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Distributed OFDMA Channel Access in the Next Generation Wireless LAN

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Abstract: - In this paper, a novel distributed Orthogonal Frequency Domain Multiple Access (OFDMA) channel access scheme in the next generation Wireless Local Area Network (WLAN) is proposed. In the next generation WLAN, heavy traffic load situation by dense user population is expected. Since WLAN employs contention based distributed channel access, heavy traffic causes very long channel access delay. One of the key enabling technologies in the next generation WLAN is OFDMA. In the proposed scheme, by utilizing the broadcast signal, trigger frame, users are autonomously grouped into multiple groups and perform channel access through multiple sub-channels. By utilizing the proposed scheme, since active users can be distributed to multiple sub-channels, channel access delay caused by heavy traffic can be substantially reduced.

Keywords: - *Distributed Channel Access, OFDMA, IEEE 802.11ac, Wireless LAN*

I. INTRODUCTION

IEEE 802.11 based Wireless Local Area Network (WLAN) technology [1] has been widely deployed to provide broadband services [2], [3]. The next generation WLAN standard, IEEE 802.11ax has commenced the standardization of new MAC and PHY layers since May 2014 for further performance improvement. IEEE 802.11ax targets to provide at least four times improvement in the average throughput per station in a dense deployment scenario, while maintaining or improving the power efficiency per station [4]. Since, IEEE 802.11ax considers a dense deployment scenario, heavy traffic load is one of the basic assumptions of the next generation WLAN. It is well known, Medium Access Control (MAC) access delay exponentially increases as number of users increases in WLAN [5], [6].

In order to provide broadband channel access, wider bandwidth allocation scheme is employed in IEEE 802.11n and IEEE 802.11ac. In the wider bandwidth allocation scheme, stations which have packets to transmit perform contention process starting from channel sensing on the primary channel. Other secondary channels are sensed for Point Coordination Function Inter-frame Space (PCF) time prior to the packet transmission time to check whether secondary channels are idle or not. A station which wins the contention process transmits packets using the wide channel bandwidth of idle channels.

In the next generation WLAN, heavy traffic load situation by dense user population is expected. Since WLAN employs contention based distributed channel access, heavy traffic causes very long channel access delay. One of the key enabling technologies in the next generation WLAN is OFDMA. In the conventional Distributed Coordination Function (DCF) channel access and wider bandwidth operation, a single user is allowed to a channel at a given time. In OFDMA, however, multiple users are allowed to access channels at the same time.

In order to alleviate such heavy channel access load problem, in this paper, a novel distributed OFDMA channel access scheme is proposed. In the proposed scheme, by utilizing the broadcast signal, trigger frame, users are autonomously grouped into multiple groups and perform channel access through multiple sub-channels. By utilizing the proposed scheme, since active users can be distributed to multiple sub-channels, channel access delay caused by heavy traffic can be substantially reduced.

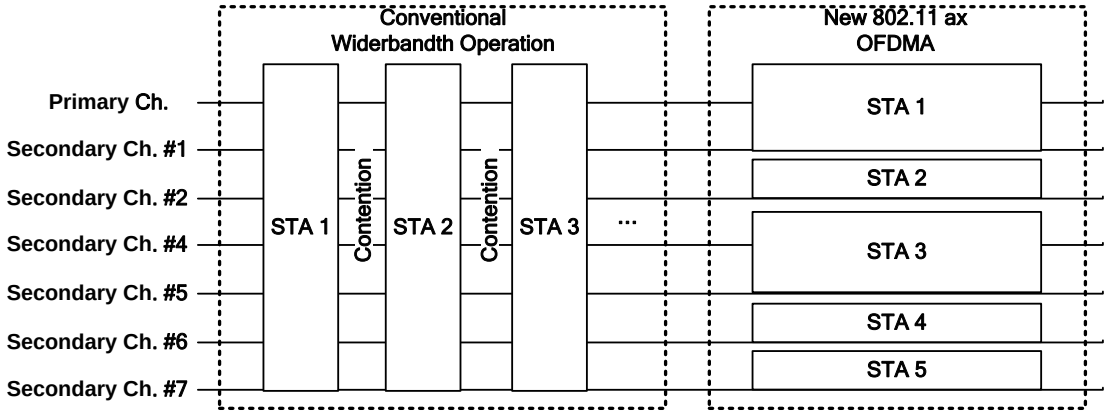

Fig. 1. IEEE 802.11ac wider bandwidth channel allocation and IEEE 802.11ax OFDMA

II. WIDER BANDWIDTH OPERATION & OFDMA

In order to provide broadband channel access, as shown in Fig. 1, wider bandwidth allocation scheme is employed in IEEE 802.11n and IEEE 802.11ac. In the wider bandwidth allocation scheme, stations which have packets to transmit perform contention process starting from channel sensing on the primary channel. Other secondary channels are sensed for PCF time prior to the packet transmission time to check whether secondary channels are idle or not. A station which wins the contention process transmits packets using the wide channel bandwidth of idle channels. Since only one station is allowed to transmit a packet after a successful contention procedure, as shown in Fig 1, another station needs to perform another contention resolution procedure in order to gain a channel access opportunity. In the process of contention resolution to gain a channel access opportunity, only the primary channel is utilized for all stations in the same Basic Service Set (BSS). As MAC access delay exponentially increases as number of users increases in WLAN [5], [6], same problem of excessive MAC access delay in the heavy load situation is anticipated in the wider bandwidth channel operation. One of the key enabling technologies in the next generation WLAN is OFDMA. When OFDMA is used, as shown in Fig. 1, contention can be isolated by allowing multiple stations to transmit packets at the same time. Due to contention isolation, MAC access delay can be reduced substantially. In IEEE 802.11ax OFDMA, similar to the wider bandwidth operation, primary channel is also used for initial channel access. Therefore, as number of active users increases, same problem of excessive MAC access delay can happen. In this paper, by utilizing the broadcast channel and distributed characteristics of WLAN, a novel distributed OFDMA channel access scheme is proposed as explained in Section III.

III. DISTRIBUTED OFDMA CHANNEL ACCESS SCHEME

In this paper, a novel distributed OFDMA channel access scheme is proposed as explained in this section. In the proposed scheme, by utilizing the broadcast signal, trigger frame, users are autonomously grouped into multiple groups and perform channel access through multiple sub-channels. The proposed distributed OFDMA channel access scheme is illustrated in Fig. 2. The proposed scheme consists of 3 steps: Step 1. Trigger Frame Broadcast, Step 2. Group Configuration, and Step 3. Distributed Channel Access.

The proposed scheme starts with Step 1. Trigger frame broadcast. In order to commence the uplink OFDMA procedure, trigger frame should be broadcast in IEEE 802.11ax. In the trigger frame, information on the available channel number is included. As Step 2, all stations, which has packets to transmit, decides the channel number to perform contention. In the example of Fig. 2, station (STA) 1 and STA 2 are autonomously assigned to channel 1, STA 2 and STA 4 are assigned to channel 2, and STA 5 and STA 6 are assigned to channel 3. Various algorithms can be employed for autonomous channel assignment. In this paper, modulo operation using number of channels and MAC address is assumed. As Step 3, all stations performs contention procedure on the assigned channel and a station with a successful contention procedure transmits a packet. In

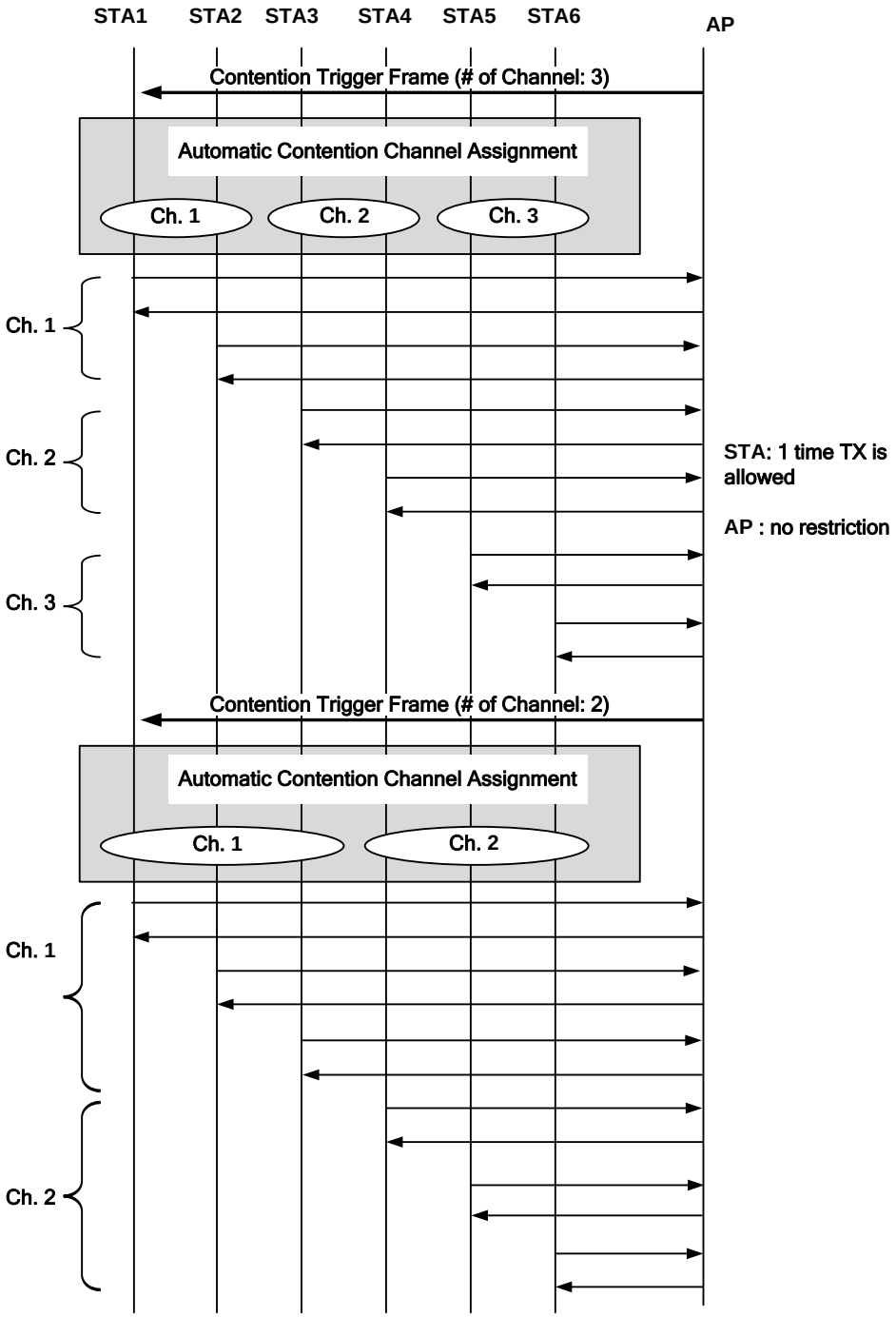

Fig. 2. Proposed distributed OFDMA channel access scheme.

this proposed scheme, stations are allowed to transmit a packet only one time and AP is allowed to transmit packets multiple times to multiple stations.

The proposed scheme also provides to dynamically adopt to the traffic condition. As illustrated in Fig. 2, when traffic load is reduced, a new trigger frame containing new access channel number can be transmitted. On reception of the new trigger frame, stations autonomously configure their access channel. In the example of Fig. 2, since new access channel number 2, STA 1, STA 2, and STA 3 are grouped to access channel 1 and STA 4, STA 5, and STA 6 are grouped to access channel 2. After autonomous channel assignment, stations transmit packets on the assigned channel.

IV. CONCLUSION

In this paper, a novel distributed OFDMA channel access scheme for heavy load traffic is proposed. By utilizing the distributed nature of WLAN and OFDMA, a large number of users is able to access WLAN channel with relatively small delays to the conventional channel access scheme. Since the proposed scheme also provides a way to dynamically adopt to the traffic load, channel utilization is expected to be maximized.

V. ACKNOWLEDGEMENTS

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