QOS FACTORS BASED NODE SELECTION AND SCHEDULING ALGORITHM FOR IMPROVING SYSTEM PERFORMANCE IN MOBILE ADHOC NETWORKS

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Abstract
Mobile ad-hoc networks consist of a collection of mobile nodes without having a fixed communication. Due to the communication less network, there exist a ordinary link breakages which can leads to frequent path failures and finding the route. A mobile nodes can blindly rebroadcasts the first received route request packets unless it has a route to the destination and thus it causes the broadcast storm problem. So, a neighbor coverage-based probabilistic rebroadcast protocol (NCPR) for reducing routing overhead in mobile ad-hoc networks and propose a novel rebroadcast delay to determine the rebroadcast order and then obtain the more accurate additional coverage ratio by sensing neighbor coverage knowledge. By using the neighbor coverage knowledge and the probabilistic method, which can considerably reduce the number of retransmissions so as to reduce the routing overhead and can also improve the performance of routing. It provides a reduced amount of quality-of-service in terms of throughput, packet delivery ratio and delay. In this research work, to overcome this problem we have implemented a new algorithm called “QOS factors based node selection method and Scheduling” (QFNSS) in which the node is selected for the routing process. In Proposed work, for each and every link the packet delivery ratio, throughput, delay, bandwidth, stability, interference is computed. Based on the node selection, the packet priority is computed for the scheduling process. It selects an intermediate node assigns the highest priority to the packet with the closest deadline and forwards the packet with the highest priority first. An experimental result shows in the proposed system to achieve high packet delivery ratio, less delay, high bandwidth utilization when compared to the NCPR.

Keywords: Scheduling, QFNSS(QOS factors based node selection method and Scheduling), NCPR, MANET.

1. Introduction
MANET is a type of ad-hoc network that can be used to change location and arrange itself. It can use by the wireless connections to connect to various networks. It can be a standard Wi-Fi link or a different medium of communication such as a cellular or satellite transmission. Each must forward traffic not related to its own use and therefore be a router. The primary challenge can be used for building a MANET and to equipment each device continuously to maintain the information required to the right route transfer. Such network may work by them or may be connected to the larger Internet. Different protocols are evaluated based on measures such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput etc.

2. Review of literature
Mobile ad hoc networks (MANETs) consist of a collection of mobile nodes which can move freely. These nodes can be dynamically self-organized into arbitrary topology networks without a fixed infrastructure. One of the fundamental challenges of MANETs is the design of dynamic routing protocols with good performance and less overhead. Many routing protocols, such as Ad hoc On-demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) that have been proposed for MANETs. D. Johnson[1], it deals about the Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is completely self-organizing and self-configuring and requires no existing network infrastructure or
administration. Network nodes cooperate to forward packets for each other to allow communication over multiple “hops” between nodes not directly within wireless transmission range of one another. However, due to node mobility in MANETs there is a frequent link breakages may lead to frequent path failures and route discoveries which could increase the overhead of routing protocols and reduce the packet delivery ratio and increasing the end-to-end delay. Thus, reducing the routing overhead in route discovery is an essential problem.

H.R. Sadjadpour[2], it describes the fundamental challenges to the design of protocol stacks for mobile ad hoc networks (MANET). Because of nodes movements, routing protocols of MANETs have to cope with frequent topology evolutions and ensure quick response and adaptation to topology changes result in “broadcast-storm” problem and the whole network will be congested. It is thus essential to understand the intricate relations between routing overhead and topology evolutions, for the design of routing protocols in MANETs and the topology evolutions from node mobility were not considered. In this research, provide the first attempt to provide answers to these questions with a general analytical framework for proactive routing protocols, where the inter-dependence between topology evolutions and routing overhead is explored and quantitative measures are to be provided to justify the routing overhead as a function of node mobility. The conventional on-demand routing protocols can use flooding to discover a route. It can used to broadcast a Route Request (RREQ) packet to the networks and the broadcasting induces excessive redundant retransmissions of RREQ packet and causes the broadcast storm problem which leads to a considerable number of packet collisions especially in dense networks. Therefore, it is used to vital for optimize the broadcasting mechanism. This mechanism may also be used in LAN emulation or serve as a last resort to provide multicast services in networks with rapid changing topologies [3]. Some methods have been proposed to optimize the broadcast protocol problem in MANETs in the past few years. The broadcasting protocols are categorized into four classes: “simple flooding, probability-based methods, area based methods, and neighbor knowledge methods.” For the above four classes of broadcasting protocols, they showed that an increase in the number of nodes in a static network will degrade the performance of the probability-based and area-based methods [4].

J. Kim[5], it deals about the Broadcasting is to transmit a message from a source to all the other nodes in the network. It is widely used to resolve many network layer problems. Several ad-hoc network protocols assume that the broadcasting service is basically available. In this research, a dynamic probabilistic broadcasting approach is presented with coverage area and neighbor confirmation. The coverage area concept is used to adjust the rebroadcast probability of a node.

Z. Haas et al. [6] proposed a gossip based approach, where each node forwards a packet with a probability. They showed that gossip-based approach can save up to 35 percent overhead compared to the flooding. Lu [11] proposed a neighbor knowledge scheme named Scalable Broadcast Algorithm (SBA). This scheme determines the rebroadcast of a packet according to the fact whether this rebroadcast would reach additional nodes. Keshavarz-Haddad et al. [8] proposed two deterministic timer-based broadcast schemes: Dynamic Reflector Broadcast (DRB) and Dynamic Connector-Connector Broadcast (DCCB). They pointed out that their schemes can achieve full reach ability over an idealistic lossless MAC layer, and for the situation of node failure and mobility, their schemes are robustness. Stann et al. [9] proposed a Robust Broadcast Propagation (RBP) protocol to provide near-perfect reliability for flooding in wireless networks, and this protocol also has a good efficiency. They presented a new perspective for broadcasting is not to make a single broadcast more efficient but to make a single broadcast more reliable, which means by reducing the frequency of upper layer invoking flooding to improve the overall performance of flooding. In our protocol, we also set a deterministic rebroadcast delay, but the goal is to make the dissemination of neighbor knowledge much quicker. It can be suggested that six to eight neighbors can make a small size network connected with high probability. In fact, show that there are no magic numbers if one takes connectivity also into consideration. Specifically, for every finite number, the probability of network disconnectivity converges to one as the number of nodes in the network increases [10]. Since, limiting the number of rebroadcasts can effectively optimize the broadcasting, and the neighbor knowledge methods perform better than the area-based ones and the probability-based ones and then propose a neighbor coverage-based probabilistic rebroadcast protocol (NCPR) and in order to effectively exploit the neighbor coverage knowledge we need a novel rebroadcast delay to determine the rebroadcast order and then can obtain a more accurate additional coverage ratio. In order to keep the network connectivity and reduce the redundant retransmissions, we need a metric named as connectivity factor to determine how many neighbors should receive the RREQ packet. But the drawback of the NCPR protocol is fewer throughputs and less packet delivery ratio. In the proposed system, “QOS factors based node selection and scheduling method” (QFNSS) is introduced and selects the node for routing based on the following metrics such as interference level, bandwidth and stability to get high packet delivery ratio and throughput.
3. Materials and methods

3.1 Neighbor coverage-based probabilistic rebroadcast protocol (NCPR):

In order to reduce the retransmissions in the mobile ad-hoc networks neighbor coverage-based probabilistic rebroadcast protocol is used. In this neighbor coverage knowledge, a novel rebroadcast delay is used to determine the rebroadcast order, and then obtain a more accurate additional coverage ratio. In order to keep the network connectivity and reduce the redundant retransmissions, need a metric named connectivity factor to determine how many neighbors should receive the RREQ packet. After that, combining the additional coverage ratio and the connectivity factor, a rebroadcast probability is used, which can be used to reduce the number of rebroadcasts of the RREQ packet, to improve the routing performance.

The main contributions of this work

- Propose a novel scheme to calculate the rebroadcast delay. The rebroadcast delay is to determine the forwarding order. The node which has more common neighbors with the previous node has the lower delay. If this node rebroadcasts a packet, then more common neighbors will know this fact. Therefore, rebroadcast delay enables the information that the nodes have transmitted the packet spread to more neighbors, which is the key to success for the proposed scheme. The Propose a novel scheme to calculate the rebroadcast probability. The scheme considers the information about the uncovered neighbors (UCN), connectivity metric and local node density to calculate the rebroadcast probability. It is composed of two parts:
  - Additional coverage ratio, which is the ratio of the number of nodes that should be covered by a single broadcast to the total number of neighbors.
  - Connectivity factor, which reflects the relationship of network connectivity and the number of neighbors of a given node.

3.1.2 Steps for creating research process

- Network creation
- Node selection process
- Identification of Uncovered Neighbors Set
- Determination of Rebroadcast Delay
- Determination of Rebroadcast Probability
  - Additional Coverage ratio
  - Connectivity factor
- Packet scheduling process

Network creation

An undirected graph G (V, E) where the set of vertices V represent the mobile nodes in the network and E represents set of edges in the graph which represents the physical or logical links between the mobile nodes. Sensor nodes are placed at a same level. Two nodes that can communicate directly with each other are connected by an edge in the graph. Let N denote a network of m mobile nodes, \( N_1, N_2, \ldots, N_m \) and let D denote a collection of n data items \( d_1, d_2, \ldots, d_n \) distributed in the network. For each pair of mobile nodes \( N_i \) and \( N_j \) let \( t_{ij} \) denote the delay of transmitting a data item of unit-size between these two nodes.

Node selection process

In this section the node is selected for the routing process. For this the packet delivery ratio of the nodes is computed which is nothing but the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination. After that the link stability is determined based on the residual lifetime of the link. The interference level is computed based on the signal-to-noise ratio. Based on these factors the node is selected for the routing process.

Identification of Uncovered Neighbors Set

When node \( n_i \) receives an RREQ packet from its previous node s, it can use the neighbor list in the RREQ packet to estimate how many its neighbors have not been covered by the RREQ packet from s. If node \( n_i \) has more neighbors uncovered by the RREQ packet from s, if node \( n_i \) rebroadcasts the RREQ packet, the RREQ packet can reach more additional neighbor nodes. To define the Uncovered Neighbors set \( U(n_i) \) of node \( n_i \) as follows:

\[
U(n_i) = N(n_i) - [N(n_i) \cap N(s)] - \{s\}
\]

Where \( N(s) \) and \( N(n_i) \) are the neighbors sets of node s and \( n_i \), respectively. s is the node which sends an RREQ packet to node \( n_i \). From this obtain the initial UCN set[12].

Determination of Rebroadcast Delay

Due to broadcast characteristics of an RREQ packet, node \( n_i \) can receive the duplicate RREQ packets from its neighbors. Node \( n_i \) could further adjust the U (\( n_i \)) with the neighbor knowledge. In order to sufficiently exploit the neighbor knowledge and avoid channel collisions, each node should set a rebroadcast delay. The rebroadcast delay \( T_{d} (n_i) \) of node \( n_i \) is defined as follows:

\[
T_{d} (n_i) = \frac{1 - |N(s) \cap N(n_i)|}{|N(s)|} \\
T_{d} (n_i) = \text{MaxDelay} \times T_{b} (n_i)
\]

Where \( T_{b} (n_i) \) is the delay ratio of node \( n_i \), and MaxDelay is a small constant delay. |\( | \) is the number of elements in a set. The above rebroadcast delay is defined with the following reasons: First, the delay time is used to

Determination of Rebroadcast Probability

The node which has a larger rebroadcast delay may listen to RREQ packets from the nodes which have lowered one. For example, if node \( n_i \) receives a duplicate RREQ packet from its neighbor \( n_j \), it knows that how many of its neighbors have been covered by the RREQ packet from \( n_j \). Thus, node \( n_i \) could further adjust its UCN set according to the neighbor list in the RREQ packet from \( n_j \). Then, the UCN set can be adjusted as follows:

\[
U(n_i) = [U(n_i) \cap N(n_j)]
\]

After adjusting the UCN set, the RREQ packet received from \( n_j \) is discarded. When the timer of the rebroadcast delay of node \( n_i \) expires, the node obtains the final UCN set. The nodes belonging to the final UCN set are the nodes that need to receive and process the RREQ packet. Note that, if a node does not sense any duplicate RREQ packets from its neighborhood, its UCN set is not changed, which is the initial UCN set.

Additional Coverage ratio

The additional coverage ratio is defined \( R_a(n_i) \) of node \( n_i \) as

\[
R_a(n_i) = \frac{|U(n_i)|}{|N(n_i)|}
\]

This metric indicates the ratio of the number of nodes that are additionally covered by this rebroadcast to the total number of neighbors of node \( n_i \). The nodes that are additionally covered need to receive and process the RREQ packet. As \( R_a \) becomes bigger, more nodes will be covered by this rebroadcast and more nodes need to receive and process the RREQ packet and thus, the rebroadcast probability should be set to be higher.

Connectivity factor

To define the minimum \( F_c(n_i) \) as a connectivity factor, which is

\[
F_c(n_i) = \frac{N_c}{|N(n_i)|}
\]

Where \( N_c = 5.1774 \log n \), and \( n \) is the number of nodes in the network. When \( |N(n_i)| \) is greater than \( N_c \), \( F_c(n_i) \) is less than 1. That means node is in the dense area of the network, then only part of neighbors of node \( n_i \) forward the RREQ packet to keep the network connectivity. And when \( |N(n_i)| \) is less than \( N_c \), \( F_c(n_i) \) is greater than 1. That means node \( n_i \) is in the sparse area of the network, then node \( n_i \) should forward the RREQ packet in order to approach network connectivity [12].

Combining the additional coverage ratio and connectivity factor, obtain the rebroadcast probability pre (\( n_i \)) of node \( n_i \).

\[
Pre(n_i) = F_c(n_i) \cdot R_a(n_i)
\]

Where, if the \( Pre(n_i) \) is greater than 1, set the \( Pre(n_i) \) to 1. Although the parameter \( R_a \) reflects how many next-hop nodes should receive and process the RREQ packet, it does not consider the relationship of the local node density and the overall network connectivity. The parameter \( F_c \) is inversely proportional to the local node density. That means if the local node density is low, the parameter \( F_c \) increases the rebroadcast probability, and then increases the reliability of the NCPR in the sparse area [12].

Proposed Work:

Packet scheduling algorithm

In this proposed techniques, a packet scheduling algorithm is proposed for packet routing. This algorithm assigns earlier generated packets to forwarders with higher queuing delays and scheduling feasibility, while assigns more recently generated packets to forwarders with lower queuing delays and scheduling feasibility, so that the transmission delay of an entire packet stream can be reduced. An intermediate node assigns the highest priority to the packet with the closest deadline and forwards the packet with the highest priority first. It can be estimate the queuing time \( T_w^{(x)} \) of a packet with priority \( x \). It can be calculated as,

\[
T_w^{(x)} = \sum_{j=1}^{x-1} \left( T_{\text{delay}}^{(j)} + \frac{T_{w}^{(x)}}{T_{a}^{(j)}} \right) (0 < j < x),
\]

Where \( x \) denotes a packet with the \( x \)th priority in the queue, and \( T_{\text{delay}}^{(j)} \) and \( T_{a}^{(j)} \) respectively denote the transmission delay and arrival interval of a packet with the \( j \)th priority. \( \left[ T_{w}^{(x)}/T_{a}^{(j)} \right] \) is the number of packets arriving during the packet’s queuing time \( T_w^{(x)} \) which are sent out from the queue before this packet. After scheduling traffics to qualified intermediate nodes based allocation the earlier generated packet from source node is transmitted to a node with longer queuing delay but still within the deadline bound. Taking advantage of the different \( T_w \) in different neighbor nodes, the transmission time of the entire traffic stream can be decreased by making the queuing of previous generated packets and the generating of new packets be conducted in parallel.
3.2 QOS factors based node selection and Scheduling algorithm (QFNSS)

1. Initialize N number of nodes randomly in the mobile adhoc network
2. Set of nodes \( V = (v_1, v_2, \ldots v_N) \) // \( N \) = total number of nodes, \( i=1,2,..N, i=\text{identifier of the node} \)
3. ∀\( i \) compute the metrics
4. // Computation of interference
   Signal to interference ratio (SIR) distribution between two nodes with RSSI distribution \( P_i \) and \( P_j \) is given by,
   \[
   \text{SINR}_i = J(e_i) \cdot d(u_i, v_i) - \beta \geq \beta
   \]
   \( N_0 \) = noise density, \( \alpha = \text{path loss component} \), \( J(e_i) = \text{power level which node } u_i \text{ transmits} \), \( \beta = \text{antenna gain} \), \( d(u_i, v_i) = \text{Euclidean distance between nodes} \)
5. // Computation of bandwidth
   \[
   \text{BW}_i = \frac{S_Z}{T_{M_i}}
   \]
   \( S_Z = \text{Size of the input data for node } v_i, T_{M_i} = \text{data movement time} \)
6. // Computation of stability
   \[
   R_{i,j}(a_{ij}) = \frac{\sum_{a=1}^{a_{\text{max}}} d[a]}{\sum_{a=i}^{a_{\text{max}}} d[a]} \cdot a_{ij} \]
   \( a_{\text{max}} \) represents the maximum observed age of the links, \( d \) is an array of length \( a_{\text{max}} + 1 \) used to store the observed data, \( d[a] \) represents the number of links
   If \( n_i = \text{(More stable+ less traffic+ High packet delivery ratio+ high throughput+ less interference)} \) then
   Compute every node capacity in terms of stability, interference and bandwidth and the RREQ packets are forwarded
7. // Scheduler
   Compute the queuing time of the packets
   \[
   T_{w} = \sum_{j=1}^{x} (T_{d} - T_{a}) \cdot \frac{T_{w}}{T_{a}} (0 < j < x) \]
   \( x \) denotes a packet with the xth priority in the queue, and \( T_{d} \) and \( T_{a} \) respectively denote the transmission delay and arrival interval of a packet, \( \frac{T_{w}}{T_{a}} \) is the number of packets arriving during the packet’s queuing time \( T_{w} \) which are sent out from the queue before this packet and the packets are forwarded by the intermediate nodes.

4. Results and discussion

4.1.1 Performance Evaluation
   In the proposed work, we evaluate the performance of the QOS factors based node selection and scheduling method (QFNSS) using NS2 version 2.34. QFNSS is a modified AODV protocol. It is introduced in which the node capacity is computed for the routing process. This method computes the delay, bandwidth, stability, interference for each and every link in the network. Compare to the existing system, NCPR produce a high performance (high packet delivery ratio and throughput).

4.1.2 Simulation environment
   By using NS2 version 2.34 simulator, we find out the simulation parameters such as packet send, packet receive and throughput etc.

<table>
<thead>
<tr>
<th>Simulation Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation Area</td>
<td>1000*1000m</td>
</tr>
<tr>
<td>Number of Nodes</td>
<td>30</td>
</tr>
<tr>
<td>Scheduling queue type</td>
<td>Priority queue</td>
</tr>
<tr>
<td>Protocol</td>
<td>AODV</td>
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<td>Propagation mode</td>
<td>Radio-propagation model</td>
</tr>
<tr>
<td>Antenna</td>
<td>Omni-antenna model</td>
</tr>
<tr>
<td>Topology</td>
<td>Flat grid</td>
</tr>
<tr>
<td>Traffic type</td>
<td>CBR</td>
</tr>
<tr>
<td>Agent</td>
<td>UDP</td>
</tr>
<tr>
<td>Simulation-time</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Table 1: Simulation results
4.1.3 Routing metrics

Collision
Packet collision rate is the number of data packet collisions occurring in a network over a specified period of time. It indicates the rate at which data packets crash or lost during in the collisions. The rate of collision packet is measured in terms as a percentage of the data packets successfully sent out through the destination.

End-to-end delay
This is the delay elapsed between the packet generation at the source and successful reception at the destination.

Figure 1: Collision rate
In this figure 1, it shows the X-axis denotes total number of the nodes and the Y-axis denotes collision rate. Compare to the NCPR collision rate the QFNSS collision rate is reduced.

Figure 2: End-to-end delay
In this figure 2, it shows the X-axis denotes total number of the nodes and the Y-axis denotes delay ratio. Compare to the NCPR end-to-end delay the QFNSS end-to-end delay rate is reduced.

Packet delivery ratio:
It is defined as the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

\[ \text{PDR} = \frac{\sum \text{Number of packet receive}}{\sum \text{Number of packet send}}. \]

Routing Overhead
The ratio of the total packet size of control packets (include RREQ, RREP, RERR, and Hello) to the total packet size of data packets delivered to the destinations. For the control packets sent over multiple hops, each single hop is counted as one transmission.

Figure 3: Packet delivery ratio
In the figure 3, it shows the X-axis denotes total number of the nodes and the Y-axis denotes packet delivery ratio. In the packet delivery ratio is measured with varying from source to destination distance. The QFNSS protocol is compared with NCPR and experienced with an increase in packet delivery ratio as shown in figure 3. In NCPR increases the packet delivery ratio when compared to QFNSS.

Routing overhead

Figure 4: Routing overhead
In this figure 4, it shows the X-axis denotes total number of the nodes and the Y-axis denotes packet delivery ratio. The routing overhead that can occurred in the NCPR
when the packet size increases and it decreases the packet size when compare to QFNSS.

5. Conclusion

In this research work, we have explored crucial problems such as link breakage and routing overhead etc. But in proposed work a new techniques is implemented called as (QFNSS)-“QOS factors based node selection and scheduling algorithm” based techniques it aims to reduce the end -to- end delay, routing overhead and increase the packet delivery ratio and throughput. This algorithm assigns earlier generated packets to forwarders with higher queuing delays and scheduling feasibility, while assigns more recently generated packets to forwarders with lower queuing delays and scheduling feasibility, so that the transmission delay of an entire packet stream can be reduced. But in the existing system, NCPR it can produce less overhead and occur link breakage problem. The performance comparison of two algorithm NCPR and QFNSS algorithm that can be evaluated in the NS2 Simulator. So that, the QFNSS algorithm can performs better performance than NCPR in terms of reducing overhead, packet delivery ratio and throughput. It can be conclude that to get maximum PDR and throughput with the help of simulation results in a new developed QFNSS algorithm. By implementing this concept in the mobile ad-hoc network along with various security technologies for considering the configuration and management point of view can be done in future work.

6. REFERENCES