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AN EFFICIENT MULTI-CONSTRAINED FEASIBLE PATH SELECTION FOR MANET

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Abstract- Quality-of-service (QoS) routing in an Ad-Hoc network is difficult because the network topology may change constantly and the available state information for routing is inherently imprecise. This paper proposes a method for multi-constrained feasible path selection for MANET. We introduce the composite function which allows OLSR to find the feasible path in case of multiple routes are available to reach the same destination. Combinations of additive and non additive QoS metrics are considered to find the best path. Our simulation results show that the QoS version of the OLSR do improve the Packet Delivery Ratio, Throughput, Normalized control overhead, End-to-End delay and Packet loss but with the increased time complexity.

***Keywords** -MANET,OLSR (Optimized Link State Routing), Multi-constrained QoS Routing.*

I. INTRODUCTION

An Mobile Ad Hoc Network is a set of mobile nodes that are equipped with wireless transmitters and receivers which allow them to communicate each other without the infrastructure. Since there is no infrastructure is used for networking the central administration for the network is not required. Each transmitter has a limited effective range; the nods within the coverage are able to communicate directly otherwise the nodes are communicated through a multi-hop basis. There are number of applications for this type of network. A group of moving soldiers in a battlefield communicates and coordinates with each other. A group of people with portable computers share their data in a conference room without laying cables between them.

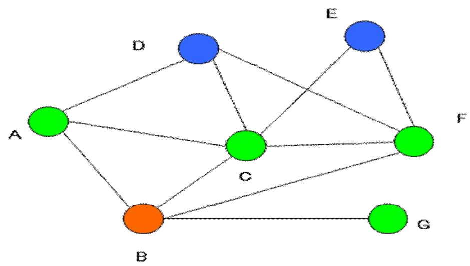
The Optimized Link State Routing Protocol (OLSR) is developed for mobile ad hoc networks which can also be used on other wireless ad-hoc networks. It is a proactive link state protocol, the nodes are maintains the route information in the route table, so routes are available immediately when it is required. The source node will be alerted by the topology whenever the node mobility in the route or changes in the bandwidth then the new route should be identified. Instead of pure flooding to identify the route OLSR uses MPR to reduce the number of the host which broadcasts the information throughout the network. The MPR is a node which is selected such that it covers all nodes that are two hops away. The nodes which are selected as a MPR by some neighbor nodes announce this information periodically in their control messages. In route calculation, the MPRs are used to form the route from a given node to any destination in the network.

A. *Neighbour Sensing*

Each node periodically broadcast its HELLO messages, containing the information about its neighbors and their link status. Each node must detect the neighbor nodes with which it has a direct and bi-directional link. If a node finds its own address in a HELLO message, it considers the link to the sender node as bi-directional.

B. *Multipoint Relay Selection*

Every node in the network selects its own set of MPRs. A set of selected one hop neighbour nodes are the MPRs. This covers all the two hop neighbours. MPRs minimize the flooding of the broadcast messages.



Network example for MPR selection

Node	1 Hop Neighbours	2 Hop Nighbours	MPR(s)
B	A,C,F,G	D,E	C

C. *MPR information declaration*

A Transmission Control message is sent periodically by each node in the network to declare its MPR selector set. i.e the message contains the list of neighbours who have selected the sender node as multi-point relay. The sequence number associated to this MPR selector is also attached to the list. Each node of the network maintains a topology table, in which it records the information about the topology of the network obtained from the TC messages.

D. Routing Table Calculation

To route the packets in the network each node maintains a routing table in the network. The route entries in the routing table consist of destination address, next-hop address, and estimated distance to destination. The entries are recorded in the table for each destination in the network for which the route is known. The routing table is based on the information contained in the neighbour table and the topology table. Therefore, if any of these tables is changed the routing table is recalculated to update the route information.

Quality of Service in MANET is defined as a set of service requirements to be met by the network while transmitting the packets between the source and destination. The measurable specified service attributes are end-to-end delay, bandwidth, packet loss, energy and delay. The QoS metrics can be classified as additive, concave and multiplicative. Bandwidth and energy are concave metric, while cost, delay, and jitter are additive metrics. Bandwidth and energy are concave in the sense that end-to-end bandwidth and energy are the minimum of all links along the path. The end-to-end delay is an additive constraint because it is the accumulation of all delays of the links along the path. The reliability or availability of a link based on some criteria such as link break probability is a multiplicative metric. Finding the best path subject to two or more additive/concave metrics is a complex problem.

The works done so far in MANET for QoS routing consider either only bandwidth or delay. While other important QoS metrics remained untouched. It is thus obvious that the paths that are discovered by these conventional and limited QoS-aware routing protocols without taking all the important QoS parameters into account are not suitable to transmit large amount of data.

II. RELATED WORKS AND PRELIMINARY

A. Related works

Suman Banik [2] proposed a method to utilize the network resources such as bandwidth and energy. Anelise Munaretto [3] introducted the new tailored metric for and adhoc environment. Kamal Oudidi [4] developed the new QOLSR algorithm using composite metrics which selects a more stable MPR. Badis et al. [5] proposed two algorithms for MPRs selection processes in Optimal Path selection in a Link State QoS Routing Protocol where MPRs are chosen based on the largest numbers discovered two-hop neighbours, bandwidth and delay. Jeremie Leguay [6] divided QoS routing with OLSR into two strategies. One is strictly based on MPR selection. The other called QOLSR uses MPR selection and also employs a revised version of TC messages to make QoS information available at the scale of the whole network.

B. Preliminary

A network is modeled by a directed graph G=(V, E) where V is the set of nodes and E is the set of Links. Each link (i,j) Є E is associated with K additive QoS parameters $w_k(i,j)$,k=1,…K, where all the parameters are non negative. The Given K constraints c_k, k=1,…, K the problem is to find a path p from source node *O* to a destination node d such that [7]

$$w_k(p) = \sum_{(i,j)\epsilon p} w_k(i,j) \le c_k \;\; for\; k = 1,2,\ldots K$$

III. PROPOSED SYSTEM

A. An Efficient Multiconstrained Feabilbe Path Selection for MANET

Where the QoS metrics are independent to each other a new composite function p is derived. The composite function p applies the additive and non-additive QoS parameters in Euclidean space with some modifications.

$$f(p) = \frac{1}{\sqrt{K}}\sqrt{\sum_{k=1}^{k}\left(\frac{C_k - w_k}{C_k}\right)^2} + \frac{B_a - B_{\min}}{B_a}, B_a > B_{\min}$$

Consider K is the total number of additive QoS constraints. C_k is the maximum QoS requirement on path p of the k^{th} additive QoS Constraint. W_k is the actual QoS value of the k^{th} additive constraint along the path p, B_a is the available bottleneck bandwidth of path p, B_{min} is the minimum bandwidth required for application. Higher the value of the function f(p) implies longer the overall Euclidean distance from constraint points i.e the path is out of constraint values with minimum resources and hence will be the more suitable one. If there are multiple feasible routes for the same destination then the proposed composite function will be selected.

B. Algorithm for MPR Selection

In the given algorithm G is a graph which is illustrated us G = (V, E), V is the set of nodes and E is the set of Links. N1 is the first hop neighbour and N2 is the second hop neighbour. Node s is the source node which calculates the route and I is an intermediate node. B_i, C_i and F_i are the bandwidth, non-linear cost and the composite function value of the path from node s to i.

1. Create a empty multipoint relay set, MPR(x) = {}
2. Select the 1 hop neighbour nodes in N1 as MPR nodes which provide the only path to reach some 2-hop neighbour nodes to the MPR set MPR(x)
3. While the 2 hop nodes in the N2 which are not yet covered by any one node in the MPR(x) set.

a. Add nodes in N1 to MPR(x) which offer the best feasible 1 hop path in terms of maximum value of p.

b. Mark the 2 hop neighbour as covered.

4. Repeat the above process until all the 2-hop nodes are reachable via at least one of its MPR Nodes.

C. Algorithm for Path Selection Process

Each node maintains a routing table which allows it to route the packets for other destination in the network.

For, G = (V, E), N1 Є V, N2 Є V

$b(p)_{s-1}$ = bottleneck bandwidth on path p

$$c(p)_{s-1} = \max\left[\frac{w_k(p)}{c_k}\right] \quad for\, 1 \le k \le K$$

$$f(p)_{s-1} = \frac{1}{\sqrt{K}}\sqrt{\sum_{k=1}^{k}\left(\frac{C_k - w_k}{C_k}\right)^2} + \frac{B_a - B_{min}}{B_a},\ B_a > B_{min}$$

Step 1: Initially, delete all entries from the routing table

Set $B_1 = b(p)_{s-1}$, $C_1 = c(p)_{s-1}$ and $F_1 = f(p)_{s-1}$

Step 2: For all members in N1, If $B_1 \ge B_{min}$ and $C_1 \le 1$ add i to routing table as the destination node with Bandwidth = B_i, Function value = F_1, hop count = 1.

Step 3: For all members in N2, if there is no entry in the routing table to reach I and $B_i \ge B_{min}$ and $C_1 \le 1$ add I to the routing table as the destination node with Bandwidth = B_i, function value = F1, hop count = 2

Else if ($B_i \ge B_{min}$ and $F_1 > F_{rtable}$)

Delete entry to i in the routing table

Add i to the routing table as the destination node with bandwidth = B_i, Function value = F_1, hop count = 2

Step 4: For all members in the topology set starting when hop count (h) = 2 and increment it each time by 1

If there is no entry in the routing table to reach I and $B_i \ge B_{min}$ and $C_i \le 1$

Add i to the routing table as the destination node with bandwidth = B_i, Function value = F_1,

Hop count = h + 1

Else if ($B_i \ge B_{min}$ and $F_1 > F_{1\ rtable}$)

Delete entry to i in routing table

Add i to routing table as the destination node with Bandwidth = B_i, Function value = F_1,

Hop count = h + 1

D. Simulation Model and Parameters

For simulating the original OLSR protocol and the modified OLSR protocol we have used the OLSR protocol implementation which runs in version 2.29 of the Network Simulator NS2[9]

Table1 Simulation Parameters

Parameters	Value
Software	NS-2 Version 2.29 [9]
MAC Protocol	IEEE802.11
Node's Transmission range	90 m
Topology area	1000 X 1000 m2
Number of nodes	200
Mobility Model	Random way point model
Packet Size	512 bytes
Traffic type	Constant Bit Rate
Link bandwidth	1 Mbps
Routing protocol	OLSR
Hello and TC message interval	1 and 2 respectively
Simulation time	200 seconds
Node mobility speed	0-15 m/s

E. Performance Evaluation Metrics

The performance evaluation aims to assess the improvement achieved in Modified OLSR to find the best path. The evaluation is done using the various metrics like

Average End-to-End delay: The average time required to send the packets to source to destination. The delay parameter will be calculated to improve the selection of best path by the proposed routing algorithm. The average delay is calculated by subtracting "time at which first packet was transmitted by source" from "time at which first data packet arrived to destination". This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times. This metric is crucial in understanding the delay introduced by path discovery.

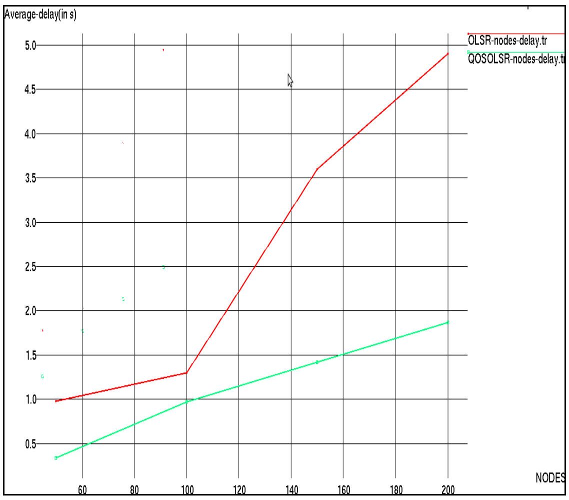


Figure 1: Average End-to-End delay per S-D pair (kbps)

Packet Delivery Ratio: This will be calculated based on number of packets received by the destination divided by number of packets sent by source node. This performance metric will give us an idea of how well the protocol is performing in terms of packet delivery at different speeds using different traffic models.

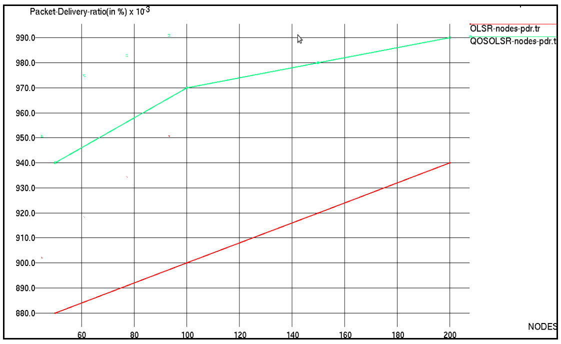


Figure 2: Packet Delivery Ratio (PDR)

Normalized Control Overhead: Ratio of the total number of control overheads to the total number of packets received Here, we analyze the average number of routing packets required to deliver a single data packet. This metric gives an idea about the extra bandwidth utilized by overhead to deliver data traffic.

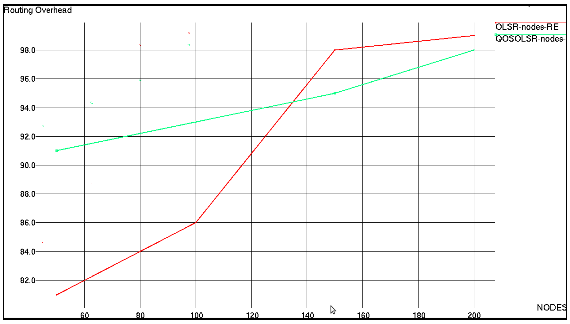


Figure 3: Routing Overhead

Throughput: The amount of data received by the destination during the simulation period. It can be calculated of delivered data packets divided by the total duration of simulation time. We analyze the throughput of the protocol in terms of number of messages delivered per one second.

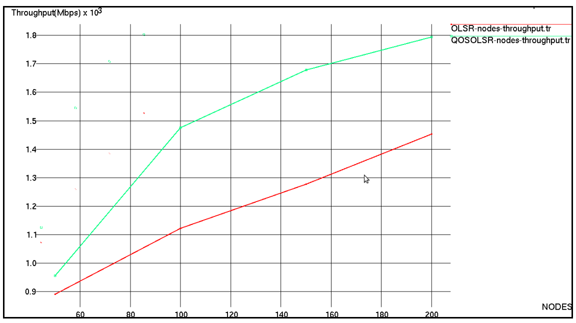


Figure 4: Throughput

Packet Loss: More packet losses may occur in MANET than wired network. The dynamic nature of MANET topology and unpredictable movement of the mobile node imposes a great challenge in ensuring the error free transmission. Packet losses caused by transmission failures, link failures, and network congestion coexist. In MANET, Links fail frequently leading to packet loss or delay in transmission.

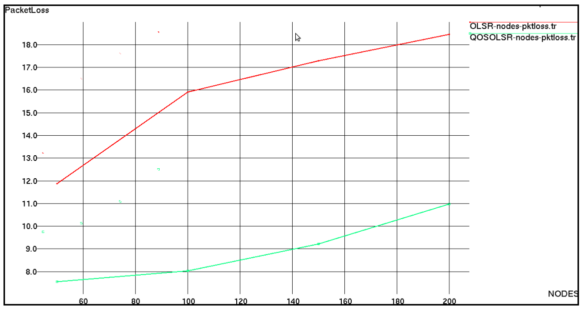


Figure 5: Packet loss

IV. CONCLUSION

In this work we proposed a method to find the multi-constrained feasible path in MANET utilizing the maximum resources available with the nodes. The extended OLSR is made to find the feasible path, because the original OLSR does not support QoS. In case of multiple paths are available to the destination, our composite function will judge the more suitable path. According to the simulation results, our proposed algorithm proves the improvement over the original OLSR protocol with additional time complexity.

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