Dynamic Resource Scheduling for Hybrid Networks Based on QOS

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***Abstract*— Wireless communications are the need for the hour in this modern era. QoS(Quality of Service) is a total efficiency of a computer network, which is encountered by the user. Hybrid wireless networks puts up a good performance by interfacing MANET's and infrastructureless wireless network. In this paper, we propose a QoS based Scattering routing protocol(QSR) to improvise the quality of service of hybrid wireless networks. QSR transpose the packet routing issue to a dynamic resource scheduling problem. QSR assimilates five algorithms: 1) assured QoS neighbor node choosing algorithm for the selection of relevant neighboring nodes, 2) a scheduling algorithm for packet distribution to reduce the total transmission delay, 3) segment rescaling algorithm based on mobility resizes every packet stream for appropriate node according to the mobility of the respective nodes, 4) progressive scheduling algorithm based on soft-deadline where a transitional node forwards the packet with least time, 5) packet overhearing termination based transmission which discards the replicated data to enhance the quality of service of the data transmission. Diagnostic and simulation results influenced by the real time human mobility model display that QSR protocol can generate extraordinary QoS efficiency in terms of throughput, packet overhead, error rates, availability, jitter, etc.**

Keywords*— *Hybrid wireless networks, Quality of Service, routing algorithm, data transmission.

I. INTRODUCTION

A hybrid wireless network interfaces a mobile wireless ad hoc network (MANET) and a wireless infrastructure network has been declared to be a best next generation networks. Some of the most common wireless technology are radio waves, electromagnetic waves, etc. QoS(Quality of Service) is a total efficiency of a computer network, which is constructed by the user of the appropriate network. Several elements of the networks are taken into consideration are the throughput, error rates, transmission delay, availability of path, mobility-resilience and scalability. QoS is mainly important for traffic transportation. A premium QoS is mandatorily required for certain type of network traffic, for example 1) Video conference, 2) Streaming media(IPTV), 3) Telepresence, 4) online games, 5) circuit emulation services, 6) safety critical applications such as remote surgery, 7) storage applications like iSCSI and FCOE, 8) industrial control system protocols such as ethernet. These types of services are effective and require a less amount of bandwidth and more latency to function. They are also indicated as inelastic. Asynchronous transfer mode (ATM) or Global system for mobile (GSM) have incorporated QoS in their core protocol. The need for QoS is exculpated in their expenses, the users of the network and service providers can go out for a service level agreement (SLA) which directs the covenant for providing a fulfilled efficient throughput and latency bounds.

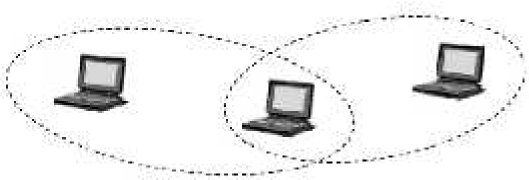

Fig 1: Adhoc wireless network

Over accoutrement and over provisioning is to facilitate network with effective quality communication, the capacity relies on the highest load of traffic. However QoS is far better than the overprovisioning mechanism since it links that are needed to substitute QoS relies on the users and the data for the traffic. This is the major disadvantage of the overprovisioning method. The support for the QoS deducts the end-to-end transmission delay and increases the throughput to ensure the contiguous communication between mobile networking atmospheres.

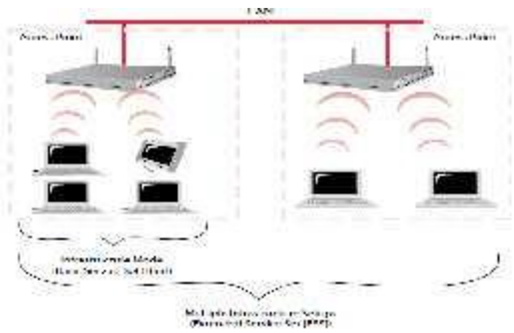

Fig 2: Infrastructure wireless networks.

Infrastructure networks improve the scalability of MANETs, in which self-functioning networks are automated. Basically MANET is a sequential auto-configured infrastructure less network of mobile devices which are of wireless connections. Each device in a MANET can mobile freely in all directions and can susceptible to change links to some other devices very often and it is also declared reliable.

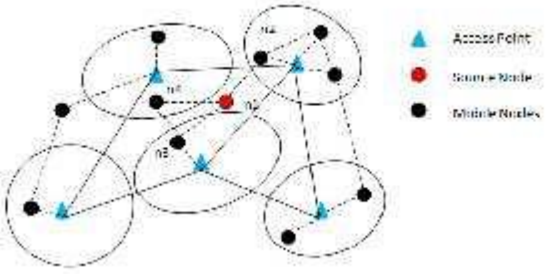

Fig.3. Hybrid wireless network.

Many numbers of Qos routing protocols have been proposed for MANETs which make routes formed by the nodes and links that fix their resource to accomplish QoS standards. Most of the current works in hybrid networks concentrate on the reliable network capacity and the routing efficiency but fail to fulfill QoS ensured services. Packet transmission in hybrid wireless networks has two aspects. First, an access point can be a source or a destination to any mobile node. Another, the number of data transmission hops between and access point and a mobile node is less. Considering the entire eminence of the two aspects, the QSR converts the packet routing problem into a dynamic resource scheduling problem. Many studies and works have proved that other QoS routing protocols are being affected by void stipulation and race condition problems. This QSR protocol provides a reliable and high performance communication networking compared to other routing protocols.

II. RELATED WORK

Existing approaches for providing guaranteed services in the infrastructure networks are based on two models: Integrated Services (IntServ) and Differentiated Service (DiffServ) IntServ is a stateful model that uses resource reservation for individual flow, and uses admission control and a scheduler to maintain the QoS of traffic flows. The IntServ model includes two sorts of service targeted towards real-time traffic: guaranteed and predictive service. It integrates these services with controlled link sharing, and it is designed to work well with multicast as well as unicast. The assumption is that resources (e.g., bandwidth) must beexplicitly managed in order to meet application requirements. This implies that resource reservation and admission control are key building blocks of the service.

In contrast, DiffServ is a stateless model which uses coarse-grained class-based mechanism for traffic management. A number of queuing scheduling algorithms have been proposed for DiffServ to further minimize packet droppings and bandwidth consumption. Stoicaet. al. [1] proposed a Dynamic Packet Service (DPS) model to provide unicast IntServ guaranteed service and Diffserv-like scalability. The IETF completed the Request for Comments (RFCs) for DiffServ toward the end of 1998. As stated in the DiffServ working group objectives [Ref-C], "There is a clear need for relatively simple and coarse approach for allotting classified service for internet transit, to guide numerous applications and distinctive business requirements. The differentiated service accession for allotting QoS in networks exert a less, precise intent of building set of building blocks from which a variety of aggregate behavior may be built. A small bit-pattern in each packet, in the IPv4 QoS octet or the Internet protocol version6 class octet, denotes the packet to procure a certain aiding treatment, or the action of per-hop, at every network node.

A majority of QoS routing protocols are based on resource reservation [2], in which a source node sends probe messages to a destination to discover and reserve paths satisfying a given QoS requirement. A QoS aware routing that is based on the bandwidth estimation for mobile ad hoc networks is proposed in Chen and Heinzelman (2005). The protocol incorporates an admission control scheme together with a feedback scheme to meet the QoS requirements of real-time applications. The QoS routing protocol is based on Ad hoc On-demand Distance Vector (AODV) routing.

Perkins et al. [3] extended the AODV routing protocol [4] by adding information of the maximum delay and minimum available bandwidth of each neighbor in a node’s routing table. Jiang et al. [5] proposed to reserve the resources from the nodes with higher link stability to reduce the effects of node mobility. Liao et al. [6] proposed an extension of the DSR (Distance vector Source Routing) protocol [7] by reserving resources based on time slots.

A QoS routing protocol that guarantees the bandwidth for ad hoc networks with interference considerations is presented in Jia et al. (2005). The protocol addresses the problem of Ad hoc Shortest Widest Paths (ASWP) routing. A routing protocol that is aware of the interference called as Interference Aware QoS Routing (IQRouting) is proposed in Gupta et al. (2005). In IQRouting, several paths are probed using flow packets in a distributed fashion for satisfying QoS. The paths that satisfy the QoS are known as candidate paths. The path that is the best in terms of the QoS amongst all candidate paths is chosen by the destination node.

A QoS routing protocol called Geographical Vehicular Grid (GVGrid) for Vehicular Ad hoc Networks (VANET) is presented in Sun et al. (2006). GVGrid is an on-demand and a position based routing protocol that identifies a route from a source node (which is a fixed base station) to vehicles that lie in a destination region.Venkataramanan et al. [6] proposed a scheduling algorithm to ensure the smallest buffer usage of the nodes in the forwarding path to base stations. However, these works focus on maximizing network capacity based on scheduling but fail to guarantee QoS delay performance.

Very few methods have been proposed to provide QoS-guaranteed routing for hybrid networks. Most of the routing protocols [9–16] only try to improve the network capacity and reliability to indirectly provide QoS service but bypass the constraints in QoS routing that require the protocols to provide guaranteed service. Jiang et al. [14] proposed a resource provision method in hybrid networks modeled by IEEE802.16e and mobile WiMax to provide service with high reliability. Ibrahim et al. [9] and Bletasa et al. [10] also tried to select “best” relay that has the maximum instantaneous value of a metric which can achieve higher bandwidth efficiency for data transmission..

Ng et al. [11] considered cooperative networks that use physical layer relaying strategies, which take advantage of the broadcast nature of wireless channels and allow the destination to cooperatively "combine" signals sent by source and the relay to reinforce the same signal. Cai et al. [12] proposed a semi- distributed relaying algorithm to jointly optimize relay selection and power allocation of the system. Wei et al. [15] proposed to use the first-order finite state Markov channels to approximate the time variations of the average received Signal-to-Noise ratio (SNR) for the packet transmission and use the adaptive modulation and coding scheme to achieve high spectral efficiency.

Lee et al. [16] presented a framework of link capacity analysis for optimal transmission over uplink transmission in multi-hop cellular networks. Wei et al. [13] proposed a two-hop packet forwarding mechanism, in which the source node adaptively chooses direct transmission and forward transmission to base stations. Unlike the above works, QOD aims to provide QoS-guaranteed routing. QOD fully takes advantage of the widely deployed APs, and novelty treats the packet routing problem as a resource scheduling problem between nodes and APs. In the infrastructure wireless networks, QoS provision has been proposed for QoS routing, which often requires node negotiation, admission control, resource reservation, and priority scheduling of packets. However, it is more difficult to guarantee QoS in MANETs due to their unique features including user mobility, channel variance errors and limited bandwidth. Thus, attempts to directly adapt the QoS solutions for infrastructure networks to MANETs generally do not have great success.

III. PROPOSED WORK

A. Network models

Network model consider a hybrid wireless network with an arbitrary number of base stations spreading over the network. N mobile nodes are moving around in the network. Each node ni ($1 \le i \le N$) uses IEEE 802.11 interface with the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol [34]. Since a hybrid network where nodes are equipped with multi-interfaces that transmit packets through multi-channels generate much less interference than a hybrid network where nodes are equipped with a single WiFi interface, assume that each node is equipped with a single WiFi interface in order to deal with a more difficult problem. Therefore, the base stations considered in this project are access points (APs).

The WiFi interface enables nodes to communicate with both APs and mobile nodes and use Ri and Ri' to denote the packet transmission range and transmission interference range of node ni, respectively and di,j to denote the distance between nodes ni and nj . A packet transmission from ni to nj is successful if both conditions below are satisfied:

(1) $d_{i,j} \le R_i$, and

(2) any node nk satisfying $d_{k,j} \le R_k'$ is not transmitting packets,

where $0 < k < N$ and $k \ne j$.

Algorithm Pseudo-code for the QOD routing protocol executed by a source node

(1) if admit a packet aiding request from a source node then
(2) if volume feasibility<threshold then
(3) Reply to the source node.
(4) end if
(5) end if
(6) if admit forwarding request replies for neighbor nodes then
(7) Arbitrate the appropriate neighbor which is relevant to the deadline.
(8) Workload rate(W_r) allotment for every node.
(9) Sort the appropriate nodes in descendent order of Q_w.
(10) Approximate the queuing delay Q_w for the packet for every neighbor.
(11) Evaluate the size of the packet $P_z(n)$ to each neighbor.
(12) Transmit packets to n_i with transmission interval $S_p(i)$
(13) end for
(14) end if

B. Assured QoS neighbor node choosing algorithm

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. Let us use $P_z(i)$ to denote the size of the packet steam from node ni, use Wi to denote the bandwidth of node i and Ta(i) to denote the packet arrival interval from node ni. The QoS of the packets going through node ni can be satisfied if

$$\frac{P_z(1)}{T_a(1)} + \frac{P_z(2)}{T_a(2)} + \frac{P_z(j)}{T_a(j)} \ldots\ldots\ldots + \frac{P_z(m)}{T_a(m)} \le \overline{W_i}$$

After the source node determines the Nq nodes that can satisfy the deadline requirement of the source node, the source node needs to distribute its packets to the Nq nodes based on their available workload rate Vbr(x)*Wx to make the scheduling feasible in each of the neighbour nodes. Then, the problem can be modelled as a linear programming process. Suppose the packet generating rate of the source node is Wgkb/s, the available workload rate of the intermediate node i is Vbr(x)*Wx , and the workload rate allocation from source node to immediate node i is Ai = Sp(i)/Ta(i) , where $0 < i < n$. Then, need to solve the following equations to get an allocation set S:

$$A = \left\{ W_g = \sum_{i=1}^{N_q} A_i \,, A_i \le \text{Vbr(x)} \ * \text{Wx} \right.$$

Any results satisfy the above equation can be used by the source node. If the equation cannot be solved, which means the QoS of the source node cannot be satisfied, then the source node stops generating packets based on the admission control policy.

C. Scheduling algorithm for packet distribution

A distributed 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.Let T_w denote the packet queuing time and T_w (i) denote the packet queuing time of n_i. The queuing delay requirement is calculated as $Q_w < Q_{QoS} - Q_{S\to I} - Q_{I\to D}$. As Q_{QoS} , $Q_{S\to I}$ and are already known, the source node needs to calculate Tw of each intermediate node to select intermediate nodes that can send its packets by the deadline, i.e., that can satisfy $Q_w < Q_{QoS} - Q_{S\to I} - Q_{I\to D}$. An intermediate node can determine the priorities of its packets based on their deadlines D_p. A packet with a smaller priority value x has a higher priority. Before introducing the details of the distributed packet scheduling algorithm and explain how to estimate the queuing time $Q_w^{(x)}$ of a packet with priority x. It is estimated by the following equation.

$$Q_w(x) = \sum_{i=1}^{x-1} Q_{I\to D}^{(j)}.(Q_w(x)/Q_a(j)(0<j<x)$$

D. Segment rescaling algorithm based on mobility

In a highly dynamic mobile wireless network, the transmission link between two nodes is frequently broken down. The delay generated in the packet re-transmission 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 the equation shows, the space utility of an intermediate node that is used for forwarding a packet p is U_p/W_iT_a .That is, reducing packet size can increase the scheduling feasibility of an intermediate node and reduces packet dropping probability. 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. Specifically, in QOD, as the mobility of a node increases, the size of a packet U_p sent from a node to its neighbor nodes i decreases as following

$$U_p(new) = \frac{\gamma}{v_i} U_p(unit)$$

E. Progressive scheduling algorithm based on soft-deadline

A forwarding node can take advantage of the Least slack time(LSF) scheduling algorithm. The slack time of the packet p is represented as D_p-c-r^1, where c is the current time and r^1 is the remaining time of the packet transmission. In this mechanism, an intermediate node periodically calculate the slack time of every packet have similar slack time, anyone of the packet is randomly chosen to get transmitted. LSF does not fully involve in transmitting the packet flow before their relevant deadlines. It enforces to create delays and the size of delayed part of the delayed packet of various packet flow almost the same. LSF is very much reliable and moderate than EDF (Earliest Deadline First).

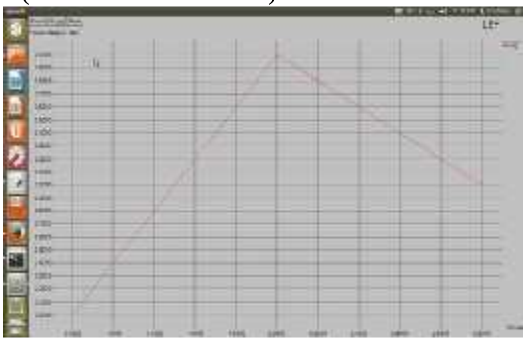

Fig.4. Xgraph of LSF

In EDF, an intermediate node transmits the packets in order from the packets with closest deadline to packets with far deadline. QSR can adopt LSF or EDF based on the applications.

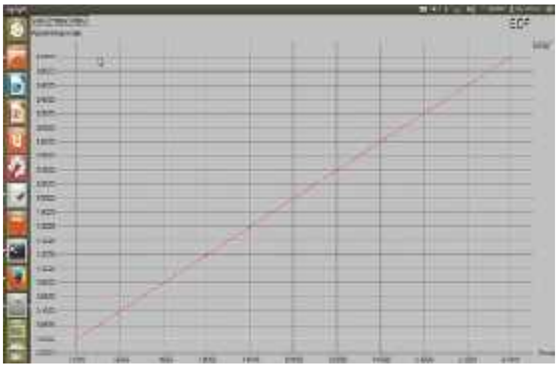

Fig.5. Xgraph of EDF

F. Packet overhearing termination transmission

The network allocation vector is a virtual carrier sensing mechanism used with wireless network protocols such as IEEE 802.11 and IEEE 802.16(WiMax).An enormous amount of NAV leads to a less available bandwidth and less scheduling utility of mobile nodes. The mobile node approximated their NAV value depending on the overhearing packet transmission persistence time. By deducting the NAV value, we can maximize the scheduling utility of the intermediate nodes and successfully increase the quality of service in the data transmission. An end-to-end traffic redundancy elimination(TRE) algorithm is incorporated to eliminate the redundant data to maximize the efficiency of the QoS of the data transmission in QSR. For estimating the frontier of the chunks in a packet stream TRE is adopted. The source node caches the data it has sent out and the receiver also caches its received data.

IV. CONCLUSION

The next generation networks is expected to be more promising with the network structure of the hybrid wireless networks, which interfaces MANETs and infrastructure less wireless networks. Existing QoS routing protocols are being affected by void stipulation and race condition problems so QSR protocol is employed to provide a reliable and high performance communication networking in contrast to other routing protocols. Diagnostic and simulation results influenced by the real time human mobility model display that QSR protocol can generate extraordinary QoS efficiency in terms of throughput, packet overhead, error rates, availability, jitter, etc. In the upcoming era, we propose to estimate the efficiency and performance of the QSR protocol on real time scenario.

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