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Enhancing the Performance of Wireless Network through Efficient Bandwidth Estimation Technique

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Abstract

Bandwidth estimation is the main issue for quality-of-service (QOS) in Wireless Communication. Recent bandwidth estimation solutions concentrate on either probing techniques or cross-layer techniques and require bandwidth resources with the protocol modifications. To overcome these problems, MBE (Model Based Available Bandwidth Estimation) is used. MBE is based on transmission control protocol or user datagram protocol throughput models for wireless communications. MBE provides the result with the lowest standard deviation and mean value for error rate and overhead. The proposed approach is to extend MBE, which considers the combined effect of TCP and UDP traffic over WLAN and makes use of TCP and UDP over WLAN throughput models introduced before. When TCP and UDP traffic are transmitted together, their throughputs are different with those when TCP and UDP are delivered alone. TCP adopts a congestion control mechanism to adjust the transmission rate to the available bandwidth. UDP is more aggressive to take possible bandwidth, and affect the TCP traffic. The major difference between the TCP and UDP is the consideration of retransmissions of lost packets. The extended MBE is to be used in IEEE802.11e networks which provide multimedia QOS support.

Keywords

Bandwidth Estimation, Congestion, Throughput, IEEE802.11, Performance analysis

I. Introduction

Bandwidth Estimation schemes have widely been used to improve the quality of service compulsory of multimedia services. Estimation of bandwidth is considered in Broadband networks, Cross layer networks and in Wireless networks etc. Bandwidth estimation is a prerequisite problem for real-time applications in all kind of networks. Since the Bandwidth Estimation is one of the important factor to be considered for QOS in MANET. Bandwidth estimation is taken as a main factor for avoiding congestion, reduce delay time and overall avoid data loss and to improve throughput. However, bandwidth estimation in wireless networks is a more challenging issue due to flexible wireless conditions, such as increased and variable packet error rate(PER), wireless link rate adaptation, signal fading, contention, transmission retries, etc. Most of the existing wireless bandwidth estimation solutions such as WBest and Diet TOPP use probing-based techniques. Probing techniques introduce extra traffic that has a negative influence on multimedia applications. Recently, mechanisms like iBE and Idle Gap that employ cross-layer-based techniques have been proposed to estimate the wireless channel bandwidth. Cross-layer solution s require modifications of standard protocols that make it complex and not desirable. The successful data transmission is completely depends on the TCP traffic behavior as bandwidth. To alleviate the traffic problems due to bandwidth, an analytical model-based bandwidth estimation algorithm (MBE) used for multimedia services over IEEE 802.11 networks [2]. The MBE module for available bandwidth estimation is developed based on novel transmission control protocol /user datagram protocol throughput models for wireless data communications. The novel aspects in comparison with other works include the fact that no probing traffic is required and that no modification of medium access control (MAC) protocol is needed. Both TCP and UDP bandwidth behavior is used for controlling the congestion, traffic, data loss. MBE provide good bandwidth estimation results with different packet sizes & channel noises.

II. Related Work

A. Congestion Control Protocol

Comparing with current approaches for the estimation of bandwidth WXCP [9] makes more precise and computes the rate feedback based on multiple congestion metrics. For high bandwidth delay networks window based explicit congestion control scheme is designed. To accurately calculate feedback, the XCP router must know the precise link capacity in advance. Intermediate stations make congestion control and made decision in control separately, based on flow information carried in data packet headers and the estimation of congestion metrics.

B. Joint design of congestion control and media access control

The joint design of congestion control and media access control (MAC) [6] is used in Adhoc-network. To allocate resource in the network and to maximize the utility problem with constraints that arise from channel access, contention graph and contention matrix is used. The algorithm specified is not only involving spatial distribution, but they also decompose vertically in to two protocol layers by which TCP and MAC jointly solves the system problem. Here, two algorithms are proposed to utilize the bandwidth resources. A primal algorithm where the MAC layer at the links generates congestion prices and TCP sources adjust their rates based on the aggregate prices in their paths. A dual sub-gradient algorithm where the MAC sub-algorithm is applied through scheduling link-layer that flows according to the congestion prices of the links. For these convergence properties are proved. According to the media access control, the link layer flows are scheduled on the basis of congestion. This method not only improves the performance, but also it makes their interaction more transparent.

C. Congestion aware routing protocol

In Heterogeneous mobile adhoc networks, the occurrence of congestion[12] is limited. The transmissions of packet suffer

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from interference and fading. In this method the occurrence of throughput in a route is based on the minimum data rate of all its links. There is a chance of congestion, if a high data rate node forwards more traffic to a low data rate node, which leads to long queuing delays in such routes. The occurrence of hop count in traditional routing, does not adapt well to mobile nodes. Around a link Transmission capability, reliability, and congestion must be incorporated for MANETs. In this paper, author propose a method to develop a hop-by-hop congestion aware routing protocol[11] which employs a combined weight value as a routing metric, based on the data rate, queuing delay, link quality and MAC overhead. The attainment of high throughput, packet delivery ratio, reduced packet drop and delay are proved by using the proposed routing protocol.

D. Modify Scheduling at MAC layer

A method where the scheduling at the MAC layer has been modified and by increasing the data rate as well as increasing higher bandwidth utilization[8], the slots has been prepared to transmit the data. In Microsoft Visual Studio 2010 platform [10] the overall system architecture is developed and shows highly optimized results based on quality oriented parameters like network throughput, network congestion rate, transmission error rate, bandwidth utilization, maintenance count packets, and end to end delay. The number of maintenance count has been reduced drastically. Thus the proposed system has exhibited a highly potent mechanism.

Available bandwidth estimation [5] for data transmission works are done by the MODEL BASED BANDWIDTH ESTIMATION (MBE) algorithm with the three major contributions. The characteristics of IEEE 802.11 WLANs are considered with the extension of existing TCP throughput model [1] by the novel transmission control protocol. Utilization of UDP packet transmission probability and the channel delay of IEEE802.11 [3]. One derives a formula for the estimation of bandwidth when TCP and UDP traffic coexists in IEEE802.11 networks.

$$MBE = BWE_{TCP} + BWE_{UDP}$$

Unlike most existing estimation techniques, protocol modifications in current transmissions are not required and probing traffic is not used in MBE. Between the source and destination for data transmission, MBE algorithm chooses multipath selection method. Using any intermediate nodes for transmission and any one of the nodes are busy, transmitted packets are lost. For retransmission, repeat path selection until the medium is idle. Creates longer delay time and inefficiency brought by the bottleneck create a queue and a longer overall cycle time.

III. Proposed Approach

Data transmission between Sender & receiver takes place through Request to Send/Clear to Send (RTS/CTS) frames to configure MAC protocol. To normalize packet size, reduce collision effect & delay time, extending MBE with Content Slot Allocation with Time Division Multiple Access (TDMA) and Duty Cycling with the Carrier Sense Multiple Access (CSMA) to schedule the slot allocation again

A. Network Creation

Let G be a Network with N number of Nodes are deployed randomly in the Network. Assume a Base station BS which never dead. Any Node can communicate with any other nodes in the network. We can assume any node as a source node which sends a data to any node can select as destination node in the network. While the route discovery the intermediate nodes can be assigned with RTS/CTS mechanism and they behave under it. Each node allocated with a contention slot allocation manner. And the overall functionality is repeated under duty cycle manner.

B. RTS/CTS Integration

The most widely used MAC protocol in MANETs is the IEEE 802.11 DCF [4] (CSMA/CA+ RTS/CTS) mechanism. In 802.11, mobile nodes try to avoid collisions with carrier sensing before transmission. If the channel is busy, the node will defer transmission and enter into back off state. Otherwise, the nodes will begin the RTS/CTS dialog process to capture the channel and then transmit the packets. The CSMA/CA scheme effectively reduces the amount of possible collisions. The RTS/CTS is also helpful since it will reserve the channel spatially and temporarily. RTS/CTS exchange is helpful in avoiding hidden terminal problem, since any node overhearing a CTS message cannot transmit for the duration of the transfer. However, this process severely limits available bandwidth.

In MAC layer, unnecessary collisions should be avoided, since retransmissions cause additional power consumption and further increase packet delay. MAC protocols based on RTS/CTS have been proposed to alleviate these problems. However, as the number of mobile terminals increase, more energy will be consumed for channel contention and the network performance will degrade quickly. On the other hand, as explained in the following, RTS/CTS-based protocols do not completely solve the hidden terminal and exposed terminal problems.

Collisions [7] may also happen and in some cases may degrade the performance. This is even worse when the mobile nodes are of high density. A simple idea to overcome this deficiency is to broadcast CTS or its variation multiple times such that more nodes clear the channel for the initiating node. However, simulation study shows that the potential gain of this strategy is outweighed by the corresponding overhead.

C. Content Slot Allocation

Slot Allocation with three slots such as sleep, Active (Transmit packet), Active (Receive packet) state. At sleeping state, no transmission occurs. In Active state a node can transmit and receive packet. Round Robin scheduling scheme is used for scheduling the slots and time quantum for each node. A node may be in active state, will transmit or receive the packets and no more chance will given to node at first round. The number of slots is equal to the number of scheduling, when all the data are transmitted then slot value become zero. In the MAC slot reservation scheme, if there is no traffic in the network, then nodes must wake up at the contention slot for receiving a data packet and at the control slot for broadcasting the schedule of the reservation slots. Contrary to S-MAC and T-MAC, our protocol is a slotted MAC protocol is termed as AMAC. Nodes can handle their traffic more efficiently based on the slotted architecture. With the time slotted architecture, receiver can reserve slots to the senders and perform a collision free transmission. Therefore, our protocol can improve the network throughput and reduce transmission delays without impacting on the conservation of energy.

D. Duty cycling

A duty cycle is the percent of time that an entity spends in an active state as a fraction of the total time under consideration. Duty Cycle takes some length of the time that the packet takes to complete one cycle period for the scheduled slot. All the data packets are transmitted, the slot allocation cannot transmit all complete data; it is repeated until the data should be transmitted completely. For the repetition of slot allocation the duty cycling method is assigned in network .When the slot allocation is completed once, duty cycle is rescheduled again and the slots are allocated for each node .Restarting process of content slot allocation is done by the duty cycle using carrier sense multiple access with collision avoidance.

The extended MBE algorithm follows the steps given below for the bandwidth estimation

1.Construct the network with Tree architecture or circular architecture.

2.Configure the MAC protocol with TDMA for Slot allocation, CSMA for duty cycle settings

3. Set the transmission rates: 11, 5.5, 2, and 1 Mb/s.

4. Use the RTS/CTS mechanism for communicating nodes

5. Assign the RTT as the CSMA

6. Assign TCP, UDP based source and sink to the communication pair of nodes.

7. To calculate Bandwidth

$$B = \frac{MSS}{RTT \times \sqrt{\frac{2bPtcp}{3}} + T_o \times \min\left(1, 3\sqrt{\frac{3bPtcp}{8}} \times Ptcp \times (1+32Ptcp^2)\right)}$$

8. To calculate throughput

$$P_{Succ}^{TCP} = 1 - P_{retry}^{TCP}$$

TCP throughput model is described in bandwidth calculation, where B is the throughput received, MSS denotes the maximum segment size, RTT is the transport layer roundtrip time between sender and receiver, b is the number of packets that are acknowledged by a received ACK, P TCP is the steady-state loss probability, and to is the timeout value to trigger retransmission.

E. Parameter Results

Quality of Service parameters such as throughput, delay time, energy level is considered for enhancing the performance of bandwidth estimation technique. The result shows that throughput is increased in the extension of MBE and at the same time delay time and energy level is reduced, when compared with the existing approach. The performance results are shown in comparisons graph.

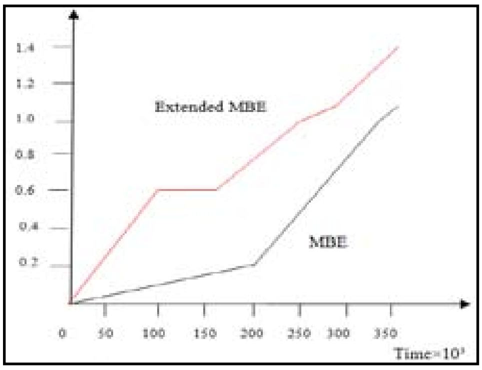

Fig. 1: Throughput

In Fig 1 shows that the existing system level with low throughput is compared with proposed system using Extended MBE algorithm.

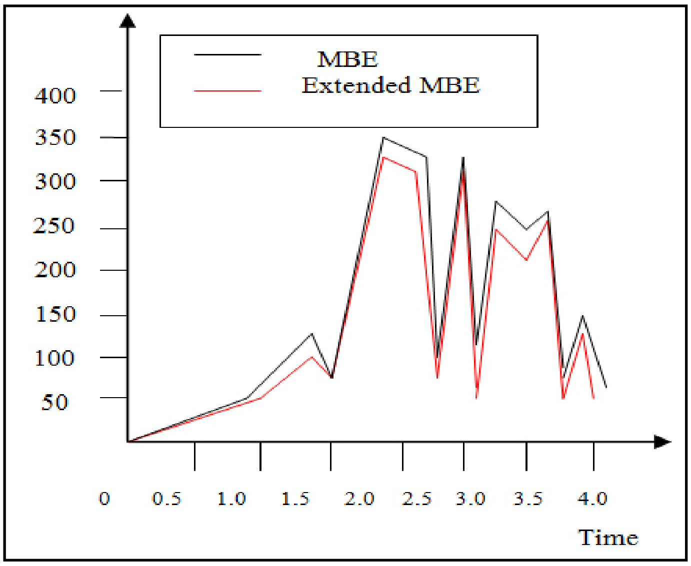

Fig. 2: Delay Time

In Fig 2 the delay time is reduced in proposed system when compared with existing MBE.

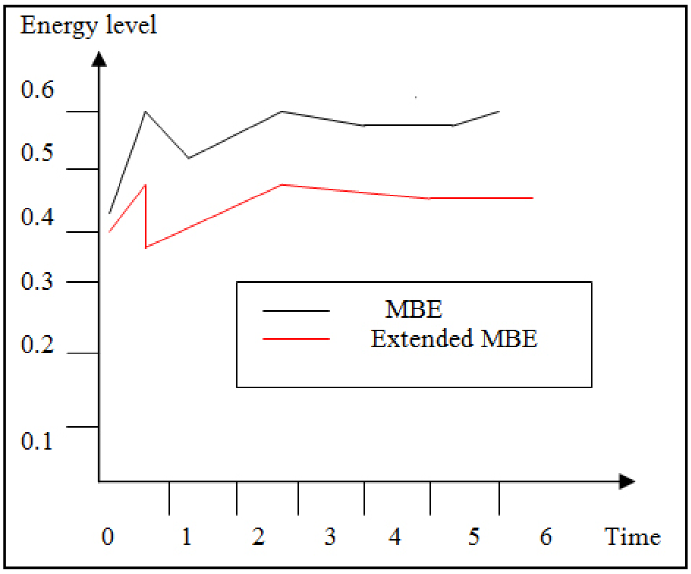

Fig 3: Energy Consumption

In Fig 3 the delay time is reduced in proposed system when compared with existing MBE.

IV. Conclusion and Future Work

In this paper a novel MBE to estimate the available bandwidth for TCP and UDP traffic over 802.11 WLANs.MBE is based on novel throughput models for TCP and UDP traffic over IEEE 802.11 WLANs, which are also proposed. In contrast with current wireless bandwidth estimation techniques, MBE is fully compatible with the IEEE 802.11 standard protocol, has higher estimation accuracy, and introduces lower overhead. MBE does not use additional probing traffic, which in turn reduces the required bandwidth resources. Experiments results show that the MBE model with different conditions: variant packet size, PER, and dynamic wireless link. MBE results with accurate bandwidth estimation

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in comparison with existing bandwidth estimation techniques such as iBE, Diet TOPP, and Idle Gap. By comparing the three techniques, Idle Gap gives the smallest estimation error rate, and iBE introduced the lowest overhead.MBE achieves 47% less estimation error rate than Idle Gap and 18% lower overhead than iBE. Additionally, MBE produces the lowest standard deviation and mean value for both error rate and overhead. In this paper the Extended MBE which estimates the bandwidth according to the content slot allocation and TDMA scheduling method, which more effective than the MBE.

V. Acknowledgement

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Author's Profile and Image

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