IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 06, Issue 01 (January. 2016), ||V2|| PP 08-11

Sub-channel Based Uplink OFDMA Random Access Scheme Considering Hidden Nodes in the Next Generation Wireless LAN

Ronny Yongho Kim[1]
Korea National University of Transportation, Department of Railroad Electrical and Electronics Engineering Gyeonggi, Uiwang, Korea,

Abstract: **-** In this paper, a novel sub-channel based uplink Orthogonal Frequency Domain Multiple Access (OFDMA) random access scheme is proposed. In the next generation Wireless Local Area Network (WLAN), OFDMA was adopted in order to enhance throughput performance. OFDMA can be used for both downlink and uplink. In order to utilize OFDMA for uplink, AP needs to schedule stations' packet transmission. In order for AP to schedule stations' uplink packet transmission, either random access scheme or pre-scheduling scheme can be utilized. Because pre-scheduling scheme requires lengthy scheduling procedure, random access scheme is preferred and used in various wireless technologies including 4th generation wireless technology. For such purpose, IEEE 802.11ax adopted uplink OFDMA random access scheme. However, how multiple channels can be utilized or how stations transmit random access packets during random access period is not defined. In this paper, a novel sub-channel based uplink OFDMA random access scheme considering hidden nodes is proposed. Detailed Medium Access Control (MAC) header formats are presented in order to provide a complete protocol.

Keywords: **-** *OFDMA, Uplink, Random Access, IEEE 802.11ax*

I. INTRODUCTION

Wireless Local Area Network (WLAN) [1] has made a big progress since its emergence due to easy deployment and excellent performance [2], [3]. In order to further enhance its performance, a new WLAN air interface standard, IEEE 802.11ax commenced its standardization from May 2014. IEEE 802.11ax aims to enhance its performance 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]. The basic access scheme of WLAN is Distributed Coordination Function (DCF). Due to distributed nature of DCF, stations are required to perform contention procedure in order to access wireless channel. Therefore, it is well known, WLAN MAC access delay exponentially increases with large number of active users [5], [6].

In order to alleviate such WLAN MAC access delay problem, OFDMA was adopted. Whereas one station is able to transmit a packet at a given time, OFDMA allows stations to transmit packets at same time. OFDMA can be utilized in both downlink and uplink. Uplink OFDMA requires more sophisticated procedure [7] than downlink OFDMA since stations' buffer status should be notified prior to uplink OFDMA packet transmission. As a simple solution, random access based uplink OFDMA scheme was adopted in IEEE 802.11ax [8]. Random access based uplink transmission is widely used in various wireless technology including the 4th generation wireless technologies, e.g., 3GPP Long Term Evolution (LTE). Due to distributed nature of WLAN, WLAN uplink OFDMA random access is different from other wireless access technologies' random access schemes.

Since WLAN is loosely organized network compared to cellular networks, many transmissions suffer from hidden nodes. Since IEEE 802.11ax is the first WLAN standard with OFDMA, hidden node problem across multiple channels has not been considered. Therefore, uplink OFDMA random access scheme needs to provide an efficient channel access without hidden node problem. Currently proposed uplink OFDMA random access scheme [8] does not consider hidden node problem and provide a complete procedure. In this paper, a

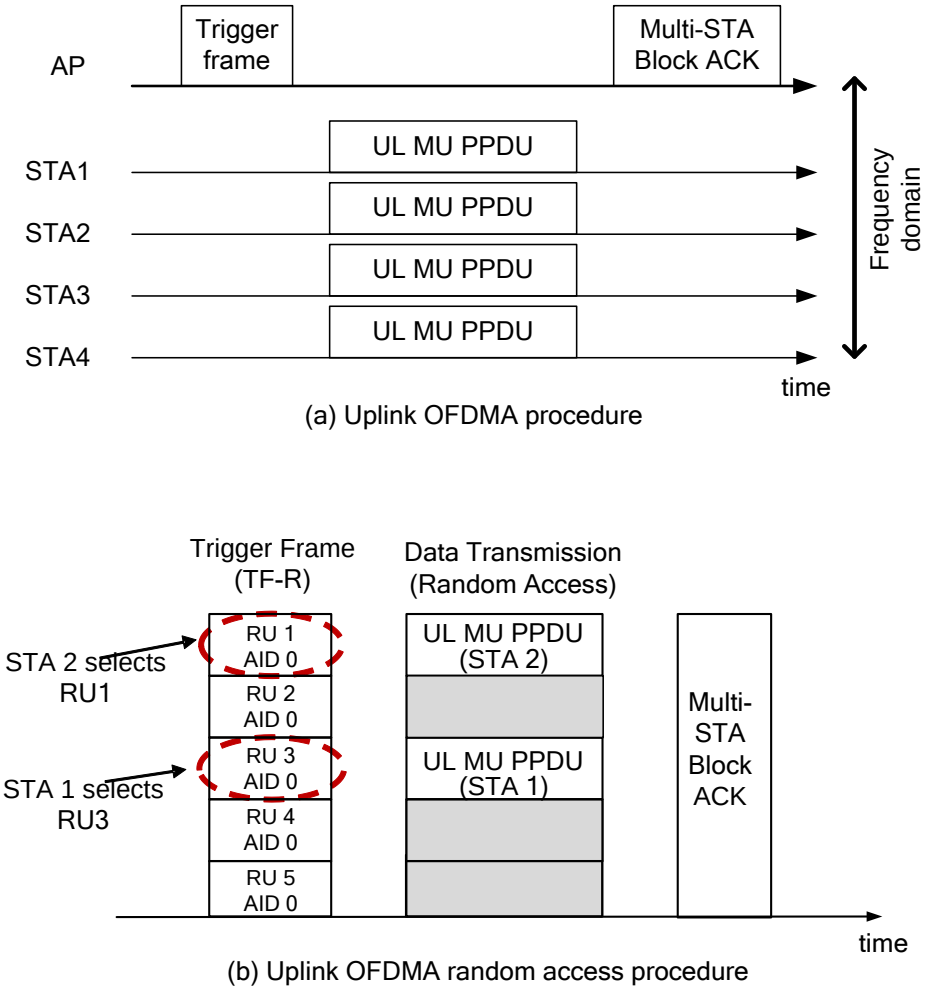

Fig. 1. WLAN uplink OFDMA & uplink OFDMA random access in IEEE 802.11ax

complete and efficient uplink OFDMA random access scheme without hidden node problem is proposed. By utilizing the proposed scheme, throughput performance can be enhanced substantially.

II. IEEE 802.11AX UPLINK OFDMA

In order for AP to schedule stations' uplink packet transmission, either random access scheme or pre-scheduling scheme can be utilized. Because pre-scheduling scheme requires a lengthy scheduling procedure, random access scheme is preferred and used in various wireless technologies including 4th generation wireless technologies, e.g., 3GPP LTE. For such purpose, IEEE 802.11ax adopted uplink OFDMA random access scheme [8]. However, how multiple channels can be utilized or how stations transmit random access packets during random access period is not defined. Especially, how hidden node can be avoided in multi-channel operation is not discussed. In this section, uplink OFDMA and uplink OFDMA random access procedure adopted in IEEE 802.11ax are presented.

Fig. 1 illustrates the procedures of uplink OFDMA (a) and uplink OFDMA random access (b). In order for stations to synchronize the transmission time, AP needs to signal the packet transmission time. By transmitting Trigger Frame, AP is able to indicate uplink packet transmission time. In Trigger Frame, uplink resource information is included. Therefore, once Trigger frame is received by stations, stations know when and where they need to transmit their uplink packets. After uplink (UL) multiuser (MU) Physical Layer Convergence Protocol (PLCP) protocol data unit (PPDU) transmission, reception status is notified with ACK. Multi-STA Block ACK is newly defined for multi-user operation. For uplink OFDMA procedure shown in Fig.

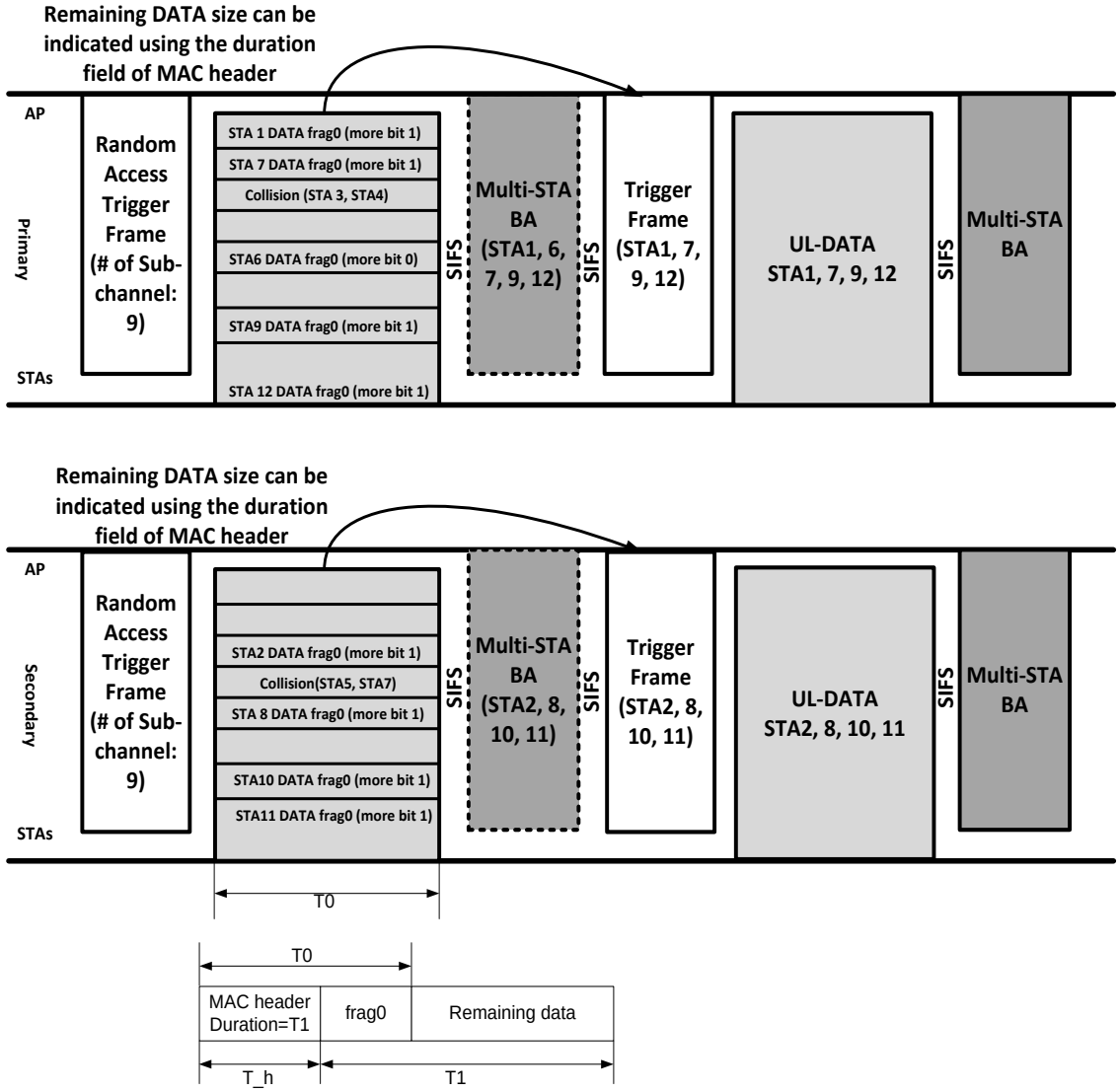

Fig. 2. Proposed sub-channel based uplink OFDMA random access

1 (a), it is assumed that AP has finished pre-scheduling before commencement of uplink OFDMA. Therefore, AP is able to transmit Trigger Frame with stations' scheduling information. However, because pre-scheduling scheme requires a lengthy scheduling procedure, random access scheme is preferred. As shown in Fig. 1 (b), in uplink OFDMA random access procedure, random access OFDMA is indicated with AID 0. When certain resource is assigned to AID 0, this means any station can transmit a packet in a random access fashion. Stations with uplink packets choose resources with Uniform Probability. In the example in Fig. 1 (b), STA 2 uniformly selects RU1 and STA 1 uniformly selects RU3. Similarly, reception status is notified with Multi-STA block ACK.

III. PROPOSED SUB-CHANNEL BASED UPLINK OFDMA RANDOM ACCESS

The proposed sub-channel based uplink OFDMA random access is illustrated in Fig. 2. Trigger frame notifying random access is same as the one adopted in IEEE 802.11ax. Since the uplink transmission time for random access data transmission is decided by AP, stations' uplink packets may or may not fit with allocated uplink transmission time. When allocated uplink transmission time is long, stations' uplink packets need to be padded which causes resource waste. When allocated uplink transmission time is short, stations' uplink packet can not be completely transmitted. In the proposed scheme, in order to use resource in an efficient way, uplink transmission is divided into multiple stages. First uplink transmission is initiated with random access and uplink transmission time is restricted to be short so that stations can transmit part of their uplink packets with remaining packet information. The remaining packet information is simply included by using the existing header

information. If there is remaining packet, more bit is set to be 1 and length is set to be total data length. Using the example shown in Fig. 2, duration is set to be T1 and PPDU length in preamble indicates T0. By receiving uplink packets, AP is able to know how much data are remained for each station. Therefore, AP is able to efficiently schedule second uplink transmission with Trigger Frame.

In order to alleviate the problem of hidden node, AP allocates multiple channels for uplink OFDMA random access. Stations may have different channel condition due to hidden node. The example shown in Fig. 2, STA 1, 6, 7, 12 sense the primary channel as idle but STA 2, 8, 10, 11 cannot access the primary channel due to hidden node. Therefore, STA 2, 8, 10, 11 utilizes the secondary channel for random access. Since stations only know their channel status affected by hidden nodes, only stations are able to choose correct channel. In the proposed scheme, because AP allocates multiple channels, stations are able to correctly choose idle channels to access.

IV. CONCLUSION

In this paper, a novel sub-channel based uplink OFDMA random access scheme is proposed. In order for AP to schedule stations' uplink packet transmission, random access scheme is preferred for its simplicity. The next generation WLAN, IEEE 802.11ax adopted OFDMA but detailed random access based OFDMA procedure with hidden node problem has not been discussed. Since the proposed sub-channel based uplink OFDMA random access scheme provides a way to transmit a partial packet with buffer status information using existing header, protocol overhead is low. Also the proposed scheme provides a way to avoid hidden node problem. Therefore, using the proposed scheme, random access based OFDMA scheme is able to provide high efficient uplink OFDMA performance.

V. ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

[1] "IEEE Standard for Information Technology-Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications," IEEE Std 802.11-2012, 2012

[2] Mohamed M. Abo Ghazala, Mohamed F. Zaghloul, and Mohammed Zahra, "Performance Evaluation of Multimedia Streams Over Wireless Computer Networks (WLANs)," International Journal of Advanced Science and Technology, Vol. 13, pp 63-76, December 2009

[3] Raja Hasyifah Raja Bongsu, Nazirah Abd. Hamid, Ahmad Nazari Mohd. Rose and Shamala Subramaniam, "Enhanced Packet Scheduling Algorithm for Multihop Wireless LANs," International Journal of Advanced Science and Technology, Vol. 49, pp 63-72, December 2012

[4] IEEE 802.11-14/0165r1 802.11 HEW SG Proposed PAR, 2014

[5] Bianchi, G., Performance analysis of the IEEE 802.11 distributed coordination function, *IEEE J. Sel. Areas Commun.*, (2000) 18, 535–547.

[6] Kwak, B.-J., Song, N.-O., and Miller, L. E., Performance analysis of exponential backoff, *IEEE/ACM Trans. Networking*. (2005) 13, 343–355.

[7] Kiseon Ryu, Et. Al., IEEE 802.11-15/0365r0, "UL MU Procedure," March 2015.

[8] Chittabrata Ghosh, Et. Al., IEEE 802.11-15/0875r1, "Random Access with Trigger Frames Using OFDMA," July 2015.