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Predictive Location-Based QoS Routing with Admission Control in Mobile Ad-hoc Networks

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***Abstract*— This paper is aimed at identifying the issues and challenges involved in providing QoS in MANETs, overcoming these issues by using predictive location based QoS routing with admission control which are required to ensure high levels of QoS, improving bandwidth, throughput and minimizing packet loss rate, end to end delay, jitter, throughput QoS metrics. Distributed Admission Control Mechanism (DACME) applies on the valid route to check whether that route satisfies QoS or not if it satisfies QoS requirement then only route is selected otherwise rejected.The aim here is to improve peer to peer communication in wireless mobile ad hoc networks by identifying the location of mobile node using Predictive Location Based Routing Protocol (PLBRP) and Admission Control mechanism. This project can adapt to applications with bandwidth, delay and jitter constraints .This application proposes optimizations based on interactions between routing, and admission control layers which offer important performance improvements.**

***Index Terms*— Predictive Location Based QoS Routing Protocol (PLQRP), Quality of Service (QoS), Medium Access Control (MAC), QoS Specification (QSPEC).**

I. INTRODUCTION

Quality of service routing is a routing mechanism under which paths are generated based on some knowledge of the quality of network, and then selected according to the quality of service requirements of flows The main goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources are better utilized. The network services can be characterized by a pre specified services requirements such as maximum delay, maximum delay variance (jitter), mini-mum bandwidth and maximum packet loss rate etc. The current ad hoc networks (MANETs) are not able to satisfy the requirements of quality of service (QoS). In Ad-hoc networks, the routing phase plays an important role for improving Quality of Services. There are some challenges faced while providing QoS in MANET due to dynamic network topology, network flow stops receiving QoS provisions due to path breaks so new path must be established, causing data loss and delays. Again link state changes continuously and flow states change over time. There is no central control in Mobile Ad-hoc NETwork. One more challenge is of limited resource availability in ad-hoc network in terms of Bandwidth, battery life, storage, processing capabilities etc.

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II. MOTIVATION

Due to the frequent changes in network topology and the lack of the network resources both in the wireless medium and in the mobile nodes, mobile ad hoc networking becomes a challenging task.

As a result, routing in such networks experiences link failure more often. Hence, a routing protocol that supports QoS for ad hoc networks requires to consider the reasons for link failure to improve its performance. Link failure stems from node mobility and lack of the network resources. Therefore it is essential to capture the aforesaid characteristics to identify the quality of links. Furthermore, the routing protocols must be adaptive to cope with the time-varying low-capacity resources. For instance, it is possible that a route that was earlier found to meet certain QoS requirements no longer does so due to the dynamic nature of the topology. In such a case, it is important that the network intelligently adapts the session to its new and changed conditions. Quality of service means providing a set of service requirements to the flows while routing them through the network. Believe that for mobile ad hoc wireless networks, with time-varying low-capacity resources, the notion of being able to meet specific application requirements such as delay is not credible

III.RELATED WORK

The primary goal of the QoS-aware routing protocols is to determine a path from a source to the destination that satisfies the needs of the desired QoS. The QoS-aware path is determined within the constraints of bandwidth, minimal search, distance, and traffic conditions. Since path selection is based on the desired QoS, the routing protocol can be termed QoS-aware. QoS aware routing protocols like Core Extraction Distributed Ad Hoc Routing (CEDAR), Multipath Routing Protocol (MRP), QoS Multicast Routing Protocol with Dynamic group topology (QMRPD), Ad hoc QoS on-demand routing (AQOR).

IV. PROGRAMMING DESIGN

Let us consider architectural design of PLQRP with admission control system which consists of four different modules viz. Location Prediction by Predictive Location Based Routing Protocol, QoS Routing, Distributed admission control agent and finally comparison of QoS parameters which will generates graphs to prove that this system improves QoS parameters.

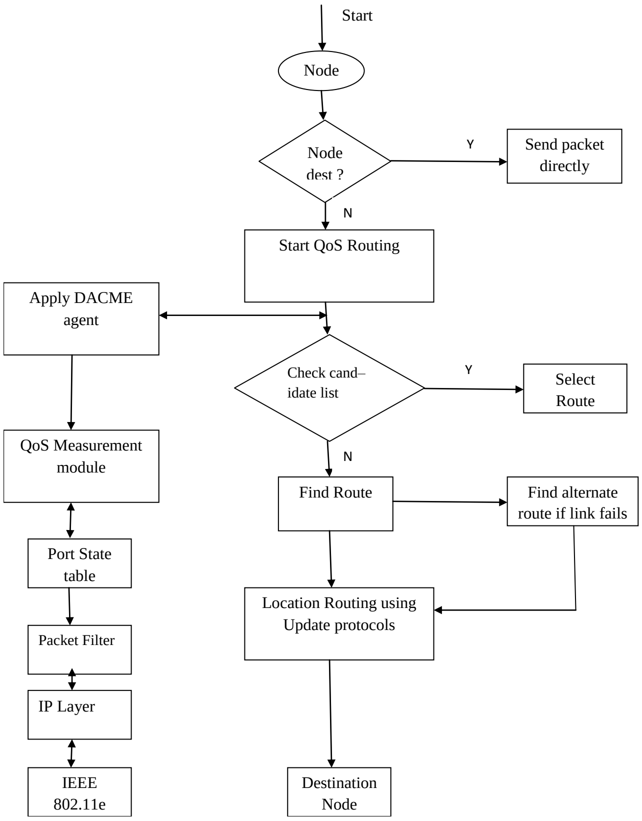

Fig 1. Design Flow Diagram

Algorithm used for PLQRP with admission control in MANET :

Step 1: Generate topology
Step 2: Start flooding information
Each nodes uses 802.11e mac to access channel
A: for every link/node do
B: Exchange neighbor Nodes information.
C: end for
D: send neighbor node information to the gateway
Step 3: Select source node.
Step 4: Establish path from source to destination
Step 5: Start packet transmission.
Step 6: If packet received by node is destination then directly send packet to destination
Step 7: Else qos routing needs to be done
Step 8: In qos routing check candidate nodes from routing table to reach destination else find route from source, nodes receives this message store the sender info and update delay between two nodes.
Step 9: If location routing executes based on receiving signal strength get proper x and y location then compute distance between two nodes and based on coverage also stability and delay between two nodes.
Step 10: It will check four parameters for qos power, range, delay and stability if it matches, update current sequence number else drop the packet.
Step 11: Then destination will send route reply, source receives this reply and start to send data packets.
Step 12: In routing table if next hop node entry not available to reach destination or link failure occurred during data transmission remove node entry in routing table and find alternate next hop to reach destination.
Step 13: When searching route or alternate route use probe packet for end to end path qos measurements in MANET for qos, DACME agent need to run. Here the qos specification is bandwidth, delay, jitter, packet delay ratio and throughput.
Step 14: The application should register with DACME Agent to get benefit with source and destination IP and port address.
Step 15: If this requirement does not meet, DACME will notify this if it is success means DACME agent will do periodic path probing between source to destination to meet the qos metric bandwidth, delay, jitter, packet delivery ratio and throughput.
Step 16: Once the destination receives probe packet it will update statistic table about source at current period then send reply to DACME agent and this agent update BW, delay, jitter and packet delivery ratio.
Step 17: Then DACME agent decides to accept the connection or reject or preserve packet filtering used by all nodes to block the traffic if it is not accepted by the qos measurement.
Step 18: Stop.

PLQRP routing with admission control in MANET has following different modules,

I Location Predictions

There are two types of updates:

1. Type 1 update: A type 1 update is generated periodically. It can be generated with a constant frequency, i.e. the time between successive type 1 updates remains constant. Alternatively, the frequency of the type 1 update can vary linearly between a maximum (f_{max}) and a minimum (f_{min}) threshold, with the velocity v of the node. Consequently, the distance travelled between successive type 1 updates remains constant. This function is illustrated in Figure 2

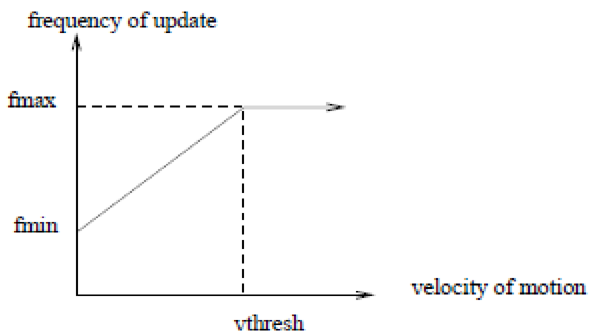

Figure 2. Types 1 update protocol [8]

The update protocol is crucial for distribution of geographical location and resource information. Here consider resources such as battery power, queuing space, processor speed, transmission range, etc.

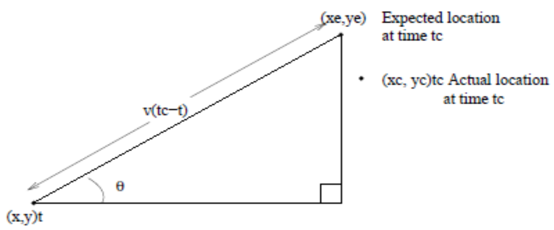

Figure 3. Type 2 update protocol [8]

2. Type 2 update: A type 2 update is generated when there is a considerable

change in the node's velocity or direction of motion. From its recent history (i.e. from recent updates), the mobile node can calculate an expected location that it should be in at a particular instant. The node then periodically checks if it has deviated a distance greater than δ from this expected location. If it has deviated more than a distance δ from its expected location, a type 2 update is generated..

Then, expected location (x_e,y_e) is given by the equations:

$x_e = x+v.(t_e-t)\ \mathrm{Cos}\ \theta$
(1)

$y_e = y+v.(t_e-t)\ \mathrm{Sin}\ \theta$
(2)

If $[(x_e-x_c)^2+(y_e-y_c)^2]^{1/2} > \delta$, then a type 2 update due to significant change in the pattern of motion is generated at the time of checking, i.e. care is taken to see that δ is large enough to prevent the reporting of minor perturbations in direction. Predictions:

When a packet arrives at a node 'a' to be routed to a particular destination 'b', 'a' has to follow a two step process to forward the packet along. The first step is to predict the geographic location of the destination 'b' as well as the candidate next hop nodes, at the instant when this packet will reach the respective nodes. Hence, this step involves a location as well as propagation delay prediction. The location prediction is used to determine the geographical location of some node (either an intermediate node or the destination b) at a particular instant of time tp in the future when the packet reaches it. The propagation delay is used to estimate the value of t_p used in the above location prediction. These predictions are performed based on previous updates of the respective nodes. The second step is to perform QoS routing based on the information, determined in the first step.

I. Location Prediction: Assume that a node moves in a piecewise linear pattern. In other words, assume that between successive update points, the node has moved in a straight line. For a piecewise linear motion pattern and update packets that do not contain direction information, two previous updates are sufficient to predict a future location of the mobile node in the plane.

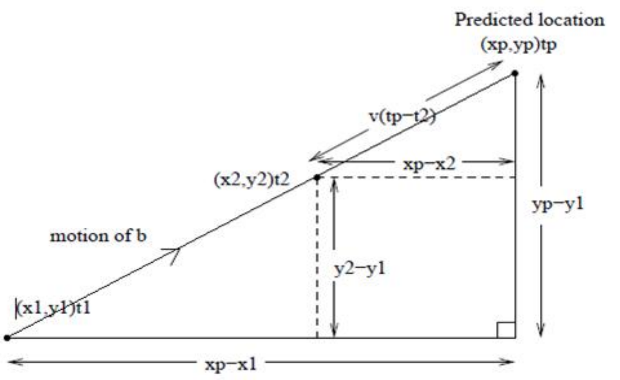

Figure 4. Prediction of future location [8]

Let (x_1, y_1) at t_1 and (x_2,y_2) at t_2 $(t_2>t_1)$ be the latest two updates respectively from a destination node 'b' to a particular correspondent node 'a'. Let the second update also indicate v to be the velocity of b at (x_2,y_2). Assume that a wishes to predict the location (x_p,y_p) of 'b' at some instant t_p in the future. The value of t_p is set by a to current time plus predicted delay for the packet to reach b from a.

From Figure 4, using similarity of triangles:

$(y_2 - y_1) / (y_p- y_1) = (x_2-x_1) / (x_p-x_1)$ (3)

Solving for yp from the above equation,

$y_p = y_1+(x_p-x_1) (y_2-y_1) /(x_2-x_1)$ (4)

Using the above equation, a can calculate yp if it knows xp, which

in turn can be calculated as follows. Using similarity of triangles

again getting:

$y_p - y_2 = (y_2-y_1) (x_p-x_2) / (x_2-x_1)$
(5)

Also, using Pythagoras' theorem,

$(x_p-x_2)^2 + (y_p-y_2)^2 =v^2 (t_p - t_2)^2$
(6)

Substituting for yp - y2 from Equation 5 in the above and solving

for xp, get x_p:

$x_p = x_2+ [(v (t_p – t_2) (x_2 – x_1)) / [(x_2-x_1)^2 + (y_2-y_1)^2]^{1/2}]$ (7)

II QoS Routing

Here algorithm is given for QoS routing and admission control is applied on valid route.

Global stack

/* Here assume function compute_cl which performs location-delay prediction and distributed admission control for each node in the source's proximity list to obtain a list of candidate next hops. */

```
proc QoS routing(src,dest,<qos_requirements>)
 if
valid_routes={};
candlist = (src,<qos_requirements>)
if candlist!= {}
then if dest € candlist
then Directly forward packet to destination;
else foreach c € candlist do
stack = {};
push (stack,c);
apply DACME agent while searching route
find_route(c,dest,<qos_requirements>)
do complete
if complete
if complete
 if valid_routes = {}
 then No route, reject connection;
else Output shortest distance route from valid routes ;
if complete
 proc find_route(start,dest,<qos_requirements>)
cand_list = compute_cl (start,<qos_requirements>);
 if cand_list != {}
 then foreach n € cand_list do
if n ≠ stack
 then push (stack,n)
if n=dest
 then validroutes:=validroutes U stack;
else find route(n,dest,<qosrequirements>);fi
pop(stack);
if complete
do complete
if complete
```

Figure 5 QoS Routing Algorithm

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III Distributed Admission Control Mechanism (DACME)

In order to operate under optimal conditions in IEEE 802.11 based MANETs, it is recommended that all radio interfaces are IEEE 802.11e enabled. In terms of the software required for MANET nodes, the sources and destinations of QoS flows must have a DACME agent [7] running. The rest of the nodes will simply treat DACME packets as regular data packets, being unaware of the mechanism itself. The main elements of DACME are the QoS measurement module and the packet filter. The QoS measurement module is responsible for assessing QoS parameters on an end-to-end path, while the packet filter blocks all traffic that is not accepted into the MANET according to these end-to-end measurements. An application that wishes to benefit from DACME must register itself with the DACME agent, indicating the desired destination IP address and the source and destination UDP ports, along with a QoS specification (QSPEC), stating the requested bandwidth, delay, jitter, packet delay ratio and throughput: (*BR*, *DR*, *JR*, *PDR*, *Th*). If any among the available bandwidth, the end-to-end delay, jitter or PDR values does not meet the application's requirements, DACME will notify this event to the application. Once registration is successfully completed, the QoS measurement module is activated; it will periodically perform path probing between the source and destination. The purpose is to assess if the path can meet the QoS requirements (*QSPEC*), which may be defined in terms of end-to-end bandwidth, delay, jitter, PDR and throughput. The destination agent, upon receiving probe packets, will update the destination statistics table where it keeps per-source information of the packets received during the current probing period. After receiving the last packet of a probe (or if a timeout is triggered), the destination agent will send a reply back to the source DACME agent. The QoS measurement module, upon receiving each probe reply, will update the state of the path using per-connection bandwidth, delay, and jitter flags. Once enough information is gathered, it checks all the registered connections towards that destination, and then decides whether a connection should be accepted, preserved, or rejected, updating the Port state table accordingly. QoS support becomes effective when the packet filter module, according to the port state table, interacts with the IP layer by configuring the TOS header field of packets pertaining to accepted data flows. The IEEE 802.11e MAC must then map the service type defined in the IP TOS packet header field to one of the four MAC access categories that it makes available.

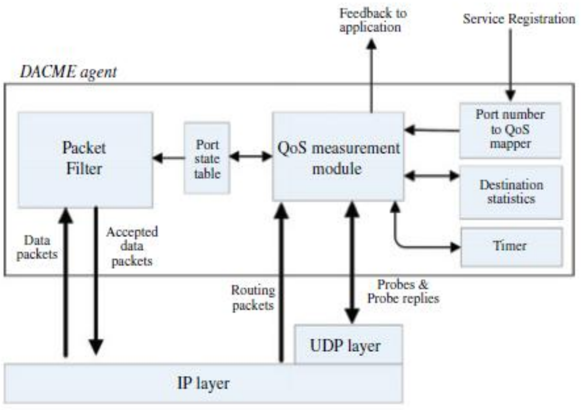

Figure 6. Functional block diagram of the DACME agent. [7]

IV Comparison of graphs between PLQRP without location routing and PLQRP with location aware routing and admission control

In this module graphs are generated which proves that this newly designed system gives better results along with improved quality of service in MANET.

V. SIMULATION RESULT

Following graph shows that by using PLQRP with admission control in MANET improves the results in terms of delay, jitter, PDR and throughput. In simulation four scenarios are considered as 30, 50, 70, 80 and 100 nodes, will get result and from result following graphs are generated which clearly proves that applying DACME along with location prediction gives better throughput and require less delay, jitter as shown in graphs.

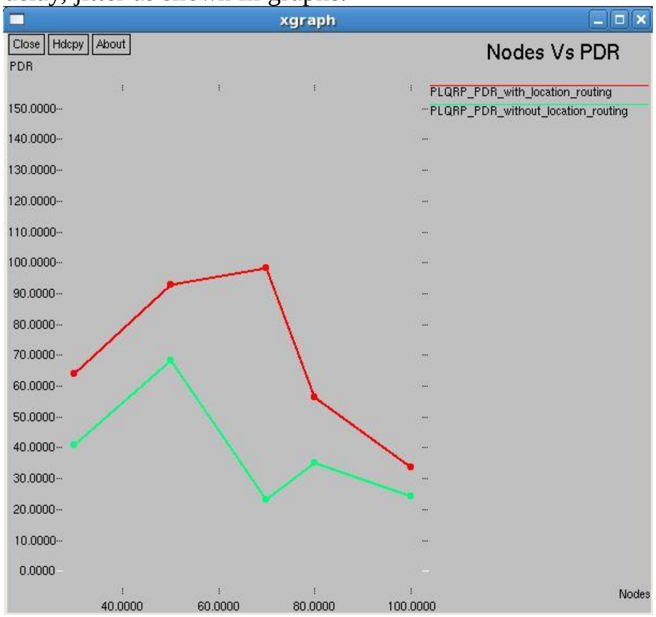

FIG 7: NODES VS PDR

FIG 8: NODES VS DELAY

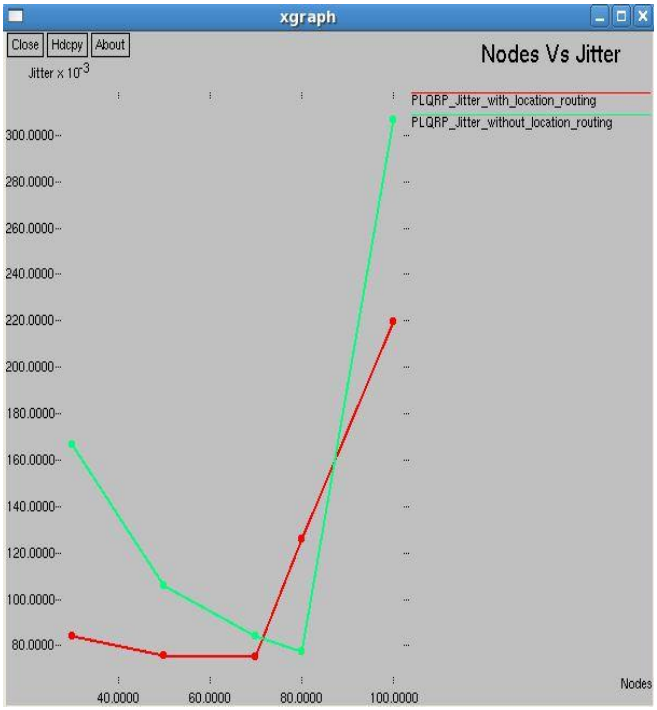

FIG 9 NODES VS JITTER

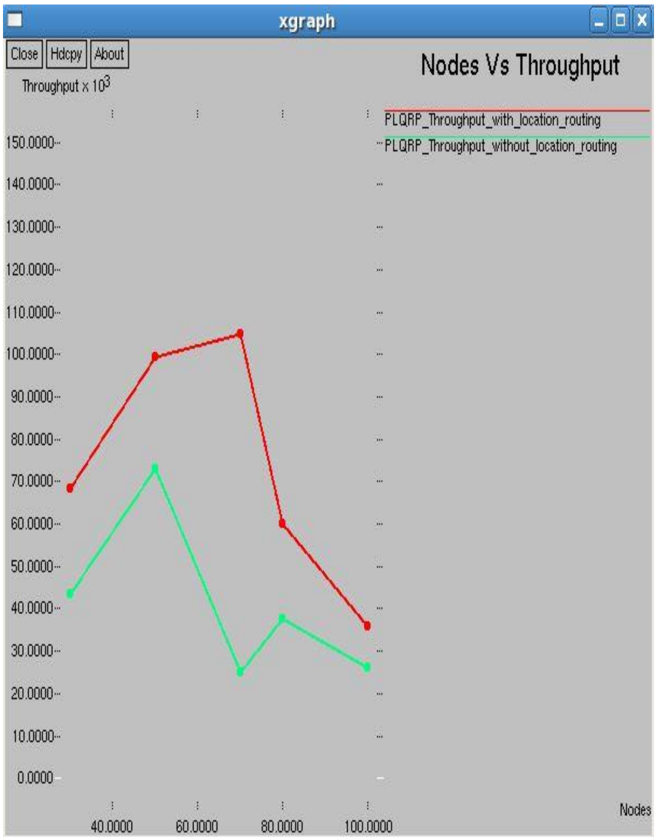

FIG 10 NODES VS THROUGHPUT

VI. CONCLUSION

The performance of PLQRP and admission control and PLQRP without location routing in MANET is considered for five different scenarios as 30 nodes, 50 nodes, 70, nodes, 80 nodes and 100 nodes. Simulation result shows that PLQRP with location routing by applying admission control delivers more packets and gives maximum throughput as compare to PLQRP without location routing.

Packet delivery ratio is highly increased when location of a mobile node is considered as compare to PLQRP without location routing. End to end delay is significantly reduced in PLQRP with location routing scenario. As the number of nodes increased, PLQRP without location routing gives lower end to end delay as compare to PLQRP with location routing. Routing overhead is highly reduced when location of a mobile node is considered and admission control is applied on it as compare to PLQRP without location routing. Throughput is significantly increased for PLQRP with location routing protocol for network scenario with 30, 50, 70, 80 and 100 nodes.

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