A Priority-based Distributed Polling Mechanism for Ad Hoc Medium Access Control

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Abstract

In IEEE 802.11 and 802.11e for ad hoc networks, DCF and EDCF use a contention-based protocol called carrier sense multiple access with collision avoidance (CSMA/CA), which is simple to implement and efficient when the system is light loaded. But the performance of CSMA/CA decreases dramatically when the system load is heavy because of increasing collisions. In PCF and HCF modes, stations are completely controlled by a base station by polling, no collision ever occurs. However, when the system load is light, the performance is poor because few stations have data to transfer. More important, PCF and HCF can not be used in the ad hoc networks. In this paper, we address a priority-based distributed polling mechanism (PDPM) that implements polling scheme into DCF or EDCF modes for ad hoc networks by adding a polling approach before every contention-based procedure. PDPM takes the advantages of polling mechanism that avoids most of collisions in a high load condition. At the same time, it also keeps the contention-based mechanism for a light loaded condition. PDPM provides quality of service (QoS) with fewer collisions and higher throughput compared with IEEE 802.11e.

1. Introduction

IEEE 802.11 is one of the most popular MAC protocols in the world, but it has no QoS support because all the stations have same parameters and same scheme. With the growth of wireless communication, there is a demand for QoS support, so that the IEEE 802.11e has been brought out. In IEEE 802.11e, enhanced DCF (EDCF) mode is used to give the different priorities in ad hoc networks, however, EDCF suffers from more collisions and dramatically decreased throughput when the load of system is heavy. Many schemes are provided to improve the throughput [1-4], but all of them treat contention-based medium access scheme and central controlled medium access scheme separately. It means that only one scheme can be applied at a certain time and networks can only take one advantage one of them.

Though the central polling scheme can avoid collisions and provide QoS, it does not accord with the ad hoc networks' essence. Ad hoc networks are formed by clusters of mobile stations without any pre-designed infrastructure of base stations. A main advantage of ad hoc network is that it can be rapidly deployed since no base station or fixed network infrastructure is required [5]. So that PCF of IEEE 802.11 and HCF of IEEE 802.11e can be hardly used in ad hoc networks because they both need coordinate point as a central controller. In ad hoc networks, request to send (RTS) and clear to send (CTS) should be used to solve the hidden node problem and to combat the effects of collisions. The RTS/CTS reserves the channel for transmitting a larger data packet, with the desired effect that if a collision occurs with the RTS/CTS handshake, less bandwidth is wasted than if the larger data packet is transmitted and corrupted.

Another way to overcome collisions is utilizing the token. The token circulates around all the stations, thus every station has the chance to transmit [5], but most wireless token protocols do not consider about the hidden problem. A hidden station out of the token circle can easily cause a collision with receiving stations. Similar to other polling mechanisms, token passing protocols are inefficient under the low load situation. At the same time, these token schemes do not give the method to provide QoS.

In this paper, we propose the priority-based distributed polling mechanism (PDPM) based on RTS/CTS exchange to provide QoS. PDPM can be implemented to both DCF mode of IEEE 802.11 and EDCF mode of IEEE 802.11e. The new polling scheme behaves as contention-based and contention free schemes at the same time, and provides QoS differentiations as 802.11e does. Our PDPM decreases the collision opportunity greatly comparing to DCF and EDCF modes so that increases the channel utility and decrease some time delay.

The rest of this paper is organized as follow: we provide our priority-based polling mechanism in Section 2. In Section 3, we give the simulation results. In Section 4 we conclude this paper.

2. Priority Based Distributed Polling Mechanism

RTS/CTS exchange mechanism can be used to prevent the hidden node problem and decrease the influence of collision by concentrating collisions on short RTS frames but not long data frames. But RTS/CTS can give us more functions than it is expected. The basic idea of the proposed PDPM is adding a polling function in each RTS frame to give a polling signal to a station according to the priority of each station.

In our priority-based distributed polling mechanism, we take the following issues into account:

1. To give the polling message according to the priority of all stations, each station must have a table that contains all stations' priority information. The table has station id (e.g., MAC address) and station priority items.
2. A method to generate polling information to provide QoS to different priority stations.
3. The table should be updated when the network is changed, for example, a new station can enter the network or a existing station in the network can log out even sudden power off at any time.

The proposed PDPM provides the solutions for the above issues:

1. We can get the other station's MAC address easily. RTS frame contains the source address of the sender; each

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