

METHODS AND APPARATUSES FOR TRIGGERING UPLINK TRANSMISSION IN WIRELESS LOCAL AREA NETWORKS

Field of Invention

The invention relates to wireless communications, and more particularly to methods and apparatuses for triggering uplink transmission in a wireless local area network (WLAN) with an enhanced trigger frame.

Background

Institute of Electrical and Electronics Engineers (IEEE) 802.11be extremely high throughput (EHT) WLAN supports a bandwidth (BW) up to 320 MHz. It is expected that high efficiency (HE) stations (STAs) will exist with R1 (Release 1) EHT STAs and/or R2 (Release 2) EHT STAs in a same EHT basic service set (BSS). In order to maximize throughput of an EHT BSS with large BW, e.g. 320 MHz, a frequency domain aggregated physical layer protocol data unit (FD-A-PPDU) supported by HE STAs and R2 EHT STAs has been proposed. It should be noted that R1 EHT STAs do not support FD-A-PPDU transmission and reception.

In wireless communications, a trigger frame may be generated by an access point (AP) and used to solicit physical layer protocol data unit (PPDU) transmissions from a plurality of STAs. However, as different types of PPDU transmissions will exist in IEEE 802.11be EHT WLAN, e.g. HE triggered-based (TB) PPDU transmission from HE STAs, R1 EHT STAs and/or R2 EHT STAs, EHT TB PPDU transmission from R1 EHT STAs and/or R2 EHT STAs, and TB FD-A-PPDU transmission from both HE STAs and R2 EHT STAs, it would therefore be desirable to provide an enhanced trigger frame suitable for triggering different types of PPDU transmissions in WLAN.

Summary of Invention

Embodiments of the invention provide methods and apparatuses for triggering different types of uplink transmission in a WLAN with a proposed enhanced trigger frame.

According to a first aspect of the invention, various embodiments of the invention provide a method for triggering uplink transmission in a WLAN. The method may be implemented by an AP in the WLAN and comprises: generating, by an access point (AP), a trigger frame based on a type of PPDU transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and transmitting, by the AP, the generated trigger frame to the plurality of STAs.

According to a second aspect of the invention, various embodiments of the invention provide an AP for triggering uplink transmission in a WLAN. The AP comprises: a memory configured to store instructions for triggering uplink transmission in the WLAN, and a processor communicably coupled

with the memory, the processor configured to execute the instructions to: generate a trigger frame based on a type of PPDU transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and transmit the generated trigger frame to the plurality of STAs.

According to a third aspect of the invention, various embodiments of the invention provide a method for triggering uplink transmission in WLAN. The method may be implemented by a STA in the WLAN and comprises: receiving, by a STA, a trigger frame from an access point (AP), wherein the trigger frame is generated based on a type of PPDU transmissions to be solicited from a plurality of STAs, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and determining, by the STA, the type of the solicited PPDU transmissions by decoding the common information field of the received trigger frame.

According to a fourth aspect of the invention, various embodiments of the invention provide a STA. The STA comprises: a memory to store instructions for triggering uplink transmission in the WLAN, and a processor communicably coupled with the memory, the processor configured to execute the instructions to: receive a trigger frame from an access point (AP), wherein the trigger frame is generated based on a type of PPDU transmissions to be solicited from a plurality of STAs, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and determine the type of the solicited PPDU transmissions by decoding the common information field of the received trigger frame.

According to a fifth aspect of the invention, various embodiments of the invention provide a computer program product. The computer program product comprises instructions to cause a computer to perform a method for triggering uplink transmission in WLAN according to any embodiment of the invention, when executed thereon.

Brief Description of the Drawings

The invention will be described in detail with reference to the accompanying drawings, in which:

Figure 1A is a schematic diagram showing an example of a WLAN according to some embodiments of the invention;

Figure 1B is a schematic diagram showing an example of the first type PPDU transmission in a WLAN;

Figure 1C is a schematic diagram showing an example of the second type PPDU transmission in a WLAN;

Figure 1D is a schematic diagram showing an example of the third type PPDU transmission in a WLAN;

5 Figure 1E is a schematic diagram illustrating an uplink multi-user (MU) transmission according to one embodiment of the invention;

Figure 1F is a block diagram illustrating a format of an HE TB PPDU

Figure 1G is block diagram illustrating a format of an EHT TB PPDU;

10 Figure 2A is a block diagram illustrating a trigger frame format according to one embodiment of the invention;

Figure 2B is a block diagram illustrating an example of an EHT format user information field format according to one embodiment of the invention;

Figure 2C shows an example of a format of a special user information field according to one embodiment of the invention;

15 Figure 3 is a flowchart illustrating a method for triggering uplink transmission in WLAN implemented by an AP according to one embodiment of the invention;

Figure 4A to Figure 4C show three options for BW allocation for the TB FD-A-PPDU transmission according to one embodiment of the invention respectively;

20 Figure 5A is a schematic diagram illustrating an AP for triggering uplink transmission in a WLAN according to one embodiment of the invention;

Figure 5B is a schematic diagram illustrating a first apparatus for triggering uplink transmission in a WLAN according to one embodiment of the invention;

Figure 6 is a flowchart illustrating a method for triggering uplink transmission in the WLAN implemented by a STA according to some embodiments of the invention;

25 Figure 7 is a flowchart illustrating a method for triggering uplink transmission in the WLAN implemented by a STA according to one embodiment of the invention;

Figure 8A is a schematic diagram illustrating a STA for triggering uplink transmission in a WLAN according to one embodiment of the invention;

30 Figure 8B is a schematic diagram illustrating a second apparatus for triggering uplink transmission in a WLAN according to one embodiment of the invention;

Figure 9 is a block diagram illustrating a format of the common information field of a trigger frame according to a first embodiment of the invention;

Figure 10 is a block diagram illustrating a format of the common information field of a trigger frame according to a second embodiment of the invention.

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Detailed Description of Embodiments of the Invention

In the following description, numerous specific details are set forth in order to provide a thorough

understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. It is understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the invention.

5 Embodiments described in the context of one of the methods or apparatuses are analogously valid for the other methods or apparatuses. Similarly, embodiments described in the context of a method are analogously valid for an apparatus, and vice versa.

10 Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

15 As used herein, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. As used herein, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. As used herein, the term “configured to” is interchangeable with “operative” or “adapted to”.

20 Embodiments of the invention propose a trigger frame which can be used to solicit different types of PPDU transmissions in a WLAN. Compared to the existing trigger frame, the enhanced trigger frame proposed by the embodiments of the invention further includes a first subfield in a common information field or common info field of the trigger frame to indicate whether the trigger frame is a first type trigger frame, i.e. an 802.11ax trigger frame, or a second type trigger frame, i.e. the proposed enhanced trigger frame, and if the trigger frame is the second type trigger frame, the common information field of the trigger frame further includes a second subfield in the common information field to indicate the type of PPDU transmissions to be solicited.

30 Figure 1A is a schematic diagram showing an example of a WLAN 100 according to some embodiments of the invention. As shown in Figure 1A, the WLAN 100 includes an AP 101 and a plurality of different types of STAs, e.g. HE STAs 102, R1 EHT STAs 103 and R2 EHT STAs 104. In the WLAN 100, a trigger frame may be used to solicit the following three different types of PPDU transmissions.

35 **First type PPDU transmission:** the first type PPDU transmission comprises a plurality of HE TB PPDU transmitted from a plurality of HE STAs 102, R1 EHT STAs 103 and/or R2 EHT STAs 104. Figure 1B is a schematic diagram showing an example of the first type PPDU transmission in WLAN 100. In this example, the trigger frame is used to solicit HE TB PPDU transmission from an HE STA (STA1) and a R1 EHT STA (STA2).

Second type PPDU transmission: the second type PPDU transmission comprises a plurality of EHT TB PPDU transmitted from a plurality of R1 EHT STAs 103 and/or R2 EHT STAs 104. Figure 1C is a schematic diagram showing an example of the second type PPDU transmission in WLAN 100. In this example, the trigger frame is used to solicit EHT TB PPDU transmission from a R1 EHT STA (STA1), and a R2 EHT STA (STA2).

Third type PPDU transmission: the third type PPDU transmission comprises a TB FD-A-PPDU transmission from at least one HE STA 102 and at least one R2 EHT STA 104, wherein the TB FD-A-PPDU transmission comprises a HE TB PPDU transmission and an EHT TB PPDU transmission. The HE TB PPDU transmission may include at least one HE TB PPDU transmitted from at least one HE STA 102 and/or at least one R2 EHT STA 104. The EHT TB PPDU transmission may include at least one EHT TB PPDU transmitted from at least one R2 EHT STA. Figure 1D is a schematic diagram showing an example of the third type PPDU transmission in WLAN 100. In this example, the trigger frame is used to solicit a TB FD-A-PPDU transmission from an HE STA (STA1) and a R2 EHT STA (STA2).

Figure 1E is a schematic diagram illustrating an uplink multi-user (MU) transmission according to one embodiment of the invention. In the uplink transmission, a trigger frame from an AP is used to solicit a third type PPDU transmission, i.e. a TB FD-A-PPDU transmission from a plurality of HE STAs and R2 EHT STAs. Each of the scheduled HE STAs and R2 EHT STAs will transmit a TB PPDU based on the scheduling information in the received trigger frame. The TB PPDU transmitted by each scheduled HE STA is an HE TB PPDU, while the TB PPDU transmitted by each scheduled R2 EHT STA is an HE TB PPDU or an EHT TB PPDU. A TB FD-A-PPDU transmission includes an HE TB PPDU transmission comprising one or more HE TB PPDU and an EHT TB PPDU transmission comprising one or more EHT TB PPDU. The one or more HE TB PPDU and one or more EHT TB PPDU are transmitted by scheduled STAs at non-overlapping frequency-domain resource and/or spatial domain resource in a 320 MHz channel. The AP will transmit a Multi-STA Block Acknowledgement (BA) frame in a response to the received TB FD-A-PPDU.

Figure 1F and Figure 1G are block diagrams illustrating the formats of an HE TB PPDU and an EHT TB PPDU respectively. In a HE TB PPDU, the Non-HT Short Training field (L-STF), Non-HT Long Training field (L-LTF), Non-HT SIGNAL field (L-SIG), Repeated L-SIG (RL-SIG) field and HE SIGNAL A field (HE-SIG-A) are called pre-HE modulated fields while the HE Short Training field (HE-STF), HE Long Training field (HE-LTF), Data field and packet extension (PE) field are called HE modulated fields. In an EHT TB PPDU, the L-STF, L-LTF, L-SIG field, RL-SIG field and universal SIGNAL (U-SIG) field are called pre-EHT modulated fields while the EHT-STF, EHT-LTF, Data field and PE field are called EHT modulated fields.

Each HE-LTF or EHT-LTF symbol has the same guard interval (GI) duration as each data symbol, which is 0.8 μ s, 1.6 μ s or 3.2 μ s. The HE-LTF field includes three types: 1x HE-LTF, 2x HE-LTF and 4x HE-LTF. Similarly, the EHT-LTF field includes three types: 1x EHT-LTF, 2x EHT-LTF and

4x EHT-LTF. The duration of each 1x HE-LTF/EHT-LTF, 2x HE-LTF/EHT-LTF or 4x HE-LTF/EHT-LTF symbol without GI is 3.2 μ s, 6.4 μ s or 12.8 μ s. Each data symbol without GI is 12.8 μ s. The PE field duration of a HE TB PPDU is 0 μ s, 4 μ s, 8 μ s, 12 μ s or 16 μ s; while the PE field duration of an EHT TB PPDU is 0 μ s, 4 μ s, 8 μ s, 12 μ s, 16 μ s or 20 μ s.

5 In an EHT BSS with a large BW, e.g. 320 MHz, a trigger frame can be used to solicit TB FD-A-PPDU transmission from a plurality of HE STAs and R2 EHT STAs. A TB FD-A-PPDU may include at least one HE TB PPDU and at least one EHT TB PPDU, wherein the HE-LTF field of the HE TB PPDU has a same symbol duration and a same GI duration as the EHT-LTF field of the EHT TB PPDU. The number of HE-LTF symbols in the HE TB PPDU may be the same as or different from
10 the number of EHT-LTF symbols in the EHT TB PPDU. When the number of HE-LTF symbols is the same as the number of EHT-LTF symbols, each HE-LTF/EHT-LTF symbol may have a different duration or a same duration from each data symbol. In other words, each HE-LTF/EHT-LTF symbol without GI may be 6.4 μ s or 12.8 μ s. When the number of HE-LTF symbols is different from the number of EHT-LTF symbols, each HE-LTF/EHT-LTF symbol shall have a same duration as each
15 data symbol. In other words, each HE-LTF/EHT-LTF symbol without GI shall be 12.8 μ s. As a result, the pre-HE modulated fields of HE TB PPDU and the pre-EHT modulated fields of EHT TB PPDU can be kept orthogonal in frequency domain symbol-by-symbol.

Figure 2A is a block diagram illustrating a trigger frame format according to one embodiment of the invention. As shown in Figure 2A, the trigger frame includes a common information field and a
20 user information list field or user info list field. The common information field further includes a first subfield indicating whether the trigger frame is a first type trigger frame, i.e. an 802.11ax trigger frame, or a second type trigger frame, i.e. the proposed enhanced trigger frame, and if the trigger frame is a second type trigger frame, the common information field further includes a second subfield indicating the type of PPDU transmissions to be solicited, or whether the trigger frame is used to solicit the
25 second type PPDU transmission or the third type PPDU transmission.

The user information list field may comprise three types of user information fields including HE format user information/info fields, EHT format user information/info fields and special user information/info field. The types of user information fields included in the user information list are determined based on the type of PPDU transmissions to be solicited. This will be described in detail
30 below in some embodiments of the invention. The HE format user information field is defined in the IEEE 802.11ax specification.

Figure 2B is a block diagram illustrating an example of the EHT format user information field format according to one embodiment of the invention. The resource unit (RU) allocation subfield together with the PS160 subfield in the EHT format user information field may be used to indicate the
35 RU or multiple resource unit (MRU) at which a TB PPDU is to be transmitted by a STA indicated by the AID12 subfield of the EHT format user information field, i.e. a STA has an AID which is matched with the AID12 field of the EHT format user information field. Since the EHT format user info field

is designed to be backward compatible with the HE format user info field, in some embodiments of the invention, a STA may determine its allocated RU or MRU by only decoding a user info field with an AID12 subfield which is matched with an AID of the STA, without knowing a priori whether the user info field is an HE format user info field or an EHT format user info field.

5 The special user information field carries necessary U-SIG subfields of the solicited EHT TB PPDUs. The special user information field is located immediately after the common information field in the trigger frame. Figure 2C shows an example of the format of the special user info field according to one embodiment of the invention. In this example, the AID12 subfield is set to a first value, e.g. 2007, to indicate the special user information field. The PPDU bandwidth (PPDU BW) subfield is
10 used to indicate the BW allocated for EHT TB PPDU transmission.

Figure 3 is a flowchart illustrating a method 300 for triggering uplink transmission in WLAN 100 implemented by an AP according to one embodiment of the invention. In this embodiment of the invention, the method 300 is implemented by an AP, e.g. the AP 101 in Figure 1A. In other embodiments, the method 300 may be implemented by any other suitable network interface device.

15 At **block 301**, a trigger frame is generated by the AP 101 based on a type of PPDU transmissions to be solicited from a plurality of STAs in the WLAN, e.g. the HE STAs 102, R1 EHT STAs 103 and/or R2 EHT STAs 104. A common information field of the generated trigger frame includes a first subfield indicating whether the trigger frame is a first type trigger frame, i.e. an 802.11ax trigger frame, or a second type trigger frame, i.e. the enhanced trigger frame proposed by embodiments of the
20 invention, and if the trigger frame is the second type trigger frame, the trigger frame further includes a second subfield indicating the type of the PPDU transmissions, or whether the trigger frame is used to solicit the second type PPDU transmission or the third type PPDU transmission.

At **block 302**, the generated trigger frame is transmitted to the plurality of STAs.

In this embodiment, the first subfield may be set to 0 or 1 to indicate whether the generated
25 trigger frame is a first type trigger frame or a second type trigger frame. For example, if the trigger frame is the first type trigger frame, the first subfield is set to 0; and if the trigger frame is the second type trigger frame, the first subfield is set to 1.

In this embodiment, if the first type PPDU transmission is to be solicited, the first subfield of the common information is set to indicate that the generated trigger frame is the first type trigger frame,
30 and a UL BW subfield of the common information field is set to indicate the BW allocated for the first type PPDU transmission.

In this embodiment, if the second type PPDU transmission is to be solicited, the first subfield of the common information field is set to indicate that the type of the trigger frame is the second type trigger frame, and the second subfield of the common information field is set to indicate that the type
35 of PPDU transmissions to be solicited is the second type PPDU transmission.

When the second type PPDU transmission is to be solicited, at least one subfield for resource unit (RU) allocation, e.g. a RU allocation subfield and a PS160 subfield of an EHT format user

information field of the generated trigger frame is set to indicate a RU or a multiple resource unit (MRU) at which an EHT TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the EHT format user information field; and a subfield of a special user information field, e.g. a PPDU BW subfield, is set to indicate a bandwidth (BW) allocated for the second type PPDU transmission.

5 In this embodiment, if the third type PPDU transmission is to be solicited, the first subfield of the common information field is set to indicate that the type of the trigger frame is the second type trigger frame and the second subfield is set to indicate that the type of PPDU transmissions is the third type PPDU transmission.

10 In this embodiment, the second subfield of the common information field may be set to 0 or 1 to indicate the type of PPDU transmissions. For example, if the type of PPDU transmissions to be solicited is the second type PPDU transmission, the second subfield is set to 0, and if the type of PPDU transmissions to be solicited is the third type PPDU transmission, the second subfield is set to 1.

15 When the third type PPDU transmission is to be solicited, a UL BW subfield of the common information field is set to indicate the BW allocated for the HE TB PPDU transmission of the third type PPDU transmission, at least one subfield for RU allocation of a user information field, e.g. a RU allocation subfield and a PS160 subfield of an EHT format user information field or a RU allocation subfield of a HE format user information field, of the generated trigger frame is set to indicate a RU or a MRU at which a TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the user information field; and a subfield of a special user information field, e.g. a PPDU BW subfield, is set to indicate a BW allocated for the EHT TB PPDU transmission of the third type PPDU transmission.

20 In this embodiment, when the third type PPDU transmission is to be solicited, in a 320 MHz BW TB FD-A-PPDU, the BW allocated for the HE TB PPDU transmission is a primary 80 MHz channel (P80) or a primary 160 MHz channel (P160); while the BW allocated for the EHT PPDU transmission from R2 EHT STAs is a secondary 160 MHz channel (S160) or one of two 80 MHz frequency segments of a S160. For a 320 MHz BW FD-A-PPDU transmission, there may have the following three options for BW allocation for the TB FD-A-PPDU transmission:

Option 1: As shown in Figure 4A, if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the PPDU BW subfield of the special user information field is set to indicate 160 MHz BW, a primary 80 MHz channel is allocated for the HE TB PPDU transmission and a secondary 160 MHz channel is allocated for the EHT TB PPDU transmission.

Option 2: As shown in Figure 4B, if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the PPDU BW subfield of the special user information field is set to indicate 80 MHz BW, a primary 160 MHz channel is allocated for the HE TB PPDU transmission, and an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel is allocated for the EHT TB PPDU transmission.

Option 3: As shown in Figure 4C, if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the PPDU BW subfield of the special user information field is set to indicate 160 MHz BW, a primary 160 MHz channel is allocated for the HE TB PPDU transmission, and a secondary 160 MHz channel is allocated for the EHT TB PPDU transmission.

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In this embodiment, when the third type PPDU transmission is to be solicited, if the number of HE-LTF symbols in each HE TB PPDU to be solicited is the same as the number of the EHT-LTF symbols in each EHT TB PPDU to be solicited, a third subfield of the common information field, e.g. a subfield named “Number of HE-LTF Symbols And Midamble Periodically”, is set to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited or a count number of EHT-LTF symbols in each EHT TB PPDU to be solicited.

In this embodiment, when the third type PPDU transmission is to be solicited, if the number of HE-LTF symbols in each HE TB PPDU to be solicited may be different from the number of the EHT-LTF symbols in each EHT TB PPDU to be solicited, a third subfield of the common information field, e.g. a subfield named “Number of HE-LTF Symbols And Midamble Periodically”, is set to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited; and a fourth subfield of the common information field is set to indicate a count number of EHT-LTF symbols in each EHT TB PPDU to be solicited. It should be noted that the fourth subfield is a newly added subfield in the common information field of the trigger frame.

In this embodiment, the UL BW subfield of the common information field may be set according to a predetermined encoding rule of the UL BW subfield; the subfield, e.g. the PPDU BW subfield, of the special user information field may be set according to a predetermined encoding rule of this subfield; the third subfield may be set based on a value indicated in the Doppler subfield of the common information field and a predetermined encoding rule of the third subfield, and the fourth subfield may be set according to a predetermined rule of the fourth subfield.

Figure 5A is a schematic diagram illustrating an AP 101 for triggering uplink transmission in the WLAN 100 according to one embodiment of the invention. The AP 101 includes a memory 101a configured to store instructions for triggering uplink transmission in the WLAN, and a processor 101b communicably coupled with the memory, the processor 101b configured to execute the instructions to perform the method for triggering uplink transmission in a WLAN according to some embodiments of the invention, e.g. the method described above and illustrated in Figure 3.

In this embodiment, the processor 101b is configured to execute the instructions to generate a trigger frame based on a type of PPDU transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and transmit the generated trigger

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frame to the plurality of STAs.

In this embodiment, if a first type PPDU transmission is to be solicited, the processor 101b is further configured to execute the instructions to set the first subfield of the common information field to indicate that the generated trigger frame is the first type trigger frame. Further, the processor 101b
5 is configured to execute the instructions to set a UL BW subfield of the common information field to indicate a BW allocated for the first type PPDU transmission.

In this embodiment, if the second type PPDU transmission is to be solicited, the processor 101b is further configured to execute the instructions to set the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and set the second
10 subfield of the common information field to indicate that the type of PPDU transmissions is the second type PPDU transmission. Further, the processor 101b is configured to execute the instructions to set at least one subfield for RU allocation, e.g. the RU allocation subfield and the PS160 subfield, of an EHT format user information field of the trigger frame to indicate a RU or a MRU at which an EHT TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the EHT format user
15 information field; and set a subfield, e.g. the PPDU BW subfield, of a special user information field to indicate a BW allocated for the second type PPDU transmission.

In this embodiment, if the third type PPDU transmission is to be solicited, the processor 101b is further configured to execute instructions to set the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and set the second subfield
20 of the common information field to indicate that the type of PPDU transmissions is the third type PPDU transmission. Further, the processor 101b is configured to execute instructions to set a UL BW subfield of the common information field to indicate a BW allocated for the HE TB PPDU transmission, and set at least one subfield for RU allocation of a user information field, e.g. the RU allocation subfield and the PS160 subfield of an EHT format user information field or the RU
25 allocation subfield of an HE format user information field, of the trigger frame to indicate a RU or a MRU at which a TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the user information field; and set a subfield, e.g. the PPDU BW subfield, of a special user information field of the trigger frame to indicate a BW allocated for the EHT TB PPDU transmission.

To establish a link between the BW allocations and the channel allocations for the HE TB PPDU
30 transmission and EHT TB PPDU transmission in the TB FD-A-PPDU transmission, the processor 101b is further configured to execute the instructions to allocate a primary 80 MHz channel for the HE TB PPDU transmission, and allocate a secondary 160 MHz channel for the EHT TB PPDU transmission if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW; allocate a
35 primary 160 MHz channel for the HE TB PPDU transmission, and allocate an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel for the EHT TB PPDU transmission if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the

special user information field is set to indicate 80 MHz BW; or allocate a primary 160 MHz channel for the HE TB PPDU transmission, and allocate a secondary 160 MHz channel for the EHT TB PPDU transmission if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW.

5 In this embodiment, the processor 101b may be further configured to execute the instructions to set a third subfield of the common information field to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited or a count number of EHT-LTF symbols in each EHT TB PPDU to be solicited. Specifically, if the first type PPDU transmission is to be solicited, the third subfield is set to indicate the number of HE-LTF symbols in each HE TB PPDU to be solicited; if the second
10 type PPDU transmission is to be solicited, the third subfield is set to indicate the number of EHT-LTF symbols in each EHT TB PPDU to be solicited; if the third type PPDU transmission is to be solicited, the third subfield is set to indicate the number of HE-LTF symbols in each HE TB PPDU to be solicited or the number of EHT-LTF symbols in each EHT TB PPDU to be solicited. In this case, the number of HE-LTF symbols in each HE TB PPDU to be solicited is the same as the number of EHT-
15 LTF symbols in each EHT TB PPDU to be solicited.

Alternatively, if the third type PPDU transmission is to be solicited, the processor 101b may be further configured to execute the instructions to set a third subfield of the common information field to indicate the number of HE-LTF symbols in each HE TB PPDU to be solicited, and set a fourth
20 subfield of the common information field to indicate the number of EHT-LTF symbols in each EHT TB PPDU to be solicited. In this case, the number of HE-LTF symbols in each HE TB PPDU to be solicited may be different from the number of EHT-LTF symbols in each EHT TB PPDU to be solicited.

Figure 5B is a schematic diagram illustrating a first apparatus 500 for triggering uplink transmission in a WLAN according to one embodiment of the invention. In this embodiment, the
25 apparatus 500 includes a trigger frame generation unit 500a and a transmission unit 500b. The trigger frame generation unit is configured to generate a trigger frame according to the method for triggering uplink transmission in a WLAN according to some embodiments of the invention, e.g. the method described above and illustrated in Figure 3.

Figure 6 is a flowchart illustrating a method 600 for triggering uplink transmission in the WLAN according to some embodiments of the invention. In these embodiments, the method 600 is
30 implemented by a STA, e.g. the HE STAs 102, R1 EHT STAs 103 and/or R2 EHT STAs 104 in Figure 1A. In other embodiments, the method 600 may be implemented by any other suitable client device.

At **block** 601, a trigger frame from an AP is received by a STA, wherein the trigger frame is generated based on a type of PPDU transmissions to be solicited from a plurality of STAs, wherein a
35 common information field of the trigger frame includes a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the trigger frame further includes a second subfield indicating the type of the PPDU

transmissions.

At **block 602**, the type of the solicited PPDU transmissions is determined by the STA by decoding the common information field of the received trigger frame.

Figure 7 is a flowchart illustrating a method 700 for triggering uplink transmission in the WLAN according to one embodiment of the invention.

At **block 701**, a trigger frame from an AP is received by a STA.

At **block 702**, the first subfield of the common information field is decoded.

At **block 703**, if the first subfield is set to indicate that the trigger frame is the first type trigger frame, the process goes to block 704; if the first subfield is set to indicate that the trigger frame is the second type trigger frame, the process goes to block 705.

At **block 704**, the type of the solicited PPDU transmissions is determined to be the first type PPDU transmission.

If the STA is a R1 EHT STA or a R2 EHT STA, when the solicited PPDU transmissions is determined to be the first type PPDU transmission, the STA will identify an HE format user information field with an AID12 subfield which is matched with an AID of the STA and decode the identified HE format user information field. Further, the UL BW subfield of the common information field is to be decoded to determine a BW allocated for the first type PPDU transmission. Based on the information of the common information field and the identified HE format user information field, the STA will prepare and transmit a HE TB PPDU.

At **block 705**, the second subfield of the common information field is decoded to determine the solicited type of PPDU transmissions.

At **block 706**, if the second subfield is set to indicate that the solicited PPDU transmissions is the second type PPDU transmission, the process goes to block 707; if the second subfield is set to indicate that the type of the solicited PPDU transmissions is the third type PPDU transmission, the process goes to block 708.

At **block 707**, the type of the solicited PPDU transmissions is determined to be the second type PPDU transmission.

When the solicited PPDU transmissions is determined to be the second type PPDU transmission, the STA will identify an EHT format user information field with an AID12 subfield which is matched with an AID of the STA and decode the identified EHT format user information field. For example, the STA will decode at least one subfield for RU allocation of the identified EHT format user information field, e.g. a RU allocation subfield and a PS160 subfield, to determine a RU or a MRU at which an EHT TB PPDU to be transmitted by the STA; and decode a subfield, e.g. the PPDU BW subfield, of a special user information field of the received trigger frame to determine a BW allocated for the second type PPDU transmission. Based on the information of the common information field, the identified EHT format user information field and the special user information field, the STA will prepare and transmit an EHT TB PPDU.

At **block** 708, the type of the solicited PPDU transmissions is determined to be the third type PPDU transmission.

When the solicited PPDU transmission is determined to be the third type PPDU transmission, the STA will further decode a UL BW subfield of the common information field to determine a BW
5 allocated for the HE TB PPDU transmission of the third type PPDU transmission; identify a user information field of the received trigger frame, which has an AID12 subfield which is matched with an AID of the STA; decode at least one subfield for RU allocation of the identified user information field to determine a RU or a MRU allocated for TB PPDU transmission from the STA; decode a subfield, e.g. PPDU BW subfield, of a special user information field of the received trigger frame to
10 determine a BW allocated for the EHT TB PPDU transmission; and determine that a HE TB PPDU is to be transmitted if the allocated RU or MRU is located within the BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be transmitted if the allocated RU or MRU is located within the BW allocated for the EHT TB transmission. Alternatively, in some other embodiments of the invention, the STA may determine that an HE TB PPDU is to be transmitted if a RU is allocated to
15 the STA and the allocated RU is located within a BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be transmitted if a MRU is allocated to the STA, or if a RU is allocated to the STA and the allocated RU is located within a BW allocated for the EHT TB PPDU transmission.

In this embodiment, when the solicited PPDU transmission is the third type PPDU transmission, e.g. a 320 MHz BW TB FD-A-PPDU, if the UL BW subfield of the common information field is set
20 to indicate 80 MHz BW and the subfield, e.g. PPDU BW subfield, of the special user information field is set to indicate 160 MHz BW, the STA will transmit a HE TB PPDU in a primary 80 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel; if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 80 MHz BW, the STA will transmit a HE TB PPDU in a primary 160 MHz channel,
25 or an EHT TB PPDU in an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel; or if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, the STA will transmit a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel.

When the third type of PPDU transmissions is solicited, if the number of HE-LTF symbols in
30 each solicited HE TB PPDU is the same as the number of the EHT-LTF symbols in each solicited EHT TB PPDU, the STA will decode a third subfield of the common information field to determine a count number of HE-LTF symbols in a solicited HE TB PPDU or a count number of EHT-LTF symbols in a solicited EHT TB PPDU.

Alternatively, if the number of HE-LTF symbols in each solicited HE TB PPDU may be different
35 from the number of the EHT-LTF symbols in each solicited EHT TB PPDU, the STA will decode a third subfield, e.g. a subfield named “Number of HE-LTF Symbols And Midamble Periodically” of the common information field, to determine a count number of HE-LTF symbols in a solicited HE TB

PPDU; or decode a fourth subfield of the common information field to determine a count number of EHT-LTF symbols in a solicited EHT TB PPDU.

In this embodiment, the UL BW subfield of the common information field may be decoded according to a predetermined encoding rule of the UL BW subfield; the subfield, e.g. the PPDU BW subfield, of the special user information field may be decoded according to a predetermined encoding rule of this subfield; the third subfield of the common information field may be decoded based on a value indicated in the Doppler subfield of the common information field and a predetermined encoding rule of the third subfield, and the fourth subfield of the common information field may be decoded according to a predetermined rule of the fourth subfield.

Figure 8A is a schematic diagram illustrating a STA 800A for triggering uplink transmission in a WLAN according to one embodiment of the invention. The STA 800A includes a memory 801a and a processor 802a communicably coupled with the memory. In one embodiment, the memory 801a is configured to store instructions for triggering uplink transmission in the WLAN according to some embodiments of the invention, e.g. the method 600 or the method 700 described above and illustrated in Figure 6 and Figure 7; and the processor 802a is configured to execute the instructions stored in the memory to perform the method for triggering uplink transmission according to some embodiments of the invention.

In this embodiment, the processor 802a is configured to execute the instructions to receive a trigger frame from an AP, wherein the trigger frame is generated based on a type of PPDU transmissions to be solicited from a plurality of STAs, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and determine the type of the solicited PPDU transmissions by decoding the common information field of the received trigger frame.

In this embodiment, the processor 802a is further configured to execute the instructions to decode the first subfield of the common information field; and determine that the type of the solicited PPDU transmissions is the first type PPDU transmission if the first subfield is set to indicate that the trigger frame is the first type trigger frame. Further, the processor 802a is configured to execute the instructions to decode a UL BW subfield of the common information field to determine a BW allocated for the first type PPDU transmission.

In this embodiment, the processor 802a is further configured to execute the instructions to decode the first subfield of the common information field; and if the first subfield is set to indicate that the trigger frame is the second type trigger frame, decode the second subfield of the common information field; and determine that the type of the solicited PPDU transmissions is a second type PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the second type PPDU transmission. Further, the processor 802a is further configured to execute the instructions

to identify an EHT format user information field of the received trigger frame, which has an AID12 subfield matched with an AID of the STA; decode at least one subfield for RU allocation, e.g. a RU allocation subfield and a PS160 subfield, of the identified EHT format user information field to determine a RU or a MRU at which an EHT TB PPDU to be transmitted by the STA; and decode a subfield, e.g. the PPDU BW subfield, of a special user information field of the received trigger frame to determine a BW allocated for the second type PPDU transmission.

In this embodiment, the processor 802a is further configured to execute the instructions to decode the first subfield of the common information field; and if the first subfield is set to indicate that the received trigger frame is the second type trigger frame, decode the second subfield of the common information field; and determine that the type of the solicited PPDU transmissions is the third type PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the third type PPDU transmission. In this case, the processor 802a is further configured to execute the instructions to decode a UL BW subfield of the common information field to determine a BW allocated for the HE TB PPDU transmission; identify a user information field of the received trigger frame, which has an AID12 subfield matched with an AID of the STA; decode at least one subfield for RU allocation of the identified user information field to determine a RU or a MRU allocated for a TB PPDU transmission from the STA; decode a subfield, e.g. the PPDU BW subfield, of a special user information field of the received trigger frame to determine a BW allocated for the EHT TB PPDU transmission; and determine that a HE TB PPDU is to be transmitted if the allocated RU or MRU is located within the BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be transmitted if the allocated RU or MRU is located within the BW allocated for the EHT TB transmission. Alternatively, in some other embodiments, the processor 802a may be configured to execute the instructions to determine that an HE TB PPDU is to be transmitted if a RU is allocated to the STA and the allocated RU is located within a BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be transmitted if a MRU is allocated to the STA, or if a RU is allocated to the STA and the allocated RU is located within a BW allocated for the EHT TB PPDU transmission.

Further, to provide a link between the BW allocations and channel allocations for the HE TB PPDU transmission and the EHT TB PPDU transmission in the TB FD-A-PPDU transmission, the processor 802a is further configured to execute the instructions to transmit a HE TB PPDU in a primary 80 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW; transmit a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 80 MHz BW; or transmit a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of

the special user information field is set to indicate 160 MHz BW.

In this embodiment, the processor 802a may be further configured to execute the instructions to decode a third subfield of the common information field to determine a count number of HE-LTF symbols in a solicited HE TB PPDU or a count number of EHT-LTF symbols in a solicited EHT TB PPDU. Specifically, if the first type PPDU transmission is solicited, the third subfield is decoded by the STA to determine the number of HE-LTF symbols in the solicited HE TB PPDU; if the second type PPDU transmission is solicited, the third subfield is decoded by the STA to determine the number of EHT-LTF symbols in the solicited EHT TB PPDU; if the third type PPDU transmission is solicited, the third subfield is decoded by the STA to determine the number of HE-LTF symbols in the solicited HE TB PPDU or the number of EHT-LTF symbols in the solicited EHT TB PPDU.

Alternatively, if the third type TB PPDU transmission is solicited, the processor 802a may be further configured to execute the instructions to decode the third subfield to determine the number of HE-LTF symbols in a solicited HE TB PPDU, and decode a fourth subfield of the common information field to determine a count number of EHT-LTF symbols in a solicited EHT TB PPDU. It should be noted that the fourth subfield is a newly added subfield in the common information field.

Figure 8B is a schematic diagram illustrating a second apparatus 800B for triggering uplink transmission in a WLAN according to one embodiment of the invention. The apparatus 800B includes a receiving unit 801b and a decoding unit 802b, which are configured to perform the method for triggering uplink transmission in WLAN according to some embodiments of the invention, e. g. the method 600 and method 700 described above and illustrated in Figure 6 and Figure 7. In one embodiment, the receiving unit 801b is configured to receive a trigger frame from an AP, wherein the trigger frame is generated based on a type of PPDU transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the trigger frame further includes a second subfield indicating the type of the PPDU transmissions; and the decoding unit 802b is configured to determine the solicited type of PPDU transmissions by decoding the common information of the received trigger frame.

Two embodiments of the invention will be described below to illustrate the details of the method for triggering uplink transmission in WLAN according to some embodiments of the invention. It should be noted that these embodiments are provided for illustrative purpose only, not to limit the scope of the invention.

Embodiment 1

Figure 9 is a block diagram illustrating a format of the common information field of a trigger frame according to a first embodiment of the invention. In this embodiment, the first subfield of the common information field is the Enhanced Trigger Frame Flag subfield which indicates whether the trigger frame is an 802.11ax trigger frame or an enhanced trigger frame. The Enhanced Trigger Frame

Flag subfield is set to 0 to indicate the 802.11ax trigger frame; and set to 1 to indicate the enhanced trigger frame. The second subfield of the common information field is the A-PPDU Flag subfield which indicates the type of PPDU transmissions or whether a TB FD-A-PPDU transmission, i.e. the third type PPDU transmission, or an EHT TB PPDU transmission, i.e. the second type PPDU transmission, is solicited. The A-PPDU Flag subfield is set to 0 to indicate an EHT TB PPDU transmission is solicited; and set to 1 to indicate a TB FD-A-PPDU transmission is solicited. It should be noted that when the Enhanced Trigger Frame Flag subfield is set to indicate an 802.11ax trigger frame, the special user info field is not present in the trigger frame; and the A-PPDU Flag subfield is reserved.

When the trigger frame is used to solicit a first type PPDU transmission, i.e. an HE TB PPDU transmission from HE STAs, R1 EHT STAs and/or R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 0 to indicate the 802.11ax trigger frame, the UL BW subfield is set to indicate the BW allocated for the solicited HE TB PPDU transmission, i.e. the BW in the HE-SIG-A field of each solicited HE TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield, together with the Doppler subfield, indicates the number of HE-LTF symbols in each solicited HE TB PPDU. In this case, a R1 EHT STA or R2 EHT STA would treat a user info field with the AID12 subfield matched with its AID as the HE format user info field and transmit an HE TB PPDU. An example of a predetermined encoding rule of the UL BW subfield when the trigger frame is used to solicit HE TB PPDU transmission is shown in Table 1. An example of a predetermined encoding rule of the Number Of HE-LTF Symbols And Midamble Periodicity subfield when the Enhanced Trigger Frame Flag subfield is set to 0 is shown in Table 2.

Table 1

UL BW subfield value	BW for HE TB PPDU
0	20 MHz
1	40 MHz
2	80 MHz
3	160/80+80 MHz
4-7	reserved

Table 2

Number Of HE-LTF Symbols And Midamble Periodicity Subfield Value	Number of HE-LTF Symbols (Doppler = 0)	Number of HE-LTF Symbols & Midamble Periodicity (Doppler = 1)
0	1	1 & 10 symbols
1	2	2 & 10 symbols
2	4	4 & 10 symbols
3	6	Reserved
4	8	1 & 20 symbols
5	Reserved	2 & 20 symbols
6	Reserved	4 & 20 symbols
7	Reserved	Reserved

In one example, according to the predetermined encoding rules shown in Table 1 and Table 2, when the trigger frame is used to solicit 160 MHz HE TB PPDU transmission with 4 spatial streams and no midamble from HE STAs, R1 EHT STAs and/or R2 EHT STAs, the UL BW subfield is set to 3 to indicate 160/80+80 MHz BW for the solicited HE TB PPDU; the Doppler subfield is set to 0 to indicate no midamble in the solicited HE TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield is set to 2 to indicate 4 HE-LTF symbols in the solicited HE TB PPDU.

When the trigger frame is used to solicit a second type PPDU transmission, i.e. an EHT TB PPDU transmission from R1 EHT STAs and/or R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 1 to indicate an enhanced trigger frame; the A-PPDU Flag subfield is set to 0 to indicate the EHT TB PPDU transmission is solicited; the PPDU BW subfield of the special user information field indicates the BW allocated for the solicited EHT TB PPDU transmission, i.e. the BW in the U-SIG of each solicited EHT TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield is repurposed to indicate the number of EHT-LTF symbols in each solicited EHT TB PPDU.

In this case, a R1 EHT STA or R2 EHT STA would treat the user information field with the AID12 subfield matched with its AID as the EHT format user info field and transmit an EHT TB PPDU. An example of a predetermined encoding rule of the PPDU BW subfield when the trigger frame is used to solicit EHT TB PPDU transmission is shown in Table 3. An example of a predetermined encoding rule of the Number Of HE-LTF Symbols And Midamble Periodicity subfield of trigger frame when the Enhanced Trigger Frame Flag subfield is set to 1 and the A-PPDU Flag subfield is set to 0 is shown in Table 4.

Table 3

PPDU Bandwidth subfield value	BW for EHT TB PPDU
0	20 MHz
1	40 MHz
2	80 MHz
3	160 MHz
4	320 MHz-1
5	320 MHz-2
6-7	reserved

Table 4

Number Of HE-LTF Symbols And Midamble Periodicity Subfield Value	Number of EHT-LTF Symbols
0	1
1	2
2	4
3	6
4	8
5	12
6	16
7	Reserved

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In one example, according to the predetermined encoding rules shown in Table 3 and Table 4, when the trigger frame is used to solicit 320 MHz EHT TB PPDU transmission with 12 spatial streams from R1 EHT STAs and/or R2 EHT STAs, the PPDU BW subfield of the special user info field is set to 4 or 5 to indicate 320 MHz BW for the solicited EHT TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield is set to 5 to indicate 12 EHT-LTF symbols in the solicited EHT TB PPDU.

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When the trigger frame is used to solicit a third type PPDU transmission, i.e. a TB FD-A-PPDU transmission from HE STAs and R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 1 to indicate an enhanced trigger frame; the A-PPDU Flag subfield is set to 1 to indicate the TB FD-A-PPDU transmission is solicited; the UL BW subfield indicates the BW allocated for the HE TB PPDU transmission of the solicited TB FD-A-PPDU transmission, i.e. the BW in the HE-SIG-A field of each solicited HE TB PPDU; the PPDU BW subfield of the special user information field indicates the BW allocated for the EHT TB PPDU transmission of the solicited TB FD-A-PPDU transmission, i.e. the BW in the U-SIG field of each solicited EHT TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield, together with the Doppler subfield, indicates the number of HE-

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LTF symbols in each solicited HE TB PPDU and the number of EHT-LTF symbols in each solicited EHT TB PPDU. In this embodiment, the number of HE-LTF symbols in each solicited HE TB PPDU is the same as the number of EHT-LTF symbols in each solicited EHT TB PPDU. An example of a predetermined encoding rule of the Number Of HE-LTF Symbols And Midamble Periodicity subfield when the Enhanced Trigger Frame Flag subfield is set to 1 and the A-PPDU Flag subfield is set to 1 is shown in Table 5.

Table 5

Number Of HE-LTF Symbols And Midamble Periodicity Subfield Value	Number of HE-LTF/EHT-LTF Symbols (Doppler = 0)	Number of HE-LTF/EHT-LTF Symbols & Midamble Periodicity (Doppler = 1)
0	1	1 & 10 symbols
1	2	2 & 10 symbols
2	4	4 & 10 symbols
3	6	Reserved
4	8	1 & 20 symbols
5	Reserved	2 & 20 symbols
6	Reserved	4 & 20 symbols
7	Reserved	Reserved

In one example, according to the predetermined encoding rules shown in Table 1, Table 3 and Table 5, when the trigger frame is used to solicit 320 MHz BW TB FD-A-PPDU transmission comprising one 80 MHz HE TB PPDU transmission with 4 spatial streams and no midamble and one 160 MHz EHT TB PPDU transmission with 4 spatial streams, the UL BW subfield is set to 2 to indicate 80 MHz BW for the solicited HE TB PPDU transmission; the PPDU BW subfield of the special user info field is set to 3 to indicate 160 MHz BW for the solicited EHT TB PPDU transmission; the Doppler subfield is set to 0 to indicate no midamble in each solicited HE TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield is set to 2 to indicate 4 HE-LTF symbols in each solicited HE TB PPDU and 4 EHT-LTF symbols in each solicited EHT TB PPDU.

In the first embodiment, the trigger frame can only be used to solicit TB FD-A-PPDU transmission where the number of HE-LTF symbols in each solicited HE TB PPDU is the same as the number of EHT-LTF symbols in each solicited EHT TB PPDU.

Embodiment 2

Figure 10 is a block diagram illustrating a format of the common information field of a trigger frame according to a second embodiment of the invention. In this embodiment, the first subfield of the common information field is the Enhanced Trigger Frame Flag subfield of the common info field which indicates whether the trigger frame is an 802.11ax trigger frame or an enhanced trigger frame.

The Enhanced Trigger Frame Flag subfield is set to 0 to indicate an 802.11ax trigger frame; and set to 1 to indicate the enhanced trigger frame. The second subfield of the common information field is the A-PPDU Flag subfield which indicates the type of PPDU transmissions or whether a TB FD-A-PPDU transmission, i.e. the third type PPDU transmission, or an EHT TB PPDU transmission, i.e. the second type PPDU transmission, is solicited. The A-PPDU Flag subfield is set to 0 to indicate an EHT TB PPDU transmission is solicited; and set to 1 to indicate a TB FD-A-PPDU transmission is solicited. The Number Of EHT-LTF Symbols subfield indicates the number of EHT-LTF symbols in the solicited EHT TB PPDU. When the Enhanced Trigger Frame Flag subfield is set to indicate an 802.11ax trigger frame, the special user information field is not present in the trigger frame; and the A-PPDU Flag subfield and the Number Of EHT-LTF Symbols subfield are reserved.

When the trigger frame is used to solicit a first type PPDU transmission, i.e. an HE TB PPDU transmission from HE STAs, R1 EHT STAs and/or R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 0 to indicate the 802.11ax trigger frame, the UL BW subfield is set to indicate the BW allocated for the solicited HE TB PPDU transmission, i.e. the BW in the HE-SIG-A field of each solicited HE TB PPDU; and the Number Of HE-LTF Symbols And Midamble Periodicity subfield, together with the Doppler subfield, indicates the number of HE-LTF symbols in each solicited HE TB PPDU. In this case, a R1 EHT STA or R2 EHT STA would treat a user info field with the AID12 subfield equal to its AID as the HE format user info field and transmit a HE TB PPDU. The UL BW subfield, the Number Of HE-LTF Symbols And Midamble Periodicity subfield and the Doppler subfield may be set according to the predetermined encoding rules of these subfields, e.g. the examples of the predetermined encoding rules shown in Table 1 and Table 2.

When the trigger frame is used to solicit a second type PPDU transmission, i.e. an EHT TB PPDU transmission from R1 EHT STAs and/or R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 1 to indicate an enhanced trigger frame; the A-PPDU Flag subfield is set to 0 to indicate the EHT TB PPDU transmission is solicited; the PPDU BW subfield of the special user information field indicates the BW allocated for the solicited EHT TB PPDU transmission, i.e. the BW in the U-SIG field of each solicited EHT TB PPDU; and the Number Of EHT-LTF Symbols subfield is set to indicate the number of EHT-LTF symbols in each solicited EHT TB PPDU. An example of a predetermined encoding rule of the Number Of EHT-LTF Symbols subfield of trigger frame when the Enhanced Trigger Frame Flag subfield is set to 1 and the A-PPDU Flag subfield is set to 0 according to the second embodiment is shown in Table 6. In this case, a R1 EHT STA or R2 EHT STA would treat the user info field with the AID12 subfield matched with its AID as the EHT format user info field and transmit an EHT TB PPDU.

Table 6

Number Of EHT-LTF Symbols Subfield Value	Number of EHT-LTF Symbols
0	1
1	2
2	4
3	6
4	8
5	12
6	16
7	Reserved

In one example, according to the predetermined encoding rules shown in Table 3 and Table 6, when the trigger frame is used to solicit 320 MHz EHT TB PPDU transmission with 12 spatial streams from R1 EHT STAs and/or R2 EHT STAs, the PPDU BW subfield of the special user info field is set to 4 or 5 to indicate 320 MHz BW for the solicited EHT TB PPDU; and the Number Of EHT-LTF Symbols subfield is set to 5 to indicate 12 EHT-LTF symbols in the solicited EHT TB PPDU.

When the trigger frame is used to solicit a third type PPDU transmission, i.e. a TB FD-A-PPDU transmission from HE STAs and R2 EHT STAs, the Enhanced Trigger Frame Flag subfield is set to 1 to indicate an enhanced trigger frame; the A-PPDU Flag subfield is set to 1 to indicate the TB FD-A-PPDU transmission is solicited; the UL BW subfield indicates the BW allocated for the HE TB PPDU transmission of the solicited TB FD-A-PPDU transmission, i.e. the BW in the HE-SIG-A field of each solicited HE TB PPDU; the PPDU BW subfield of the special user information field indicates the BW allocated for the EHT TB PPDU transmission of the solicited TB FD-A-PPDU transmission, i.e. the BW in the U-SIG field of each solicited EHT TB PPDU; the Number Of HE-LTF Symbols And Midamble Periodicity subfield, together with the Doppler subfield, indicates the number of HE-LTF symbols in each solicited HE TB PPDU; and the Number Of EHT-LTF Symbols subfield indicates the number of EHT-LTF symbols in each solicited EHT TB PPDU. The UL BW subfield, the PPDU BW subfield, the Number Of HE-LTF Symbols And Midamble Periodicity subfield and the Doppler subfield, and the Number Of EHT-LTF Symbols subfield may be set according to the predetermined encoding rules of these subfields, e.g. the examples of the predetermined encoding rules shown in Table 1, Table 2, Table 3 and Table 6.

In one example, according to the predetermined encoding rules shown in Table 1, Table 2, Table 3 and Table 6, when the trigger frame is used to solicit 320 MHz BW TB FD-A-PPDU transmission comprising one 80 MHz HE TB PPDU transmission with 4 spatial streams and no midamble and one

160 MHz EHT TB PPDU transmission with 4 spatial streams, the UL BW subfield is set to 2 to indicate 80 MHz BW for the solicited HE TB PPDU transmission; the PPDU BW subfield of the special user information field is set to 3 to indicate 160 MHz BW for the solicited EHT TB PPDU transmission; the Doppler subfield is set to 0 to indicate no midamble in each solicited HE TB PPDU;
5 the Number Of HE-LTF Symbols And Midamble Periodicity subfield is set to 2 to indicate 4 HE-LTF symbols in each solicited HE TB PPDU; and the Number Of EHT-LTF Symbols subfield is set to 2 to indicate 4 EHT-LTF symbols in each solicited EHT TB PPDU.

In the second embodiment, as two separate subfields are used to indicate the number of HE-LTF symbols in each solicited HE TB PPDU and the number of EHT-LTF symbols in each solicited EHT
10 TB PPDU, the generated trigger frame may be used to solicit TB FD-A-PPDU transmission where the number of HE-LTF symbols in each solicited HE TB PPDU is different from the number of EHT-LTF symbols in each solicited EHT TB PPDU.

In some embodiments of the invention, when the trigger frame is used to solicit a TB FD-A-PPDU transmission from a plurality of HE STAs and R2 EHT STA, the BW allocated for HE TB
15 PPDU transmission is indicated in the UL BW subfield of the common information field and the BW allocated for EHT TB PPDU transmission is indicated in the PPDU BW subfield of the special user information field. One example of a predetermined encoding rule of the UL BW subfield of the common information field and the PPDU BW subfield of the special user information field when the trigger frame is used to solicit TB FD-A-PPDU transmission is shown in Table 6. The UL BW subfield
20 is set to 2 and the PPDU BW subfield is set to 3 correspond to the BW allocation option 1 as shown in Figure 4A. The UL BW subfield is set to 3 and the PPDU BW subfield is set to 2 correspond to the BW allocation option 2 as shown in Figure 4B. The UL BW subfield is set to 3 and the PPDU BW subfield is set to 3 correspond to the BW allocation option 3 as shown in Figure 4C. In other words, when the UL BW subfield is set to 2 and the PPDU BW subfield is set to 3, the BW allocated for HE
25 TB PPDU transmission is P80 while the BW allocated for EHT TB PPDU transmission is S160. When the UL BW subfield is set to 3 and the PPDU BW subfield is set to 2, the BW allocated for HE TB PPDU transmission is P160 while the BW allocated for EHT TB PPDU transmission is an unpunctured 80 MHz frequency segment of S160. When the UL BW subfield is set to 3 and the PPDU BW subfield is set to 3, the BW allocated for HE TB PPDU transmission is P160 while the BW
30 allocated for EHT TB PPDU transmission is S160.

In some embodiments of the invention, when the trigger frame is used to solicit, a third type PPDU transmission, i.e. a TB FD-A-PPDU transmission from a plurality of HE STAs and R2 EHT STAs, a R1 EHT STA would treat the user info field with the AID12 subfield matched with its AID as the EHT format user information field and transmit an EHT TB PPDU. A R2 EHT STA would
35 treat the user information field with the AID12 subfield matched with its AID as the HE format user information field or the EHT format user information field depending on whether the allocated RU or MRU is located within the BW allocated for HE TB PPDU transmission or EHT TB PPDU

transmission. Specifically, a R2 EHT STA would treat the user info field with the AID12 subfield matched with its AID as the HE format user information field when the allocated RU or MRU is located within the BW allocated for the HE TB PPDU transmission; and would treat the user information field with the AID12 subfield matched with its AID as the EHT format user info field when the allocated RU or MRU is located within the BW allocated for the EHT TB PPDU transmission.

Embodiments of the invention also provide a computer product comprising instructions to cause a computer to perform any method for triggering uplink transmission according to any embodiment of the invention, when executed thereon.

At least some steps of the methods for triggering uplink transmission according to any embodiment s of the invention described above may be implemented utilizing hardware, a processor executing firmware instructions, a processor executing software instructions, or any combination thereof. When implemented utilizing a processor executing software or firmware instructions, the software or firmware instructions may be stored in any computer readable memory such as on a magnetic disk, an optical disk, or other storage medium, in a RAM or ROM or flash memory, processor, hard disk drive, optical disk drive, tape drive, etc. Likewise, the software or firmware instructions may be delivered to a user or a system via any known or desired delivery method including, for example, on a computer readable disk or other transportable computer storage mechanism or via communication media.

As described above, with the methods and apparatuses provided in various embodiments of the invention, the proposed enhanced trigger frame may be used to solicit different types of PPDU transmissions in a WLAN as a first subfield is introduced in the common information field of the trigger frame to indicate the type of the trigger frame, i.e. whether the trigger frame is an existing 802.11ax trigger frame or an enhanced trigger frame, and a second subfield is further introduced to indicate the type of the PPDU transmissions to be solicited, i.e. whether an EHT TB PPDU transmission or a TB FD-A-PPDU transmission is solicited, when the first subfield indicates that the trigger frame is an enhanced trigger frame.

Further, in some embodiments of the invention, when a TB A-PPDU transmission is solicited, the BW allocated for the EH TB PPDU transmission in the TB FD-A-PPDU transmission and the BW allocated for the EHT TB PPDU transmission in the TB F-A-PPDU transmission are indicated by a UL BW subfield in the common information field and a PPDU BW subfield in the special user information field respectively. Also, a method for linking the BW allocations with corresponding channel allocations for the EH TB PPDU transmission and the EHT TB PPDU transmission is provided in one embodiment of the invention. In addition, in some embodiments of the invention, two separate subfields in the common information field are used to indicate the number of HE-LTF symbols in each solicited HE TB PPDU and the number of EHT-LTF symbols in the solicited EHT TB PPDU so that the trigger frame may be used to solicit a TB FD-A PPDU transmission in which

the number of HE-LTF symbols in each solicited HE TB PPDU is different from the number of EHT-LTF symbols in the solicited EHT TB PPDU.

5 It is to be understood that the embodiments and features described above should be considered exemplary and not restrictive. Many other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention.

CLAIMS

1. A method for triggering uplink transmission in a wireless local area network (WLAN), the method comprising:

generating, by an access point (AP), a trigger frame based on a type of physical layer protocol data unit (PPDU) transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and
transmitting, by the AP, the generated trigger frame to the plurality of STAs.

2. The method according to claim 1, wherein the generating the trigger frame based on the type of PPDU transmissions comprises:

setting, by the AP, the first subfield of the common information field to indicate that the generated trigger frame is the first type trigger frame if a first type PPDU transmission is to be solicited, wherein the first type PPDU transmission comprises a plurality of high efficiency (HE) trigger-based (TB) PPDUs transmitted from a plurality of HE STAs, release 1 (R1) extremely high throughput (EHT) STAs and/or release 2 (R2) EHT STAs.

3. The method according to claim 2, wherein the generating the trigger frame based on the type of PPDU transmissions further comprises:

setting, by the AP, an uplink (UL) bandwidth (BW) subfield of the common information field to indicate a BW allocated for the first type PPDU transmission.

4. The method according to claim 1, wherein the generating the trigger frame based on the type of PPDU transmissions comprises:

setting, by the AP, the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and
setting, by the AP, the second subfield of the common information field to indicate that the type of PPDU transmissions is a second type PPDU transmission if the second type PPDU transmission is to be solicited, wherein the second type PPDU transmission comprises a plurality of EHT TB PPDUs transmitted from a plurality of R1 EHT STAs and/or R2 EHT STAs.

5. The method according to claim 4, wherein the generating the trigger frame based on the type of PPDU transmissions further comprises:

setting, by the AP, at least one subfield for resource unit (RU) allocation of an EHT format user information field of the trigger frame to indicate a RU or a multiple resource unit (MRU) at which

an EHT TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the EHT format user information field; and

setting, by the AP, a subfield of a special user information field to indicate a BW allocated for the second type PPDU transmission.

5

6. The method according to claim 1, wherein the generating the trigger frame based on the type of PPDU transmissions comprises:

setting, by the AP, the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and

10 setting, by the AP, the second subfield of the common information field to indicate that the type of PPDU transmissions is a third type PPDU transmission if a third type PPDU transmission is to be solicited, wherein the third type PPDU transmission comprises a TB frequency domain aggregated PPDU (FD-A-PPDU) transmission from at least one HE STA and at least one R2 EHT STA, wherein the TB FD-A-PPDU transmission comprises a HE TB PPDU transmission and an EHT TB PPDU
15 transmission.

7. The method according to claim 6, wherein the generating the trigger frame based on the type of PPDU transmissions further comprises:

20 setting, by the AP, a UL BW subfield of the common information field to indicate a BW allocated for the HE TB PPDU transmission,

setting, by the AP, at least one subfield for RU allocation of a user information field of the trigger frame to indicate a RU or a MRU at which a TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the user information field, and

25 setting, by the AP, a subfield of a special user information field of the trigger frame to indicate a BW allocated for the EHT TB PPDU transmission.

8. The method according to claim 7, further comprising:

30 if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, allocating a primary 80 MHz channel for the HE TB PPDU transmission, and allocating a secondary 160 MHz channel for the EHT TB PPDU transmission;

35 if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 80 MHz BW, allocating a primary 160 MHz channel for the HE TB PPDU transmission, and allocating an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel for the EHT TB PPDU transmission; or

if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, allocating a primary

160 MHz channel for the HE TB PPDU transmission, and allocating a secondary 160 MHz channel for the EHT TB PPDU transmission.

9. The method according to any one of claim 2 to claim 8, wherein the generating
5 the trigger frame based on the type of PPDU transmissions further comprises:
setting, by the AP, a third subfield of the common information field to indicate a count number of HE Long Training field (HE-LTF) symbols in each HE TB PPDU to be solicited or a count number of EHT Long Training field (EHT-LTF) symbols in each EHT TB PPDU to be solicited.

10. The method according to any one of claim 2 to claim 8, wherein the generating
10 the trigger frame based on the type of PPDU transmissions further comprises:
setting, by the AP, a third subfield of the common information field to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited; and
setting, by the AP, a fourth subfield of the common information field to indicate a count number
15 of EHT-LTF symbols in each EHT TB PPDU to be solicited.

11. An access point (AP) for triggering uplink transmission in a WLAN, the AP
comprising: a memory configured to store instructions for triggering uplink transmission in the
WLAN, and a processor communicably coupled with the memory, the processor configured to execute
20 the instructions to:
generate a trigger frame based on a type of physical layer protocol data unit (PPDU)
transmissions to be solicited from a plurality of stations (STAs) in the WLAN, wherein a common
information field of the trigger frame comprises a first subfield indicating whether the trigger frame
is a first type trigger frame or a second type trigger frame, and if the trigger frame is the second type
25 trigger frame, the common information field further comprises a second subfield indicating the type
of the PPDU transmissions, and
transmit the generated trigger frame to the plurality of STAs.

12. The AP according to claim 11, wherein the processor is further configured to
30 execute the instructions to:
set the first subfield of the common information field to indicate that the generated
trigger frame is the first type trigger frame if a first type PPDU transmission is to be solicited, wherein
the first type PPDU transmission comprises a plurality of high efficiency (HE) trigger-based (TB)
PPDUs transmitted from a plurality of HE STAs, release 1 (R1) extremely high throughput (EHT)
35 STAs and/or release 2 (R2) EHT STAs.

13. The AP according to claim 12, wherein the processor is further configured to

execute the instructions to:

set a UL BW subfield of the common information field to indicate a BW allocated for the first type PPDU transmission.

5 14. The AP according to claim 11, wherein the processor is further configured to execute the instructions to:

set the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and

10 set the second subfield of the common information field to indicate that the type of PPDU transmissions is a second type PPDU transmission if the second type PPDU transmission is to be solicited, wherein the second type PPDU transmission comprises a plurality of EHT TB PPDU transmitted from a plurality of R1 EHT STAs and/or R2 EHT STAs.

15 15. The AP according to claim 14, wherein the processor is further configured to execute the instructions to:

set at least one subfield for resource unit (RU) allocation of an EHT format user information field of the trigger frame to indicate a RU or a multiple resource unit (MRU) at which an EHT TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the EHT format user information field; and

20 set a subfield of a special user information field to indicate a BW allocated for the second type PPDU transmission.

16. The AP according to claim 11, wherein the processor is further configured to execute the instructions to:

25 set the first subfield of the common information field to indicate that the type of the trigger frame is the second type trigger frame, and

30 set the second subfield of the common information field to indicate that the type of PPDU transmissions is a third type PPDU transmission if the third type PPDU transmission is to be solicited, wherein the third type PPDU transmission comprises a TB frequency domain aggregated PPDU (FD-A-PPDU) transmission from at least one HE STA and at least one R2 EHT STA, wherein the TB FD-A-PPDU transmission comprises a HE TB PPDU transmission and a EHT TB PPDU transmission.

17. The AP according to claim 16, wherein the processor is further configured to execute the instructions to:

35 set a UL BW subfield of the common information field to indicate a BW allocated for the HE TB PPDU transmission, and

set at least one subfield for RU allocation of a user information field of the trigger frame to

indicate a RU or a MRU at which a TB PPDU to be transmitted by a STA indicated by an AID12 subfield of the user information field; and

set a subfield of a special user information field of the trigger frame to indicate a BW allocated for the EHT TB PPDU transmission.

5

18. The AP according to claim 17, wherein the processor is further configured to execute the instructions to:

if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, allocate a primary 80 MHz channel for the HE TB PPDU transmission, and allocate a secondary 160 MHz channel for the EHT TB PPDU transmission;

if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 80 MHz BW, allocate a primary 160 MHz channel for the HE TB PPDU transmission is, and allocate an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel for the EHT TB PPDU transmission; or

if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, allocate a primary 160 MHz channel for the HE TB PPDU transmission, and allocate a secondary 160 MHz channel for the EHT TB PPDU transmission.

20

19. The AP according to any one of claim 12 to claim 18, wherein the processor is further configured to execute the instructions to set a third subfield of the common information field to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited or a count number of EHT-LTF symbols in each EHT TB PPDU to be solicited.

25

20. The AP according to any one of claim 12 to claim 18, wherein the processor is further configured to execute the instructions to set a third subfield of the common information field to indicate a count number of HE-LTF symbols in each HE TB PPDU to be solicited; and set a fourth subfield of the common information field to indicate a count number of EHT-LTF symbols in each EHT TB PPDU to be solicited.

30

21. A method for triggering uplink transmission in a wireless local area network (WLAN), the method comprising:

receiving, by a station (STA), a trigger frame from an access point (AP), wherein the trigger frame is generated based on a type of physical layer protocol data unit (PPDU) transmissions to be solicited from a plurality of STAs, wherein a common information field of the trigger frame comprises a first subfield indicating whether the trigger frame is a first type trigger frame or a second type trigger

35

frame, and if the trigger frame is the second type trigger frame, the common information field further comprises a second subfield indicating the type of the PPDU transmissions, and

determining, by the STA, the type of the solicited PPDU transmissions by decoding the common information field of the received trigger frame.

5

22. The method according to claim 21, wherein the determining the type of the solicited PPDU transmissions comprises:

decoding, by the STA, the first subfield of the common information field; and

10 determining, by the STA, that the type of the solicited PPDU transmissions is a first type PPDU transmission if the first subfield is set to indicate that the trigger frame is the first type trigger frame, wherein the first type PPDU transmission comprises a plurality of high efficiency (HE) trigger-based (TB) PPDUs transmitted from a plurality of HE STAs, release 1 (R1) extremely high throughput (EHT) STAs and/or release 2 (R2) EHT STAs.

15 23. The method according to claim 22, further comprising: decoding, by the STA, an uplink (UL) bandwidth (BW) subfield of the common information field to determine a BW allocated for the first type PPDU transmission.

20 24. The method according to claim 21, wherein the determining the type of the solicited PPDU transmissions comprises:

decoding, by the STA, the first subfield of the common information field; and

if the first subfield is set to indicate that the trigger frame is the second type trigger frame, decoding, by the STA, the second subfield of the common information field; and

25 determining, by the STA, that the type of the solicited PPDU transmissions is a second type PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the second type PPDU transmission, wherein the second type PPDU transmission comprises a plurality of EHT TB PPDUs transmitted from a plurality of R1 EHT STAs and/or R2 EHT STAs.

25. The method according to claim 24, further comprising:

30 identifying, by the STA, an EHT format user information field of the received trigger frame, which has an AID12 subfield matched with an AID of the STA;

decoding, by the STA, at least one subfield for resource unit (RU) allocation of the identified EHT format user information field to determine a RU or a multiple resource unit (MRU) at which an EHT TB PPDU to be transmitted by the STA; and

35 decoding, by the STA, a subfield of a special user information field of the received trigger frame to determine a BW allocated for the second type PPDU transmission.

26. The method according to claim 21, wherein the determining the type of the solicited PPDU transmissions comprises:

decoding, by the STA, the first subfield of the common information field; and

if the first subfield is set to indicate that the received trigger frame is the second type trigger
5 frame, decoding, by the STA, the second subfield of the common information field; and

determining, by the STA, that the type of the solicited PPDU transmissions is a third type
PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the
third type PPDU transmission, wherein the third type PPDU transmission comprises a TB frequency
domain aggregated PPDU (FD-A-PPDU) transmission from at least one HE STA and at least one R2
10 EHT STA, wherein the TB FD-A-PPDU transmission comprises a HE TB PPDU transmission and an
EHT TB PPDU transmission.

27. The method according to claim 26, further comprising:

decoding, by the STA, a UL BW subfield of the common information field to determine a BW
15 allocated for the HE TB PPDU transmission;

identifying, by the STA, a user information field of the received trigger frame, which has an
AID12 subfield matched with an AID of the STA;

decoding, by the STA, at least one subfield for RU allocation of the identified user information
field to determine a RU or a MRU allocated for a TB PPDU transmission from the STA;

20 decoding, by the STA, a subfield of a special user information field of the received trigger frame
to determine a BW allocated for the EHT TB PPDU transmission; and

determining, by the STA, that a HE TB PPDU is to be transmitted if the allocated RU or MRU
is located within the BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be
transmitted if the allocated RU or MRU is located within the BW allocated for the EHT TB
25 transmission.

28. The method according to claim 27, further comprising:

if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the
subfield of the special user information field is set to indicate 160 MHz BW, transmitting, by the STA,
30 a HE TB PPDU in a primary 80 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel;

if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the
subfield of the special user information field is set to indicate 80 MHz BW, transmitting, by the STA,
a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in an unpunctured 80 MHz
frequency segment of a secondary 160 MHz channel; or

35 if the UL BW subfield of the common information field is set to indicate 160 MHz BW and
the subfield of the special user information field is set to indicate 160 MHz BW, transmitting, by the
STA, a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in a secondary 160 MHz

channel.

29. The method according to any one of claim 22 to claim 28, further comprising:

5 decoding, by the STA, a third subfield of the common information field to determine a count
number of HE-LTF symbols in a solicited HE TB PPDU or a count number of EHT-LTF symbols in
a solicited EHT TB PPDU.

30. The method according to any one of claim 22 to claim 28, further comprising:

10 decoding, by the STA, a third subfield of the common information field to determine a count
number of HE-LTF symbols in a solicited HE TB PPDU; or

 decoding, by the STA, a fourth subfield of the common information field to determine a count
number of EHT-LTF symbols in a solicited EHT TB PPDU.

31. A station (STA) for triggering uplink transmission in a WLAN, the STA

15 comprising a memory to store instructions for triggering uplink transmission in the WLAN, and a
processor communicably coupled with the memory, the processor configured to execute the
instructions to:

20 receive a trigger frame from an access point (AP), wherein the trigger frame is generated based
on a type of physical layer protocol data unit (PPDU) transmissions to be solicited from a plurality of
STAs, wherein a common information field of the trigger frame comprises a first subfield indicating
whether the trigger frame is a first type trigger frame or a second type trigger frame, and if the trigger
frame is the second type trigger frame, the common information field further comprises a second
subfield indicating the type of the PPDU transmissions, and

25 determine the type of the solicited PPDU transmissions by decoding the common information
field of the received trigger frame.

32. The STA according to claim 31, wherein the processor is further configured to
execute the instructions to:

30 decode the first subfield of the common information field; and
determine that the type of the solicited PPDU transmissions is a first type PPDU transmission
if the first subfield is set to indicate that the trigger frame is the first type trigger frame, wherein the
first type PPDU transmission comprises a plurality of high efficiency (HE) trigger-based (TB) PPDUs
transmitted from a plurality of HE STAs, release 1 (R1) extremely high throughput (EHT) STAs
and/or release 2 (R2) EHT STAs.

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33. The STA according to claim 32, wherein the processor is further configured to
execute the instructions to decode a UL bandwidth (BW) subfield of the common information field to

determine a BW allocated for the first type PPDU transmission.

34. The STA according to claim 31, wherein the processor is further configured to execute the instructions to:

5 decode the first subfield of the common information field; and

if the first subfield is set to indicate that the trigger frame is the second type trigger frame, decode the second subfield of the common information field; and

10 determine that the type of the solicited PPDU transmissions is a second type PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the second type PPDU transmission, wherein the second type PPDU transmission comprises a plurality of EHT TB PDUs transmitted from a plurality of R1 EHT STAs and/or R2 EHT STAs.

35. The STA according to claim 34, wherein the processor is further configured to execute the instructions to:

15

identify an EHT format user information field of the received trigger frame, which has an AID12 subfield matched with an AID of the STA;

20 decode at least one subfield for resource unit (RU) allocation of the identified EHT format user information field to determine a RU or a multiple resource unit (MRU) at which an EHT TB PPDU to be transmitted by the STA; and

decode a subfield of a special user information field of the received trigger frame to determine a BW allocated for the second type PPDU transmission.

36. The STA according to claim 31, wherein the processor is further configured to execute the instructions to:

25 decode the first subfield of the common information field; and

if the first subfield is set to indicate that the received trigger frame is the second type trigger frame, decode the second subfield of the common information field; and

30 determine that the type of the solicited PPDU transmissions is a third type PPDU transmission if the second subfield is set to indicate that the type of PPDU transmissions is the third type PPDU transmission, wherein the third type PPDU transmission comprises a TB frequency domain aggregated PPDU (FD-A-PPDU) transmission from at least one HE STA and at least one R2 EHT STA, wherein the TB FD-A-PPDU transmission comprises a HE TB PPDU transmission and a EHT TB PPDU transmission.

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37. The STA according to claim 36, wherein the processor is further configured to execute the instructions to:

decode a UL BW subfield of the common information field to determine a BW allocated for the HE TB PPDU transmission;

identify a user information field of the received trigger frame, which has an AID12 subfield matched with an AID of the STA;

5 decode at least one subfield for RU allocation of the identified user information field to determine RU or a MRU allocated for a TB PPDU transmission from the STA;

 decode a subfield of a special user information field of the received trigger frame to determine a BW allocated for the EHT TB PPDU transmission; and

 determine that a HE TB PPDU is to be transmitted if the allocated RU or MRU is located within
10 the BW allocated for the HE TB PPDU transmission; or an EHT TB PPDU is to be transmitted if the allocated RU or MRU is located within the BW allocated for the EHT TB transmission.

38. The SAT according to claim 37, the processor is further configured to execute the instructions to:

15 if the UL BW subfield of the common information field is set to indicate 80 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, transmit a HE TB PPDU in a primary 80 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel;

 if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 80 MHz BW, transmit a HE TB PPDU
20 in a primary 160 MHz channel, or an EHT TB PPDU in an unpunctured 80 MHz frequency segment of a secondary 160 MHz channel; or

 if the UL BW subfield of the common information field is set to indicate 160 MHz BW and the subfield of the special user information field is set to indicate 160 MHz BW, transmit a HE TB PPDU in a primary 160 MHz channel, or an EHT TB PPDU in a secondary 160 MHz channel.

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39. The SAT according to any one of claim 32 to claim 38, the processor is further configured to execute the instructions to:

 decode a third subfield of the common information field to determine a count number of HE-LTF symbols in a solicited HE TB PPDU or a count number of EHT-LTF symbols in a solicited EHT
30 TB PPDU.

40. The SAT according to any one of claim 32 to claim 38, the processor is further configured to execute the instructions to:

 decode a third subfield of the common information field to determine a count number of HE-LTF symbols in a solicited HE TB PPDU; or
35 LTF symbols in a solicited HE TB PPDU; or

 decode a fourth subfield of the common information field to determine a count number of EHT-LTF symbols in a solicited EHT TB PPDU.

41. A computer program product comprising instructions to cause a computer to perform a method according to any one of claim 1 to claim 10, or any one of claim 21 to claim 30, when executed thereon.