A Heuristic Approach for Link Quality Establishment and Reduced Re-routing Time in WSN using MPR Algorithm

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Abstract— In WSN MANET's encounters the link breakups when the node moves from one position onto next position, and forms the dynamic topology consequently. Hence the link constraint is an essential hassle with MANET's. Whenever the node breaks its link while moving, the routing protocol has to generate alternate link with its one hop neighbour node, thus establishing alternate path. This refers to increase the latency in the network which is referred as retransmission. In this paper the OLSR routing protocol is used to establish the alternate links when the nodes experience the frequent link breaks. The OLSR maintains the link quality of the nodes which are in the one and two hop neighbour distance. This protocol maintains two main tables 1) Neighbour table 2) Topology table. These two main tables give the functionalities in establishing routes to known destinations. The objective of the proposed system is to support higher PHY rate when the packet size is more. Second, MPR is used to select the best one hop neighbour link to reduce the latency. Further, to increase the network lifetime and to conserve the energy S-MAC protocol is used to send nodes in sleep mode, when there is no transmission in the network.

Key words: Wireless sensor network, MANET, Routing, Rerouting Time

I. INTRODUCTION

MANET's are formed in large area, and it is dynamic in nature. Due to its dynamic nature the routing is a challenging task. Ad-hoc network is autonomous network and its working is based on infrastructure less or centralized authority. If the network topology is dynamic, this leads to frequent breakup of the routes, thus affecting the packet delivery ratio to the destination. Moreover the nodes are dependent on the limited battery power. Power shortage in any node may result in network partitioning. Routing is the key functionality for directing communication over large networks. The primary task of any routing protocol is to discover and maintain routes to needed network destinations. The routing protocols for ad hoc networks can be divided into two groups, proactive and reactive. Proactive routing refers to the condition that whenever a node has some data for a particular destination it can be transmitted immediately. On the other hand reactive routing protocol determines the routes as and when it is required by a node in the network. Link break is a common characteristic of MANET due to dynamic topology [12]. In such cases routing protocol has to find alternative paths. The time period before new paths are found is referred to as the rerouting interval, and the duration of rerouting interval is referred as rerouting time.

During the rerouting interval, stale routes exist over the link that has been broken. Rerouting can only take place after the routing protocol has detected that the link is broken. In fact, a significant part of the rerouting time is associated with the detection of the link break.

In summary, the rerouting time due to link breaks depends on the time to carry out the following processes:

- Detection of a link break
- The emptying of all stale packets from the output queue
- Network-wide link-state announcement to establish new paths.

For a good routing protocol, throughput and packet delivery ratio should be high where as average delay or rerouting time should be less. Unfortunately nodes in MANETs are limited in energy, bandwidth. These resources constraints pose a set of non trivial problems; in particular, routing and flow control. In Energy constrained operations, it is important to save energy which results in improvement in network lifetime. The routing protocol has to designed in such a way that it works effectively in energy constrained applications.

The major contributions in this paper are:

1) We identify the inefficiency of previous sender selection algorithms and devise more accurate metric about establishing the link quality information by using MPR algorithm, which effectively reduces transmission collisions and transmission latency.
2) In Energy constrained operations, it is important to save energy which results in improvement in network lifetime. Hence S-MAC protocol is used to conserve energy for WSN nodes.

II. PROBLEM DEFINITION

The problem in Wireless Sensor Network is that sensor nodes are deployed in open environment, thus the battery is the major console for all the sensor nodes. The radio of the node consumes more energy. In Mobile Ad hoc Network (MANET) all the nodes are mobile in nature having limited battery capacity that is called energy. Because of the dynamic behavior of network link are not maintained for long time. All nodes in network are energy dependent and efficient energy utilization is one of the important issues in MANET. During the rerouting interval, stale routes exist over the link that has been broken. Rerouting can only take place after the routing protocol has detected that the link is broken.

III. RELEATED WORK

Nabendu Chaki, [5] A new QoS algorithm for mobile ad hoc network has been proposed. The proposed algorithm combines the idea of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) protocol to identify multiple stable paths between source and destination nodes. Dr.P.Sheik Abdul Khader [9] A mobile Ad-hoc network

(MANET) is a dynamic multi hop wireless network established by a group of nodes in which there is no central administration. Due to mobility of nodes and dynamic network topology, the routing is one of the most important challenges in ad-hoc networks. Several routing algorithms for MANETs have been proposed by the researchers which have been classified into various categories, however, the most prominent categories are proactive, reactive and hybrid. K. Øvsthus, P. Engelstad, and Ø. Kure [11] In a MANET network where nodes move frequently, the probability of connectivity loss between nodes might be high, and communication sessions may easily loose connectivity during transmission. The routing protocol is designed to find alternative paths in these situations. This rerouting takes time, and the latency is referred to as the rerouting time. This paper investigates the rerouting time of proactive routing protocols and shows that the rerouting time is considerably affected by queuing. Simulations and analysis are conducted to explore the problem.

IV. PROPOSED MODEL

A. *Optimized Link State Routing Protocol (OLSR):*

OLSR is a proactive routing protocol for mobile ad hoc networks. The protocol inherits the stability of a link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature. OLSR is an optimization over the classical link state protocol, tailored for mobile ad hoc networks [1]. OLSR minimizes the overhead from flooding of control traffic by using only selected nodes, called MPRs, to retransmit control messages. This technique significantly reduces the number of retransmissions required to flood a message to all nodes in the network. Secondly, OLSR requires only partial link state to be flooded in order to provide shortest path routes. The minimal set of link state information required is that all nodes, selected as MPRs, must declare the links to their MPR selectors. Additional topological information, if present, may be utilized for redundancy purpose.

OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission. Furthermore, as OLSR continuously maintains routes to all destinations in the network, the protocol is beneficial for traffic patterns where a large subset of nodes are communicating with another large subset of nodes, and where the source, destination pairs are changing over time. The protocol is particularly suited for large and dense networks, as the optimization done using MPRs works well in this context. The larger and more dense a network, the more optimization can be achieved as compared to the classic link state algorithm.

OLSR is designed to work in a completely distributed manner and does not depend on any central entity. The protocol does not require reliable transmission of control messages, each node sends control messages periodically, and can therefore sustain a reasonable loss of some such messages. Such losses occur frequently in radio networks due to collisions or other transmission problems.

Also, OLSR does not require sequenced delivery of messages. Each control message contains a sequence number which is incremented for each message. Thus the recipient of a control message can, if required, easily identify which information is more recent, even if messages have been re-ordered while in transmission. Furthermore, OLSR provides support for protocol extensions such as sleep mode operation, multicast-routing etc. Such extensions may be introduced as additions to the protocol without breaking backwards compatibility with earlier versions. OLSR does not require any changes to the format of IP packets. Thus any existing IP stack can be used as the protocol only interacts with routing table management.

B. *Multipoint Relays*

The idea of multipoint relays is to minimize the overhead of flooding messages in the network by reducing redundant retransmissions in the same region. Each node in the network selects a set of nodes in its symmetric 1-hop neighborhood which may retransmit its messages. This set of selected neighbor nodes is called the "Multipoint Relay" (MPR) set of that node. The neighbors of node N which are not in its MPR set receive and process broadcast messages but do not retransmit broadcast messages received from node N.

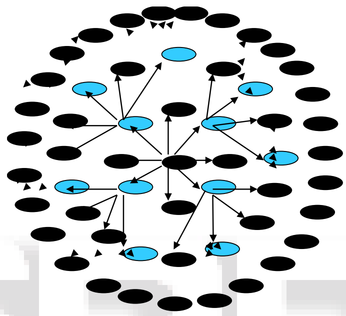

Fig. 1:Multipoint Relays

Each node selects its MPR set from among its 1-hop symmetric neighbors. This set is selected such that it covers (in terms of radio range) all symmetric strict 2-hop nodes. The MPR set of N, denoted as MPR (N), is then an arbitrary subset of the symmetric 1-hop neighborhood of N which satisfies the following condition: every node in the symmetric strict 2-hop neighborhood of N must have a symmetric link towards MPR (N). The smaller a MPR set the less control traffic overhead results from the routing protocol. Each node maintains information about the set of neighbors that have selected it as MPR. This set is called the "Multipoint Relay Selector set" (MPR selector set) of a node. A node obtains this information from periodic HELLO messages received from the neighbors.

A broadcast message, intended to be diffused in the whole network, coming from any of the MPR selectors of node N is assumed to be retransmitted by node N, if N has not received it yet. This set can change over time (i.e., when a node selects another MPR-set) and is indicated by the selector nodes in their HELLO messages.

C. *MPR Algorithm*

The node with maximum reach-ability is selected as MPRs. The node is MPR and that if and only neighbor can provide the only reach-ability to some nodes in the 2-hop neighbor list. Each node has its MPR set and will broadcast its MPR information in the periodic update packets. When propagating the periodic update packets, only the MPRs forward update packets. The following terminology are used in describing the MPR selection

N: represents the subset of neighbors of the node.

N2: represents the set of 2-hop neighbors of the node

D(y): represent the degree of a 1-hop neighbor node y (where y is a member of N). It is defined as the number of symmetric neighbors of node y, excluding all the members of N and excluding all the members of N and excluding the node performing the computation. The fig 3.2 represents the flow of the MPR Selection in OLSR.

The Proposed algorithm is as follows:

1) Step 1: Calculate the one-hop, N and two-hop neighbors, N2 for the nodes.
2) Step 2: Calculate the degree for each node, D(y) where y is a member of N, for all nodes in N
3) Step 3: Find the one-hop neighbors which provides reach ability for nodes in two-hop neighbors and select those nodes as MPRs. Remove those covered nodes in two-hop neighbors
4) Step 4: If there is no node in N2, then end. Else go to step 5.
5) Step 5: Recalculate the degree for all the nodes in N and select the one with least degree
6) Step 6: If there is only one node with smallest degree, then delete that node from N. Then again calculate the degree for all nodes in N2 and go to step 3.
7) Step 7: If two nodes have the same degree as in step 6, then proceed as follow
   – Find all the two-hop neighbors that are covered by y
   – Find all node in N that could cover any nodes found in step a.
   – Calculate the number of nodes covered by nodes of step b
   – Select the one that has the larger number of count
8) Step 8: Delete the selected node from N. Recalculate D(y) of all nodes in N2 and go to step

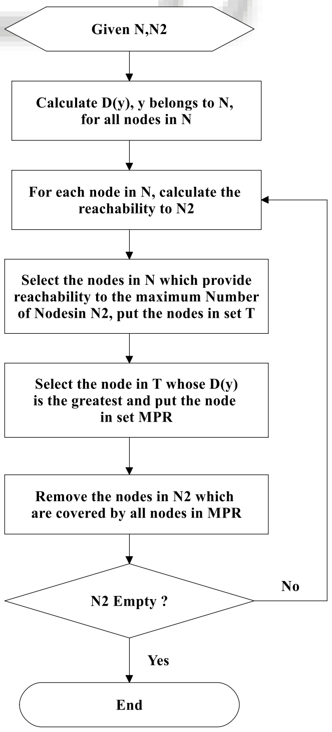

Fig. 2: Flow chart of the MPR selection

D. Topology Information

In order to exchange the topological information and to build the topology information base the node that was selected as MPR need to sent the topology control (TC) message. The TC messages are broadcasted throughout the network and only MPR are allowed to forward TC messages. The TC messages are generated and broadcasted periodically in the network.

The TC message is sent by a node in order to advertise own links in the network. The node must send at least the links of its MPR selector set. The TC message includes the own set of advertised links and the sequence number of each message. The sequence number is used to avoid loops of the messages and for indicating the freshness of the message, so if the node gets a message with the smaller sequence number it must discard the message without any updates. The node must increment the sequence number when the links are removed from the TC message and also it should increment the sequence number when the links are added to the message. The sequence numbers are wrapped around. When the nodes advertised links set becomes empty, it should still send empty TC messages for specified amount of time, in order to invalidate previous TC messages. This should stop sending the TC messages until it has again some information to send.

The size of the TC message can be quite big, so the TC message can be sent in parts, but then the receiver must combine all parts during some specified amount of time. Node can increase its transmission rate to become more sensible to the possible link failures. When the change in the MPR Selector set is noticed, it indicates that the link failure has happened and the node must transmit the new TC message as soon as possible.

E. Routing Table Calculation

The node maintains the routing table, the routing table entries have following information: destination address, next address, number of hops to the destination and local interface address. Next address indicates the next hop node. The information is got from the topological set (from the TC messages) and from the local link information base (from the Hello messages). So if any changes occur in these sets, then the routing table is recalculated. Because this is proactive protocol then the routing table must have routes for all available nodes in the network. The information about broken links or partially known links is not stored in the routing table.

The routing table is changed if the changes occur in the following cases: neighbor link appear or disappear, two hops neighbor is created or removed, topological link is appeared or lost or when the multiple interface association information changes. But the update of this information does not lead to the sending of the messages into the network. For finding the routes for the routing table entry the shortest path algorithm is used.

F. Sleep Scheduling of S-MAC

Energy is the major constraint in WSN, to increase network lifetime of the nodes, conservation of the energy has to be done. S-MAC protocol is the one which reduces the unnecessary consumption of the node energy. Thus saving energy of the node and helps in prolong the network. The

SMAC modes are active and sleep mode. The synchronous flags SYNC commands are issued to send nodes to sleep and to awake the nodes. Duty cycles are assigned to send nodes to sleep in different rounds. When the node are in active state the sensor node radios are ON. When there is no transmission between the nodes while in the active state, the energy is wasted. By using duty cycle data loss can be prevented. The SMAC states when the node receives the synchronous flags from the SMAC protocol, which makes the nodes to go sleep and awake states [4].

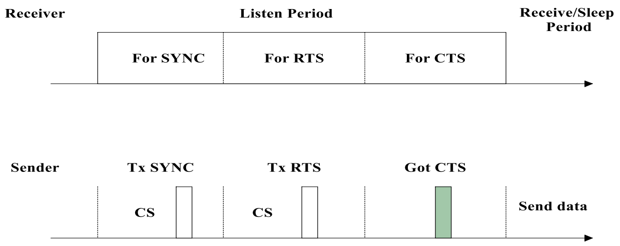

Fig 3: Phases of Listen and Sleep of a node

V. Evaluation Metrics

In this section, the simulation is done on NS-2.35 (Network Simulator tool) and the simulation results of OLSR are compared with AODV and OLSR with S-MAC. The simulation parameters are specified in Table.1

Parameters	value
Number of Nodes	10,20,30
Topology Area	1500 x 1500 m
Traffic Type	CBR
Packet Size	512 bytes
Mobility speed	10m/s
Mobility model	Random waypoint
Transmission range	250m
MAC- Type	802.11
Routing Protocol	OLSR and AODV

Table 1: Simulation Parameters

A. Simulation Results

1) Normalized Routing:

It represents the ratio of the control packets number propagated by every node in the network to the data packets number received by the destination nodes. Fig.4 shows the comparison of Normalized routing of OLSR and AODV. As network size increased the normalised routing in OLSR is less when compare to AODV.

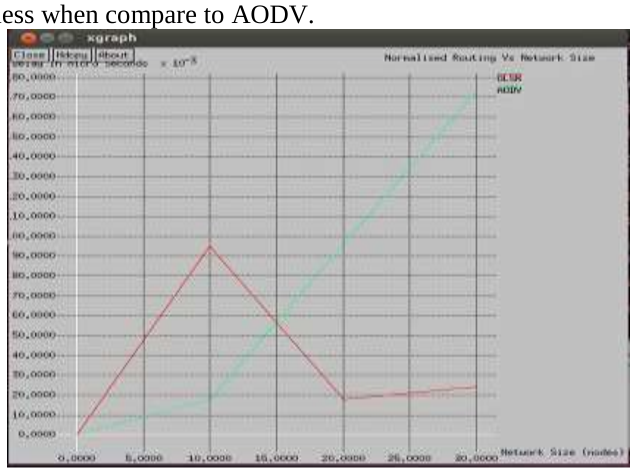

Fig 4: Comparison of Normalized routing in OLSR and AODV

2) Throughput:

It is the amount of data per time that is delivered from to other via a communication link. Fig.5 represents the comparison of Throughput in OLSR and AODV and throughput are measured in terms of kbps for different network size, as the nodes increases the average throughput increases and the OLSR throughput is more as compared to AODV.

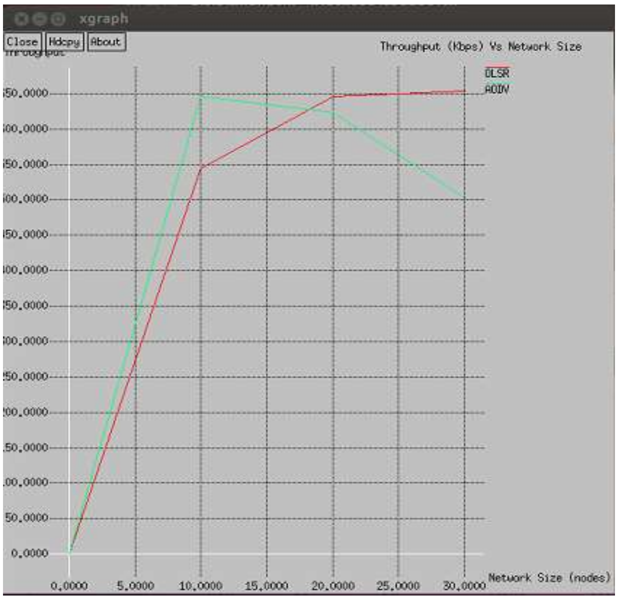

Fig 5: Comparison of Throughput in OLSR and AODV

3) Energy utilization:

Energy utilized by Individual nodes varies with respect to the distance between the transmitter and the receiver and the size of the packet of data. Fig.6 represents the comparison of energy consumption for different node size in OLSR, AODV and OLSR with S-MAC. As the node increases the uitlization of energy were more in OLSR when compare to AODV.

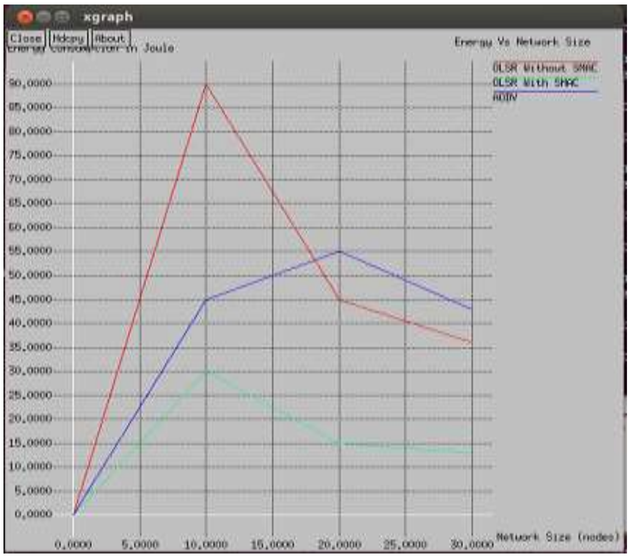

Fig 6: Comparison of Energy utilization of OSLR, AODV and OLSR with S-MAC

VI. Conclusion

Re-routing time is an important performance measure in MANET's where network topology is dynamic and connectivity between nodes is disrupted frequently. OLSR provides the link establishment when the break is detected in the network. The performance of OLSR in establishing alternate links and reduced rerouting time in the network is carried out in NS-2 simulation. We show that the rerouting time is reduced. And simulation result is compared with other routing protocols. Further, the use of S-MAC protocol conserves the node energy, thus increases the network lifetime.

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