An Efficient Bandwidth Estimation Schemes used in Wireless Mesh Networks

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Abstract: wireless mesh networks (WMNs) has been widely used for the new generation wireless network. The capability of self-organization in WMNs reduces the complexity of wireless network deployment and maintenance. So, the perfect estimation of the bandwidth available of the mesh nodes is the required to admission control mechanism which provides QOs confirmation in wireless mesh networks. The bandwidth estimation of schemes do not give clear output. Here we are proposing bandwidth scheme estimation for decreasing the parallel transmission will cause the accurate and it will solve the maximum clique problem in the theory of graph. The hop by hop routing protocol is integrated by the admission control mechanism. Finally the implementation phase was simulated by the mechanism based on BEPTC will effectively control the traffic load and offer QoS guarantee for admitted new flows all these lead the network to accommodate more flows with QOS guarantee and obtain higher system throughput make difference with other conservative approaches.

***Key words*—wireless mesh network; bandwidth estimation admission control; QoS**

I INTRODUCTION

WIRELESS mesh networks (WMNs) have become a critical part of the future Internet. They can be widely deployed for many applications, such as campus networking, community networking, and so on, due to their fast configuration and low cost. However, the way to provide the proper QoS for multimedia traffic is an important design issue.

Recently, QoS provisioning for wireless local area networks (WLANs) or scheduled multihop ad hoc networks has been investigated. QoS provisioning can be addressed in various protocol layers, such as the medium-access control (MAC) layer, the network layer, the transport layer, and so on. The aim of the QoS guarantee is to provide users with guaranteed QoS in terms of bandwidth, delay, and delay jitter. Generally speaking, bandwidth is the essential measurement of the wireless resource. Therefore, how to estimate the available bandwidth is a crucial problem that needs to be addressed.

Due to the dynamic characteristics of resource allocation, it is difficult to obtain the available bandwidth at the MAC layer. Zhai *et al.* developed the admission and rate control scheme at the MAC layer for wireless LANs without considering the hidden terminals. By considering the impact of hidden terminals, we develop an approach to estimating the available bandwidth for the first time in the multihop WMNs. Then, based on the estimation of the available bandwidth in the MAC layer, we propose an admission control algorithm (ACA) to support the QoS in WMNs. The ACA treats various traffic types in different ways. It provides the real-time flows with admission decisions at the MAC layer and the non real-time flows with sending rates. Since wireless resource is scarce, the ACA adjusts all sending rates of ongoing non real-time flows to maintain the QoS for the real-time flows.

However, the above estimation scheme has considered the channel reuse due to parallel transmission, thus causing the underestimation of the available bandwidth. During parallel transmission to obtain more available bandwidth of a given node in the neighborhood of that node can reuse the channel. Therefore, ignoring the parallel transmission may cause inaccurate estimation of the bandwidth.

In this paper, we are proposed to implement a novel bandwidth scheme called BEPTC scheme which consider the parallel transmission on available bandwidth. This proposed scheme use maximum clique in the theory of graph which is used to solve the problem of inaccurate bandwidth estimation. Here graph consists of set of nodes. Consider a node which consists of neighbor nodes is partitioned into different overlapping maximal cliques by BEPTC. For each clique, BEPTC uses the information of existing flows to calculate the available bandwidth separately. BEPTC scheme which cooperates with the estimation of flows' bandwidth consumption is applied to a distributed admission control mechanism working with an ondemand routing protocol.

II RELATED WORK

Recently, a few schemes based on admission control have been proposed to address the QoS issue at the network layer in wireless ad hoc or mesh networks. In INSIGNIA, inband signaling allows it to quickly restore the flow state when a topology change occurs. In SWAN, the admission control mechanism collects the bandwidth information by a node listening to all transmissions in its transmission range. Unfortunately, the probing method introduces a lot of overhead and may not obtain an accurate value if any probe is lost. Meanwhile,

Sun *et al [6]* design an admission control mechanism considering the load at each node and the predicted delay to measure the network utilization.

Luo *et al [9]* propose an admission control to solve the QoS in a multirate environment, and it takes parallel transmissions into consideration. The contention-aware admission control protocol (CACP) and the perceptive admission control (PAC) are protocols that enable a better QoS guarantee by limiting flows in the networks. However, the CACP has high overhead since a packet transmission using high power significantly affects the ongoing transmission. For the PAC, the extension of the sensing range decreases the spatial reuse, and it will result in some incorrect rejection decisions. Meanwhile, the CACP and the PAC assume that the available bandwidth has a fixed linear relationship to the idle channel time.

In [4], the authors developed a bandwidth measurement based capacity utilization model for an IEEE 802.11-based mesh network.

The authors in [5] proposed an admission control algorithm (ACA) which considered the effect of hidden terminals on available bandwidth estimation. However, none of the above estimation schemes has considered the channel reuse due to parallel transmission, thus causing the underestimation of the available bandwidth. The parallel transmission in the neighborhood of a given node can reuse the channel so that the given node can obtain more available bandwidth. Therefore, ignoring the parallel transmission may cause inaccurate estimation of the bandwidth.

Wei *et al [8]* propose a call admission control method for WMNs, and their scheme is based on the interference capacity in a chain topology. Zhai *et al [10]* propose the original definition of the channel busyness ratio in WLANs, and based on the channel busyness ratio, they propose a call admission and rate control scheme in the MAC layer for Voice-over-Internet Protocol and the best effort traffic, respectively.

In addition, Cheng *et al [9]* adopt the channel busyness ratio concept in their framework to guarantee the accuracy of their analysis. However, the impact of the hidden terminals has not been taken into consideration in admission control schemes in all previous works.

III BACKGROUND

Given the bandwidth requirement of a flow, we calculate link utilization requirement of a mesh node by considering basic contention-based access mechanism of IEEE 802.11 DCF. The DCF channel access mechanism performs an RTS-CTS-DATA-ACK handshake to send an application data packet. According to the DCF channel access mechanism, single-hop channel occupation duration of a data packet, T_{occupy}, can be expressed as

$$T_{\text{occup}} = 4T_{\text{PLCP}} + T_{\text{difs}} + T_{\text{backoff}} + T_{\text{rts}} + T_{\text{cts}} + \frac{L}{B} + T_{\text{ack}} + 3T_{\text{sifs}},$$

where L is the length of the data packet including MAC header, T_{PLCP}, T_{rts}, T_{cts}, and T_{ack} are time taken by PHY layer PLCP header, RTS, CTS, and ACK packet transmissions, respectively. T_{sifs} and T_{difs} denote short and DCF inter- frame spacing's of the IEEE 802.11 standard. B is the link rate used by the transmitting node. $T_{backoff}$ denotes the random backoff duration prior to the transmission. Assuming that source of the flow generates *R* packets with average length *L* in one second, the bandwidth consumption due to this flow on a single hop can be expressed as follow:

$$W_{consume} = R \times T_{data} \times B_{channel} ,$$

Where $B_{channel}$ is the maximum channel capacity that a node can use theoretically.

IV PROPOSED SCHEME

We propose a novel bandwidth estimation scheme, BEPTC, which considers the parallel transmission thus can estimate the available bandwidth accurately. We can estimate the occupied bandwidth accurately only if there is no transmission occurring in parallel in the interfering neighbors. To utilize this characteristic, the interfering neighbors are separated into different sets S_i in our BEPTC scheme. The set S_i must satisfy the condition that the nodes in the same S_i cannot transmit in parallel.

$$B_{occupy} = B_{channel} \Sigma_i \Sigma_j R^i_j T^j_{data}$$

In each S_i, without the existence of parallel transmission, the above equation is used to accurately calculate the occupied bandwidth of the existing flows in this node set, B^{set}_{occupy} . Because there may exist potential parallel transmission which can reuse the channel between a node belonging to one S_i and a node outside of the S_i, the exact total occupied bandwidth of all the existing flows $B^{set}occupy$ is not the sum of B^{set}_{occupy} in different node sets, but the maximal value of B^{set}_{occupy} . In this way, BEPTC can use B_{occupy} to estimate the available bandwidth of a given node accurately without the influence of parallel transmission.

Our proposed scheme estimates a given node's available bandwidth as following:

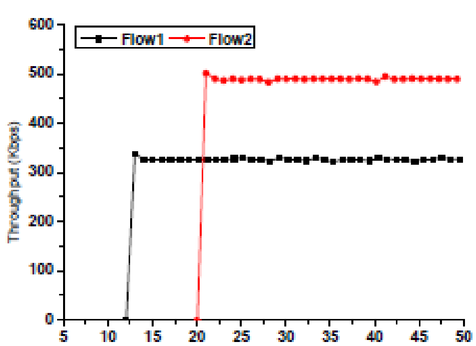
1) Initially, construct an interference graph that consists of the given node's interfering neighbor nodes based on the local topology information assembled by the given node.
2) After constructing the graph, computes the maximal cliques to which the given node belongs. The finding of the maximal cliques is a NP-complete problem.
3) After the computation of the cliques, now calculate the occupied bandwidth B_{occupy} of all the existing flows as specified above.
4) finally the BEPTC scheme can estimate the available bandwidth of the given node as follows:
   $W_{available} = B_{channel} - B_{occupy} - B_{local}$

While constructing the interference graph, the Hello messages are used to assemble the topology information. The Hello messages are broadcasted with an extended transmission range to incorporate the node information in the interference neighborhood of the given node. After a node receive the Hello messages from all of its neighbors for the first time, it can get its interfering neighbor set. Then the node broadcasts a Hello message attached with its neighbor information. When a node receives the Hello messages from its interfering neighbors again, then it construct the local interference graph.

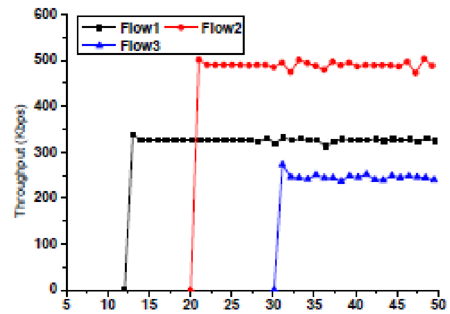
V PERFORMANCE

The admission control mechanism with the using of CACP fig 1(a) only admits two flows, because it does not consider the channel reuse due to parallel transmission. CACP conservatively estimates the available bandwidth of the node A from which Flow 3 entries the network. Thus, the admission control mechanism rejects Flow 3 which should be admitted into the network. In contrast, our proposed BEPTC scheme can estimate the available bandwidth at higher accuracy with the consideration of parallel transmission.

As shown in Fig.1(b), Flow 3 is allowed to entry the network by our admission control mechanism. Flow 3 yield stable throughputs which satisfies its QoS requirement while the throughputs of Flow 1 and 2 keep constant. It indicates that the network has enough available bandwidth to satisfy Flow 3's bandwidth requirement and the acceptance of Flow 3 would not interfere the existing flows. Our BEPTC captures this fact successfully and makes an accurate estimation. The acceptance of Flow 3 increases the cumulative system throughput by 240Kbps. we can conclude that the estimation result of BEPTC is correct and more accurate than that of CACP.



(a) Throughput, CACP



(b) Throughput, BEPTC

Fig 1: Parallel Transmission consideration

VI CONCLUSION

In this paper, we are proposed to implement a novel bandwidth scheme called BEPTC scheme which consider the parallel transmission on available bandwidth. This proposed scheme use maximum clique in the theory of graph which is used to solve the problem of inaccurate bandwidth estimation. Here graph consists of set of nodes. Consider a node which consists of neighbor nodes is partitioned into different overlapping maximal cliques by BEPTC. For each clique, BEPTC uses the information of existing flows to calculate the available bandwidth separately. BEPTC scheme which cooperates with the estimation of flows' bandwidth consumption is applied to a distributed admission control mechanism working with an ondemand routing protocol. With the accurate estimation of the available bandwidth, our proposed scheme can admit more flows with QoS guarantee and obtain higher system throughput, compared with the existing mechanisms that do not consider the parallel transmission.

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