Enhancing Quality of Service (QoS) in Hybrid Wireless Networks by Dynamic Resource Scheduling

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***Abstract* —Everyday numerous real time, wireless applications are get deployed. These multimedia applications stimulated the requirement of stringent end-to-end Quality of Service (QoS). So Hybrid wireless networks are better future networks, for next generation wireless communication. As Hybrid wireless networks combines existing wireless infrastructure network and a mobile wireless ad hoc network (MANET).**

Here a QoS-Oriented Distributed routing protocol (QOD) is proposed to enhance the QoS support capability of hybrid networks. QOD takes advantage of fewer transmission hops and anycast transmission features of the hybrid networks, QOD transforms the packet routing problem to a resource scheduling problem. QOD consists of six algorithms. A QoS guaranteed neighbor selection algorithm to meet the transmission delay requirement. A distributed packet scheduling algorithm to further reduce transmission delay. A mobility-based segment resizing algorithm that adaptively adjusts segment size according to node mobility in order to reduce transmission time. A Soft deadline based forwarding scheduling algorithm to increase the transmission throughput by utilizing slack time of packets. Deflate Compression Algorithm-Deflate is Loss less data compression algorithm. It is applied on whole packet it eliminates duplicate data and hence reduces packet transmission delay. A Traffic redundancy elimination based transmission algorithm it eliminate the redundant data.

***Keywords*— Hybrid wireless network, MANET, Cellular networks, QoS, QOD.**

I. INTRODUCTION

The number of wireless Internet users are tripled world-wide in the last years[1].Also Wi-Fi capable mobile devices including laptops and handheld devices like smartphone and tablet PC are increasing rapidly. Users wish to be always online and watch videos, play games, watch TV, make long distance conferencing via wireless mobile devices.

The real time and multimedia applications need the high Quality of Service (QoS) support in wireless and mobile networking environments. The hybrid wireless networks are a better network structure for the next generation wireless networks [2]. It combines infrastructure networks and Mobile Ad-hoc Network (MANETs). Hence it can take advantage of widespread access points(AP) when available and MANET can build network as per requirement and availability of range.

This paper design a QoS Oriented Distributed routing protocol (QOD) to enhance the QoS support capability of hybrid Networks. The data transmission in hybrid networks has two features. First, an AP can be a source or a destination to any mobile node that allows anycast transmission. Second, the number of transmission hops between a mobile node and an AP is small that is at most two-hop from source to AP through intermediate node. QOD has total six algorithms to achieve QoS.

- Neighbor selection algorithm-The algorithm selects qualified neighbors and use deadline driven scheduling mechanism to guarantee QoS routing.
- Distributed packet scheduling algorithm-After qualified neighbors are identified, this algorithm schedules packet routing.
- Mobility based segment resizing algorithm. The source node adaptively resizes each packet in its packet stream for each neighbor node according to the neighbor's mobility.
- Soft deadline based forwarding scheduling algorithm. This algorithm utilizes slack time of packet and reduces the total delay time.
- Data redundancy elimination based transmission. This algorithm eliminates the redundant data to improve the QoS of the packet transmission.
- Deflate compression Algorithm-This algorithms applies compression on whole packet to reduce size of packet in tern improves transmission delay.

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II. LITERATURE REVIEW

Hybrid wireless networks increses the capacity of a cellular network because it has the properties of multi-hop relaying along with the support of existing fixed infrastructure. Various QoS provision has been proposed for fixed infrastructure wireless network.

But it is difficult to guarantee QoS in MANETs due to user mobility, channel variance errors, and limited bandwidth. The network nodes are mobile, an Ad hoc network have a dynamic topology, which will have adverse effects on network characteristics. Network nodes or mobile devices are battery powered, which limits the capacity of CPU, memory, and bandwidth. Many reservation based QoS routing protocols are proposed for MANETs [3] that create routes formed by nodes and links that reserve their resources to fulfill QoS requirements. A considerable amount of research is done in this area.

I. Jawhar et al. [3] gives detail study of various MANET routing protocols. These algorithms are classified into two different categories: on-demand (reactive) such as DSR,AODV and TORA, and table-driven (proactive) such as Destination Sequenced Distance Vector protocol (DSDV)[3].

In the on-demand protocols, routes are discovered between a source and a destination only when there is a need to send data. This provides a reduced overhead of communication and scalability.

In the table-driven protocols, routing tables are maintained all the time regardless of need. This approach requires more memory due to increasing size of the routing table.

A third hybrid approach, the Zone Routing Protocol (ZRP), combines the benefits of both methods. This approach can be effective in larger networks with relatively high degree of locality of communication, nodes with close proximity to one another.

Location Assisted routing. This approach use of localization information to improve route discovery. Here position and velocity of the mobile node is used. Fisheye Routing: Here the nodes keep track of topology data for closer nodes to achieve scalability. Cedar (Core Extraction Distributed Ad Hoc Routing): The strategy used is to increase scalability by creating and maintaining a backbone for communication of route requests to avoid broadcasting such information on a network wide basis..[3]

Most of these protocols such as the Dynamic Source Vector protocol (AODV), Temporally Ordered Routing Protocol (TORA) , and others might be sufficient for a certain class of MANET applications, but it is not adequate for the support of more demanding applications such as multimedia audio and video. Such applications require the network to provide guarantees on the Quality of Service (QoS).

Also direct use of reservation based QoS routing protocols of MANETs into hybrid networks inherits the invalid reservation and race condition problems. Hence cannot directly adapt routing protocols designed for infrastructure networks.

H.Wu et al.[2] propose a new scheme that uses multiple paths/trees in parallel to meet the QoS requirements of a call. The major advantages are it greatly reduces the system blockings. Thus, system resources can be better utilized. Multicast routing is done in a distributed fashion.

E.Crawley R.et al.[4],author suggests RSVP (Resource Reservation Protocol) is a network-control protocol to provide QoS for individual data flows. RSVP reserves appropriate resources along the end-to-end path traversed by a new flow requesting a QoS service. It scales poorly since it will be difficult to implement in a core router in a backbone network with millions of flows; it is useful at the edge routers.

X.Du et al. [5], considers non-homogeneous properties of mobile nodes such as transmission range, transmission bandwidth. They design more efficient QoS routing protocol that calculates bandwidth and reserves slots for MANET.

M.Conti et al. [6], proposes REEF Reliable and efficient forwarding mechanism takes ad- vantage of multipath routing and transport layer information to estimate the best route through which packets have to be forwarded.

C.Shen et al. [7] designed and implemented a packet delivery improvement service for multicast routing in mobile ad hoc networks called PIDIS.

Z.Shen et al. [8], proposed a distributed flexible mechanism to optimize security and QoS in mobile ad hoc networks.

G.Chakrabarti et al. [9], gives routing schemes each aiming at particular type of MANET with different mobility degrees (e.g., flat or clustered MANETs) have been proposed .A quantity that can predict the link status for a time period in the future with considering mobility is required and such a quantity then investigate how well this quantity can be used by the link caching scheme in the Dynamic Source Routing (DSR) protocol to provide the adaptability to variable topologies caused by mobility. The basic idea is to use to quantify link reliability.

S.Jiang et al. [10], proposed the QoS version of protocol, a source explicitly reserves the requested bandwidth before transmitting. For the case where the route chosen by the source breaks, no explicit reservations are made on the alternate routes used. However, implicit reservations are maintained on all links.

A.Argyriou et al. [11], provides the QoS goals are achieved by fully exploiting the presence of multiple paths in mobile ad hoc networks in order to jointly attack the problems of frequent route failures and load balancing. More specifically, it built a disjoint-path identification mechanism for maintaining multiple routes between two endpoints on top of the Stream Control Transmission Protocol (SCTP), and the

Dynamic Source Routing (DSR) protocol. a system for better path reliability and load balancing in ad hoc networks.

Y.Li et al. [12], provide a centralized algorithm of joint power control, scheduling, and routing to achieve the network performance, in terms of throughput, delay, and power consumption, through use of the joint algorithm.

For hybrid networks [13], [14], [15], [16], [17] authors focuses on increasing network capacity or routing reliability but cannot provide QoS guaranteed services. Here a utility maximization framework that is capable of selecting the best relay strategy, and the best power, bandwidth and rate allocation in a cellular network with relays is proposed .Various relay selection protocols, which achieves higher bandwidth efficiency are given.

Y.Wei et al. [17] proposed a two-hop packet forwarding mechanism; direct transmission between source node and base stations is carried out.

Ze Li et al. [18] proposed more reliable routing protocol for hybrid network but further more compression can be done for more efficiency.

But little effort are given to support QoS routing in hybrid wireless networks.

III. SYSTEM DESIGN

A) QOD Protocol

Basically when source and destination are within a range of Access point we can guarantee QoS transmission. But when the direct transmission between a source node and an AP not possible , the source node sends a request message to its neighbor nodes. QOD provides the steps for selection of qualified intermediate neighbor then scheduling of packets to that node then relating the node mobility with packet size again eliminating redundant data in order to improve QoS. Scheduling feasibility is the ability of a node to guarantee a packet to arrive at its destination within QoS requirements.

Algorithm 1 shows the pseudo code for the QOD routing protocol executed by each node.

```
if receive a packet forwarding request from a source node
then
    if this.SpaceUtility < threshold
    then
        Reply to the source node.
    end if
end if
if receive forwarding request replies for neighbor nodes
then
    Determine the packet size Sp(i) to each neighbor i
    Estimate the queuing delay Tw for the packet for each neighbor.
    Determine the qualified neighbors that can satisfy the deadline requirements based on Tw.
    Sort the qualified nodes in descending order of Tw
    Allocate workload rate Ai for each node.
        for each intermediate node ni in the sorted list do
            Send packets to ni with transmission interval Sp(i)/Ai
        end for
end if
```

Table 1: List of symbols

N	# of network nodes
n_i	Node i
U_s	Space utility
W_i	Bandwidth of n_i
T_p	Transmission time of packet p
T_a	Packet arrival time
T_{QoS}	Delay QoS requirement
T_w	Queuing Delay
N_q	Set of nodes satisfying deadline
U_{as}(i)	Available space utility
T_{U_s}	Space utility threshold

QOD includes 6 algorithms which deals with selection of qualified neighbor, scheduling of packet distribution, packet resizing according to node mobility, traffic control, packet compression and data redundancy elimination.

a) Neighbor Selection Algorithm

It uses Earliest Deadline First scheduling algorithm (EDF) [19].It is a deadline driven scheduling algorithm for data traffic scheduling in intermediate nodes. 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.

Here a space utility threshold $T_{U_s}$for each node is first decided .Threshold value is decided such that it should provide QoS support. Space utility is amount of time node I is busy for forwarding packet in unit time. Then U_{as} (i) denote the available space utility U_{as}(i)= $T_{U_s} - U_s$(i). In QOD, after receiving a forward request from a source node, an intermediate node $n_i$with space utility less than threshold T_{U_s} replies the source node. The replied node n_i informs the source node about its available workload rate U_{as}(i)*W_i and the necessary information to calculate the queuing delay of the packets from the source node. The source node selects the replied neighbor nodes that can meet its QoS deadline for packet forwarding based on the calculated queuing delay. After the source node determines the N_q nodes that can satisfy the deadline requirement of the source node, the source node needs to distribute its packets to the N_q nodes based on their available workload rate U_{as} (i)* W_i to make the scheduling feasible in each of the neighbor nodes[18].

b) Distributed Packet Scheduling Algorithm

This algorithm assigns earlier generated packets to forwarders with higher queuing delays and scheduling feasibility, 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. Here t denote the time when a packet is generated, and use T_{QoS} to denote the delay QoS requirement. Let T_w denote the packet queuing time and $T_w\ (i)$ denote the packet queuing time of n_i .After receiving the reply messages from neighbor nodes that includes the scheduling information of all flows in their queues, the source node calculates the Tw of its packets in each intermediate node and then chooses the intermediate node n_i that satisfies $T_w\ (i)<T_{QoS} - T_{S\to I}$-$T_{I\to D}$[18].

c) Mobility-Based Packet Resizing Algorithm

The basic idea is that the larger size packets are assigned to lower mobility intermediate nodes and smaller size packets are assigned to higher mobility intermediate nodes, which increases the QoS guaranteed packet transmissions.

This algorithm is beneficial for resource scheduling because a node in a highly dynamic network has higher probability to meet different mobile nodes and APs[18].

d) Soft-Deadline-Based Forwarding Scheduling

This algorithm calculates the slack time of packet. The slack time of a packet p is defined as D_p -t -C', where t is the current time and C' is the remaining packet transmission time of the packet.

With this least slack first(LSF) algorithm, an intermediate node periodically calculates the slack time of each of its packets, and forwards the packet with the least slack time. This algorithm is beneficial to soft deadline driven applications[18].

e) Compression Algorithm

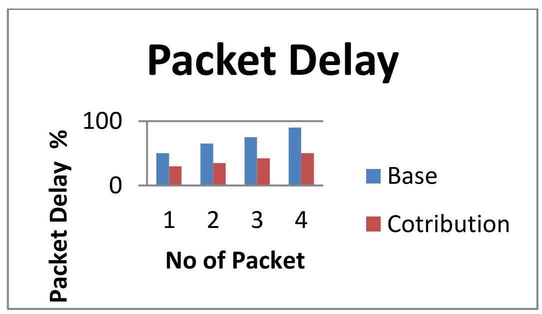
Here deflate compression algorithm is used [20]. This algorithm is applied on whole packet then it compresses the redundant data .This algorithm minimizes the packet size. Hence our packet reaches before deadlines.so packet delivery rate increases.

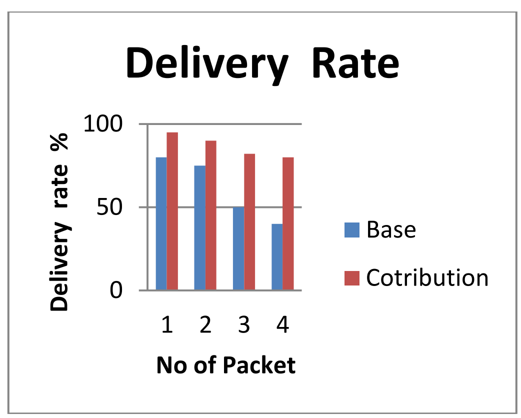
f) Traffic Redundancy Elimination

Due to broadcasting in wireless networks, the APs and mobile nodes can overhead and cache packets. This end-to-end traffic redundancy elimination (TRE) algorithm [21] is used to eliminate the redundant 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. When a source node begins to send out packets, it scans the content for duplicated chunks in its cache. If the sender finds a duplicated chunk and it knows that the AP receiver has received this chunk before, it replaces this chunk with its signature.

IV. COMARISIOIN

For comparison we are going to use two parameters Packet Delay and Delivery rate. Delay is, we show how much time required reaching at destination before deadline. And the delivery rate is how many packets we are going to send and how many of them are reached with better QoS performance.Contribution work increses the delivery rate upto 25 % and decreses delay upto 30 %.





V. CONCLUSION

This proposed system is to enhance quality of service (QoS) of Hybrid wireless network. Hybrid networks take the advantages of cellular infrastructure network and mobile adhoc network as per availability of resources and user mobility. Efficient intermediate node selection, packet scheduling, slack time utilization and compression together improve quality performance in terms of packet delay and delivery rate.

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