An Enhanced Protocol for the evaluation of QOS using collective-path routing protocol in hybrid wireless Networks

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Abstract

In Mobile ad hoc networks (MANET), the quality of service (QoS) depends on the available resources in the network and node mobility, as mobility may result in frequent route failures. Some existing hybrid approach of collective-path routing technique rarely considers QoS metrics for path selection. In this paper, we propose a QoS enhanced hybrid collective-path routing protocol for MANET. In this protocol, topology discovery is performed proactively and route discovery is performed in the reactive manner. In proactive topology discovery phase, each node collects the battery power, queue length and residual bandwidth of every other nodes and stores in the topology information table (TIT). By exchanging the TIT among the nodes, the topology is discovered. When the source node wants to forward the data packet to the destination, it utilizes the reactive route discovery technique where the multiple paths are established using collective-path Dijkstra algorithm. When any intermediate node does not recognize the next 2-hop information from TIT towards destination, the new collective-path route discovery is performed. By simulation results, it is shown that the proposed approach reduces the overhead.

Key words : MANET, Quality of service (QoS), Topology Information Table (TIT), Ad Hoc On-Demand Distance Vector (AODV)

Introduction

The wireless applications are used in wide areas such as commerce, emergency services, military, education and entertainment. WiFi capable machines like laptop, mobile devices and hand held devices (e.g: smartphone and tablet PC) has been increasing rapidly. For example, the wireless Internet users has tripled world-wide in the last three years, and the smartphone users counting in US has increased from 92.8 million in 2011 to 121.4 million in 2012, and will reach around 207 million by 2017. Nowadays, people wish to watch videos, play games, watch TV, and make long distance conferencing via wireless mobile devices“on the go.” Therefore, video streaming applications such as Qik, Flixwagon, and FaceTime on the infrastructure wireless networks have received increasing attention recently. These applications use an infrastructure to directly connect mobile users for video watching or interaction in real time. As the usage of wireless and mobile devices increases, demand for mobile multimedia streaming services are in high demand where wireless multimedia services (e.g., mobile gaming, online TV, and online conferences) are widely deployed. The usage of real time and
multimedia applications have stimulated the need of high Quality of Service(QoS) support in wireless and mobile networking environments. End-to-end transmission delay and enhances throughput are achieved with help of the QoS support thereby providing enough communication between mobile devices and wireless infrastructures. At the same time, hybrid wireless networks (i.e., multihop cellular networks) have been proven to be a better network structure for the next generation wireless networks and can help to tackle the stringent end-to-end QoS requirements of different applications.

Combining the hybrid networks like infrastructure networks and MANETs to support each other. Particularly, scalability of MANETs is progressed by infrastructure networks, while MANETs automatically establish self-organizing networks thereby extending the coverage of the infrastructure networks.

**Project Objective:**

Promising the QOS in hybrid wireless network is the crucial purpose. TO achieve this QOS enhanced hybrid collective-path routing protocol has been proposed and guarantees the high QOS performance in hybrid network in terms of Overhead, Transmission Delay, Mobility Resilience and scalability.

**Related Works:**

Luo Liu et al. have proposed architecture for assuring QoS based on Node-Disjoint collective-path routing protocol (NDMR) in mobile ad-hoc networks. The problem related to provisioning of QoS is extremely difficult task in MANETs. But the multiple node-disjoint paths help in assigning the packets to paths in a best possible method to handle some limitations. The proposed methodology offered limitations and also compared the functioning in variation circumstance of NDMR. This method also determined ways of establishing NDMR with the help of queue length field and updates route packets for permitting QoS computations over node-disjoint paths.

Chunxue Wu et al. have proposed Q-AOMDV protocol for ad-hoc networks. The proposed protocol with path preference probability calculates the delay, bandwidth, hop count for choosing the path for forwarding the packet. The provision of multiple paths is more efficient in ad-hoc networks since the source can just utilize the existing routes in case of any route
failure instead of carrying out route recovery process.
Fujian Qin et al. have proposed a new collective-path source routing protocol with bandwidth and reliability constraints for MANET. In order to get the collective-path routing, they expand DSR’s routing discovery and maintenance technique. To attain a better cooperation among load balancing and network overhead, an ultimate count of collective-path route is examined. Also, per packet granularity is utilized to allocate the packets from multiple links between the paths in MSR. Sanguankotchakorn et al. have proposed NQoS AODV by altering the conventional AODV. NQoS AODV upholds a routing table which frequently offers routes thus minimizing the average delay. This approach increases the packet delivery ratio since it upholds the QoS information and observes for the path fulfilling QoS necessities of the applications. Further it forwards a smaller number of control packets to maintain route discovery and route failure which causes reduced control overhead.

Nityananda Sarma et al. have proposed a Route Stability based QoS Routing (RSQR) protocol in Mobile Ad Hoc Networks (MANETs) which is an extension of QoS routing with throughput and delay constraints. In order to guarantee the suitable data path for adequate longer duration in MANET, they have proposed easy model for measuring the link stability and route stability depending on received signal strengths. Some additional fields in route request/reply packets is taken into consideration so that the route stability information can be used to choose a route with increased stability when compared to all possible routes among existing source destination pair.

Kun-Ming Yu et al. have proposed a new protocol (ARMBR) to enhance the prevailing on demand routing protocols. This is performed by building multiple backup routes. During the modulation in network topology, the protocol can transfer the data packets actively via backup routes. In addition, they have developed an analytical model to determine the reconnection probability of the proposed algorithm.

Samuel Pierre et al. have proposed a new approach based on a mobile routing backbone for supporting Quality of
service (QoS) in MANETs. This proposed protocol allocates the traffic inside the network as per the existing network traffic level and nodes processing loads. The QoS support is recognized with the help of communicating packets possessing particular necessities to nodes that are loaded with more resources and connected through stable links.

A Network is a sharing of data or file within the group. The data can be transferred from and to. The process of transferring the data from one computer to another is a Routing. Routing protocol is a standard that decide the feasible routes from the optimized routes in a network. This can be categorized into three types. They are 1. Proactive 2. Reactive and 3. Hybrid.

**Proactive routing:**

It is also known as Table driven protocol. In this type, each and every node in this network will maintain a separate routing table. Routing table consists of routing information about the networks. A hybrid network is a mixture of self organizing network and Wireless network. In this type of network, the topology of the network can’t be fixed and frequent failure communication links between two nodes. If a Existing communication links between two nodes failed then the new links can be established with the reference of routing table.

The main disadvantages are:

1. Maintain Huge amount of data that causes network overhead.
2. Slow reaction on failures.

Examples of proactive algorithms are

*Optimized Link State Routing Protocol (OLSR)*

*Destination Sequence Distance Vector (DSDV)*

**Reactive Routing:**

It is also known as On demand protocol. Routing table cant be maintained for the network. In this type, If a Existing communication links between two nodes failed then the new links can be established when on demand basis.

The main disadvantage:

1. High latency time in route finding.
2. Excessive flooding can lead to network clogging.
Examples of on-demand algorithms are:

- Ad hoc On-demand Distance Vector (AODV)
- Dynamic Source Routing

**Hybrid routing:**

This type of protocol combines the advantages of proactive and reactive routing.

Examples of hybrid algorithms are:

- ZRP (Zone Routing Protocol)

**Existing system:**

A hybrid wireless network, a next generation network is a combination of wireless network i.e. (Infrastructure network) and Adhoc network (Infrastructure less network). Adhoc network is a network having the tendency of self organizing nature. In a hybrid network, a source node wants to send a message to its destination. If a source node will be a transmission range of base station then the data can be delivered successfully. Since, it is unlikely that base station covers entire area. Then the data will transfer to the intermediate adhoc nodes. For an example, people want to upload or download data from the server need a good Quality Of Service (QOS).

**Disadvantages:**

Achieving the QOS in hybrid network is very difficult to achieve due to their unique characteristics of MANET. By adopting QOs solutions of infrastructure network can’t be applied directly to infrastructureless network.

**Present work**

In this protocol, topology discovery is performed proactive in manner while route discovery is performed in the reactive manner. In proactive topology discovery phase, each node collects the battery power, queue length and residual bandwidth of every other nodes and stores in the topology information table (TIT). By exchanging the TIT among the nodes, the topology is discovered. When the source node wants to forward the data packet to the destination, it utilizes the reactive route discovery technique where the multiple paths are established using collective-path Dijkstra algorithm. When any intermediate node does not recognize the next 2-hop information from TIT towards destination, the new collective-path route discovery is performed.

**Mythologies to be adopted**
**Single Path Routing**

In case of single path routing, a single path is utilized to transmit the packets from the source to destination. The process of including the route information in the packet header corresponds to the dynamic source routing (DSR) protocol which is considered as source dependent single path routing algorithm. Whereas for ad hoc on-demand distance vector routing (AODV) protocol, the destination nodes information is included in the packet header and in order to transfer the data packets in single path, hop-by-hop packet forwarding mechanism is utilized. [3]

Owing to the inconsistency of the wireless infrastructure and nodes mobility, single path routing protocols causes performance degradation in mobile networks.

**Collective-path Routing**

The process of discovering multiple routes among the distinct source and single destination at the time of single route discovery corresponds to collective-path routing. In MANET, the prevailing issues such as scalability, security, network lifetime, etc can be handled by the collective-path routing protocols. This protocol enhances the end-to-end throughput and offers load balancing in MANETs.

**Quality of Service (QoS)**

The network offering a group of service necessities to some traffic for fulfilling the users needs related to that traffic is termed as Quality of service (QoS). The main idea of QoS is to assure certain pre-defined service performance limitations of the user with respect to end-to-end delay, available bandwidth, packet loss probability etc.

**QoS in MANETs**

Quality of service in MANET relies on both existing resources in the network and mobility rate of such resources. These metrics are considered since the mobility may cause route failure and MANET holds only limited resources when compared to the fixed networks. Hence excess metrics need to be considered to confine with quality of the links among nodes. This quality ought to be a function of resource availability existing in wireless and mobile environment. Also QoS-based routing metric for MANETs must include minimum available bandwidth and end-to-end latency together with congestion around a link.

**Description of working principle**

**System Architecture:**

When a source node S wants to upload files to a server through base station, it can choose to send packets to the APs directly if
it is in the transmission range of source node or else it require its neighbor nodes to support the packet broadcast. We assume that queuing occurs only at the output ports of the mobile nodes. In order to enhance the QoS support capability of hybrid networks, in this paper, QoS-Hybrid collective-path Routing protocol has been proposed.

Algorithms QOD constitutes following five algorithms.

**QoS guaranteed neighbor selection algorithm.**

In this algorithm qualified neighbors can be selected and adopt deadline-driven scheduling mechanism to ensure QoS routing. In this algorithm, an intermediate node assigns the highest priority to the packet with the closest deadline and forwards the packet with the highest priority first.

**Distributed packet scheduling algorithm.**

After qualified neighbors are known, this algorithm schedules packet routing. It assigns earlier generated packets to forwarders with higher queuing delays, while assigns a lot of recently generated packets to forwarders with lower queuing delays to decrease total transmission delay. In order to further reduce the stream transmission time, a distributed packet scheduling algorithm is proposed for packet routing.

**Traffic redundant elimination algorithm.**

An intermediate node forwards the packet with the first smallest amount time allowed to attend before being forwarded to determined succeed fairness in packet forwarding. Recall that in the EDF algorithm, an intermediate node forwards the packets in the order from the packets with the closest deadlines to the packets with the farthest deadlines. If an intermediate node has no problem to meet...
all packets’ deadlines in forwarding, that is, the packets are scheduling feasible, the EDF algorithm works satisfactorily. However, when an intermediate node has too many packets to forward out and the deadlines of some packets must be missed, EDF forwards out the packets with the closest deadlines but may delay the packets with the farthest deadlines. Therefore, EDF is suitable for hard-deadline Mobility based segment resizing algorithm.

The source node resizes every packet in its packet stream for every neighbor node in line with the neighbor’s quality so as to extend the programming feasibility of the packets from the source node. In a highly dynamic mobile wireless network, the transmission link between two nodes is frequently broken down. The delay generated in the packet retransmission degrades the QoS of the transmission of a packet flow. On the other hand, a node in a highly dynamic network has higher probability to meet different mobile nodes and APs, which is beneficial to resource scheduling. As (2) shows, the space utility of an intermediate node that is used for forwarding a packet $p$ is $Sp / Wi . Ta$. That is, reducing packet size can increase the scheduling feasibility of an intermediate node and reduces packet dropping probability. However, we cannot make the size of the packet too small because it generates more packets to be transmitted, producing higher packet overhead.

Due to the broadcasting feature of the wireless networks, the access point and mobile nodes will cache packets. This algorithmic rule eliminates the redundant data to boost the QoS of the packet transmission. The mobile nodes set their NAV values based on the overhearing message’s transmission duration time. A large NAV leads to a small available bandwidth and a small scheduling feasibility of the mobile nodes based on (2). Therefore, by reducing the NAV value, we can increase the scheduling feasibility of the intermediate nodes and sequentially increase the QoS of the packet transmission. Due to the broadcasting feature of the wireless networks, in a hybrid network, the APs and mobile nodes can overhead and cache packets, we use an end-to-end traffic redundancy elimination (TRE) algorithm to eliminate the redundancy data to improve the QoS of the packet transmission in QOD. TRE uses a chunking scheme to determine
the boundary of the chunks in a data stream. The source node caches the data it has sent out and the receiver also caches its received data. In QOD with TRE, the AP and mobile nodes overhear and cache packets.

Collective-path Routing

The main goal of this collective-path algorithm is to construct a group of N routes devoid of loops, connecting source (S) and destination (D). In the source node, the collective-path optimized link state routing protocol holds a updated flag \( Z_i \) for every possible node in the network for recognizing the validity of the routes related to the node. Primarily, \( Z_i \) is assigned to be false which reveals that either there is no route related to the destination or renewal process is required. The condition to obtain the multiple paths for any node \( n_i \) is as follows.

If \( Z_i = \) false, Then

The node executes collective-path Dijkstra algorithm to obtain the multiple paths to \( n_i \), store it in the collective-path routing table, and performs the renewal of corresponding \( Z_i \) to be true.

Else

The node will discover a valid route to \( n_i \) in the collective-path routing table.

End if

**collective-path Dijkstra Algorithm**

Let \( ST \) represent the source tree.
Let \( w_r \) represent the opposite edge of arc \( w \).
Let \( h(w) \) offers the vertex edge to \( w \) points. \( F(ST, D) \) is the function that obtains the shortest path to \( D \) from \( ST \).
\( F_p \) is used to increase the costs of \( w \) that belong to the previous path \( (P_i) \)
\( F_w \) is used to increase the costs of \( w \) that lead to vertices of \( P_i \).
The algorithm is applied to a graph \( G = \{y, t, s\} \) to compute \( N \) routes in \( G \) from \( S \) to \( D \).
Where \( y = \) set of vertices \( t \)
\( = y \ast y = \) set of arcs
\( s : y \ast K^+ = \) strictly positive cost function. \( s_1 = s \)
\( G_1 = G \)

For \( i \leftarrow 1 \) to \( N \)
do

\( ST_i \leftarrow \text{Dijkstra}(G_1, S) \ P_i \)
\( \leftarrow F(ST_i, D) \)

For all arcs \( w \) in \( t \)
If \( w \) is in \( P_i \) or Reverse (\( w \)) is in \( P_i \)
Then
\( s_i + 1(w) \leftarrow F_p(s_i(w)) \) Else
if the \( h(w) \) is in \( P_i \) Then
\( s_i + 1(w) \leftarrow F_w(s_i(w)) \)
Else
$s_{i+1}(w) - s_i(w)$

End if

End for

$G_{i+1} \leftarrow (y,t,s_{i+1})$

End for

Return($P_1, P_2, P_3, ..., P_N$)

Results

Performance Metrics:

We evaluate performance of the new protocol mainly according to the following parameters. We compare the MPOLSR [5] routing protocol with our proposed QEHMR protocol.

Average Packet Delivery Ratio: It is the ratio of the number of packets received successfully and the total number of packets transmitted.

Average end-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Control overhead: The control overhead is defined as the total number of routing control packets normalized by the total number of received data packets.

Throughput: It is the number of packets successfully received by the receiver.

Energy Consumption: It is the total amount of energy consumed by the nodes during the data transmission.

Network Overhead:

Packet delivery ratio:

The ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

$PDR = \sum \frac{\text{Number of packet send}}{\sum \text{Number of packet send}}$

End-to-end Delay: the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

$\sum (\text{arrive time} - \text{send time}) / \sum \text{Number of connections}$

Packet Lost: the total number of packets dropped during the simulation.

Packet lost = Number of packet send – Number of packet received.

Results & Analysis
A. Effect of varying Number of Nodes
Initially we vary the number of nodes as 30, 50, 70, 90 and 110.

<table>
<thead>
<tr>
<th>nodes vs delivery ration</th>
<th>OB-MR</th>
<th>MPOLSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>b</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>c</td>
<td>0.7</td>
<td>0.45</td>
</tr>
<tr>
<td>d</td>
<td>0.6</td>
<td>0.45</td>
</tr>
<tr>
<td>e</td>
<td>0.6</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Table 1. Nodes Vs Delivery Ratio

![Figure 1. Nodes Vs Delivery Ratio](image1)

Table 2. Nodes Vs Delay

<table>
<thead>
<tr>
<th>nodes vs delay</th>
<th>OB-MR</th>
<th>MPOLSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>b</td>
<td>6</td>
<td>9.8</td>
</tr>
<tr>
<td>c</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>d</td>
<td>5</td>
<td>6.5</td>
</tr>
<tr>
<td>e</td>
<td>5.2</td>
<td>5.5</td>
</tr>
</tbody>
</table>

![Figure 2. Nodes Vs Delay](image2)

Table 3. Nodes Vs Overhead

<table>
<thead>
<tr>
<th>nodes vs Overhead</th>
<th>OB-MR</th>
<th>MPOLSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>15000</td>
<td>15500</td>
</tr>
<tr>
<td>b</td>
<td>14000</td>
<td>15000</td>
</tr>
<tr>
<td>c</td>
<td>11000</td>
<td>14800</td>
</tr>
<tr>
<td>d</td>
<td>15000</td>
<td>15200</td>
</tr>
<tr>
<td>e</td>
<td>14500</td>
<td>15000</td>
</tr>
</tbody>
</table>

![Figure 3. Nodes Vs Overhead](image3)

Table 4. Nodes Vs Throughput

<table>
<thead>
<tr>
<th>nodes vs Throughput</th>
<th>OB-MR</th>
<th>MPOLSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>15000</td>
<td>15000</td>
</tr>
<tr>
<td>b</td>
<td>11000</td>
<td>10000</td>
</tr>
<tr>
<td>c</td>
<td>10000</td>
<td>9000</td>
</tr>
<tr>
<td>d</td>
<td>10000</td>
<td>8000</td>
</tr>
<tr>
<td>e</td>
<td>10000</td>
<td>7000</td>
</tr>
</tbody>
</table>

![Figure 4. Nodes Vs Throughput](image4)

When the number of nodes is increased from 30 to 110, the throughput and packet delivery ratio begin to reduce, as there is chances of more collisions.

Figure 1 and 4 show the results of average packet delivery ratio and throughput,
respectively for the increased the nodes scenario. Clearly our QEHMR protocol achieves 23% better packet delivery ratio and 17% throughput than the POLSR since the proactive routing is done based on the QoS parameters bandwidth and queue length.

Figure 2 shows the results of average end-to-end delay for the increasing number of nodes. The figure depicts that delay increases when the nodes are increased from 30 to 70, and then it reduces beyond 70 nodes. This is due to fact that the proactive routing couldn’t discover more shortest paths, since the nodes are sparse. From the results, we can see that QEHMR protocol has of 21% lower delay than the MPOLSR protocol.

Figure 3 shows the results of routing overhead versus number of nodes. The routing overhead decreases up to 70 nodes and increases beyond that since after 70 nodes, reactive routing is applied, rather than proactive.

From the results, we can see that QEHMR protocol produces 13% less routing overhead than the MPOLSR protocol, since QEHMR uses the hybrid approach for route discovery.

**Conclusion and feature enhancement**

In this paper, we have proposed a QoS enhanced hybrid collective-path routing protocol for MANET. In this technique, topology discovery is performed proactively and route discovery is performed in the reactive manner. In topology discovery phase, each node learns the battery power, queue length and residual bandwidth of every other nodes and stores in the topology information table (TIT). By exchanging the TIT among the nodes, the topology is discovered. When source wants to forward a data packet to destination, it verifies TIT and computes the link metric (LM) using the data in its TIT. The source chooses the nodes with minimum LM and initiates the packet transfer through the chosen node within 2-hop. The collective-path Dijkstra algorithm is employed to transmit the data through multiple paths with the nodes holding minimum link metric. When any intermediate node does not recognize the next 2-hop information from TIT towards destination, the reactive collective-path routing protocol is performed for route discovery. By
simulation results, it is shown that the proposed approach reduces the overhead.

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