proactive and LPSR .This means that by using EPSR protocol, maximum number of Messages can be delivered from source to destination with minimum loss.

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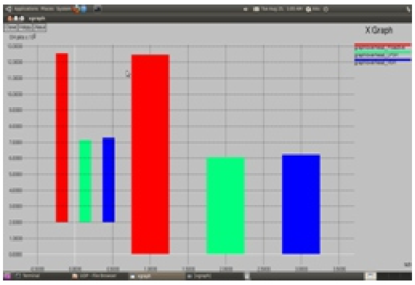

Figure 3: Bar graph depicting the overhead against different technologies

The above figure depicts a bar graph which compares overhead of the three protocols in terms of total number of Messages sent or received. Data which is sent across a wireless network is housed in a data envelope called a Message. Each transmission includes additional information, called overhead, that is required to route the data to the proper location. We can calculate network overhead by sending a fixed-size data transmission across the network and observing the number of extra bytes of data transmitted for the action to be completed.

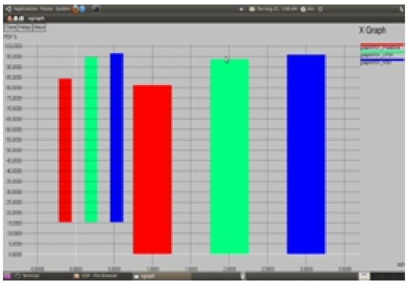

Figure 4: Bar graph depicting the delay against different technologies

The above figure depicts a bar graph which compares delay of the three protocols in seconds. The delay specifies how long it takes for a Message to travel across the network from one node to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. The x-axis represents the delay in seconds while the y-axis represents the technology used. The delay of EPSR is the lower when compared to both the protocols. The reason is the reactive nature of link recovery mechanism.

Conclusion and future work:

This work has been motivated by the need to support opportunistic data forwarding in MANETs.A protocol was required which could provide more topology information than DVs but must have significantly smaller overhead than LS routing protocols; even the MPR technique in OLSR would not suffice. Thus, a tree based routing protocol i.e. EPSR has been put forward where each node has the full-path information to reach all other nodes. However it has a small footprint. One of the main objectives is to transmit the Message from source to destination with minimum loss or maximum Message delivery fraction .Another objective is to transmit the Message with minimum delay which has been achieved to some extent. However, some effort has to be put in reducing overhead in order to improve Message delivery especially in position based routing. We have tested our system with TCP protocol, while some other researcher doing the same with UDP.

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