Distributed Collision-Free Message Broadcasting in Multichannel Wireless Networks

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Abstract
Broadcasting is essential in many wireless network applications. The main problem of broadcasting in a wireless network is the broadcast messages may collide with other transmissions. Normally, no acknowledgement (ACK) message is sent back on receipt of broadcast packet, thus, the source node cannot determine if the broadcast is successful. In this paper, a mechanism that ensures collision-free message broadcasting in a multichannel wireless network is provided.

1. Introduction

Recently many research works have focused on developing multichannel MAC protocols since multichannel operation can enhance throughput, reliability and spectrum efficiency of wireless networks. By using multiple channels, the throughput can be enhanced because multiple transmissions can take place simultaneously on different channels [1]. Most of the multichannel MAC protocols for wireless networks were designed to efficiently utilize the multiple channels and improve the throughput. Just very few works consider how to broadcast a message in multichannel wireless networks [2].

As we all know, broadcasting is essential in many wireless network applications, such as delivering multimedia messages, route discovery in gossip based routing protocols, emergency and warning messages and so on [3]. In a multi-channel network, the main challenge is how to successfully deliver a message to all users that are currently dwelling on different channels. Since it is a broadcast message, it should be received by all nodes in the network. The major drawback is no acknowledgement (ACK) message is sent back on receipt of broadcast packet, thus, the source node, the one which broadcasts the message, cannot determine if the broadcasting is successful.

In this paper, we propose a broadcasting mechanism that can ensure collision free broadcasting.

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In this mechanism, no centralized coordinator is required, thus, it is a distributed protocol. Note that, unicast communication, such as data communication between a pair of nodes, is also important aspect. There are a lot of research works that deeply considers improving unicast communication [4]. However, broadcasting in multichannel environment is one of the overlook problems and just a few works tried to address the problem. Therefore, in this paper, we solely focus on proposing a mechanism that can enable collision-free broadcasting in multichannel environments.

2. Collision Free Broadcasting

We assume that there are m data channels, $M = \{CH_1, CH_2, .., CH_m\}$, and one broadcast channel (BC). There are N numbers of nodes in the network and there is no centralized coordinator. Each node is equipped with single transceiver. A node can either transmit or receive, but cannot do both simultaneously. Time is divided into super frames (SF) and further divided into broadcast interval (BI) and, contention and data (CAD) interval. BI is divided into m equal broadcast time slots (BS) as shown in Fig. 1. Each BS is dedicated for each channel, for example, BS_j is dedicated for CH_j. All nodes are synchronized based on the Coordinated Universal Time (UTC) as in [5].

At the beginning of each SF, all nodes switch to BC. Nodes then transmit broadcast messages during BSs. During CAD nodes can perform coordination/data communication and contention for the accessing the BSs. In order to provide collision free broadcasting, only one node should transmit during a BS. Note that each

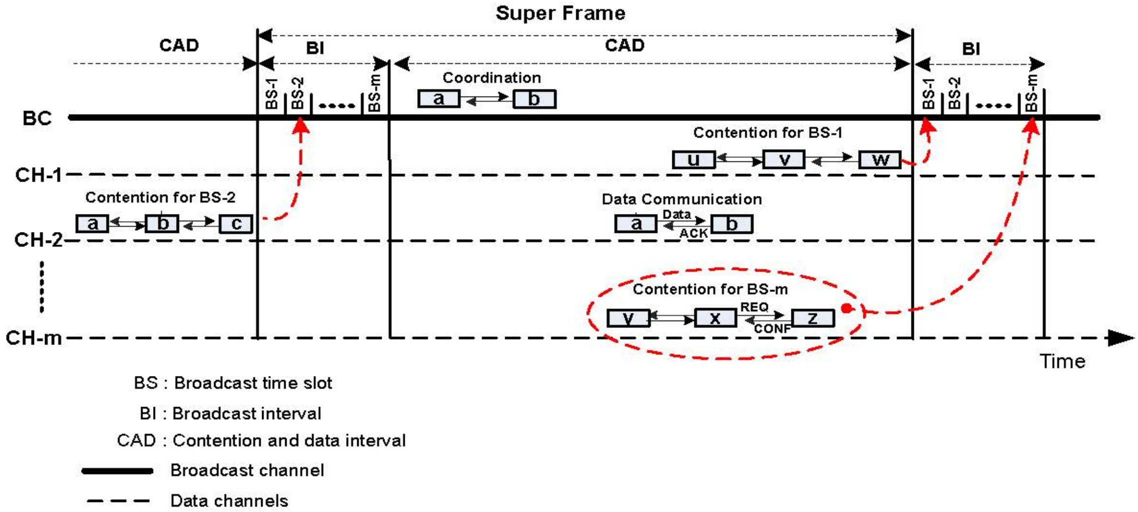

Fig 1. Super frame structure.

BS is solely dedicated to each channel. Therefore, if there are m channels in the network, only m number of BSs will be available. Obviously, the number of nodes is much larger than the number of BSs. Thus, if a node wants to access a BS, it needs to contend on corresponding channel. Suppose, node i wants to access the BS_i for broadcasting. It first switches to CH_i during CAD and transmits the broadcast request (REQ) via CH_i. Any node that receives the REQ can reply with the confirmation (CONF) message. The CONF message indicates that the BS_i for upcoming SF has been reserved by a node. Therefore, If a node on CH_i receives REQ and CONF, it can realized that the BS_i has been reserved. Thus, if it wants to access a BS, it can wait for next SF or switch to another channels to perform contention for BSs.

Note that, any node can broadcast the messages during CAD via BS or other data channels. However, it cannot guarantee collision-free broadcasting. Thus, the broadcast may or may not be successful. Moreover, if a node broadcasts a message during CAD via a channel, only some nodes that are currently dwelling on that channel will receive the broadcast message. Nonetheless, some multimedia messages should be transmitted during CAD in order to reduce congestion during BI. Only important emergency messages should be transmitted by using BS.

3. Conclusions and Future Works

We have presented a distributed broadcasting mechanism that can be used in multichannel environments. It is a hybrid approach of TDMA and contention based channel access mechanisms. In this mechanism, no centralized coordinator is required. The main drawback of this mechanism is it only can provide limited numbers of collision free broadcasting during a super frame. However, since it can provide collision free broadcasting, it can be used very efficiently in some emergency messages broadcasting. One of our future works is to embed this mechanism in some multichannel wireless networks, such as IEEE 1609.4; multichannel medium access control (MAC) standard for wireless access in vehicular environment (WAVE) [5], and improve the broadcast efficiency.

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