Providing QoS in MANET using Bandwidth Estimation

Navneet Dhanda[1], Trilok Gabba[2], Swati Dhull[3],
Research Scholar,BITS,Bhiwani[1], Asst.Professor, BITS,Bhiwani[2] , Asst.Professor, IITM,Murthal[3]

Abstract- **Ad hoc networks present unique advanced challenges, including the design of protocols for mobility management, effective routing, data transport, security, power management, and quality-of-service (QoS) provisioning. Once these problems are solved, the practical use of MANETs will be realizable. Bandwidth estimation is an important issue in the Mobile Ad-hoc Network (MANET) because bandwidth estimation in MANET is difficult, because each host has imprecise knowledge of the network status and links change dynamically. Therefore, an effective bandwidth estimation scheme for MANET is highly desirable.In this paper we presents bandwidth estimation scheme for MANET, which uses some components of the two methods for the bandwidth estimation: 'Hello Bandwidth Estimation' & 'Listen Bandwidth Estimation'. The proposed method is based on the comparison of these two methods.**

Keywords: **Bandwidth Estimation, Mobile Ad Hoc Network (MANET), "Hello" Bandwidth Estimation Method, "Listen" Bandwidth Estimation Method, QoS**

1 INTRODUCTION

Bandwidth estimation is a basic function that is required to provide QoS in MANETs. It is a way to determine the data rate available on a network route. It is of interest to users wishing to optimize end-to-end transport performance, overlay network routing, and peer-to-peer file distribution.

Techniques for accurate bandwidth estimation are also necessary for traffic engineering and capacity planning support. Having information existing can help to develop better methods for e.g. gateway selection, channel selection, routing, etc.

Literally, ad-hoc means in Latin, ad -hoc means is "for this," meaning "for this special purpose". An ad-hoc network is a local area network (LAN) that is built spontaneously as devices connect and autonomous self-organized wireless and mobile networks. They do not require any fixed infrastructure for instance a base station to work. The nodes themselves address topology changes due to the mobility, the entrance or the exits of nodes. These networks use a radio medium.

MANET is a group of two or more devices or nodes or terminals with wireless communications and networking competence that communicate with each other without the help of any centralized administrator also the wireless nodes that can form a network to exchange information according to their need at that time. It is an independent system in which mobile hosts connected without wire and are free to move dynamically and sometimes they act as routers at the same time.

There are two types of mobile network namely Mobile IP and MANET. MANET consists of nodes that are cable to communicate wirelessly among them. MANETs consist of a group of wireless mobile nodes which dynamically exchange data among themselves without the reliance on a fixed base station or a wired backbone network.

MANET nodes are typically differentiated by their limited power, processing, and memory resources as well as high degree of mobility. In MANETs, the wireless mobile nodes may dynamically enter in the network as well as leave the network. Because of the limited transmission range of wireless network nodes, multiple hops are generally required for a node to exchange information with any other node in the network.

Multipath routing permits the formation of multiple paths between one source node and one destination node. It is basically proposed in order to enhance the reliability of data transmission (i.e., fault tolerance) or to provide load balancing. Available bandwidth estimation techniques can be divided in two major approaches:

1. *Intrusive Bandwidth Estimation Techniques:*

   The intrusive approaches techniques are based on end-to-end probe packets to estimate the available bandwidth along a path.

2. *Passive Bandwidth Estimation Techniques:*

   The passive approaches techniques uses local information on the used bandwidth and that may exchange this information via local broadcasts.

Till date much of the research work is targeted at finding a possible path from a source to a destination without considering current network traffic or usage requirements. Such QoS support can be accomplished by either finding a path to fulfill the application requirements or offering network response to the application, when the requirements cannot be met. This paper is also about a QoS-aware routing protocol that incorporates a feedback scheme and an admission control scheme to meet the QoS requirements (provides better than best-effort service) of real-time applications using IEEE 802.11. The novel work of this QoS-aware routing protocol is the use of the approximate bandwidth estimation to response to the network traffic.

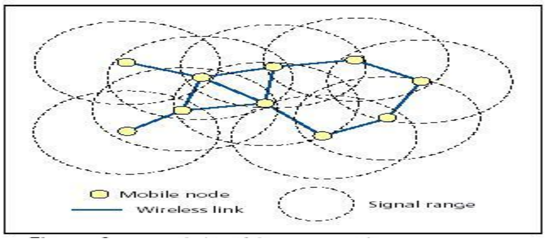

Fig 1 Ad hoc Network

2 LITERATURE REVIEW

In an ad hoc network, a host's available bandwidth refers to amount of bandwidth available to the node to send packets to the network. Whole channel will not be used for packet transmission. Bandwidth estimation can be done using various methods; for example, bandwidth estimation is a cross-layer design of the routing and MAC layers and the available bandwidth is estimated in the MAC layer and is sent to the routing layer for admission control. Therefore, bandwidth estimation can be carried out in various network layers.

Present bandwidth estimation tools measure one or more of three related metrics: capacity, available bandwidth, and bulk transfer capacity. Currently available bandwidth estimation tools utilize a various strategies to measure these metrics.

The issues of multipath routing in MANETs were specifically examined. They also discuss the application of multipath routing to support application constraints such as reliability, load-balancing, energy-conservation, and QoS.

An improved mechanism was proposed to estimate the available bandwidth in IEEE 802.11 -based ad hoc networks. In 802.11-based ad hoc networks, few works deal with solutions for bandwidth estimation.

In a distributed ad hoc network, a host's available bandwidth cannot decided only by the raw channel bandwidth, but also by its neighbor's bandwidth usage and interference caused by other sources, each of which reduces a host's available bandwidth for transmitting data. Therefore, applications cannot properly optimize their coding rate without knowledge of the status of the entire network.

An incorporating QoS into routing, and introduce bandwidth estimation by propagating bandwidth information through "Hello" messages. A cross-layer approach, including an adaptive feedback scheme and an admission scheme to give information to the application about the network position, are implemented.

According to the simulations show that their QoS-aware routing protocol can improve packet delivery ratio greatly without impacting the overall end-to-end throughput, while also decreasing the packet delay and the energy consumption significantly.

The problem in available bandwidth estimation was rethink in IEEE 802.11 based ad hoc networks. According to them estimation accuracy is increased by improving the calculation accuracy of the probability for two adjacent nodes idle period to overlap.

All the information of MANET which include the History of ad hoc, wireless ad hoc, wireless mobile approaches and types of MANETs, and then they present more than 13 types of the routing Ad Hoc Networks protocols were proposed. They give description of routing protocols, analysis of individual characteristics and advantage and disadvantages to collect and compare, and present all the applications or the Possible Service of Ad Hoc Networks.

2.1 Characteristics of MANET

The intention of the MANET is to standardize IP routing protocol functionality is appropriate for the wireless routing application within both dynamic and static topologies with raised dynamics because of node motion and other factors:

- Dynamicity: Every host can randomly change position. The topology is generally unpredictable, and the network status is imprecise.
- Non-centralization: There is no centralized control in the network and, thus, network resources cannot be assigned in a predetermined manner.
- Radio properties: The wireless channel can suffer fading, multipath effects, time variation, etc.

With these constraints, Hard QoS (e.g., guaranteed constant bit rate and delay) is difficult to achieve. The reasons are as follows:

- To support QoS the end host should have knowledge of the worldwide position of the network. The dynamic nature of MANETs makes it difficult for hosts to determine information about their local neighborhood, much less the global status of the network.
- It is hard to establish cooperation between neighboring hosts to determine a transmit schedule for guaranteed packet delivery without centralized control. In MANETs, each host's transmissions will interfere with neighboring hosts' transmissions.
- The wireless channel's main deficiency is its unreliability caused by various reasons such as fading and interference.

Thus if the topology changes too frequently, the source host cannot detect the network status changes and cannot make the corresponding adjustment to meet the specific QoS requirements. Therefore, combinatorial stability must first be met before we can consider providing QoS to real-time applications. Solution is a QoS-aware routing protocol that either provides feedback about the available bandwidth to the application (feedback scheme), or admits a flow with the requested bandwidth (admission scheme). Both the feedback scheme and the admission scheme require knowledge of the end- to-end bandwidth available along with the route from the source to the destination. Thus, bandwidth estimation is important to support QoS.

2.2 Bandwidth Estimation Methods

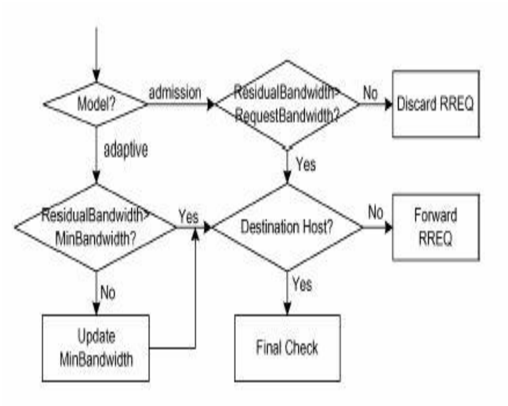

Fig 2 Host working Procedures

Estimating accurate available bandwidth allows a node to make optimal decision before transmitting a packet in networks. It is therefore clear that the available bandwidth estimation enhances the QoS in wired and wireless Networks. Measuring available bandwidth in ad hoc networks is challenging issue in MANET and calculating the residual bandwidth using the IEEE 802.11 MAC is still a challenging problem, because the bandwidth is shared among neighboring hosts, and an individual host has no knowledge about other neighboring hosts' traffic status. Two methods for estimating bandwidth are used below:

1. *"Listen" bandwidth estimation:* For hosts to listen to the channel and estimate the available bandwidth every second based on the ratio of free and busy times. The IEEE 802.11 MAC utilizes both a physical carrier sense and a virtual carrier sense [via the network allocation vector (NAV)], which can be used to find out the free and busy times. The MAC detects that the channel is free when the following three requirements are met:

- NAV's value is less than the current time;
- Receive state is idle;
- Send state is idle. The MAC declares that the channel is busy when one of following occurs:
- NAV sets a new value;
- Receive state changes from idle to any other state;
- Send state changes from idle to any other state.

⇒ Channel BW*free time/over all time Weight factor

2. *"Hello" bandwidth estimation:* The sender's current bandwidth consumption as well as the sender's one-hop neighbor's (from its two-hop neighbors) current bandwidth consumption is piggybacked onto the standard "Hello" message. Each host estimates its available bandwidth based on the information provided in the "Hello" messages and knowledge of the frequency reuse design.

The second neighboring host's information was proposed by using hop relay to propagate. AODV uses the "Hello" messages to update the neighbor caches. The "Hello" message used in AODV only keeps the address of the host who initiates this message. Modify the "Hello" message, including two fields. The first field includes host address, consumed bandwidth, timestamp, and the second field includes neighbor's addresses, consumed bandwidth, timestamp. Each host finds out its used bandwidth by monitoring the packets it supplies into the network. This value is recorded in a bandwidth-consumption register at the host and is updated periodically. Therefore, the "Listen" bandwidth estimation approach has difficulty correctly estimating the residual bandwidth. Even if some forced update schemes can be adopted, the hosts still cannot release the bandwidth correctly; since the hosts do not know how much bandwidth each node in the broken path consumes.

2.3. Incorporating QoS in Route Discovery

QoS-aware routing discovery, the source host sends a RREQ packet whose header is changed to model- flag, bandwidth request, min-bandwidth, AODV RREQ header. The model-flag indicates whether the source is using the admission scheme or the adaptive feedback scheme. When an intermediate host receives the RREQ packet, it first calculates its residual bandwidth. If the model- flag is the admission scheme, the host compares its residual bandwidth with the requested bandwidth. If its residual bandwidth is greater than the requested bandwidth, it forwards this RREQ. Otherwise, it discards this RREQ. If the model- flag is adaptive, the host compares its residual bandwidth with the min-bandwidth field in the RREQ. If its residual bandwidth is greater than the min-bandwidth, it forwards the RREQ. Otherwise, it updates

ID	Consumed Bandwidth	Timestamp
Neighbor ID 1	Consumed Bandwidth	Timestamp
⋮	⋮	⋮
Neighbor ID n	Consumed Bandwidth	Timestamp

Fig.3 Hello Structure

2.4. Route Maintenance

2.4.1 Listen Method: QoS-aware routing with ―Listen‖ bandwidth estimation, AODV's route maintenance scheme is used, because releasing bandwidth from the bandwidth consumption registers is impossible without knowing how much bandwidth is consumed by each host in the route. Therefore, no change in AODV's route maintenance scheme is needed to address the bandwidth releasing issue.

2.4.2 Hello method: We cannot directly use AODV's route maintenance scheme in the QoS-aware routing protocol with ―Hello‖ bandwidth estimation. We should incorporate a forced cache update in the route maintenance scheme. The QoS-aware routing with ―Hello‖ bandwidth estimation uses the first neighbors' relay to get the second neighbors' information. Therefore, once the neighbors get the forced updates, they should disseminate the update information immediately to their neighbors. We use an ―Immediate Hello‖ message to address this concern. This special message's content is exactly the same as the ―Hello‖ message, except the packet type is marked as ―Immediate Hello‖ in order to differentiate with the regular ―Hello‖ message. When a host receives an ―Immediate Hello‖ message, it sends its regular ―Hello‖ message immediately. The ―Error‖ message is also adopted to trigger.

Hello versus Listen Bandwidth estimation when Routes break broken route can be caused by two reasons:
1) Route break caused by losing "hello" messages:
―Hello‖ packets are dropped often when traffic becomes heavy. The packets are still successfully transmitted to the destination host during the time between the first ―Hello‖ message being dropped and another ―Hello‖ message being dropped. The route discovery procedure is initiated right after the source host receives the ―Error‖ message. A small time interval, it is almost impossible for the hosts to automatically
2) Route break caused by Moving out of a Neighbors Transmission range:
The ―Listen‖ technique cannot react well to a broken route due to the fact that the MAC's NAV cannot truly reflect the traffic status, and the bandwidth consumption registers cannot be updated in time. Thus, when routes break, ―Hello‖ bandwidth estimation performs better than ―Listen‖ bandwidth estimation.

3. SIMULATIONS AND RESULTS

To test the performance of our QoS-aware routing protocol, we ran simulations using ns-2.1b9a. We use the IEEE 802.11 MAC protocol in RTS/CTS/Data/ACK mode with a channel data rate of 2Mb/s. The topologies vary according to the different Simulation purposes.

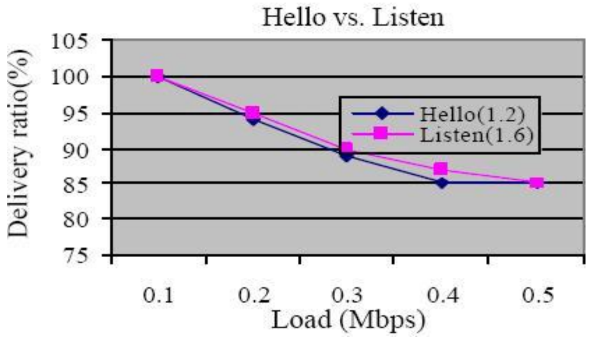

Fig.4 Time Vs Receive Rate

The input parameters Specify Mac type 802.11, protocol is used for AODV, number of nodes and number of packets in this paper specify 50 and 60.packet size max 1500 min 60.Bandwidth size 11 Mb. here slot time used as 50 micro second. Basic rate and data rate with specified as 1.0 and 0.1. Packet interval with specification of 0.020 that is equal to send rate of 8000 bytes. Changing of Data rate value and Basic rate value, make the corresponding changes in metrics.

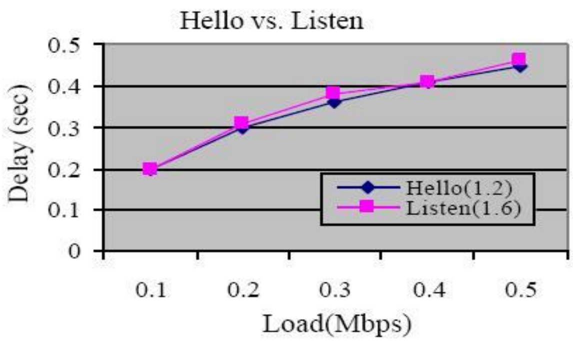

Fig.5 Load Vs Delay

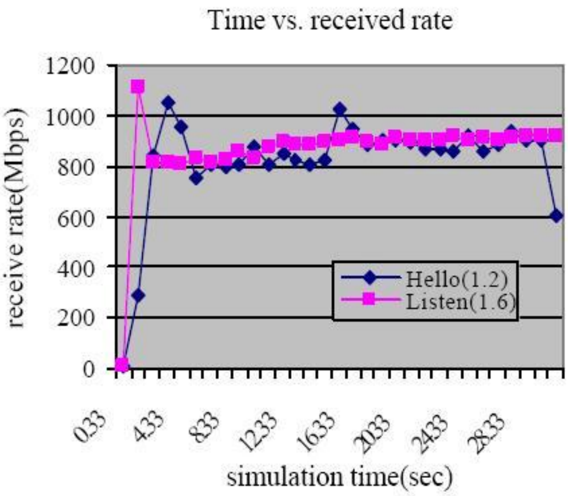

Fig.6 Load Vs Delivery Ratio

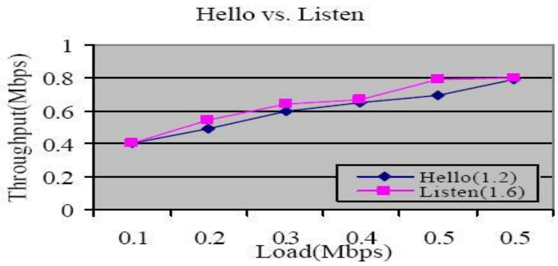

Fig.7 Load Vs Throughput

3.1 Topology using Admission scheme and Feedback scheme

Both the feedback scheme and the admission scheme require knowledge of the end-to- end bandwidth Available along the route from the source to the destination. In the admission scheme, flows are denied if there is not enough bandwidth available to support their request. This result in the total capacity of the admitted flows being less than that of the feedback scheme, so packet collisions occur less frequently. Correspondingly, the packet delay should be decreased significantly due to fewer collisions. We compare QoS-aware routing with―Hello‖ bandwidth estimation, QoS-aware routing with ―Listen‖ bandwidth estimation, and conventional AODV, which has no QoS support. The metrics used in measuring the protocols' performance are delay, packet delivery ratio, and overall end-to end throughput.

3.2 Weight Factor Comparison

We cannot compare the performance of ―Hello‖ bandwidth estimation and ―Listen‖ bandwidth estimation using the same weight factor, because these two methods define the consumed bandwidth differently.

3.2.1 "Listen" mode—accounts for RTS, CTS, ACK, retransmission, routing packets, and transmitted packets.

3.2.2 "Hello" mode—counts the transmitted packets only. Therefore, the ―Hello‖ weight factor should be smaller than the ―Listen‖ weight factor if we want to get the same performance. We find that the performance of choosing weight factor 1.9 in ―Hello‖ mode matches well with the performance of choosing weight factor 2.3 in ―Listen‖ mode. The RTS, CTS, and ACK overheads affect differently small size packets and large size packets. Therefore, different weight factors should be used for different packet sizes.

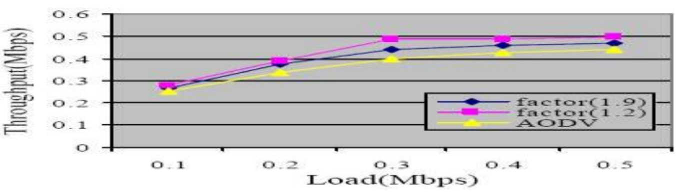

Fig.8 Load Vs Throughput (Listen Method)

The performance when the QoS-aware routing protocol with―Listen‖ bandwidth estimation is used compared with AODV and Weight factor. Fig. 9 shows great improvement in packet delivery ratio. However, Fig.8 the end-to-end throughput is decreased. In Listen, Data rate and weight rate is greater than the Hello method. While the ―Listen‖ scheme's performance is better than the ―Hello‖ scheme's performance in term of packet delivery ratio.

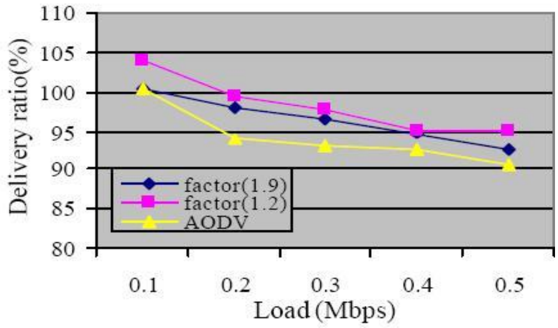

Fig.9 Load Vs Delivery Ratio (Listen Method)

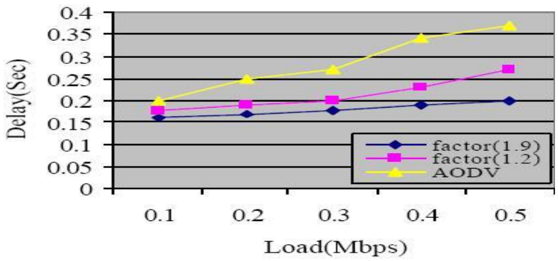

Fig.10 Load Vs Delay (Listen Method)

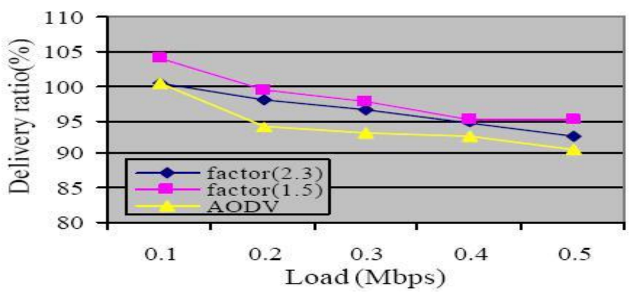

Fig.11 Load Vs Delivery Ratio (Hello Method)

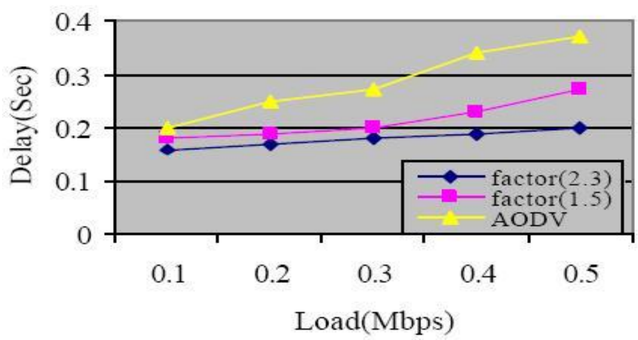

Fig.12 Load Vs Delay (Hello Method)

The ―Hello‖ scheme's performance is better than the ―Listen‖ scheme's performance in term of end-to-end throughput, while the ―Listen‖ scheme's performance is better than the ―Hello‖ scheme's performance in term of packet delivery ratio.

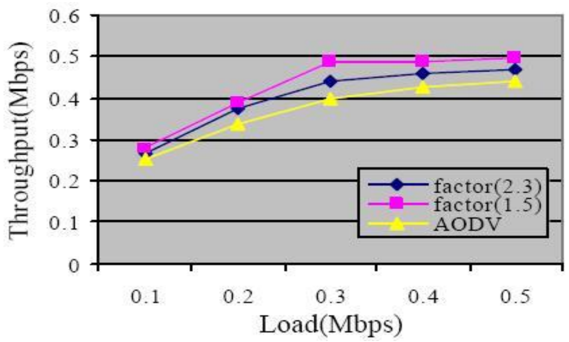

Fig.13 Load Vs Throughput (Hello Method)

4. CONCLUSION AND FUTURE WORK

This paper proposes incorporating QoS into routing, and introduces bandwidth estimation by disseminating the bandwidth information through ―Hello‖ messages. We have compared two different methods of estimating bandwidth.

The ―Hello‖ bandwidth estimation method performs better than the ―Listen‖ bandwidth estimation method when releasing bandwidth immediately is important. The accurate measurement of the capacity of a multi hop mobile network is an open issue right now. Further study of the 802.11 MAC layer's behavior could be helpful to understand this capacity issue. Also, in a real scenario, shadowing will cause a node's transmission range to vary, and it will not be the ideal circle that is assumed here. How to incorporate these non idealities into our protocol is the subject of our future research. Furthermore, incorporating different transmission ranges among all the hosts and analyzing fairness among the hosts will be explored in our future work. Our ultimate goal is to provide a model from the application layer to the MAC layer for supporting service differentiation. A transport layer protocol to support different data streams, queue management and a QoS-supported MAC will be addressed in our future work.

REFERENCES

[1]D. Kim, ―A New Mobile Environment: Mobile Ad Hoc Networks (MANET), IEEE Vehic. Tech. Soc. News, Aug. 2003, pp. 29–35.

[2]S. Chen, Routing Support for Providing Guaranteed End-to- End Quality-of-Service, Ph.D. thesis, University of Illionois at Urbana-Champaign, 1999.

[3]S. Chakrabarti and A. Mishra, ―QoS Issues in Ad Hoc Wireless Networks, IEEE Common. Mag., vol. 39, Feb. 2001, pp. 142–48.

[4]S. Chakrabarti and A. Mishra, ―Quality of Service Challenges for Wireless Mobile Ad Hoc Networks, Wiley J. Wireless Commun. and Mobile Comp., vol. 4, pp. 129–53, Mar 2004.

[5]J. N. Al-Karaki and A. E. Kamal, ―Quality of Service Routing in Mobile Ad Hoc Networks: Current and Future Trends, Mobile Computing Handbook, I. Mahgoub and M. IIays, Eds., CRC Publishers, 2004.

[6]T. B. Reddy et al., ―Quality of Service Provisioning in Ad Hoc Wireless Networks: A Survey of Issues and Solutions, April 2004, available online: http://www.sciencedirect.com.

[7]L. Chen and W. Heinzelman, ―QoS-Aware Routing Based on Bandwidth Estimation for Mobile Ad Hoc Networks, IEEE JSAC, vol. 23, Mar. 2005, pp. 561–72.

[8]C. R. Lin and J.-S. Liu, ―QoS Routing in Ad Hoc Wireless Networks, IEEE JSAC, vol. 17, Aug. 1999, pp. 1426–38.

[9]M. Sheng, J. Li, and Y. Shi, ―Routing Protocol with QoS Guarantees for Ad-Hoc Network, Electronics Letters, vol. 39, Jan. 2003, pp. 143– 45.

[10]I. Rubin and Y.-C. Liu, ―Link Stability Models for QoS Ad Hoc Routing Algorithms,‖ Proc. 58th IEEE Vehic. Tech. Conf., vol. 5, Oct. 2003, pp. 3084–88.

[11]L. Barolli, A. Koyama, and N. Shiratori, ―A QoS Routing Method for Ad Hoc Networks Based on Genetic Algorithm, Proc. 14th Int'l Wksp. Database and Expert Systems Applications, Sept. 2003, pp. 175–79.

[12]D. Kim, C.-H. Min, and S. Kim, ―On-Demand SIR and Bandwidth-Guaranteed Routing with Transmit Power Assignment in Ad Hoc Mobile Networks, IEEE Trans. Veh. Tech., vol. 53, pp. 1215–23, July 2004.

[13]N. Wisitpongphan et al., ―QoS Provisioning using BER-Based Routing in Ad Hoc Wireless Networks, Proc. Vehic. Tech. Conf., vol. 4 2005, pp.2483-87.

[14]C. E. Perkins et al., ―Performance Comparison of Two On- Demand Routing Protocols for Ad Hoc Networks, IEEE Pers. Commun. Mag., vol.8,Feb.2001,pp.16-28.

[15]J. Broch et al., ―A Performance Comparison of Multi-Hop Wireless Ad Hoc Network Routing Protocols, Proc. Int'l. Conf. Mobile Computing and Networking,Oct.1998.